The impact of food preservation on food waste

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Abstract
Purpose – The purpose of this paper is to demonstrate the relationship between food preservation and reducing consumer waste is of value in developing sustainable meal options. The research reports insights into Austrian marketplace for frozen and fresh foods that have been obtained from a consumer survey.

Design/methodology/approach – The consumer survey methodologies indicate how preservation can change meal planning and lower food waste across frozen and fresh and ambient food purchases using freezing preservation methods.

Findings – The results show food waste can be reduced by six-fold when frozen foods are compared with fresh foods.

Research limitations/implications – This study highlights the requirement for a greater understanding of the probability that specific foods will be wasted with respect to the frequency of purchase. This is a limitation of the current study that has been investigated by other researchers.

Practical implications – This research has enabled the identification of different food waste amounts for different food product categories. The data presented could be used to guide food product development so that less consumer waste is produced.

Social implications – The research suggests a decision matrix approach can be used to guide new product development and a model of this matrix is presented so that it may provide fit-for-purpose food preservation options for consumers.

Originality/value – This paper will continue to highlight the overlooked value of food preservation during processing and manufacturing of foods and their preparation in households.

Keywords Consumers, Sustainability, Food waste, Frozen foods, Food preservation, Food value

Paper type Research paper

Introduction
Consumers produce the greatest amount of food waste and loss in the food supply chains of developing and developed economies (Gustavsson et al., 2011). A recent pan-European food waste programme has identified consumer food waste as a major challenge (COST Action TD1203, EUBIS). The COST Network, EU network on food waste valorisation has given attention to solving the amount of consumer food waste produced through technological and policy interventions (Morone et al., 2017; Privett et al., 2016). Reducing all food losses will result in a more secure global food system and it is important for us to show how consumers can reduce food waste in households. This is where food preservation has an important role in facilitating this waste reducing action because it improves the utilisation of food. It has also been identified that understanding why food is wasted by consumers...
during meal occasions develops of waste reduction strategies that can be used for different foods and preservation methods (Martindale, 2014).

Previous food waste reduction initiatives have typically focussed outside of this consumer arena and they have focussed on manufacturing and retail food losses. They have been successful at designing out food waste using the right-weighting of food products (portion control) and light-weighting of packaging (material resource efficiency). Their success has been made possible through cooperative actions across the food industry that have developed joint responsibility for food waste. It is essential that these initiatives now act to reduce the food that consumers purchase but do not eat (Mena et al., 2011). Furthermore, FAO reported Food Balance statistics show supply chain losses for food groups such as meat, fruit and vegetables to be below 5 per cent of production or domestic supply quantities (Martindale, 2017). While these food losses remain incredibly important it is reported by national agencies and government departments that consumers’ food waste regularly reaches 20 per cent or more of food purchased (Defra, 2017).

There has been an emergence of re-distribution schemes and community focussed actions that have been successful at removing food waste from supply chains. Redistribution of foods that are close to shelf-life limits and schemes that facilitate providing food to consumers such as “community fridges” have an exceptionally important role to play in waste reduction particularly where communities experience limited accessibility and affordability of foods. The redistribution of foods from retailers and manufacturers that are close to shelf life limits or charitable donations has also seen the impact of using on-line communication technologies that connect providers with consumers of redistributed foods (Aschemann-Witzel et al., 2017; Aschemann-Witzel et al., 2015). What has become evident in this arena is the reduction of food wastes from the food supply chain to the point of consumer sale is dependent on the application of many actions. That is, there is no single solution here and many actions that redistribute, involve communities and use on-line technologies will help to reduce food waste and create awareness of responsible use of foods. The study reported here highlights the value of preservation technologies and the need for food category models that take account of differing shelf life and quality considerations because these will help to guide food policy. Previous studies of fresh and frozen shelf life of foods have shown a reduction in household waste associated with frozen food use (Martindale, 2014). A more recent study in the Netherlands has developed a stochastic model to show the influence of ambient, frozen and fresh preservation on household food waste (Janssen et al., 2017). This study is critically important because it shows how food preservation methods that extend shelf life of foods in the home can reduce food waste over annual time periods. These studies also suggest that knowledge of food preparation and the best use of foods in households are critical in waste reduction.

Schemes that engage and redistribute resources to reduce food waste do not fully address the issue of food and drink products being wasted by consumers because they are not designed to reduce food waste. They redistribute food that would otherwise be waste; the study reported here focusses on reducing the wastage of food that is purchased with the intention of using it. The preservation of foods and types of food preservation methods available to consumers can facilitate this because it reduces food degradation and improves the utilisation of food in the domestic environment. This is a principle that has remained largely unconsidered even though the production of food waste increases greenhouse gas emissions or the carbon footprint of food consumption (Garnett, 2013; O’Rourke, 2014). It is crucial to consider food waste reduction as an outcome of using preserved foods because research carried out previously demonstrated it can help us to define the sustainability of meals that consumers prepare (Martindale, 2017).

In this study, it is demonstrated how frozen preservation can provide greater utilisation of food by consumers and reduce household food waste. It is not intended to show frozen is
the only option for reducing consumer food waste. It is hoped that the research will highlight the use of preservation methods in reducing consumer food waste and that there are several factors that must work together in food waste reduction to be successful. Previous research carried out in the UK market compared fresh and frozen food use in households and the amount of consumer food waste was dependent on food preservation method. The study showed a 47 per cent reduction in household food waste for frozen products compared to fresh products (Martindale, 2014).

Frozen food in this study is defined by all food that is frozen via quick freezing; this ensures the cell intactness and preserves the nutritional value of the food. The process of freezing food in this household focused study is defined as non-frozen food which gets frozen via a standard freezer (at home), as such this is slow freezing where cell structure is not maintained and it is less beneficial than quick freezing but adds to shelf life significantly. The definition of fresh food in this study is all non-frozen and non-freezing food.

Working with frozen foods not only gives us an opportunity to consider the value of food preservation in households but we must also consider manufacturing factories providing efficient use of resources and continual availability (Tukker, 2015). This provides us with the opportunity to develop models of food preservation that identify control points in the supply chain that can maximise food waste reduction. Frozen and freezing foods define this requirement more effectively than many other food supply chains that do not preserve foods. The consideration of frozen or freezing foods in this study has provided an opportunity to investigate these wider impacts on food resource use by consumers. For example, freezing foods provides availability of out-of-season produce which can be included in the sustainability assessments of frozen and fresh produce (Foster et al., 2014).

While these benefits of food preservation are important it is the impact on consumer food waste that is investigated here. The value of localising food supply is important in the sustainability arena if it can provide what consumers demand and increased resilience. There are studies that show localising food supply can achieve this, particularly where there are strong regional food identities and a cultural preference of using food service (Caputo et al., 2017). Localisation and the value of it to the food system are not within the scope of this current study even though it is important to consider food preservation has enabled the supply of foods that are out of season to consumers. Indeed, this was why preservation of fruits and vegetables using pickling and osmotic preserving emerged traditionally (Martindale, 2017).

Frozen foods have played a pivotal role in enabling the global food supply chain to evolve and without that food losses would be increased in agriculture and processing. Many of the food supply chain issues highlighted in current food loss and food waste research do not exist with frozen foods because quick freezing leads to the extended shelf life gains that many waste reduction initiatives seek (Parfitt et al., 2010). Furthermore, freezing keeps within the conditions of "clean label" labelled trends and often provides greater portion control in the home (Shove and Southerton, 2000). The "clean label" trend is now clearly identified in retail environments where there are demands for ingredient labelling that clarifies ingredients and communicates any potential allergens introduced in processing and manufacturing (Asioli et al., 2017).

The Austrian market research reported in this paper allows us to extend current understanding of the utilisation of frozen foods. It also leads us to consider the broader issue of what incentivises consumers to eat a more sustainable diet. Austrian households currently produce around 369,000 tons of packed and unpacked food waste each year and there is over 23.4 million tonnes of food waste produced by households across the EC member nations (Brautigam et al., 2014; Stenmarck et al., 2016). A sustainable diet must eliminate this food waste, the Austrian food waste volume is equivalent to 300€ of food thrown away per household year (Lebersorger and Schneider, 2011; Penker and Wytrzens, 2005).
The data presented here shows both frozen food purchases and household freezing decrease food waste significantly and this has important implications for providing sustainable meals and diets.

**Research method**

The Austrian market data was collected via an online survey carried out by the Institute of Marketing & Innovation, University of Natural Resources and Life Sciences, Vienna (BOKU) and Gesellschaft für Konsumforschung (GfK SE) during July 2015 (GfK, 2016). The survey questionnaire obtained data from 2,800 participants on the frequency of their food purchases for fresh and frozen foods.

The survey participants were selected to represent the typical Austrian population with regard to age and educational level. The selection made for geographic distribution across the Federal States was proportional to the population in each Federal State. The selection to the panel of 2,800 was made using the GfK market survey methods used for market research. GfK are a commercial and international company that provided the survey panel of 2,800 households. GfK’s services are routinely used by the food sector by manufacturers and retailers to develop business activities and identify food and drink trends. The participants used in this survey bought food and drink for their household and were asked how much food they wasted across six food groups as a percentage of the total amount of the food they purchased. The six food groups were selected because they were important food categories in Austria that have both frozen and fresh options. Notably this included bread where the offer and purchasing of frozen bread rolls is typical for Austrian consumers.

The participants of the survey were asked to consider their household food waste in a week from the food they purchased, partly utilised food, leftovers (plate waste) and preparation residues. The core questions of the survey that asked participants to report their proportion of food purchased that was wasted as a percentage were as follows:

1. What percentage of fresh food from your household purchases do you throw away?
2. What percentage of the frozen food from your household purchases do you throw away?
3. What percentage of fresh food from your household purchases do you throw away per following product groups?
4. What percentage of frozen food from your household purchases do you throw away per following product groups?

The food groups were fruit; vegetables (including specific questions for potatoes and spinach); bread (fresh only); pasta; meat; and, fish (fish sticks also known as fish fingers for frozen foods). The core questions were developed in terms of what food product groups were wasted in households. The survey also collected demographic information so that the 2,800 participants reflected a typical sample of the Austrian population and this was determined using GfK’s demographic methods.

**Research results**

The amount of food waste produced in the sample of 2,800 Austrian households is shown in Figure 1. The data show that participants reported wasted 9.3 per cent of total fresh food purchased and 1.6 per cent of total frozen food purchased. Thus, the amount of reported food waste derived from the fresh foods is 5.8-fold greater than that of frozen foods in the 2,800 households assessed. This means that the six fresh food groups have a reported food waste that is 5.8-fold greater than comparable frozen food groups (see, Figure 1).

Figure 2 shows the food waste for fresh and comparable frozen food groups assessed in the Austrian study of 2,800 households. The food groups are fruits, vegetables, bread, pasta,
meat and fish. Data obtained for the vegetable group were also specifically obtained for potatoes and spinach because of the importance of these products in the frozen categories. A similar approach was taken for fish products where fish sticks (also known as fish fingers) are an important frozen product category.

Figure 2, shows the amount of food waste derived from fresh food purchases is greater than frozen food purchases across the six food groups assessed apart from fish which is assessed as “other fish” in the reported frozen products here. These data are summarised in Table I where the ratio of fresh to frozen food waste is provided.

![Figure 1](image1.jpg)

**Figure 1.** The amount of food waste associated with the total purchases of fresh and frozen foods in Austrian households.

![Figure 2](image2.jpg)

**Figure 2.** The percentage of food purchases wasted for the fresh and frozen food product categories assessed.

<table>
<thead>
<tr>
<th>Percentage of fresh food purchase wasted</th>
<th>Percentage of frozen food purchase wasted</th>
<th>Fresh to frozen food waste ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit</td>
<td>6.2</td>
<td>0.6</td>
</tr>
<tr>
<td>Vegetables</td>
<td>5.5</td>
<td>1.4</td>
</tr>
<tr>
<td>Potatoes</td>
<td>3.9</td>
<td>0.5</td>
</tr>
<tr>
<td>Pasta</td>
<td>1.7</td>
<td>0.5</td>
</tr>
<tr>
<td>Meat</td>
<td>2.8</td>
<td>1.4</td>
</tr>
<tr>
<td>Fish</td>
<td>0.6</td>
<td>0.7</td>
</tr>
</tbody>
</table>

**Table 1.** The ratio of fresh to frozen food group waste for 2,800 Austrian households for the food product groups assessed.
Research analysis

The goal of the research reported is to show how food waste behaviours connect many sustainability issues across the complex food choices consumers make when meals are prepared. Our research shows food manufacturers and food retailers occupy critical points in supply that can determine how these food consumption behaviours can be transformed into more sustainable ones. An important way of achieving this is through reducing the food waste associated with every meal.

Figure 1, shows fresh foods purchased have a reported 5.8-fold greater food waste compared to frozen food purchases in a survey of 2,800 Austrian households. The assessment of waste from different food groups provides important insights into how households utilise fresh and frozen foods (Figure 2). Table I, shows the ratio of fresh to frozen food waste across the food groups shown in Figure 2. It can be seen that fresh food is wasted in greater amounts than frozen food in every category except fish where fresh food waste is 0.9 of frozen food waste. The ratios show that the greatest differences between fresh and frozen food groups are seen for fruit where fresh is 10.3-fold greater than frozen and potatoes where fresh is 7.8-fold greater than frozen.

Notably, the fresh to frozen ratio of specific food products (Figure 2), include fresh vegetables and frozen spinach which is 13.8; and, for fresh fish and frozen fish sticks (also known as fish fingers) it is 2.0 in Austrian households. Spinach and fish sticks are specifically tested here because they are extremely popular for meal purchases in the Austrian and other European marketplaces. The 13.8-fold greater fresh vegetable waste than frozen spinach waste; and 2.0-fold greater fresh fish waste than fish stick waste is important because these products are developed to be directly placed into meals. They emphasise the impact of food product development when it is aligned to the portioning of food in meal preparation and if this is made to be optimal there is less food waste. This relationship between method of food preservation and portioning is also apparent with other food groups such as potatoes and pasta (Table I).

The reduction of food waste and correct meal portioning of specific food products are important because when they align and work together they can reduce food waste. This means data collected from consumers regarding what they consider to be the correct portion size in a meal is exceptionally valuable in waste reduction actions and it is rarely done. Obtaining such data is a challenge future research into food waste will need to address so that it can be transferred to food product development operations for maximum impact. The data collected here does not consider correct portion size data specifically but it does indicate its importance. The Austrian research reported here has shown that the fresh food thrown away per household per person for this sample was 37.48 kg each year while the frozen food thrown away per household per person was 6.46 kg and per year. The nutritional losses associated with food waste have yet to be fully characterised but they are an important component of food waste projections (Halloran et al., 2014).

While we can determine the environmental impact of consuming foods in terms of their carbon footprint, it is the impact of wasting foods as an outcome of consumption that concerns us here. This is important because assessment of the environmental value of foods requires considerable investment of finance, knowledge and skills. It seems futile to make this investment if the assessed foods are wasted downstream in the food supply chain as they are prepared and consumed. New supply chain models are required to promote the value of reducing food waste and guide processes such as freezing that can reduce food waste. The data presented in Figure 1, clearly demonstrate a means to reduce the environmental impact of the food we choose to eat by reducing waste if frozen and freezing options are considered. The difficulty is that consumers choose foods based on what they like and this frequently changes, the choices made will rarely consider the
impact of high level issues such as climate change but food waste reduction will be considered. This is because there is a very clear financial benefit to eliminating household food waste.

Current carbon footprinting methods show us that agri-production and global distribution can be the least of our problems because food wastage can be up to 20 per cent of food purchases and food losses across the supply chain can be far greater than this (Foster et al., 2014). It is difficult to communicate such sustainability trade-offs in consumer arenas because debates are too complex to be made at the point of purchase. This is partly because carbon footprinting results are extremely variable due to the diversity of different food production systems and this has been tackled by developing certifications that target many sustainability goals. These have changed consumption of food by highlighting specific issues so that more ethical purchases are made such as those concerned with sustainable fishing, rainforest produce and so on. But it is day-to-day food waste at home and in supply chains that can make any diet unsustainable regardless of food certification used. Different preservation formats can reduce food waste and in the case of frozen food we know it can be reduced with respect to fresh foods because less of it is thrown away. There is no evidence that the nutritional values of frozen foods are any different to fresh foods if robust quality standards are in place from farm to fork. The nutritional losses resulting from food waste are significant and it is important to develop a food supply chain that is not losing these resources through wastage. There is not currently a certification that shows food produced with less waste or the use of food products that result in less waste and it is evident that there is a requirement to at least highlight the value of reducing consumer food waste. Food certification schemes that take household food waste reduction into account must be a future consideration in food and drink fast-moving consumer goods.

These ideas lead us to summarise the research presented here as a decision matrix model (Table II). The decision matrix highlights the major themes of consumer food waste reduction using frozen foods or freezing foods in households. It is proposed that such a matrix can be used to help food technologists guide the development of products with respect to preservation format and household food waste reduction. What is evident from the decision matrix analysis is a requirement to highlight the value of food preservation in reducing household food waste in the consumer space. This can be achieved by communicating through food companies’ Corporate Social Responsibility programmes as

<table>
<thead>
<tr>
<th>Defining issues</th>
<th>Intervention issues identified by alternate and specific terms</th>
<th>Qualifier and outcome identifiers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is frozen or freezing suitable for the food</td>
<td>Is the food material is suitable?</td>
<td>LCA metrics can be used to improve the communication of environmental impact (e.g. the Carbon Footprint of a product)</td>
</tr>
<tr>
<td></td>
<td>Is the frozen market realistic (requiring market research)?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Continuity of supply is required (e.g. to allow eating out-of-season)</td>
<td></td>
</tr>
<tr>
<td>How do you know it will reduce food waste</td>
<td>There is a fresh equivalent</td>
<td>There is currently a lack of tools to provide consumer advice. The research presented here helps to identify the benefits of preserving foods by freezing</td>
</tr>
<tr>
<td></td>
<td>Current volumes of food waste need to be reduced</td>
<td>Peer review research studies must be used</td>
</tr>
<tr>
<td></td>
<td>Supply format provides convenience</td>
<td></td>
</tr>
<tr>
<td>How are consumption trends identified</td>
<td>Consumers must be familiar with product format. They may not typically use frozen formats</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Feedback from consumers will determine efficacy of using freezing as a preservation method</td>
<td>There is currently a lack of tools to provide consumer guidance</td>
</tr>
</tbody>
</table>

Table II. The decision matrix used to define the use of food preservation to reduce consumer food waste
well as interventions that improve culinary knowledge in households. There are several emerging methods for achieving these interventions including digital applications that aim to reduce food waste and social media communications by creating consumer interest movements. It is important that food waste reduction initiatives integrate with these communication methods that consumers use (Martindale, 2017).

Research conclusion
The research reported here shows purchased fresh foods have a six-fold greater food waste compared to purchased frozen food in a survey of 2,800 Austrian households. The research supports previous research conducted in the UK where a 47 per cent food waste reduction was demonstrated for frozen foods compared to fresh foods. This relationship shows maximal resource use is achieved for frozen food products that are manufactured for the convenience of being included in meals. The conclusion is that food manufacturers, food retailers and policy makers must consider the role of food preservation in delivering a sustainable diet. The decision matrix approach here provides initial guidance in new product development a basis for doing this and it is supported by data sets that have now been obtained in the Austrian and UK markets.

References


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‘Waste not, want not’
Exploring green consumers’ attitudes towards wasting edible food and actions to tackle food waste

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Abstract
Purpose – Scholarly research on food waste is growing, but it tends to focus on households in general. The purpose of this paper is to explore the attitudes of green consumers towards food waste, reasons for wasting edible food and acceptance of policy actions that could help address the food waste challenge.

Design/methodology/approach – Based on a quantitative survey of 346 respondents, frequency distributions, cross tabulations and non-parametric tests were performed.

Findings – This study finds that there is inconsistency between attitudes and behaviours. Green consumers, including those who value organic food and vegetarianism, waste quite a lot of edible food. Food is thrown away mainly due to spoilage, short shelf life, being forgotten in the fridge and eating outside the home. Hence, consumers, even those with the best of intentions, face behavioural constraints when it comes to reducing food waste. A surprising finding is that some consumers lack awareness of the environmental burden posed by food waste. Several policy measures to reduce food waste are acceptable to the respondents.

Research limitations/implications – Reliance on self-reported data for food waste.

Practical implications – The research identifies actions that local governments could undertake to reduce consumer-related food waste. An environmental awareness campaign targeting green consumers could correct information deficits.

Originality/value – The focus on the green segment has practical implications for reducing the economic and environmental burden of food waste.

Keywords Organic foods, Food waste, Food policy, Vegetarians

Paper type Research paper

Introduction
Households in Australia discard a good deal of edible food, although it is difficult to give an exact number of the amount of waste generated (Australian Government, 2011). The Food Waste Avoidance Benchmark Study (2009) estimated that approximately $2.5 billion worth of food is thrown away every year (EPA NSW, 2016). As food degrades in ever-expanding landfill sites, it becomes a major source of methane gas emissions (Edwards and Mercer, 2012) and is a contributor to anthropogenic climate change (Gentil and Poulsen, 2012). Wasting food is a misuse of resources, including water and energy, which go into agri-food production (Farr-Wharton et al., 2012). In addition, from a social sustainability perspective, reducing food waste is a key component of strategies aimed at reducing food insecurity and tackling global poverty (Godfray et al., 2010; Parfitt et al., 2010).

Scholarly research on food waste has grown in recent years (Gjerris and Gaiani, 2013; Jörissen et al., 2015; Koivupuro et al., 2012; Lea and Worsley, 2008; Parizeau et al., 2015; Principato et al., 2015; Reynolds et al., 2014; Stancu et al., 2016; Thyberg and Tonjes, 2016). Food waste has been studied in many disciplines, including human health and nutrition, geography and sociology. In this paper, it is argued that research from the social marketing discipline is critical to shedding light on food waste, through understanding particular segments and the determinants of food waste in niche markets. Marketing, often blamed for over-consumption, is, however, designed to understand consumer behaviour, including who wastes food, why, when and how people waste food. Social marketing seems to be having an
important contribution to the food waste literature. Policy makers in many countries, including the UK, USA and Australia have recommended the use of social marketing to address environmental problems (Dahl, 2010; Menegaki, 2012).

To help reduce food waste, this study examines green (sustainability-oriented) consumers. This study addresses three limitations in the literature. First, most studies explore generalised attitudes towards food waste and market segmentation studies, with a few exceptions (Mallinson et al., 2016) that are rare in the literature. Aschemann-Witzel et al. (2015) recommend that future research should explore food waste consumer behaviour in greater depth, by focussing on specific segments, foods and contexts. Prothero et al. (2011) argue that consumer research should focus more on those who support the ideals for sustainability yet do not engage in reduced consumption, thereby furthering an understanding of why the “attitudes-behaviour gap” persists. Second, while there are several consumer-oriented studies that examine food waste policies, very few analyse public acceptance of policy measures to address food waste. Third, there is relatively little scholarly research that assesses the dynamics of household food waste in Australia, apart from a few studies (Edwards and Mercer, 2012; Morgan, 2009; Pearson et al., 2013; Reynolds et al., 2014). This led Edwards and Mercer (2012, p. 176) to state “food waste is a growing area of concern yet to be adequately addressed in Australia”. The purpose of this paper is to identify the attitudes of green consumers towards food waste and policies designed to reduce food waste. The focus is on Australian consumers due to ease of access to the sample, and furthermore, attitudes towards food waste policies (i.e. a ban on food waste entering landfill) may vary depending on the cultural context and climatic region. It is expected that this research can initiate a debate and lead to some action on reducing food waste in high-income countries.

**Literature review: green consumers and food waste**

Green consumers are conventionally defined as consumers who engage in consumer practices that are viewed as environmental friendly (Connolly and Prothero, 2008). Such practices are wide-ranging, such reducing consumption (Huttunen and Autio, 2010); using public transportation; recycling; buying products with less packaging; buying second-hand goods; eating less meat; buying locally grown food; organic food; fair-trade items and other products that have a reduced environmental impact (Connolly and Prothero, 2008; Gilg et al., 2005). The concept of the green consumer has been subsumed under terms such as ethical consumption (Peattie, 2010). For instance, becoming a vegetarian or eating less meat can reduce carbon emissions and pressure on natural systems (Food and Agriculture Organization of the United Nations, 2006). In studying green consumers, it is important to take the heterogeneity of consumers into consideration (Tan et al., 2016; Verain et al., 2015).

Food waste is not a trivial issue but it has been largely overlooked in the literature on green consumption. Research has found that environmental concern is the strongest correlate of attitudes towards wasting edible food (Melbye et al., 2016). Jörissen et al. (2015) found the food waste decreases when people shop in local markets and grow their own food. Cecere et al. (2014) note that green consumers or recyclers, are also food waste producers. Why is this so? There is often a large discrepancy between people’s attitudes and their behaviour (Frederiks et al., 2015). It is worthwhile to explore this issue in the context of green consumers, given that the “attitudes-behaviour gap” is an on-going debate in the literature (Ajzen and Fishbein, 2005).

However, there is still no standardised definition of food waste. The European project FUSIONS, defined food waste quite broadly and it refers to “any food, and inedible parts of food, removed from the food supply chain to be recovered or disposed (including composted, crops ploughed in/not harvested, anaerobic digestion, bio-energy production, co-generation, incineration, disposal to sewer, landfill or discarded to sea)” (Stenmarck et al., 2016, p. 7). Jörissen et al. (2015, p. 2699) makes a distinction between avoidable food waste and
non-avoidable and the former refers to “products that are still fit for human consumption at the time of discarding, or products that would have been edible if they had been eaten in time”. In the present study, we adopt the definition proposed by Jörissen et al. (2015) and explore food waste that occurs in the household, at the end of the food value chain.

Food waste research is divided between several disciplines making it difficult to compare the studies directly. The causes of food waste vary greatly between the developed world and the less developed world, and in high-income countries, most food waste occurs later in the supply chain (Gustavsson et al., 2011). Culturally, not all food waste is considered unacceptable – throwing away forgotten leftovers or uneaten food from a plate is often perceived to be socially acceptable (Halloran et al., 2014). The drivers of food waste include family affection, preference for abundance, social anxieties and desire to be a good provider for family and guests (Evans, 2012; Porpino et al., 2016; Watson and Meah, 2012). The sense of emotional disconnection from food and the devaluation of food (Parfitt et al., 2010) help explain food waste. In addition, it is found that consumers show little tolerance for visual imperfections, which is shaped by societal norms (Aschemann-Witzel, 2016). Furthermore, the link between convenient consumption and reliance on pre-prepared food has been investigated (Lehman, 2015). Studies have found that low-income and price-conscious consumers are less likely to waste food due to budget constraints and/or thriftiness (Koivupuro et al., 2012). However, the relationship between income and food waste is complex, and Setti et al. (2016) found that mid-to-low-income consumers purchase higher amounts of lower quality food and waste more food. According to Jörissen et al. (2015), households with children waste food due to the preferences of children. Consumers waste food due to a variety of food management behaviours, such as shopping, meal planning, cooking and food storage habits (Aschemann-Witzel et al., 2015). Date labelling, which helps inform consumers how long a food will remain edible and safe to eat, had become a focus of research. Studies have indicated that “use by” and “best before” dates are not sufficiently understood by consumers (Van Boxstael et al., 2014). The Waste & Resources Action Program (WRAP), estimated that up to 20 per cent of the food waste in the UK could be linked to confusion over date labelling (Waste & Resources Action Program (WRAP), 2009).

The issue of how to reduce food waste has been receiving increasing attention (Reisch et al., 2013). Surveys show that there is a strong perception of individuals as bearing primary responsibility for reducing food waste (Parizeau et al., 2015). Yet, scholars argue that the view of people as atomised consumers should be reconsidered and new policy initiatives are necessary to promote more sustainable lifestyles (Prothero et al., 2011). Locating responsibility for “bad” behaviour with the individual or “blaming the consumer” is not helpful as it de-contextualises the choices that individuals make around food (Meah, 2014). Evans (2011) highlights that assumptions about profligacy and cooking incompetence have circulated in debates concerning food waste. Given that a constellation of factors influence household food waste, including sales promotion tactics of supermarkets, eating out habits, shopping, cooking and storage practices within the household (Parizeau et al., 2015), social marketing has a role to play in promoting a reduction in food waste. Researchers (Calvo-Porral et al., 2016; Principato et al., 2015; Secondi et al., 2015; Thyberg and Tonjes, 2016; Aschemann-Witzel, 2016) recommend a number of actions to tackle waste such as consumer awareness campaigns; promoting behavioural changes (i.e. drawing up shopping lists); making date labels more user-friendly; smarter packaging; retailers loosening aesthetic standards and advertising imperfections in food, abolishing or changing “buy one-get one free” promotions. Interventions, such as colour-coding the fridge contents (Farr-Wharton et al., 2012), could help reduce waste. A recent study found that smart packaging, smart fridges and technologies to extend shelf life of products, were of interest to consumers (Jörissen et al., 2015). However, many actions are at an experimentation stage.
Understanding behavioural constraints to reducing food waste can make social marketing interventions more effective and one should not rely purely on the householder’s sense of moral obligation to reduce waste. Intervention studies are rather under-represented in the literature, with a few exceptions (Aschemann-Witzel et al., 2015; Farr-Wharton et al., 2012; Jagau and Vyrastekova, 2017; Mirosa et al., 2016).

Methodology

Research questions are as follow:

RQ1. What are the factors affecting food waste behaviour?

RQ2. Why do green consumers waste food?

RQ3. What policy actions are acceptable to green food consumers?

Ethical approval for the study was obtained from the Human Ethics Committee at the authors’ University. The population of interest was households in regional cities, Townsville and Cairns, North Queensland. Survey development began in May 2016. The survey was circulated to a number of people for feedback and changes were made to clarify questions, shorten the survey and reduce the effort required by respondents. In order to reach green consumers, respondents were recruited at two eco-festivals; through a community group dedicated to local and organic food and through the local University. At the eco-festivals, respondents were asked to complete the survey on the spot and others were given information on the online survey and asked to complete it at home. To aid recruitment, snowballing and the professional networks of the authors were used. The survey was developed using Qualtrics, an online survey tool.

Questions were based on key themes in the literature and included questions drawn from previously validated instruments. Respondents were asked about green consumption in a five-point Likert scale, taken from Lea and Worsley (2008). Attitudes towards food waste and policy options were captured in five-point Likert scales (e.g. 1 = completely acceptable to 5 = completely unacceptable; 1 = strongly agree to 5 = strongly disagree), and tick-the-box options were used to capture reasons for wasting food and demographic data. The literature (e.g. Lyndhurst, 2007; Principato et al., 2015; WRAP, 2009; Thyberg and Tonjes, 2016) informed these questionnaire items. To reduce social desirability biases, we guaranteed respondent’s anonymity in the cover page of the survey, and paid close attention to survey design, such as varying the wording and using positive and negative items. An incentive (a restaurant meal voucher) was used to encourage completion of surveys. In all, 346 usable surveys were analysed and respondents who scored very low on the green consumption scale were eliminated from the analysis. The data was analysed using IBM SPSS Statistics 20 software. Cross tabulations, frequency distributions and non-parametric tests were performed. The Mann Whitney or U-test is a null hypothesis significance test. It is used for testing the homogeneity between two groups or two independent distributions (Field, 2013). This test was chosen since it is commonly used in descriptive studies and makes no assumptions about the normality of the population. Given that the literature highlights the diversity of green consumers, comparative analysis was deemed appropriate.

The demographics of the sample are as follows: there was a female bias with 74.8 per cent females and 25.2 per cent males. The female bias in the sample is consistent with data published by Roy Morgan (2015) on the high percentage of women responsible for grocery shopping (62 per cent). Income levels were high and the sample included 12.8 per cent in the lower income category (less than $64,999); 16.3 per cent in the middle-income bracket ($65,000–$99,999) and 54.7 per cent in the higher income category (greater than $100,000). The sample was well educated, with 24.6 per cent reporting a Bachelor’s degree as their highest level of educational attainment. Statistics show that 17 per cent of Australia’s
population reported having a Bachelor degree as the highest level of educational attainment in 2016 (Australian Bureau of Statistics, 2016). An estimated 29.7 per cent had a post-graduate qualification. Respondents came from all age groups, with slightly more (26.2 per cent) aged from 30 to 39 years. Half of the sample (51.8 per cent) was in full-time employment and others were working part-time (15.8 per cent), retired (10.4 per cent) or studying (12.8 per cent). The sample had a distinct socio-economic background and was not designed to be representative of the general population.

Results

Green consumption

The vast majority of respondents had positive sentiments towards green consumption and most stated that the following activities were important or very important: growing herbs or vegetables (73.6 per cent); eating free-range eggs (77.6 per cent); eating in season (84.9 per cent); avoiding processed food (85.5 per cent); eating local food (90.3 per cent); reusing containers and bottles (90.5 per cent) and recycling (92.6 per cent). The items that received lower percentage scores were eating vegetarian meals (35 per cent), eating less red meat (42.3 per cent) and eating organic food (46.4 per cent). There may be some overlap amongst the two groups (organic and vegetarian) in terms of individual respondents.

Self-reported levels of food waste

In terms of amount of food wasted, an estimated 7.8 per cent of all respondents claimed that they did not waste food at all. An estimated 16 per cent of the sample said they wasted between 10 and 15 per cent. Close to one-third (28.8 per cent) of the sample said they wasted less than 10 per cent. Almost a third (34.3 per cent) of the sample claimed that they wasted less than 5 per cent of their food. Likewise, the organic and vegetarian segments reported low levels of food waste and exhibited very similar patterns in terms of food waste. Cross tabulations showed no differences between the organic and non-organic consumers or between vegetarians and non-vegetarians in terms of levels of self-reported waste.

Reasons for wasting food

Table I shows the reasons for wasting edible food. The top three reasons were as follows: buying produce with a short shelf life; food had gone bad/ was spoiled and was forgotten about in the fridge. Other commonly reported reasons for discarding food were preparing too much; children not wanting to eat the food; food being passed its “use-by” and “best before” date; buying too much food and running out of time to cook the food due to eating out or being away from home. Entertaining/preparing too much food for guests was not a common reason for wasting food. Differences between organic and non-organic, vegetarian and non-vegetarian consumers were minimal and were not statistically significant.

Avoiding food waste

The respondents used multiple techniques to manage food waste, including composting (45.8 per cent); feeding inedible food to animals (50.6 per cent); planning meals several days ahead (55.4 per cent); making a list of food needed prior to shopping (80.5 per cent) and checking the fridge or cupboards prior to food shopping (88.8 per cent). An estimated 79.6 per cent of all respondents stated that they put a good deal of effort into reducing food waste.

Analysis showed that 11.6 per cent of the sample ate out frequently (2-3 times a week); almost a third (30.1 per cent) ate out once a week and almost half of the sample (47 per cent) ate out 2-3 times per month or less often. Cross tabulations showed a relationship between eating out frequency and food waste levels ($\chi^2(21) = 38.286, p = 0.012$).
Attitudes towards food waste

Food-related beliefs are shown in Table II. Beliefs were measured on a 5 point Likert scale, where 1 = strongly agree, 2 = agree, 3 = neutral, 4 = disagree and 5 = strongly disagree. Non-parametric tests showed that there were significant differences between two groups, the organic and non-organic groups, based on the Mann Whitney test (highlighted in bold in the table). Statistically significant differences were evident with regard to five statements, such as worry about the cost of food thrown away (U = 11,900; z = 2.799, p = .005); feeling guilty (U = 12,287; z = 3.112, p = .002); feeling disturbed about food (U = 13,261; z = 4.686, p = 0.000); thinking about food waste (U = 8,013; z = −3.091, p = 0.002) and need for more information (U = 11,940; z = 3.098; p = 0.002). Both groups were unsure as to whether food waste was harmful to the environment. The organic segment was not convinced that having information on the cost of food thrown away would help them avoid food waste. Both groups agreed that packaging was a bigger environmental problem than food waste. They agreed that they knew the difference between the “use by” and “sell by” dates. Green consumers in general appeared to be knowledgeable about expiry dates. When asked about their attitudes towards food waste, most respondents were worried about the cost of the food they threw away; felt disturbed about the waste of resources in the food supply chain and felt guilty about wasting food in the face of food insecurity.

Attempts were made to understand differences between respondents who believed vegetarianism was important and those who did not. Non-parametric tests showed that there were significant differences between the two groups, labelled vegetarian and non-vegetarian (based on the Mann Whitney test). Statistically significant differences were evident with regard to three statements: worry about the cost of food thrown away (U = 11,334.5; z = 2.278, p = 0.023); guilt about waste (U = 11,704.5; z = 2.584, p = 0.010); feeling disturbed about waste (U = 12,881.5; z = 4.602; p = 0.000).

Attitudes towards policy measures designed to reduce food waste

Respondents were presented with a list of seven different actions and asked to rate how acceptable that action was to them. Likert scales were used to assess level of acceptance, where 1 = completely acceptable; 2 = mostly acceptable, 3 = unsure, 4 = mostly...
unacceptable and 5 = completely unacceptable. The responses are shown in Table III and higher scores indicate unacceptability. All items were rated as acceptable, but some items were more acceptable than others, notably promotion of renewable energy technologies based on food waste, marketing campaigns to promote “seconds”, provision of centralised/composting facilities. A ban on food waste received a “mostly acceptable to unsure” score.

Non-parametric tests showed that there were significant differences between two groups. Statistically significant differences were evident with regard to six statements: reduction in

<table>
<thead>
<tr>
<th></th>
<th>Total sample</th>
<th>Mean</th>
<th>Mann</th>
<th>Mean</th>
<th>Mann</th>
<th>Not</th>
<th>Mann</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am worried about the cost of food that I throw away (n = 336; n = 152; n = 133; n = 113; n = 175)</td>
<td>1.90</td>
<td>1.81</td>
<td>2.05</td>
<td>0.005</td>
<td>1.75</td>
<td>1.00</td>
<td>0.023</td>
</tr>
<tr>
<td>I feel guilty /bad when I throw away food because some people don’t have enough to eat (n = 339; n = 155; n = 132; n = 115; n = 174)</td>
<td>2.06</td>
<td>1.88</td>
<td>2.26</td>
<td>0.002</td>
<td>1.89</td>
<td>2.18</td>
<td>0.010</td>
</tr>
<tr>
<td>I feel disturbed by the amount of food being wasted since it takes a lot of resources to grow, process, package and transport food (n = 338; n = 153; n = 134; n = 113; n = 176)</td>
<td>1.76</td>
<td>1.55</td>
<td>1.97</td>
<td>0.000</td>
<td>1.51</td>
<td>1.95</td>
<td>0.000</td>
</tr>
<tr>
<td>It feels good to clean out the fridge and get rid of old food (n = 330; n = 149; n = 13; n = 11; n = 174)</td>
<td>2.45</td>
<td>2.46</td>
<td>2.46</td>
<td>0.781</td>
<td>2.39</td>
<td>2.45</td>
<td>0.361</td>
</tr>
<tr>
<td>Food waste is not something I think about (n = 332; n = 151; n = 132; n = 113; n = 174)</td>
<td>4.08</td>
<td>4.22</td>
<td>3.92</td>
<td>0.002</td>
<td>4.11</td>
<td>4.04</td>
<td>0.160</td>
</tr>
<tr>
<td>I know the difference in meaning between the “use by” and “best before” label (n = 339; n = 155; n = 134; n = 115; n = 176)</td>
<td>1.70</td>
<td>1.70</td>
<td>1.69</td>
<td>0.868</td>
<td>1.65</td>
<td>1.70</td>
<td>0.333</td>
</tr>
<tr>
<td>I only throw away food if the food smells bad or is slightly off (n = 337; n = 155; n = 133; n = 115; n = 175)</td>
<td>2.21</td>
<td>2.17</td>
<td>2.31</td>
<td>0.338</td>
<td>2.16</td>
<td>2.25</td>
<td>0.395</td>
</tr>
<tr>
<td>The packaging of food thrown away is a bigger environmental problem than food waste (n = 336; n = 153; n = 132; n = 113; n = 174)</td>
<td>2.07</td>
<td>2.03</td>
<td>2.19</td>
<td>0.143</td>
<td>2.09</td>
<td>2.08</td>
<td>0.920</td>
</tr>
<tr>
<td>Food waste is not harmful to the environment since it is natural and biodegradable (n = 332; n = 152; n = 133; n = 114; n = 173)</td>
<td>3.27</td>
<td>3.35</td>
<td>3.26</td>
<td>0.277</td>
<td>3.29</td>
<td>3.21</td>
<td>0.398</td>
</tr>
<tr>
<td>I would probably throw away less food if I had more information on the cost of the food I throw away (n = 329; n = 151; n = 131; n = 113; n = 171)</td>
<td>3.22</td>
<td>3.05</td>
<td>3.47</td>
<td>0.002</td>
<td>3.17</td>
<td>3.28</td>
<td>0.340</td>
</tr>
<tr>
<td>I think it is better to throw away food than to risk gaining weight (n = 328; n = 149; n = 132; n = 111; n = 172)</td>
<td>4.00</td>
<td>4.01</td>
<td>4.01</td>
<td>0.648</td>
<td>4.12</td>
<td>3.96</td>
<td>0.081</td>
</tr>
<tr>
<td>I think it is better to throw away food than to risk eating unsafe food and getting sick (n = 332; n = 151; n = 133; n = 112; n = 173)</td>
<td>2.09</td>
<td>2.21</td>
<td>1.95</td>
<td>0.150</td>
<td>2.26</td>
<td>2.01</td>
<td>0.071</td>
</tr>
</tbody>
</table>

Table II. Food-related beliefs
rates (U = 11,261; z = 2.006; p = 0.045); composting facilities (U = 12,126.5; z = 3.418, p = 0.001); information on expiry dates (U = 11,536.5; z = 2.405; p = 0.016); government incentives to promote renewable energy/biomass (U = 11.884; z = 3.110; p = 0.002); ban (U = 12,929; z = 4.316; p = 0.000); marketing campaigns (U = 13.102; z = 4.542; p = 0.000).

The organic food consumers showed stronger acceptance levels for all six items.

Attempts were made to understand differences between respondents who believed vegetarianism was important and those who did not. Non-parametric tests showed that there were significant differences between the two groups, labelled vegetarian and non-vegetarian (based on the Mann Whitney test). Statistically significant differences were evident with regard to four statements: reduction in rates (U = 10,941; z = 2.202; p = 0.028); information on expiry dates (U = 11,200.5; z = 2.437; p = 0.015); ban (U = 11,502; z = 2.754; p = 0.006); marketing of seconds (U = 11,289.5; z = 2.352; p = 0.019). The vegetarian consumers showed stronger acceptance levels for these items.

**Discussion**

Our study contributes to the literature by specifically targeting green consumers and exploring their attitudes towards food waste and policies designed to counteract food waste.

### Table III.

<table>
<thead>
<tr>
<th>Policy measure</th>
<th>Total sample</th>
<th>Mean: organic</th>
<th>Mean: non-organic</th>
<th>p Mann Whitney</th>
<th>Mean: vegetarian</th>
<th>p Mann Whitney</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction in rates bill to encourage business and households to reduce food waste (n = 330; n = 151; n = 132; n = 111; n = 172)</td>
<td>1.93</td>
<td>1.82</td>
<td>2.02</td>
<td>0.045</td>
<td>1.85</td>
<td>2.01</td>
</tr>
<tr>
<td>Separate collection services for food waste by local council (n = 330; n = 152; n = 131; n = 112; n = 172)</td>
<td>1.95</td>
<td>1.85</td>
<td>2.00</td>
<td>0.174</td>
<td>1.85</td>
<td>1.97</td>
</tr>
<tr>
<td>Provision of centralised/ community composting facilities (n = 329; n = 152; n = 131; n = 112; n = 171)</td>
<td>1.87</td>
<td>1.65</td>
<td>2.02</td>
<td>0.001</td>
<td>1.78</td>
<td>1.88</td>
</tr>
<tr>
<td>More information on expiry dates (n = 331; n = 151; n = 132; n = 112; n = 172)</td>
<td>2.13</td>
<td>2.01</td>
<td>2.26</td>
<td>0.016</td>
<td>1.96</td>
<td>2.22</td>
</tr>
<tr>
<td>Government incentives to promote renewable energy technologies based on food and agricultural waste (n = 330; n = 150; n = 133; n = 112; n = 173)</td>
<td>1.65</td>
<td>1.49</td>
<td>1.79</td>
<td>0.002</td>
<td>1.59</td>
<td>1.69</td>
</tr>
<tr>
<td>Ban on food waste entering landfill to encourage recovery of food waste (n = 331; n = 151; n = 133; n = 112; n = 173)</td>
<td>2.48</td>
<td>2.16</td>
<td>2.27</td>
<td>0.000</td>
<td>2.23</td>
<td>2.64</td>
</tr>
<tr>
<td>Marketing campaigns promoting ‘seconds’ or pest damaged fruit and vegetables (n = 334; n = 152; n = 134; n = 112; n = 175)</td>
<td>1.78</td>
<td>1.56</td>
<td>1.99</td>
<td>0.000</td>
<td>1.65</td>
<td>1.85</td>
</tr>
</tbody>
</table>

### Attitudes towards food waste

There was not a significant difference in food waste behaviours between the organic and non-organic groups or between vegetarians and non-vegetarians. We found that some green consumers waste quite a lot of food. Approximately 20 per cent of the sample were moderate...
to high food wasters (wasting 10 to 20 per cent of the amount of food purchased). Approximately one-third of the sample reported low levels of food waste (less than 5 per cent). In a recent study by Mallinson et al. (2016), they found that the least wasteful consumer group (epicures) discarded only 2.5 per cent of the total amount of food purchased. The most wasteful group (kitchen evaders) reported wasting 5.2 per cent of their total food purchases. Our study found that approximately 5 to 10 per cent of the sample claimed that they did not waste food at all. This figure is close to that reported by Lanfranchi et al. (2016), with 11.07 per cent of the sample stating that they did not waste food. This may be due to a misunderstanding on what constitutes food waste. Food waste commonly refers to food, that is, edible but thrown into the garbage (Calvo-Porral et al., 2016). A recent study has found that misconceptions about food waste exist: people who compost and give leftovers to household pets do not perceive this to be food waste (EPA NSW, 2016). People’s perceptions of food waste warrants further investigation. There appears to be a discrepancy between consumers’ specific attitudes towards wasting food and actions in the home. Most respondents (79.6 per cent) felt they were putting a good deal of effort into reducing food waste, yet some inconsistencies became apparent when respondents reported actual behaviour.

For respondents in this sample, particularly the organic consumers and vegetarians, negative emotions were associated with food waste. Respondents felt guilty about food waste and were disturbed about the waste of resources throughout the food supply chain. In other studies, it is evident that strong feelings of guilt are associated with throwing away edible food (Evans, 2012; Jagau and Vyrastekova, 2017; Lyndhurst, 2007; Parizeau et al., 2015; Quested et al., 2013; Stefan et al., 2013). Like Parizeau et al. (2015), we found that food waste is primarily a social issue, and not simply an environmental or economic issue. Negative emotions could be used in social marketing campaigns.

What is interesting is that green consumers, including vegetarians, were unsure as to whether food waste was harmful to the environment (since it was natural and biodegradable). They do not see a link between food waste, the environment and climate change, at least not in the way defined by environmentalists. Likewise, the Waste & Resources Action Program (WRAP) (2007) found a lack of awareness amongst people on the environmental impacts of food waste. This confusion on the part of green consumers is understandable since CO₂ is widely seen as the gas of concern in climate change. The respondents agreed that packaging was a bigger environmental issue than food waste. This finding is not too surprising since the impact of plastic packaging on marine life (and the Great Barrier Reef) has received a lot of media attention. An environmental awareness campaign could be developed to correct information deficits, although the effectiveness of awareness campaigns remains unclear (Pape et al., 2011) and contextual influences on people’s choices (such as children’s food preferences) cannot be overlooked.

Although studies report that lack of knowledge on expiry dates leads to food waste (Pearson et al., 2013; Neff et al., 2015), our respondents had a high perceived knowledge of “use-by” and “best-before” dates. In line with other studies, people forgot about food left in the fridge and buying fresh produce led to waste. Hence, social marketers could prioritise the use of fresh foods with a short shelf life in consumer awareness campaigns. Parizeau et al. (2015) noted that wasting healthy foods like vegetables and fruit may be reflective of a household’s intention to eat healthy foods gone awry. Careful planning and shopping routines (Stefan et al., 2013; Schmidt, 2016) help reduce food waste and our respondents adopted good practices in this regard. Parizeau et al. (2015) along with the earlier WRAP study, found that consumer lifestyles linked to eating outside the home, affects food waste (WRAP, 2007, 2009); likewise, we found a significant relationship between eating outside of the home and food waste. Social marketing efforts should focus on reaching customers who eat outside of the home a lot and reminding them not to forget about the food left at home in the fridge.
Attitudes towards policy levers

Our study examined multiple policy levers that could be used to reduce waste. There were statistically significant differences between vegetarians and non-vegetarians as well as between organic food consumers and non-organic food consumers in relation to acceptance levels. Organic consumers showed stronger agreement with getting “more information on the cost of food thrown away” statement. Our study showed strong acceptance for composting food waste at home and economic rewards for generating less waste. There was support for rigid and more rigorous measures such as a ban of food waste entering landfill. More information on expiry dates was acceptable, even though green consumers perceived themselves as being already knowledgeable about expiry dates. Some measures can be implemented easily and with relatively low cost, such as education and promotion of “seconds”, but others, such as renewable energy based on biomass, demand higher investment. There is a need to dig deeper into acceptability of policy measures, since many policy measures involve paying through the taxpayer system or through higher rates imposed by local government. Priefer et al. (2016) argues that further research is needed on the impact and efficacy of measures to reduce food waste. A multi-stakeholder approach is required, involving industry, government and individuals. As Parizeau et al. (2015, p. 216) note “[…] there is no single strategy or intervention that can meaningfully address the diverse constraints and challenges that prevent household food waste reduction across a municipality.”

Limitations and conclusion
This study had its limitations, such as the exploratory nature of the research, reliance on self-reported data and the problem of respondents accurately reporting the amount of food they throw away. The research was conducted on Australian consumers in a developed country and generalisation of results is limited. Food waste is often a habit and reflects unconscious behaviour (Lanfranchi et al., 2016). Future research would benefit from reporting actual levels of food waste and comparing green consumers with more mainstream consumers in terms of their perceptions, practices and acceptability of various policy measures.

References


Further reading


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Food waste reduction practices in German food retail

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Chair of Economics of Horticulture and Landscaping,
Technical University of Munich, Freising, Germany

Abstract

Purpose – The purpose of this paper is to investigate food retailers food waste reduction practices in Germany. The focus is on selling and redistributing agricultural produce with visual impairments and other surplus food items. In addition, drivers and barriers regarding the implementation of both waste reduction practices are explored.

Design/methodology/approach – In total, 12 in-depth interviews with managerial actors in the food retail sector and a food bank spokesperson were recorded, transcribed and analyzed through a qualitative content analysis.

Findings – In contrast to organic retailers, conventional retailers were reluctant to include agricultural produce with visual impairments in their product assortments, due to fears of negative consumer reactions. Another obstacle was EU marketing standards for specific produce. All retailers interviewed engaged in redistribution of surplus food. Logistics and the regulatory framework were the main barriers to food redistribution.

Originality/value – The present study adds to the existing body of literature on food waste reduction practices as it explores selling produce with visual impairments and elaborates on the legal background of food redistribution in German retail. The results are the foundation for providing recommendations to policy makers and charitable food organizations.

Keywords Motivation theory, Food bank, Food donation, Legal background of food redistribution, Lowering quality standards

Paper type Research paper

Introduction

In Germany, 11 million tons of food waste per year (Kranert et al., 2012) occur throughout the supply chain from farm gate to consumer (Gadde and Amani, 2016). Although prior research emphasized that food waste is generated mostly on the consumption level (Principato et al., 2015), food retailers play a pivotal role as brokers between producers and consumers (Midgley, 2014; Cicatiello et al., 2016). Promotions entice consumers to buy more food than intended (Peattie, 1998), which may turn into waste (Gruber et al., 2016; Priefer et al., 2013). Food waste also results from quality standards prescribed by retailers. Waste resulting from produce not meeting standards is attributed to earlier supply chain stages (Göbel et al., 2015). Excluding the household level, Gustavsson et al. (2011) estimated produce losses of up to 20 percent of production in Europe, mostly due to quality requirements. The problem of food waste was targeted by German and other European governments. Government agencies developed media campaigns and initiated projects to increase awareness and educate consumers.

According to Gruber et al. (2016), retailers are concerned about food waste due to economic and moral reasons. A common waste reduction practice on the retail level is the redistribution of non-marketable food items (Lebersorger and Schneider, 2014; Göbel et al., 2015; Priefer et al., 2016). Retailers tend towards donating these items to charitable organizations such as food banks.
banks (Lebersorger and Schneider, 2014; Papargyropoulou et al., 2014; Richter and Bokelmann, 2016) and social supermarkets (Holweg et al., 2010, 2016; Holweg and Lienbacher, 2011).

Another practice to reduce food waste applied by some European retailers is lowering quality standards for fresh produce. In this context, the term lowering quality standards refers to selling fruits and vegetables with visual impairments that have no effect on food safety or taste. In 2013, different retail chains in Austria, Switzerland, and France started to include such produce in their assortment. The produce was marketed emphasizing its unique appearance. In Switzerland and France, the initiative was extended beyond the trial period (Blanke, 2015; Intermarché, 2017). Lowering quality standards of agricultural produce contributes to waste prevention; food redistribution for human consumption through charitable organizations is a form of reuse. As both practices ultimately serve to prevent food from being discarded, they are desirable from society’s point of view. The present study explores the situation in German food retail, focusing on both practices. Since prior studies in Europe, specifically Austria, mainly focused on the redistribution of produce with visual impairments to external parties (Holweg et al., 2010; Holweg and Lienbacher, 2011), the aspect of selling such produce is a research gap. Also, when exploring the aspect of redistribution in Germany, these studies are likely relevant for comparison, because German and Austrian retail are similarly structured and operating, but the regulatory framework is not identical. In addition, the present study investigates drivers and barriers regarding the implementation of both waste reduction practices.

Literature review

In order to evaluate food waste reduction practices in German food retail it is necessary to understand the food waste hierarchy (Figure 1), including suggestions how to handle surplus food and food waste. Furthermore, food quality standards and consumer preferences affect the occurrence of surplus food. Similarly, the redistribution of non-marketable food is impacted by laws and regulations as well as the personal motivation of the retail managers in charge.

Food waste hierarchy

The food waste hierarchy follows the European waste hierarchy and consists of five levels (Bates and Phillips, 1999). It prioritizes actions to prevent food waste and handle surplus food items on the background of sustainability (Papargyropoulou et al., 2014). The first level of the hierarchy, prevention, constitutes the most desirable option and the last level, disposal, constitutes the least desirable option. The authors suggested avoiding surplus food generation from production to consumption. On the reuse level, surplus food can be used for human consumption, for instance, redistribution to people in need. For food unsuitable for human consumption, recycling is an option. Recycling includes using food as animal feed or compost. On the recovery level, food waste is used for energy generation. On the last level, items which cannot be used for any other purpose must be disposed. Accordingly, desirable strategies include lowering quality standards, as prevention, and redistribution for human consumption, as reuse.

![Food waste hierarchy](image)

**Note:** Arrows in dark blue indicate the focus of the present study

**Source:** Builds on Papargyropoulou et al. (2014)
Lowering quality standards

Quality standards for marketing produce build on standards of the European Union's (EU) Common Agricultural Policy, designed to prevent produce of inferior quality from entering European markets, provide a reference framework for market transparency, and improve the profitability of production (Council of the European Union, 1996, Paras 3-5). To reduce bureaucracy and create the possibility of marketing produce independently of size and shape, marketing standards for 26 types of produce have been replaced by general standards in 2009 (European Commission, 2008). The general standards require produce to be sound, clean, sufficiently developed, and correctly labeled (Priefer et al., 2013). Classification into grades (Class Extra, Class I, Class II) is still possible. Specific marketing standards remain in place for ten types of produce, representing approximately 75 percent of the intra-EU trade. In addition to the EU standards, retailers can set quality standards for produce, such as maximum residue levels for pesticides or requirements regarding physical properties.

In addition to standards, factors such as weather events impact the marketability of produce. Heavy rain or droughts determine yield levels and physical properties. Since standards are mainly based on visual appearance, produce with optical defects receives lower prices (Göbel et al., 2012). If prices fall below harvesting costs, produce is left in the fields. In addition, farmers contracted to supply crops of specified quality and quantity may produce larger quantities to hedge against losses caused by weather events or pest infestation. If these surpluses are marketed, they lead to reduced prices (Göbel et al., 2012; Priefer et al., 2013). Food waste caused by retailers' quality standards also occurs during distribution. Returns of rejected produce are at risk of spoilage due to short shelf life (Göbel et al., 2012).

Several barriers impede retailers' lowering of quality standards. Quality standards specifying low maximum residue levels reduce the risk of exceeding required levels, preventing the involvement in food contamination scandals, which could affect retailers' reputation (Priefer et al., 2013). Also, standardized produce can increase logistic efficiency (Göbel et al., 2015). Aside from logistics, retailers also impose requirements referring to physical properties due to consumer demands (Newman and Cullen, 2001; Mena et al., 2014). Retailers assume that consumers are not willing to buy produce deviating from the standard appearance (Loebnitz et al., 2015; Di Muro et al., 2016).

For example, Danish consumers have been shown to be less likely to purchase produce deviating from the norm, confirming retailers' assumptions of visual appearance as an indicator for assessing produce quality by consumers (Loebnitz et al., 2015). Since the standardized produce typically offered serves as reference for quality assessment, consumers may assume that produce with visual impairments is of lower quality (Göbel et al., 2015). Di Muro et al. (2016) found decreased willingness to buy for Italian consumers confronted with unusual appearance. For fresh market consumers, produce with visual impairments was more acceptable than for supermarkets consumers. Loebnitz et al. (2015) suggested that consumers might accept produce with visual impairments, if they became accustomed to these products, as in France and Switzerland (Blank, 2015; Intermarché, 2017).

Redistribution of surplus food and legal background

Redistribution of surplus food for charitable purposes is an established practice in European retail. For instance, in France, retail stores with 400 square meters and above are required to provide surplus food to educational or charitable institutions (Rombach and Bitsch, 2015). However, in the UK, regulations impede redistribution since retailers fear litigation (Midgley, 2014; Gruber et al., 2016).

In Germany, the redistribution of surplus food is not required, but encouraged by the Federal Ministry of Food and Agriculture (FMFA). The Federal Ministry of Food and Agriculture (2014, pp. 14-15) has provided advice on liability in this context. Producers and retailers are liable for damages. If the producer or retailer cannot be identified, the
redistributor is liable (Art. 3, Section 1, and Art. 14, German product liability law). Accordingly,
when redistributing food to third parties retailers are advised to emphasize that the products
are, e.g., close to the best-before-date. EU Regulation 178/2002 (Sections 17 and 19)
requires retailers to act responsibly, and take unsafe products off the market. Retailer as well
as redistributors must be able to show from where they received their products.
Documentation is mandatory for traceability throughout the supply chain (EU Regulation

However, when surplus food is donated, and accordingly free of charge for redistributors,
the law of gifting applies (Articles 516-534, German civil code). As some redistributors such as
the German food bank also hand out the food items donated by German retailers to food bank
users free of charge, liability becomes more complex. Voit (2014) discusses a case when a food
bank user is injured through canned food with the best-before-date expired. The producer, the
retailer and the food bank can be held liable, if the injured party is not an affiliate but a third
party as in this case. The producer must present proof of exoneration (Art 1, German product
liability law), of not providing a spoiled product to the retailer. The retailer can be liable for
willful negligence (Art. 521, German civil code), if the retailer did not emphasize the information
to the food bank that best-before-date was expired. If the retailer willfully omitted information,
the retailer is liable for the material defect and must compensate the injured party (Art. 524,
German civil code). Voit (2014) further states that the German food bank is in an equivalent
situation with regard to its users. In terms of liability, also Articles 521 and 524, German civil
code apply in this case. To guard against these legal challenges, food pantries under the
umbrella of the German food bank carefully inspect and document donated food items upon
arrival at the pantries (Von Normann, 2011).

Retailers’ motivation to reduce food waste
Prior studies on donations showed that the awareness of need was a prerequisite for
charitable giving (Vlaholias et al., 2015). In the context of food redistribution, food recipients
are not directly involved in the donation process. Consequently, the needs of the recipients
remain unknown to the donor. Accordingly, Vlaholias et al. (2015) suggested that food
redistributors communicate the recipients’ needs to food retailers.

Food retailers are explicitly asked by food banks and other organizations, and implicitly by
society to donate surplus food (Evans, 2011; Vlaholias et al., 2015). Solicitation is a major factor
in food assistance and at the same time a critical aspect. Since food waste is perceived
negatively by society, some retailers do not want to donate to avoid drawing attention to the
amount of surplus (Holweg et al., 2010). Another reason to avoid redistribution is the fear of
additional cost for administration, as well as logistical challenges (Holweg et al., 2010).
However, since donations are cheaper than disposal, economic benefits add another motivation
to donate (Holweg et al., 2010; Lorenz, 2012; Vlaholias et al., 2015). Also, depending on the
regulatory framework in different countries, food redistribution may be tax deductible (Booth
et al., 2014; Vlaholias et al., 2015). Lorenz (2012) also found similar motivations for food
donations, including reputation gains, tax savings, and avoiding the costs of disposal.

Although some studies showed altruism as motivation of charitable activities, Vlaholias et al.
(2015) questioned altruism’s applicability to food donations. They proposed that support of
charitable organizations requires direct benefits for donors. Furthermore, they emphasized
increased self-esteem, feeling superior, joy of giving, and the desire for a world with enough to
eat for everyone as reasons to support food banks. Only striving for an ideal world reflects
personal values and a philanthropic mindset.

Few studies did explicitly discuss retailers’ motivation to sell produce with visual
impairments. Prior studies showed that consumers can get used to such produce, as they
become accustomed to it (Loebnitz et al., 2015; Blanke, 2015). Because marketing is necessary
to accomplish this, it can be assumed that these efforts aim to attract another target group
of customers. Also, retailers want to present themselves as socially responsible and concerned about food waste (Holweg and Lienbacher, 2011; Holweg et al., 2016). Selling produce with visual impairments could lead to a positive reputation similar to redistribution (Vlaholias et al., 2015). Motivations to donate food and sell produce with visual impairments can be classified applying the well-known scheme of economic, psychological and social aspects following Anik et al.'s (2010) research of donor behavior in charitable giving. Independent of the underlying motivation, donors ultimately receive a form of satisfaction (Strahilevitz, 2010). Economic motivations include avoiding costs and receiving tax benefits (Lorenz, 2012; Vlaholias et al., 2015). Improving reputation, feeling superior and the joy of giving are examples of psychological motivations (Lorenz, 2012; Vlaholias et al., 2015). Altruism and solicitation are often influenced by society, and, therefore, can be classified as social motivations. The three forms of motivation are not mutually exclusive and can reinforce each other.

**Material and methods**

Due to its exploratory character the present study employed a qualitative research approach (Bitsch, 2005). A qualitative approach is particularly suitable, since the present study focused on the perspectives and experiences of actors in their lifeworld (Bitsch and Yakura, 2007). The experiences and perceptions of actors involved in German food retail and their strategies to reduce food waste are yet unexplored. In addition, food waste is a sensitive topic, since food waste is considered socially undesirable.

In 2015, 12 in-depth interviews were conducted in Germany, 11 with actors in the food retail sector, and one with a spokesperson for a food bank (Table I). Three of the 11 retail actors were owners of conventional supermarkets, one store manager for a produce specialty store, one produce buyer of a conventional supermarket chain, and two managers of a produce wholesale market. Furthermore, two interviewees owned organic supermarkets, and one was a spokesperson of an organic supermarket chain. The store sizes of interviewees' retail outlets ranged from less than 200-2,000 m². Another interviewee was the co-founder of a start-up specializing in marketing produce not fulfilling regular retail's quality standards. Organic retailers were included to explore potential differences

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>Venture</th>
<th>Size of the sales area in m²</th>
<th>Authority for decision making (Redistribution or inclusion of new products in the assortment)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner</td>
<td>Conventional supermarket</td>
<td>1,800</td>
<td>Yes</td>
</tr>
<tr>
<td>Owner</td>
<td>Conventional supermarket</td>
<td>600</td>
<td>Yes</td>
</tr>
<tr>
<td>Owner</td>
<td>Conventional supermarket</td>
<td>1,000</td>
<td>Yes</td>
</tr>
<tr>
<td>Owner</td>
<td>Organic supermarkets</td>
<td>200</td>
<td>Yes</td>
</tr>
<tr>
<td>Owner</td>
<td>Organic supermarkets</td>
<td>220</td>
<td>Yes</td>
</tr>
<tr>
<td>Store manager</td>
<td>Specialty store for fruit and vegetables</td>
<td>1,200</td>
<td>Yes</td>
</tr>
<tr>
<td>Spokesperson</td>
<td>Organic supermarket</td>
<td>1,000</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Spokesperson</td>
<td>Federal Association of German Food Banks</td>
<td>Not</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Buyer (employed) for fruits and vegetables</td>
<td>Conventional supermarket</td>
<td>2,000</td>
<td>No</td>
</tr>
<tr>
<td>Founder and manager</td>
<td>Social start up marketing fruits and vegetables with visual impairments not affecting food safety or taste</td>
<td>Information not shared</td>
<td>Yes</td>
</tr>
<tr>
<td>Manager (employed)</td>
<td>Wholesaler market for fruit and vegetables</td>
<td>310,000</td>
<td>Yes</td>
</tr>
<tr>
<td>Manager (employed)</td>
<td>Wholesaler market for fruit and vegetables</td>
<td>250,000</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Table I.** Interviewees and their background
between conventional and organic retailers (compare Hamzaoui-Essoussi et al., 2013). Interviewee selection also strove to include retailers in a large city, suburbs and a smaller city to account for location as well as infrastructure of relevant food banks.

Interviewees were contacted through personal contacts of the researchers, and via subsequent snowball sampling. Due to the limited accessibility of actors with management positions in food retail, other sampling strategies would not have been likely to succeed. The snowball sampling procedure followed Noy (2008) and Heckathorn (2011) who suggested a multiple referral approach. This approach has the advantage that the sampling process is not easily interrupted or stopped, and reduces potential sampling bias. Each interview lasted 45-70 minutes. Depending on interviewees' preferences, nine interviews were held face-to-face and three by phone.

A semi-structured interview guide outlined the topics for the interviews. The interview guide focused on food waste reduction strategies relating to the interviewees' particular work environments and their specific tasks. In this context interviewees were asked to comment on recent policy changes in other European countries, especially France. Further topics were quality standards for produce, and the retailers' endeavors to handle produce with visual impairments. Furthermore, interviewees were asked about their working environment, their positions and duties. Topics were addressed through open-ended questions, and asked according to the interview flow.

All interviews were conducted by the first author. In total, 11 of the 12 interviews were audio recorded and transcribed verbatim. On one occasion, the interviewee did not agree to recording, and therefore field notes were taken. Field notes and all interview transcripts were analyzed through a qualitative content analysis. The first and the second author carried out the analysis using f4 software for transcription and Atlas.ti for coding, establishment of the categories, and memo writing. Computer-assisted qualitative data analysis softwares such as Atlas.ti allow to manage a large amount of qualitative data and structure the analysis process because they provide tools for annotating and coding the data.

Building on a constructivist paradigm, the analysis followed a consensus coding process. According to Sandelowski and Barroso (2003), in qualitative research, consensus is a common approach where at least two coder independently code the data, compare their coding, and discuss and resolve discrepancies when they arise. The inductive qualitative content analysis was carried out in an iterative and recursive process. The analysis process built on constant comparing and contrasting of the data material. Comparing and contrasting is an essential part of a qualitative analysis because it supports a structured analysis process and increases the audibility of the analysis (Boeije, 2002; Corbin and Strauss, 2014). The procedure served to identify food waste reduction strategies in use and interviewees' specific motivations. Steps within the qualitative content analysis were open and axial coding and the establishment categories (Table II). As an example, a category with three codes, corresponding definitions and exemplary interview excerpts illustrate the analysis process (Table III).

**Results and discussion**

According to the food waste hierarchy, retailers' practice of lowering quality standards is preferred to other strategies to reduce waste, because it prevents food from becoming waste at prior stages of the supply chain. Food redistribution measures are still more desirable than other options. Interviewees did not provide direct insights into their motivation for experimenting with lower quality standards; these can only be inferred indirectly. However, they did discuss their motivation to participate in redistribution.

**Lowering quality standards**

German retailers reported on their experience selling produce with lower external quality standards. Results showed that produce with visual impairments is rarely part of the
assortment of conventional retailers, while in organic assortments it is quite common. Both types of retailers referred to customers’ expectations with respect to food quality, and shared that customers use their prior shopping and food experiences as indicators to evaluate the quality of produce. Retailers stated that they want to offer food items and qualities meeting their customers’ expectations:

Because since decades, […] one is used to everything having a norm. […] One will rather grab something that one is used to, meaning a cucumber that is the same as it was the last ten years, instead of a cucumber that is curvy (Owner of a conventional supermarket in a suburb).

Table II. Analytic steps

<table>
<thead>
<tr>
<th>Progression of analysis</th>
<th>Analysis activity</th>
<th>Aim</th>
<th>Form of results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within a single interview</td>
<td>Open coding</td>
<td>Researchers become acquainted with the text material and develop an understanding for the data</td>
<td>Summary of the interviews</td>
</tr>
<tr>
<td></td>
<td>Summarize basic content</td>
<td></td>
<td>Preliminary coding scheme</td>
</tr>
<tr>
<td></td>
<td>Discussion to find consensus among coders</td>
<td></td>
<td>Initial memos</td>
</tr>
<tr>
<td>Within the same group</td>
<td>Axial coding</td>
<td>Identifying differences and relationships that arise from the initial coding scheme</td>
<td>Further developed coding schemes</td>
</tr>
<tr>
<td></td>
<td>Compare and contrast</td>
<td></td>
<td>Preliminary categories</td>
</tr>
<tr>
<td></td>
<td>Merging codes</td>
<td></td>
<td>Elaborated memos</td>
</tr>
<tr>
<td></td>
<td>Add new aspects to summaries</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Discussion to find consensus among coders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between different groups (organic vs conventional)</td>
<td>Axial coding</td>
<td>Developing definitions for categories and their respective codes</td>
<td>Emerging patterns</td>
</tr>
<tr>
<td></td>
<td>Compare and contrast</td>
<td></td>
<td>Elaborated memos</td>
</tr>
<tr>
<td></td>
<td>Merging codes and categories</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Add new aspects to summaries</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Discussion to find consensus among coders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comparison between transcribed interviews and field notes</td>
<td>Triangulation of data material</td>
<td>Validity</td>
<td>Showing authenticity of knowledge</td>
</tr>
<tr>
<td></td>
<td>Validity</td>
<td>Understand a different dimensions of the topic</td>
<td></td>
</tr>
</tbody>
</table>

Notes: The analytic steps merge into each other because the analysis process is iterative and recursive

Source: Authors own elaboration Builds on Boeije (2002) and Corbin and Strauss (2014)

<table>
<thead>
<tr>
<th>Code</th>
<th>Interview excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage and logistics Interviewees’ experiences with and opinion on dealing with non-standardized food items in storage and logistics</td>
<td>“Yes, logistics will be probably more expensive. With the curvy cucumbers, the biggest problem is the transportation, because they do not fit straight into the crate. And I think that would simply be an additional expense. […]” (Owner of a small organic supermarket in Freising)</td>
</tr>
<tr>
<td>Dimension and quantities of produce with visual defects Dimensions or amount of non-standardized food items in the product assortment</td>
<td>“That is difficult to say. For the carrots, […] almost 50% that you could not sell in a supermarket. But as I said, we are an organic grocery store” (Owner of a small organic supermarket near Munich)</td>
</tr>
<tr>
<td>Characteristics of produce with visual defects Characteristics of non-standardized food items in the product assortment</td>
<td>“I also have carrots here, which are unwashed. Well, they come with sand. Let us say with dirt. They get sold as well here. Also, the two-legged” (Owner of a small organic supermarket near Munich)</td>
</tr>
</tbody>
</table>

Table III. Codes for the category “produce with visual defects as part of the product assortment” with examples of interview excerpts
Well, for us the shape is not so important. Who cares if a carrot has two legs? [...] In an organic store, small defects in appearance are not so bad (Owner of an organic supermarket in a small city).

And the second reason is, relates to marketing. People that value organic are basically more willing accept the appearance as they are aware the appearance has nothing to do with taste. It is simply the external appearance (Founder and manager of a startup specialized in marketing produce with visual impairments in a large city).

Conventional retailers doubted that their customers would buy produce with visual impairments, affirming prior findings of consumers avoiding products with even small optical defects (Buder et al., 2014; Göbel et al., 2015; Loebnitz et al., 2015). They believed that the practice of showcasing perfectly shaped produce according to former EU standards (trade classes extra and I) led to consumers only being familiar that type of produce. These results confirm findings that consumers’ quality perception is influenced by the produce available on the market (Creusen and Schoormans, 2005). Further, retailers believed that customers took irregularities in size, deformations or change in color as signs of low quality resulting from long storage periods or simply as inconvenient for consumption. These findings parallel prior studies, emphasizing appearance as a cue of perceived quality (Brunsø et al., 2002).

Similarly, acceptance of such irregular produce by consumers of organic produce is related to the perception of naturalness and organic production practices. Since by nature produce does not have a perfect shape and size, these consumers are not concerned about marketing standards and trade classes. These results raise a question discussed in the literature, whether the visual requirements of consumers affect the requirements of retailers or vice versa (Göbel et al., 2015; Priefer et al. 2016).

Some conventional retailers interviewed believed consumers’ acceptance to be so low that they feared losing their customers in case of introducing produce with visual impairments into their assortment. Others were concerned about extra costs of selling produce with visual impairments. Conventional retailers enumerated extra storage, transportation, disposal and marketing costs. In contrast, organic retailers did not mention extra costs. Conventional retailers’ concerns correspond with prior studies emphasizing logistics (Frieling et al., 2013; Priefer et al., 2013) and consumer acceptance (Loebnitz et al., 2015; Di Muro et al., 2016). The absence of these concerns among organic retailers is due to produce with visual impairments being well established among their customers, and logistics and marketing of these products being normal to them.

Food redistribution
All retailers interviewed reported to engage in food redistribution measures. Non-marketable food items and surplus are given to farmers, retailers’ employees, and food banks. Although several retailers collaborate with farmers on a regular basis, they emphasized that donations to farmers, e.g., as animal feed or compost (recycling), are regarded as an inferior option compared to redistribution for human consumption. The interviewees’ prioritization corresponded to the food waste hierarchy (Figure 1). In addition, the decision whether to donate to agriculture or charitable organizations involves an ethical decision. In Germany, 7 percent of the population, approximately 5,740,000 people, suffer from food insecurity (Pfeiffer et al., 2011). Retailers seem more likely to aim at countering food insecurity than providing feed to farm animals or composting materials.

Three of the retailers interviewed allowed their employees to take home surplus food. Others mentioned that this practice was not advisable since it might cause employee deviance, undesired behaviors and actions by employees, such as deliberate damage to
packaging or over-ordering. Earlier studies showed these behaviors to be common in food retail (Boye and Slora, 1993; Dunlop and Lee, 2004):

Unfortunately we had the experience. In the past we have just given damaged items to employees. But then things start to happen. There are ‘clever’ employees from time to time or they think they are clever and also deliberately damage items. And then this gets out of hand. And therefore, there has to be a clear line (Owner of a conventional supermarket in a large city).

Especially in the outlets of retail chains it is strictly prohibited for employees to take home or buy food waste. Because it has happened that employees deliberately over-ordered and basically thought, “Yes, well, we take it with us” (Owner of a large conventional supermarket in a large city).

Contrary to the present analysis, prior studies found that the retailers themselves practiced over-ordering, and it was considered a common business practice to return unsold products to wholesalers, even if products were not in perfect condition anymore (Midgley, 2014; Gruber et al., 2016). Gruber et al. (2016) emphasized that retailers became aware through low-income employees that this practice could be perceived as morally questionable or unethical. This difference in findings may be explained by retailers’ size as well as through employer-employee relationships.

Instead of distributing the surplus items to their employees, most retail interviewees preferred to collaborate with food banks. Conventional as well as organic retailers reported on extra efforts to sort food to meet food banks’ requirements. Further they reported that their operational schedules do not match well with food banks’ collection schedules:

That will take me two hours, if I do that [sorting] for our food bank. […] First, I have to scan everything. I would have to do that anyway, but since the food bank always comes on Fridays, I have a fixed plan. And for this reason I have to think about it. Well, what do I have to take out earlier that I can then give to them? […] Well, in the past, before we gave that to the food bank, I used to look that was expiring and took it out while I did the restocking (Owner of a conventional supermarket in a large city).

The problem with the food bank was always that the food bank did not have that many people, and they couldn’t collect daily. Because some things must be collected daily. And they were always laying around here for a week. And especially in the summer the goods do not get better then. Because they also cannot always be refrigerated. […] (Owner of an organic supermarket in a suburb).

Food banks require donated items to not have exceeded the best-before-date as part of food safety provisions (Federal Ministry of Food and Agriculture, 2014; Priefer et al., 2016). However, sorting food that needs to be taken off the shelves by best-before-dates requires additional time and, in the case of perishables, additional refrigerated storage space. Further the operational differences between both parties can affect their collaboration, because retailers shun the extra efforts. The concerns regarding products that require cooling have also been found by Holweg et al. (2016). Austrian retailers appear less concerned regarding logistics (Holweg et al., 2016). Given equivalent shop sizes, differences between Austrian and German retailers are likely to due to differences in planning and ordering and other internal logistic operations.

In addition to the logistical challenges involved in donating to food banks, another barrier identified is the legal framework. Some retailers were concerned that donating items with possible food safety problems due to faulty handling or storage might cause liability. Other retailers believed they would not be liable, because only the third party, i.e., the food bank, was responsible for redistributed food:

We are liable. […] That is why meat is an absolute no-go. Especially in summer. […] And they do two, three markets in a trip and […] it is 35 degrees Celsius outside. Then everything might have been okay here, but until it arrives there, and we vouched for the good quality, respectively edibility (Owner of a conventional supermarket in a large city).
Honestly, I do not know what the guidelines of the [city] food bank are. But I know that we are not liable for the products after giving them away. And the food bank, they are liable for the products (Owner of a conventional supermarket in a large city).

Even the interviewed spokesperson of a food bank was unsure about the legal situation. Facing this uncertainty, many interviewees only donated items with minor safety concerns. The findings concerning liability and storage corroborate earlier work (Midgley, 2014). The lack of knowledge regarding the legal situation by both retailers and food banks is an unexpected finding, because the legal situation is not as uncertain as claimed by interviewees. Food items given to food banks need to be safe, both parties need to inspect and document redistributed items. In Germany, product liability law and the law of gifting frame the legal situation (Federal Ministry of Food and Agriculture, 2014; Voit, 2014). In contrast to other German speaking countries, such as Austria where waiver agreement between retailer and charities is a common practice (Holweg et al., 2016), responsibility cannot be transferred through waivers in Germany (Federal Ministry of Food and Agriculture, 2014, p. 15).

Retailers’ motivations for lowering quality standards and redistribution

When analyzing motivations to sell produce with visual impairments, none of the retailers interviewed explicitly stated economic motivations. Particularly, statements by organic retailers, emphasizing customers’ demand for natural products, allow drawing inferences regarding motivations. Unusual appearance is attractive to these consumers, which implies that organic retailers found a niche for produce with visual impairments. Accordingly, for organic retailers lowering quality standards is less due to the desire to reduce food waste, and rather an income opportunity, because their customers understand the visual impairment as a signifier of naturalness. Implicitly, this would reflect an economic motivation. However, interest in increasing reputation as responsible retailers could not be found in this context.

Although sorting storage of food items and the legal framework appear to be considerable barriers to the redistribution of surplus food items, retailers interviewed still used this practice for various reasons. All interviewees expressed positive attitudes towards redistribution, but were not interested in communicating their donations to the public:

That [donation to food banks] must not be seen by them [customers]. Because I think what I give away, I need not make a big fuzz about. That is my attitude. If I do it, then I do it and then I must not shout it from the rooftop (Owner of a conventional supermarket in a large city).

At the [city] food bank, honestly speaking, they take their stuff from everywhere. Why should I make a big deal of that? To me that is nothing special, not at all. There are stickers everywhere “We are supporting the Munich food bank”. We could have posted that too, but we did not want to (Owner of a conventional supermarket in a large city).

The findings presented differ from Holweg et al. (2010) and Lorenz (2012), emphasizing psychological and economic motivations to donate food. Interviewees showed little interest in enhancing their reputation. They also did not state any economic motivations. The absence of stated economic motivation could be due to social desirability bias. Overall, motivations seemed altruistic, since retailers did not show interest in gaining benefits for themselves. Analyzing interview statements in-depth, reputation management still played a role, but in a different way than found in prior studies. Since food waste is an undesired problem of affluent societies (Lorenz, 2012; Vlaholias et al., 2015), interviewees seemed to want to hide the amount of waste generated. Also, they did not want any weaknesses in logistical management to become public (Holweg et al., 2010, 2016). In addition, they might not want to emphasize interactions with food banks, due to potential negative perceptions by specific groups among the regular customers.
Conclusions

Results underlined the importance of increasing consumer acceptance which is critical for produce with visual impairments. Since prior research indicated that awareness of food waste could increase purchasing intentions for produce deviating from the standard appearance (Loebnitz et al., 2015), awareness campaigns could contribute to reaching this goal. For instance, the appearance of food and quality could be addressed in governmental campaigns by the FMFA, which already aim to reduce food waste. Another focus could be educating children, e.g., in the context of EU school fruit programs, which could include a share of produce with visual impairments. The program provides a venue to familiarize children with produce and foster acceptance. Simultaneously, addressing fruit production in lessons would enhance children’s knowledge of fruit quality, independent of appearance.

Furthermore, retailers could also contribute to awareness regarding food waste. Introducing produce with visual impairments could be marketed as a corporate social responsibility strategy. Retailers wishing to include produce with visual impairments in their product assortment in the long term could try to market the naturalness of the product in order to attract consumers. Based on the results, these products are be particular appealing to organic consumers and potentially others with a different understanding of product quality. In retail settings, where consumers appear skeptical, retailers could emulate practices employed in Austrian retail. For example, produce with visual impairments can be processed and sold if retailers feature fresh counters or in-store restaurants (Holweg et al., 2016). Further consumers could be provided with small pieces of produce with visual impairments to convince them of the taste, given the irregular appearance. Handing out free samples is a common practice when anchoring a new product in the market (Bawa and Shoemaker, 2004).

Corresponding with Di Muro et al. (2016), future research should focus on consumers’ willingness to pay for produce with visual impairments. Conventional supermarkets appear to be a promising location for such an investigation to understand whether it makes economic sense to offer standard produce and produce with visual impairments in parallel. When studying organic consumers, future studies could follow a willingness to accept approach, because produce with visual impairments seems appreciated by organic consumers. However, it remains unclear if produce with visual impairments is preferred over regular produce.

Results suggested that food redistribution is a common practice among German retailers. However, costs for donations resulting from logistical challenges and labor for sorting food by best-before-date may discourage retailers from collaborating with food banks. Increased frequency of food collection by food banks would contribute to reducing the strain on retailers’ storage capacity. Since the frequency of collection depends on food banks’ infrastructure, e.g., transportation and storage facilities, investments in the infrastructure of food banks are recommended. Financial resources for these investments could come from payments for redistributed food items by food recipients, even if the food items are only sold for a symbolic price. In addition to finding more sponsors, state subsidies would currently be justified since the need for services provided by food banks has increased due to the number of refugees hosted by Germany (Lang, 2015).

Considering the motivation of German retailers for participating in food redistribution, psychological and social motivations appeared more prevalent than economic motivation. Awareness of solicitation and reputation as motivations should be carefully considered by managers of charitable organizations. Based on this knowledge, different strategies to convince potential contributors can be developed. A sensitive, not too persistent approach could be helpful to convince future contributors and avoid donor fatigue. To unburden retailers from uncertainties regarding the legal liability, policy makers could establish a framework encouraging retailers to donate unmarketable food. Policy makers might consider a law similar to the “Good Samaritan Act” in the USA to limit donors’ liability (Priefer et al., 2013).
In addition to the German food bank, retailers can cooperate with special outlets focusing on produce with visual impairments. In Germany there is a recent trend of establishing supermarkets selling only redistributed products. These endeavors originated from social movements and aim to reduce food waste. In contrast to the Austrian case (Holweg et al., 2010; Holweg and Lienbacher, 2011), these new markets do not emphasize a social background. Therefore it is advisable for retailers, considering cooperation with these new ventures, to investigate the target groups the cooperating partner to avoid potential direct competition.

As the study followed a qualitative research approach, results of this study are not generalizable, because of the non-random sampling method. However, qualitative results can be transferable to other situations or populations than explored, if sending and receiving contexts have important characteristics in common (Bitsch, 2005). For example, the situation for hypermarkets, which have not been part of the present sample, could be similar, and settings in other European or extra-European countries could be comparable as well, depending on the legal framework.

The present study draws attention to the discrepancy of quality as defined through EU-norms and consumers' quality perception. Produce with a standardized appearance may ease trade, but seem to negatively impact the acceptance of produce with visual impairments both in the regular market and in redistribution. To address both aspects, the specific marketing standards could be abolished and minimum quality requirements as stipulated in the general marketing standards could be enacted for all fruits and vegetables.

References


Further reading


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Volume and value of postharvest losses: the case of tomatoes in Nepal

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Bhishma P. Subedi
Asia Network for Sustainable Agriculture and Bioresources (ANSAB), Kathmandu, Nepal

Abstract

Purpose – The purpose of this paper is to develop a straightforward method to quantify volume and value of postharvest losses in the tomato postharvest value chain in Nepal and estimate the monetary loss shouldered by value chain actors.

Design/methodology/approach – The study combines interview data to quantify volume and prices with produce sampling to quantify quality losses, and does this at four nodes of the tomato value chain in Nepal: farmers, collectors, wholesalers, and retailers to estimate volume and value of postharvest losses.

Findings – Almost one-fourth of the total tomato harvest weight that enters the value chain is lost before it reaches consumers, and other one-fifth is traded by the value chain actors at reduced price due to quality damage. The total volume of postharvest loss (weight and quality loss) is not the same for all value chain actors and the average monetary loss ranges from 4 percent of gross revenues for farmers to 12 percent for wholesalers.

Practical implications – A standard method to account for both physical weight losses and quality losses of horticultural produce is lacking in estimates of the monetary value of postharvest losses for horticultural crops. Knowing such losses is essential for postharvest technology generation, promotion, and adoption. This study provides a framework that can be adopted and improved in future loss assessment studies for estimating the volume and value of postharvest losses in a horticultural value chain.

Originality/value – The uniqueness of the method used in this study is that it combines interview data to estimate price and volume with produce sampling to quantify quality losses, and does this at four nodes of the value chain: farmers, collectors, wholesalers, and retailers. This method could become a standard approach for assessment of postharvest weight and quality losses and to estimate the monetary value of total postharvest losses in the value chain for horticultural crops.

Keywords Vegetables, Value chain, Monetary loss, Postharvest loss

Paper type Case study

1. Purpose

Globally, almost one-third of all food produced is lost before it reaches consumers. Food loss (i.e. losses that occur before food reaches consumers) is more serious in developing countries while food waste (i.e. losses that occur at the retail and consumer level) is more serious in developed countries (FAO, 2011). On average 30-50 percent of what is produced is lost in the postharvest value chain of horticultural crops in developing countries before it reaches consumers (Kitinoja and Kader, 2015). When harvested food does not reach consumers, productive resources are wasted, food supplies decrease, and there is extra pressure on scarce natural resources to meet food demand. Efforts to minimize this loss of already-harvested food are as important as efforts to increase the total food supply, but almost 95 percent of agricultural research investments go to the latter while there is very little investment in loss reduction (Kader and Rolle, 2004; Hodges et al., 2010). Postharvest literature provides evidence of value addition that comes with the introduction of appropriate postharvest practices in fresh produce value chains; these practices can be means of reducing poverty though

Conflict of interest: the authors declare no conflict of interest.
enhanced farm income for smallholders (Ruslan et al., 2013; FAO, 2011; Lipinski et al., 2013).

Although the amounts of postharvest losses are troubling, they also offer an opportunity to attain the twin goals of international development – food security and poverty reduction – through appropriate investments in postharvest interventions to improve the efficiency of value chains.

Many postharvest technologies/interventions have been developed and used in global vegetable value chains supplying supermarkets. Yet, smallholder farmers are often excluded from supermarket value chains as they do not have economies of scale to afford such technologies (Rao and Qaim, 2011). Given the fact that smallholders provide up to 80 percent of the food supply in Asia and Sub-Saharan Africa (FAO, 2012), postharvest interventions suitable for smallholder value chains are critically important. Thus, postharvest technologies need to be customized for specific crops, value chains, and food cultures to be realistic for smallholders. “Realistic” not only refers to a technology that addresses the problem, but also to technology that is accessible, affordable, and has a favorable benefit-cost ratio.

The research on postharvest system assessment in smallholder value chains in developing countries is scanty, especially in the measurement of postharvest losses. Recent review papers on postharvest losses suggest that previous studies have mostly estimated physical weight loss with little attention to quality deterioration, which may not result in produce being discarded but does result in lower prices (e.g. Affognon et al., 2015; Kitinoja and Kader, 2015; Sibomana et al., 2016). Among all vegetables, tomatoes have been most frequently studied for postharvest losses. Some previous studies for developing countries have used data collected through interviews (Rupasinghe et al., 1991; Zulfiqar et al., 2005; Genova et al., 2006; Weinberger et al., 2008; Olayemi et al., 2010; HVAP, 2011) while some have used produce sampling (Tröger et al., 2007). Table I summarizes tomato postharvest measurement studies, method used, and losses in various developing countries.

Other more recent studies have been more comprehensive and have combined interviews and physical measurements to quantify total postharvest losses of tomatoes including quantity and quality aspects (e.g. WFLO, 2010; Kitinoja and Alhassan, 2012; Kitinoja et al., 2016). Saran et al. (2012) also applied such combination of methods to calculate benefits and costs of various postharvest technologies in tomatoes. These studies show considerable variation in postharvest losses across countries, or even within a country.

<table>
<thead>
<tr>
<th>Where</th>
<th>Extent of losses</th>
<th>Who</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Method of data collection: interview</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cambodia</td>
<td>24.6%</td>
<td>Weinberger et al. (2008)</td>
</tr>
<tr>
<td>Laos</td>
<td>16.9%</td>
<td></td>
</tr>
<tr>
<td>Vietnam</td>
<td>19.1%</td>
<td></td>
</tr>
<tr>
<td>Pakistan</td>
<td>22%</td>
<td></td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>54% (at wholesale)</td>
<td>Rupasinghe et al. (1991)</td>
</tr>
<tr>
<td>Nigeria</td>
<td>20% (farm); 28% (transit)</td>
<td>Olayemi et al. (2010)</td>
</tr>
<tr>
<td>Nepal</td>
<td>33%</td>
<td>HVAP (2011)</td>
</tr>
<tr>
<td>Laos</td>
<td>Physical loss: 3% (farmer); 1% (collector); 5% (wholesaler); 8% (retailer)</td>
<td>Genova et al. (2006)</td>
</tr>
<tr>
<td>Ghana</td>
<td>20%</td>
<td>Bani et al. (2006)</td>
</tr>
<tr>
<td>B. Method of data collection: sampling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ghana</td>
<td>Physical losses: 25% (farm); 21.5% (wholesale); 23% (retail)</td>
<td>WFLO (2010)</td>
</tr>
<tr>
<td>Niger</td>
<td>15% discarded; 65% sold with high levels of quality losses</td>
<td>Tröger et al. (2007)</td>
</tr>
<tr>
<td>Rwanda</td>
<td>Physical losses: 7.8% (farm); 10.7% (wholesale); 14.7% (retail)</td>
<td>WFLO (2010)</td>
</tr>
</tbody>
</table>

**Table I.** Postharvest losses measurement and method used for tomato in developing countries

**Source:** Kitinoja and Kader (2015, pp. 9-11) plus review of other relevant work
There are clear knowledge gaps in the literature about the approach to estimate the monetary value of the postharvest losses accounting for both physical weight losses and quality deterioration. Some studies discussed both quantity and quality losses, but fell short in estimating the monetary value of such losses or how these losses are distributed over the value chain. There is a clear need for a comprehensive method to estimate the quantity and quality of losses that shows how losses are distributed along the value chain so that technology development and intervention can be targeted and prioritized.

Nepal is a net importer of tomatoes and tomato-based products (MOAD, 2013) – indicating potential for import substitution by increasing domestic supply. However, for this to happen not only more tomatoes need to be produced but the efficiency of the tomato value chain must also be improved. High tomato postharvest losses (up to 33 percent) are common in Nepal, even though tomato production appears to be more profitable than other vegetables (HVAP, 2011). High postharvest losses are inefficient and reduce profits for all value chain actors, including farmers. The adoption of better postharvest practices and technologies largely depend on economic incentives, which points at the importance of knowing costs and returns. The monetary value of postharvest losses is an important component of this. There have been few studies in Nepal to estimate postharvest losses for tomatoes (Udas et al., 2005; HVAP, 2011) but no information is available about the combined monetary value of weight and quality losses. Quality deterioration in the postharvest value chain reduces the price of vegetable crops substantially (Genova et al., 2006; WFLO, 2010) and it is important to consider these factors in accounting for the total monetary value of postharvest losses to ascertain the economic threshold for technology adoption. This study contributes to filling this research gap by developing a straightforward method to quantify total losses and applying it to a case study of tomatoes in Western Nepal.

2. Design/methodology/approach

2.1 Approach

In the framework illustrated in Figure 1, the added value along the chain is captured by the change in the price of the vegetable due to postharvest activities such as handling (grading, sorting, cleaning), transportation, storage, processing, and packaging. It is inevitable that some losses occur along the chain, especially for perishable produce. These losses can be attributed to losses in quantity and quality. Quality losses can be visible (cracks, tears,
yellowing, etc.) and non-visible, such as taste and nutritional losses. Unlike quantity losses, quality losses may not lead to produce being discarded but they reduce the market value. In Figure 1, $V_H$ is the value at harvest; $V_P$ the value added along the chain; $V_M$ the value at consumer level; $V_L$ the value lost along the chain $= (V_W + V_Q)$, $V_W$ the value lost due to weight loss (including water loss); and $V_Q$ the value lost due to quality deterioration.

The objective of postharvest interventions is to decrease $V_L$ and increase $V_M$, so as to increase the net value added along the chain ($V_N$) = ($V_M$ - $V_H$). In this paper, the following method is used to calculate the monetary value of postharvest losses ($V_L$).

Let $P_1$ is the price of produce without quality damage in a given market in a given day; and $P_2$ is the price of produce with quality damage in a given market in a given day. Then:

Monetary value of weight loss\(A = \) (Qty. traded × %weight loss/100) × $P_1$ \hspace{1cm} (1)

Monetary value of quality loss\(B = \) (Qty. traded × %sold at $P_2$/100) × ($P_1 - P_2$) \hspace{1cm} (2)

Total monetary value of postharvest loss\(V_L = A + B\) \hspace{1cm} (3)

These equations are used in this paper to access the losses at various nodes of the postharvest value chain.

### 2.2 Data and methods

#### Study area selection

This study was conducted as a part of the United States Agency for International Development-funded vegetable postharvest project implemented by the World Vegetable Center. Two Feed the Future (FtF) districts, Kapilvastu and Banke, were selected for this study based on total area, number of farmers, and the prospect of improving postharvest value chains in the FtF region. In each of these two districts, two study sites were identified for a survey based on consultation with District Agriculture Development Offices and other key informants to ensure that there would be enough farmers (who produced and sold tomato in that season) to survey. Table II lists the districts, study sites, and the market centers included in the study.

#### Data collection

The information on postharvest weight loss of tomato at four stages of the value chain (farmers, collectors, wholesalers, and retailers) was collected using pre-tested questionnaires. From the identified study sites, tomato farmers were selected using a non-probability snowballing method. This is a chain sampling method where the next respondent is picked (one among few suggested) based on information provided by the preceding respondent. This method ensured that a given farmer had grown, harvested, and marketed tomato during the season, and also helped to complete the survey within the stipulated time to minimize the effect of price fluctuation on the postharvest loss calculations. The selection of the collection/commission agents was based on information provided by the farmers. Again, the wholesalers were tracked based on information from the collectors and the interviewed farmers (as farmers also sold directly to wholesalers). The retailers were purposively selected to cover different locations of the major destination.

<table>
<thead>
<tr>
<th>District</th>
<th>Study sites</th>
<th>Collection centers</th>
<th>Wholesale and retail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banke</td>
<td>Sitapur and Parashpur</td>
<td>Collection points (including commission agents) near production area</td>
<td>Nepalgunj, Kohalpur, and Birendranagar</td>
</tr>
<tr>
<td>Kapilvastu</td>
<td>Dhankauli and Niglihawa</td>
<td>Jeetpur, Channauta hathazzar locations</td>
<td>Taulihawa, Channauta, Butwal, and Sandikharka</td>
</tr>
</tbody>
</table>

Table II. Study sites and markets
The survey tried to follow the supply chain of the tomatoes produced in the study sites by collecting information from the value chain actors linked to the produce coming from those sites. A total of 120 farmers and 87 traders (19 collectors, 23 wholesalers, and 45 retailers) were interviewed using pre-tested questionnaires. The quality loss assessment was conducted on a subset of 48 respondents (16 farmers, 8 collectors, 8 wholesalers, and 16 retailers), which used a checklist to collect data on weight, visible quality damage such as bruises, cuts, pressure damage and other physiological damage, and selling price. The number of fruits with calyces, the maturity of the fruits, and sugar content were also recorded.

The selection of value chain actors for the quality assessment was only possible when the value chain actors agreed with the procedure and were willing to make time available to engage with the survey team. Produce sampling was considered the most suitable method to estimate the quality damage and resulting monetary loss because initial interview showed that value chain actors (especially farmers) were unable to estimate these themselves. Different from quantity losses, quality is determined by multiple criteria (such as color, grading and sorting, maturity, and other physical damage during handling and transportation), which makes it more difficult to comprehend, recall and report.

The quality assessment was based on visually observable traits. A sample of the fruit was taken, separated by quality, and weighed. Value chain actors were then asked what price reduction they would expect for the produce with quality damage compared to produce without damage from which the percentage price reduction was calculated. These percentages were then applied to the total volume traded in that season by each type of value chain actor to calculate the total value of quality damage using Equation 2. Figure 2 illustrates the method.

![Diagram of quality loss assessment](image)

**Figure 2.** Sample selection and information collected for estimation of postharvest losses
3. Findings

3.1 Value chain characteristics

The average landholding of respondent farmers was 0.93 hectares (1 hectare = 30 Khatta) with almost 36 percent used for vegetable cultivation. On average, the surveyed farmers had grown tomatoes for 15 years on an average area of 0.2 hectare. The average annual household income of the farmers was US$3,150 and 90 percent of the farmers indicated vegetable sales as their main source of cash income and tomatoes as their main vegetable. The average farmer earned US$1,888 gross income from tomato alone, which was 60 percent of the household cash income. The surveyed traders considered vegetable trading an important part of their business, with tomato being the dominant commodity traded.

Some of the produce passed directly from farmers to wholesalers as many farmers were located near urban areas. In some instances, collectors visited farmers or collection points to buy produce, especially those located far from markets, and some farmers sold through commission agents in nearby towns. There were some smaller collectors selling to larger collectors and there were some wholesalers who sold to other wholesalers servicing different markets. Retailers sourced their tomatoes mostly from wholesalers but some also sourced from collection agents or directly from farmers (Figure 3).

The average duration of transportation from production sites to the markets ranged from 15 to 90 minutes depending on mode of transportation, road condition, and distance. The most common form of transport for farmers were bicycles, followed by motorcycles and four wheelers (e.g. jeep, vans) while some also used pushcarts, rickshaws, public transport, or carried on their heads to sell in nearby markets. Traders, especially wholesalers and collectors, were generally using four wheelers but some of the smaller collectors did not have their own transportation but relied on public buses and trucks. In terms of packing, about 50 percent of farmers packed tomatoes in plastic crates, 34 percent used sacks, 9 percent used bamboo baskets, 3 percent used plastic bags and paper boxes, and 2 percent used wooden boxes. Most traders, especially the wholesalers, used plastic

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**Figure 3.**
Tomato value chain of the study area in Nepal, in percent of total volume traded

**Source:** Field Survey (December 2014)
While retailers placed the tomatoes on sheets of cloth or plastic for display at the market. The use of insulated boxes or modified atmospheric packages was nonexistent at all levels.

3.2 Amount and value of postharvest losses

Weight losses. Farmers’ average annual marketable harvest was 6.41 tons and the average annual quantity of tomatoes traded by collectors, wholesalers, and retailers was 64.63, 198.79, and 10.52 tons/year, respectively (Table III). Almost one-fourth of the total harvest weight that entered the value chain was lost before it reached consumers. This information alone, however, does not help much in devising suitable postharvest interventions unless we know where and why the losses occurred. The percentage of postharvest weight loss (quantity traded minus quantity sold) is 8 percent at collection, 9 percent at wholesale, and 6 percent at retail. This is equivalent to 0.13, 5.17, 17.89, and 0.63 tons for the average farmer, collector, wholesaler, and retailer, respectively (Table III).

Quality loss. Quality assessment on a subset of the sample at farmers’ level showed that about 75 percent of the tomatoes were at maturity stage 3 (i.e. turning stage, surface turning from green to tannish yellow) or lower with almost no immature fruit. Similarly, 80 percent of the fruits were at maturity stage 3 or above for the traders, with most fruits either at maturity stage 4 (i.e. pink) or 5 (i.e. light red). At the time of trading, 34 percent of the fruits traded by farmers had the calyx attached. The tomatoes on an average scored 3.7 Brix reading at the farmers’ level and 4.2 at the retail level. Grading and sorting was not common and the produce sample had a mix of pre and postharvest damage along the entire value chain, with higher preharvest damage at the farmers’ level as some of the damaged produce was sorted out at later stages of the value chain. Table IV shows the percentage of fruit with postharvest damage and the quantity sold at reduced prices.

The average percentage of the fruit with quality damage ranged from 17 percent for retailers to 26 percent for collectors (Table IV) and was sold at a reduced price. The percentage reduction in price is based on the extent of the visual damage to the fruit. Results from the quality assessment show that 21 percent of the tomato fruits traded by farmers had some kind of quality damage at the time of trading. Opening the packages and sorting for damage incurred during transportation is not feasible for farmers once they reach the market, and thus the fruits were sold as is, a practice traders are well aware of. Yet, traders know the farmers (with repeated trading during the tomato season) and can guess the extent of damage based on the way it is packed, the type of transport used, and the maturity stage of the fruit. The traders factor in the damage in the price they offer to the farmers and thereby off-set their expected losses and ensure their profit. The transport of tomatoes is challenging for farmers as they do not have volumes large enough to use

<table>
<thead>
<tr>
<th>Farmers</th>
<th>Collectors</th>
<th>Wholesalers</th>
<th>Retailers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of value chain actors surveyed</td>
<td>120</td>
<td>19</td>
<td>23</td>
</tr>
<tr>
<td>Total marketable quantity before postharvest loss (ton/year)</td>
<td>769.44</td>
<td>1,227.88</td>
<td>4,572.19</td>
</tr>
<tr>
<td>Marketable quantity before postharvest loss (ton/year/actor)</td>
<td>6.41</td>
<td>64.63</td>
<td>198.79</td>
</tr>
<tr>
<td>% Weight loss (A)</td>
<td>2</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Total quantity loss (ton/year) (Q₂) = (Q₁ × (A/100))</td>
<td>0.13</td>
<td>5.17</td>
<td>17.89</td>
</tr>
<tr>
<td>Total amount traded (ton/year) after postharvest loss (Q₃) = (Q₁ − Q₂)</td>
<td>6.28</td>
<td>59.46</td>
<td>180.90</td>
</tr>
</tbody>
</table>

Source: Field survey (December 2014)
more suitable transportation than bicycles, motorbikes, animal/pushcarts, rickshaws, and occasionally public buses. At least part of the route is on seasonal roads, which can be bumpy. When 15 percent of the fruits were at maturity stage 4 or above, tomatoes are prone to damage from compression and handling, and the means of transport is therefore important. On the other hand, traders are likely to sort and discard some of the damaged fruit, which reduces the quality loss but increases the weight loss.

The percentage of damaged fruit varied from 17 percent for retailers to 26 percent for collectors while the price effect due to quality deterioration varied from 4 to 7 percent (Table IV). Even though the price effect looks small (in percentage terms) the total value lost is high when trading volumes are large. Damage at the farmers’ level is more severe than at the traders’ level, and may be the reason why there is a higher price reduction for farmers than for collectors, even though collectors have a higher percentage of damaged fruit. The high level of quality damage at the collectors’ level may be because some collectors transport tomatoes over longer distances.

Monetary value of the postharvest losses. Postharvest weight losses at various nodes of the value chain varied from 2 percent for farmers to 9 percent for wholesalers. Apart from this weight loss, about one-fifth of the produce was traded at reduced prices by farmers, wholesalers, and retailers while a quarter of the produce was sold at reduced prices by the collectors due to quality damage. The sum of these two components is the total postharvest loss (Table V).

The average monetary value of postharvest losses (both weight and quality) was higher for collectors and wholesalers than for farmers and retailers because of the higher volume of trade by collectors and wholesalers. This translates into a monetary loss of 4 percent for farmers to 12 percent for wholesalers of the gross revenue from tomato trade. On the other hand, the share of monetary loss due to the quality damage (resulting in price reduction) in total monetary loss due to postharvest damage is considerably high for farmers (42 percent) compared to other value chain actors which is around 10 to 13 percent. This shows that the loss in gross revenue from quality damage at the farmers’ level is as important as the weight loss; however, for an average trader, it is not as significant as that from weight loss.

4. Practical implications

The overall postharvest weight loss in the value chain was around 25 percent of the traded volume, which is similar to that reported for other developing countries in Asia. Losses at the farmers’ level (2 percent of the marketable harvest) were low compared to other developing countries in Asia (Genova et al., 2006). This probably is because: the study sites were peri-urban (short time between harvest and sale), lack of good sorting of damaged fruit (which, if sorted, would count as weight loss), and limitation on quantity that can be traded.

<table>
<thead>
<tr>
<th></th>
<th>Farmer</th>
<th>Collectors</th>
<th>Wholesaler</th>
<th>Retailer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total amount traded (ton/year) ($Q_3$)</td>
<td>6.28</td>
<td>59.46</td>
<td>180.90</td>
<td>9.89</td>
</tr>
<tr>
<td>Average market price without damage (US$/ton) ($P_1$)</td>
<td>305.15</td>
<td>344.33</td>
<td>388.65</td>
<td>473.2</td>
</tr>
<tr>
<td>Average market price with damage (US$/ton) ($P_2$)</td>
<td>283.4</td>
<td>326.91</td>
<td>360.92</td>
<td>454.12</td>
</tr>
<tr>
<td>Price reduction from quality damage (US$/ton) = ($P_3$ = $P_1$ – $P_2$)</td>
<td>21.75</td>
<td>17.42</td>
<td>27.73</td>
<td>19.08</td>
</tr>
<tr>
<td>Percentage price reduction due to quality damage ($B$)</td>
<td>7</td>
<td>5</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Quantity traded at reduced price due to quality damage ($C$) (%)</td>
<td>21</td>
<td>26</td>
<td>20</td>
<td>17</td>
</tr>
<tr>
<td>Quantity traded at reduced price due to quality damage ($Q_4$) = ($Q_3$ × ($C/100$)) tons</td>
<td>1.32</td>
<td>15.46</td>
<td>36.18</td>
<td>1.68</td>
</tr>
</tbody>
</table>

Source: Field survey (December 2014)
transported to the market at one time because of the mode of transportation (bicycle, motorbike, or in some cases, on the head or back). The farmers harvest what they can transport and sell on a given day, while leaving some of the produce in the field, which may result in preharvest loss.

Different from most other postharvest studies for developing countries, this study: assessed both weight loss and quality loss in the value chain; estimated the monetary value of both weight and quality loss in the value chain; disaggregated the total postharvest loss by four nodes of the value chain; and estimated the percentage share of the loss in the gross revenues at each of the four nodes of the value chain. This provides a better understanding of the potential of postharvest interventions.

Produce quality and freshness start to deteriorate immediately after harvest and the objective of postharvest activities is to retard this process. Postharvest interventions such as cooling, cleaning and sanitizing, grading, and sorting immediately after harvest (at the farmers’ level) can help to reduce postharvest losses further up the value chain. An average farmer currently loses US$68 per year while the total loss in the value chain is US$10,405 (Table V). Given the fact that most postharvest losses occur at the traders’ level, a farmer may have little incentive to invest time and resources on improved postharvest practices if the benefits of this accrue at a later stage of the value chain. Efforts thus need to be made to upgrade the whole value chain, build trust among the value chain actors, and ensure that benefits of postharvest technologies are shared by all value chain participants. This would enhance the efficiency of the value chain.

Improved packaging, such as the use of plastic crates or wooden boxes and the use of liners in rough surface containers like bamboo baskets, would certainly help to reduce quality damage. Since 15 percent of the fruits are of maturity stage 4 or above, postharvest losses can be reduced by harvesting fruits at an earlier stage. Many farmers use bicycles for transport and the use of plastic crates is difficult on a bicycle while four wheelers do not appear cost-effective for farmers. Collective marketing through farmers’ cooperatives, small-scale packhouses, and arrangements with the collectors or wholesalers to collect produce at such packhouses could encourage farmers to collectively adopt better postharvest handling and use of better packaging materials like plastic crates.

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Farmers</th>
<th>Collectors</th>
<th>Wholesalers</th>
<th>Retailers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential total revenue if no postharvest loss (US$) = ($Q_1 \times P_1$)</td>
<td>1,956</td>
<td>22,254</td>
<td>77,260</td>
<td>4,978</td>
</tr>
<tr>
<td>Monetary loss due to postharvest weight loss (US$) = ($L_1 = Q_2 \times P_2$)</td>
<td>39.12</td>
<td>1,780.19</td>
<td>6,953.41</td>
<td>298.58</td>
</tr>
<tr>
<td>Monetary loss due to quality damage (US$) = ($L_2 = Q_3 \times P_3$)</td>
<td>28.69</td>
<td>269.28</td>
<td>1,003.27</td>
<td>32.06</td>
</tr>
<tr>
<td>Total monetary loss from postharvest loss (US$) = ($L = L_1 + L_2$)</td>
<td>67.81</td>
<td>2,049.47</td>
<td>7,956.68</td>
<td>330.65</td>
</tr>
<tr>
<td>Gross revenue from tomato after postharvest loss (US$) = ($R_2 = R_1 - L$)</td>
<td>1,889</td>
<td>20,205</td>
<td>69,304</td>
<td>4,648</td>
</tr>
<tr>
<td>Total postharvest loss as % of gross revenue from tomato trade = ($L/R_2$)</td>
<td>4</td>
<td>10</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>Revenue loss from quality damage as percentage of total postharvest revenue loss (weight and quality)</td>
<td>42</td>
<td>13</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>Monetary loss per ton of marketable quantity of tomato (US$)</td>
<td>10.67</td>
<td>31.71</td>
<td>40.02</td>
<td>31.39</td>
</tr>
<tr>
<td>Share of postharvest loss at different nodes as % of total loss in entire value chain</td>
<td>0.13</td>
<td>5.17</td>
<td>17.89</td>
<td>0.63</td>
</tr>
</tbody>
</table>

Note: See Tables III and IV for quantities and prices used here

Source: Field survey (December 2014)

Table V. Economic value of postharvest losses of tomato along the value chain
This study provided a framework that can be adopted and improved in future loss assessment studies for estimating the volume and value of postharvest losses. This study highlighted the importance of considering both weight and quality loss in the postharvest value chain. At the farmers’ level, even though postharvest losses were small, quality loss becomes important as it contributed to 42 percent of the total postharvest loss. On the other hand, at the traders’ level (especially the wholesalers and collectors) the share of quality loss in total postharvest losses is 13 percent but the total monetary value of the quality losses is high due to economies of scale. Quality losses are important to consider in assessments of monetary value of postharvest losses, but in our review of postharvest loss measurement literature, assessment of quality losses is often lacking (Affognon et al., 2015; Kitinoja and Kader, 2015). The estimate of the total monetary value of the postharvest losses provides a benchmark for developing and testing postharvest technologies/interventions for postharvest professionals, and helps extension agents in promoting affordable and cost-effective interventions in the value chain to reduce postharvest losses. Information on the economic value of postharvest losses and the extent to which the losses can be prevented using technology are prerequisites for promoting postharvest technologies to small-scale farm households and agribusinesses.

It was not always possible to separate pre- from postharvest damage as some sampled fruits had both types of damage. Quality traits considered in this study are not exhaustive, especially non-visible quality traits such as nutritional value. Future studies could try to incorporate these non-visible but important traits. This case study examined tomato production in Western Nepal, and may not have captured all variability of tomato production, harvesting, and postharvest handling. The findings may not apply all tomato value chains in Nepal or beyond.

There is a potential to substitute tomato and tomato product imports from India through increased domestic production in Nepal. However, the high postharvest loss in value chains needs attention if the domestic supply is to increase, and to improve the efficiency of the value chain. This requires affordable and effective postharvest technologies and practices in the value chain to add value or retain the value of the produce. Smallholder farmers need information about the entire value chain – including the postharvest losses in the chain after they trade the produce – and how these losses could be reduced with basic interventions at their level. Farmers should be encouraged to adopt improved postharvest practices but this requires close coordination with all other value chain actors to ensure that farmers receive an economic incentive to adopt better practices.

5. Originality/value
Consensus is building in the international development community regarding the role of postharvest loss reduction in food security, nutrition, and poverty reduction in developing countries. Information on volume, value, and causes of losses along the value chain is essential to develop low-cost technologies suitable for small-scale producers and traders. There are few reliable approaches available to quantify postharvest losses, especially for horticultural crops such as vegetables due to the diversity of value chains. Most studies of loss assessment thus far have focused mainly on the volume of postharvest losses; not much effort has been spent on quantifying the monetary loss that results from quality deterioration along the value chain. Therefore, the total value of postharvest losses is underestimated. This study used a framework for total postharvest loss assessment (both weight and quality loss) to estimate the total monetary value of postharvest loss in the value chain and disaggregated the estimates for four common value chain participants. Adoption and improvement of this framework should help in making better estimates of the volume and value of postharvest losses – which in turn should guide the development, testing, and roll-out of suitable postharvest interventions. Strategies to
promote trust among value chain stakeholders to collectively work toward a common goal of reducing postharvest losses, and a mechanism in which the added benefit resulting from better postharvest handling can be proportionately shared by all stakeholders, are critical to the achievement of reducing loss and providing better produce for better prices.

References


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Food taxes and calories purchased in the virtual supermarket: a preliminary study

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Abstract
Purpose – The purpose of this paper is to examine the effectiveness of three food taxation schemes on energy (kcal), saturated fat (gram) and sugar (gram) purchased in the virtual supermarket.

Design/methodology/approach – Based on the literature, three food taxation schemes were developed (sugar tax, saturated fat tax and a nutrient profiling tax) and implemented in the three-dimensional virtual supermarket. A randomized control trial was conducted to determine the differences in the amount of energy (kcal), saturated fat (gram) and sugar (gram) purchased for a one-week food basket.

Findings – In total, 191 Dutch adults were randomly assigned to a sugar-tax condition (n = 48), a saturated fat-tax condition (n = 37), a nutrient profiling-tax condition (n = 62) and a control (no-tax) condition (n = 44). Fully adjusted models indicated that compared to the no-tax condition, no significant effects of a sugar-tax condition (B: −2,041 kcal (95% CI −5,350 to 1,914)), saturated fat-tax condition (B: −2,717 kcal (95% CI −6,596 to 1,163)) or nutrient profiling-tax condition (B: −1,124 kcal (95% CI −4,538 to 2,292)) were found on the amount of energy purchased. Also, none of the taxation schemes showed significant effects on saturated fat or sugar purchased.

Originality/value – This is one of the first randomized controlled trials testing the effectiveness of a variety of food taxes in the virtual supermarket. This preliminary study provides important directions for future research (the design, results, as well as the lessons learned with respect to recruitment, incentives and technology).

Keywords Public health, Computer software, Consumer purchasing decisions, Food policy, Supermarkets, Prices

Paper type Research paper

Introduction
In response to the increased prevalence of obesity and non-communicable diseases (NCDs) over the past decades, national governments and health organizations are seeking for effective prevention strategies. In 2011, the United Nations General Assembly high-level meeting on NCDs advocated the use of fiscal strategies (e.g. food taxes or subsidies) to improve human diet and health (United Nations, 2011). Already, several studies have been conducted showing the beneficial effects of food taxes on food purchases (Thow et al., 2014; Andreyeva et al., 2010; Epstein et al., 2012; Eyles et al., 2012; Cabrera Escobar et al., 2013; Nakhimovsky et al., 2016; Backholer et al., 2016).

Andreyeva et al. (2010) conducted a review study on food price elasticity (“the percentage change in the quantity demanded in response to a given percentage change in price at a particular point in the demand curve” (Perloff, 2007)) and indicated that consumer behavior is affected by changed food prices. Especially, food consumed away from home, soft drinks, juices, meats and fruits had the highest price elasticity. A review by Epstein et al. (2012) on
experimental studies in different settings (e.g. in laboratories, cafeteria’s, vending machines) showed that, in all settings, the purchase of less healthy foods reduced when prices increased. A review by Thow et al. (2014) showed that different types of food taxes can be effective to improve dietary intake although differences in effectiveness have been indicated. For example, a sugar-sweetened beverage (SSB) tax ranging from 5 to 30 percent decreased the intake of SSBs by 4-48 percent. A (saturated) fat tax of 5-17.5 percent would reduce (saturated) fat consumption by 0-3 percent, especially from certain high-fat foods (e.g. chips). A review on simulation modeling studies assessed the effects of SSB tax and saturated fat tax. A price increase of 1 percent of SSBs would lead to a decrease of 0.93 percent of energy intake derived from these drinks, and the modeled reduction in energy consumption was −0.02 percent for each 1 percent increase in price. The reduction in saturated fat would lead to a decrease of 12.8 percent of the total intake of saturated fat, corresponding to a modeled reduction of −0.02 percent in saturated fat, for each 1 percent increase in price (Eyles et al., 2012). A meta-analysis by Cabrera Escobar et al. (2013) also suggested that an elevation in SSB price is associated with a lower consumption of SSBs (price elasticity: −1.299 (95% CI: −1.089 to −1.509)). SSB taxes have either similar effects on reductions in body weight among individuals with different socio economic positions (SEP) or greater effects for individuals with lower SEP as compared to individuals with higher SEP (Backholer et al., 2016). In middle-income countries, similar results of SSB taxes as in high-income countries are reported (PE = −0.6 to −1.2, corresponding to a decrease of 5-9 kJ/pp/d given a price increase of 10 percent (Nakhimovsky et al., 2016). Overall, these reviews outline the beneficial effects of taxes on the healthiness of food purchases. Notwithstanding the importance of these studies and outcomes, most evidence is built upon simulating modeling studies and evidence from randomized controlled trials is lacking. From modeling studies, it is hard to gain good insight in cross-price elasticity or compensatory purchasing behaviors (Eyles et al., 2012): a large number of studies only determine the effect of a particular food tax on the corresponding nutrient (e.g. the impact of a sugar tax on purchased sugar) and overlook its effectiveness on other nutrients (e.g. the impact of a sugar tax on purchased saturated fat). More recently, it has also been suggested that tax salience – the visibility/notification of the tax – might be an important factor in behavioral response to food taxes and could strengthen the taxation effect (Chetty et al., 2009; Chen et al., 2015).

Randomized controlled trials on the effectiveness of a variety of food taxes and tax salience in a retail setting are scarce (Epstein et al., 2012). A potential explanation for this lack of experimental evidence is that such studies are challenging to conduct. First, the implementation of different taxation schemes (e.g. saturated fat-tax, sugar-tax, no-tax (control condition)) under systematically comparable environmental conditions (i.e. well-controlled environments) is a challenge. Second, it is challenging to engage retailers in such trials as the proposed strategies might negatively influence profits. To overcome these challenges, (online) virtual environments may provide a solution. Virtual environments allow for objective observations (participants’ shopping behavior), behavioral measures (e.g. measures on food purchases) and, most importantly, for controlled environmental manipulations in an environment that closely resembles the real-life experience.

As part of the investigation undertaken by the DEDIPAC project (the Knowledge Hub on the DEterminants of Diet and Physical Activity, which is the first Research Action of the European Union’s Joint Programming Initiative on healthy diet for healthy life) (Lakerveld et al., 2014), the present manuscript provides insight into a preliminary study that uses a virtual reality setting to examine the effectiveness of three food taxation schemes on energy (kcal), saturated fat (gram) and sugar (gram) purchased in the virtual supermarket. Results of a small sample study are presented as well as the lessons learned. Also, the input and directions for future research using a virtual setting to test food taxes are presented.
Methods

Study design and setting

This study was conducted in the virtual supermarket, which is a unique three-dimensional software application closely resembling a real supermarket (Figure 1). The virtual supermarket was validated against real-life shopping behavior in a recent New Zealand study (Waterlander et al., 2015). In virtual environments, participants can experience and interact intuitively in real time (Nichols et al., 2000). The virtual supermarket is designed in the image of an existent branch of the Dutch market leader supermarket. The shopping procedures in the virtual supermarket closely mirror a real-life supermarket experience where participants navigate a trolley along supermarket aisles and select products by a single mouse click. The stock was based on an existing supermarket. In total, the virtual supermarket contained 512 different food products (see Waterlander et al., 2012a), including 71 different types of beverages, modeling the actual distribution of store products and categories. The main features of the software are described in more detail elsewhere (Waterlander et al., 2011).

In the virtual supermarket, food prices can be adapted for each test condition in the study. In the case of this study, the prices varied for four different conditions to which study participants were randomly assigned: an experimental condition with a 25 percent tax on products rich in fat; an experimental condition with a 25 percent tax on products rich in sugar; an experimental condition with a 25 percent tax on “unhealthy” products, based on a nutrient profiling model; and a control condition with regular prices conforms the prices of the two Dutch supermarket leaders in 2014. A tax level of 25 percent was chosen because previous studies indicated that a price increase of at least 20 percent on unhealthy products is needed to be effective to decrease the demand for calories (Mytton et al., 2012). Alcoholic drinks were exempt from taxes because they are already taxed in the Netherlands.

Food taxes and calories purchased

<table>
<thead>
<tr>
<th>Allocation</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control condition n=81</td>
<td>Received allocated intervention (n=50)</td>
</tr>
<tr>
<td></td>
<td>Did not receive allocated intervention (n=31)</td>
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<tr>
<td></td>
<td>Technical problems (n=14)</td>
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<td></td>
<td>Declined for participation (n=6)</td>
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<td></td>
<td>Non-response (n=6)</td>
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<tr>
<td>Saturated fat-tax condition n=80</td>
<td>Received allocated intervention (n=42)</td>
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<tr>
<td></td>
<td>Did not receive allocated intervention (n=38)</td>
</tr>
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<td>Declined for participation (n=2)</td>
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<tr>
<td></td>
<td>Non-response (n=6)</td>
</tr>
</tbody>
</table>

Figure 1. Flow diagram of participants
Tax salience and taxation schemes

To reflect a realistic situation in which taxes are introduced (Chetty et al., 2009; Chen et al., 2015), the experimental groups were informed about the taxation before entering the supermarket by means of the following notification tailored to each of the conditions: “In the virtual supermarket, unhealthy/fat-rich/sugar-rich products are taxed. Therefore, the prices of, unhealthy/fat-rich/sugar-rich products are 25 percent more expensive. This tax aims to support healthy eating and thereby lower the chances of obesity or chronic diseases such as a diabetes type 2 or coronary heart disease.” The control group did not receive a notification. The following taxation schemes were used.

Nutrient profiling tax. The taxation for “unhealthy” products was based on the British WXY nutrient profiling scheme (Quinio et al., 2007). This scheme allocates positive and negative points based on the nutritional content per 100 g of a product. The overall score for the product is calculated in three steps and includes the following nutrient characteristics: energy (kilojoules (kJ)), saturated fat, total sugars, sodium, fiber, protein, fruit and vegetables (Rayner et al., 2007). The total score ranges from −12 to 21, where a lower value indicates a healthier product. Based on the WXY nutrient profiling scheme, foods with ≥4 points and drinks with ≥1 point were classified as “unhealthy,” and were taxed at a 25 percent level. In total, 282 (55 percent) products were taxed, including 244 foods and 38 drinks.

Sugar tax. A sugar tax was implemented using cut-off values for high and low total sugar content as used in the WXY nutrient profiling model (Rayner et al., 2007). As foods products in the Netherlands most often only provide product information of the “total” sugar content of the product rather than the amount of “added” sugar, total sugar was used. Here, foods containing ≥13.5 g/100 g of total sugar and drinks containing ≥4.5 g/100 g of total sugar were taxed with 25 percent. In total, 157 (31 percent) products were taxed, including 110 foods and 47 drinks.

Saturated fat tax. The saturated fat tax was based on the Danish fat tax (October 2011-January 2013) where the prices of products containing ≥2.3 g/100 g saturated fat were taxed, corresponding with a price increase of €2.14 per kilogram saturated fat. Empirical evidence revealed that household food purchases reduced products as butter, blends, oils, margarines by 10-15 percent (Jensen and Smed, 2013) and led to an average decrease in saturated fat consumption by 4 percent (Smed et al., 2016). In the current study, products with ≥2.3 g/100 g saturated fat were taxed with 25 percent. In total, 186 (36 percent) products were taxed, including 174 foods and 12 drinks.

No tax – control condition. In the control condition, regular prices were used. Moreover, no notification about prices was communicated before entering the supermarket.

Recruitment and procedures

A ~450 kcal decrease in calorie purchases per day for an average three-person household was determined to be a minimal relevant effect. A priori sample size estimation indicated that 700 participants (175 per group) would be required to detect a difference of 3,150 kcal (SD 10,000) per one-week food basket with a two-sided 5 percent significance level and a power of 80 percent. The study followed the standards of the institutional medical ethical committee.

Participants were recruited through advertisements in newspapers (two national, six local), social media (Twitter, Facebook), the website of the Netherlands Nutrition Centre Foundation and by a message on a local radio station. Inclusion criteria were as follows: being 18 years of age or older, familiar with the Dutch language and being the household gatekeeper (responsible/shared responsibility for doing the groceries). Two €100 and thirty €10 vouchers were raffled among the participants that completed the study. Also, a donation of €1.00 for every registered participant was provided to a health charity.
Following registration, participants were randomized via a computer-generated list containing pre-determined log-in codes for the virtual supermarket. These log-in codes corresponded with random allocation to either the control or one of the experimental conditions. Participants in the tax conditions were aware of the taxation scheme due to the tax salience. Participants received an e-mail explaining the study details and the link to the virtual supermarket. When entering the supermarket, each participant was asked to conduct a typical shopping trip for his/her household for one week. Before entering the virtual supermarket, participants were told that the experiment was virtual, the taxation message was displayed (except for the control group), and all participants were informed that they would not receive the groceries for real. Participants were asked about their household size and composition which was used to allocate a household-specific shopping budget minimally needed for weekly food consumption according the National Institute for Family Finance Information (Nibud, 2014). Next, participants were able to enter the virtual supermarket and do their groceries. When finished shopping, participants moved to the cash register and were directed to a closing questionnaire.

Measures
The primary outcome measure was the difference in energy (kilocalories) purchased between the tax conditions and the control condition. Secondary outcome measures were saturated fat (gram) and sugar (gram) purchased between the tax conditions and the control condition. Moreover, questions on potential confounders and effect modifiers were included. First, the following sociodemographic characteristics were measured: household size, level of responsibility for groceries, age, sex, gross income, educational level and BMI. Moreover, questions (15 items) regarding price perception (Lichtenstein et al., 1993) and questions (15 items) measuring impulsivity (Spinella, 2007) were assessed because these were hypothesized to be strong predictors of the outcomes. Third, one question about understanding of the virtual supermarket and two questions about participants’ notice of prices in the virtual supermarket were included. Fourth, participants were asked if their purchases in the virtual supermarket reflected a shopping trip comparable to real life with one item on a scale from 1 to 7: “The products I purchased in the Virtual Supermarket are a fair representation of what I regularly buy in a supermarket” with a response option ranging from 1 (totally not) to 7 (totally yes). Finally, the intervention conditions were asked if they had read the notification about the concerned tax in the virtual supermarket.

Statistical analyses
Participants indicating that their purchases in the supermarket reflected a fair representation of what they regularly bought in real life (≥4 out of 7) were included in the analysis. Mean (SD) and frequencies of the outcome measures were determined and tested for a normal distribution. Successively, mean differences in the main outcome measures between the conditions were analyzed using a one-way ANCOVA analysis. Both crude and adjusted analyses were conducted. The crude analysis was only adjusted for household size. The adjusted analysis included both participant characteristics (household size, sex, gross net income, educational level and BMI) and theoretically expected strong predictors of the outcomes (impulsiveness and price perception). Regression coefficients were presented for the tax conditions in comparison to the control condition. Afterward, a sensitivity analysis was conducted including all participants that completed the study, regardless of the real-life representativeness of their purchases. All tests were two sided and the level of significance was set at 0.05. Analyses were conducted using SPSS statistical software (version 21.00, IBM SPSS Inc., Chicago, IL).
Results

Participants

Recruitment ran for five months but had to be halted afterward because of (staffing) budget restraints. In total, 323 participants signed up for the study during this time. Of these, 113 (35 percent) dropped out: 50 (15.5 percent) because of technical problems with the virtual supermarket; 46 (14.2 percent) because they declined (e.g. lack of time, incentive wanted) or did not respond after signing up (following two reminder emails); and 17 (5.3 percent) because their purchases in the virtual supermarket were not processed properly by the website server. As such, 210 (65 percent) participants completed the study. Because of this dropout, numbers of participants in each condition were not evenly allocated. Of the 210 participants, 191 (91 percent) reported that their shopping behaviors were comparable to real-life purchases and were included in the analysis (Figure 1). Table I presents an overview of the participants’ characteristics. In all conditions, household size was fairly similar, most participants were female, had a healthy weight and a high educational status.

<table>
<thead>
<tr>
<th>Group and number of participants (n)</th>
<th>Control condition (n = 44)</th>
<th>Fat-tax condition (n = 37)</th>
<th>Sugar-tax condition (n = 48)</th>
<th>Nutrient profiling-tax condition (n = 62)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household size Mean (SD)</td>
<td>2.47 (1.25)</td>
<td>2.19 (1.24)</td>
<td>2.25 (1.12)</td>
<td>2.74 (1.44)</td>
</tr>
<tr>
<td>% of HHS above 14 y %</td>
<td>87.65 (20.93)</td>
<td>92.70 (15.98)</td>
<td>91.60 (19.25)</td>
<td>2.74 (1.44)</td>
</tr>
<tr>
<td>Household income (gross monthly in €)</td>
<td>23.1</td>
<td>32.3</td>
<td>27.3</td>
<td>32.8</td>
</tr>
<tr>
<td>% low (0-2,000) % mid (2,000-3,000)</td>
<td>83.62 (16.67)</td>
<td>88.09 (14.84)</td>
<td>89.23 (12.25)</td>
<td>86.05 (16.27)</td>
</tr>
<tr>
<td>Virtual shopping budget % mean (SD)</td>
<td>79.5</td>
<td>73.0</td>
<td>83.3</td>
<td>87.1</td>
</tr>
<tr>
<td>Percentage spent % mean (SD)</td>
<td>21.6</td>
<td>20.8</td>
<td>20.5</td>
<td>19.0</td>
</tr>
<tr>
<td>Age % 18-31 % 32-46 % 47-61 % 62+</td>
<td>79.5</td>
<td>73.0</td>
<td>83.3</td>
<td>87.1</td>
</tr>
<tr>
<td>Education % low % medium % high</td>
<td>6.8</td>
<td>13.5</td>
<td>18.8</td>
<td>8.1</td>
</tr>
<tr>
<td>Body mass index (BMI) Mean (SD)</td>
<td>24.5 (3.97)</td>
<td>23.7 (3.50)</td>
<td>25.1 (4.24)</td>
<td>24.0 (3.66)</td>
</tr>
<tr>
<td>BMI ≤ 25 %</td>
<td>66.7</td>
<td>77.8</td>
<td>57.8</td>
<td>70.0</td>
</tr>
<tr>
<td>BMI &gt; 25 %</td>
<td>33.3</td>
<td>22.2</td>
<td>42.2</td>
<td>30.0</td>
</tr>
<tr>
<td>Price perception score %</td>
<td>4.23 (0.82)</td>
<td>4.42 (0.90)</td>
<td>4.36 (0.74)</td>
<td>4.17 (0.79)</td>
</tr>
<tr>
<td>Impulsiveness score %</td>
<td>1.89 (0.34)</td>
<td>1.85 (0.35)</td>
<td>1.79 (0.23)</td>
<td>1.85 (0.25)</td>
</tr>
<tr>
<td>Understanding %</td>
<td>5.52 (1.30)</td>
<td>5.97 (0.90)</td>
<td>5.67 (1.15)</td>
<td>5.84 (1.18)</td>
</tr>
<tr>
<td>Price awareness in during virtual shopping %</td>
<td>3.50 (1.79)</td>
<td>3.55 (1.67)</td>
<td>3.65 (1.74)</td>
<td>3.65 (1.85)</td>
</tr>
<tr>
<td>Awareness of taxation % yes</td>
<td>89.2</td>
<td>95.8</td>
<td>93.5</td>
<td></td>
</tr>
</tbody>
</table>

Notes: "The standard gross monthly income in the Netherlands in 2014 was €2,695 (MODAAL);" measured by 15 items (seven-point Likert Scale) from the seven “price perception construct scale items” (Lichtenstein); "measured by 15 items (four-point Likert Scale) of the shortened version of the Barratt Impulsiveness Scale (barratt/spinolla);" measured by one item on the virtual supermarket software; "measured by two items about the awareness of the price in the virtual supermarket;" measured by one item about the notification of the implemented tax.

Table I.
Participant characteristics
On average, participants spent over 80 percent of the budget that they received in the virtual supermarket. In the taxation conditions, around 90 percent of the individuals were aware of the food tax present in the supermarket (Table I).

**Kilocalories (kcal) purchased**
The amount of kilocalories, saturated fat (g) and sugar (g) purchased were normally distributed. Mean (SD) calories purchased were 35,213 (12,222) per household per week in the control condition, 30,988 (10,997) in the saturated fat-tax condition, 32,239 (11,967) in the sugar-tax condition and 35,666 (15,509) in the nutrient profiling-tax condition. Primary outcomes indicated that there were no significant effects of any of the three taxation schemes compared to the control condition on the total amount of calories purchased (saturated fat tax: $b = -2,009$ (95% CI $-5,802$ to $1,783$); sugar tax: $b = -1,226$ (95% CI $-4,934$ to $1,770$)). The observed effects became somewhat stronger in the adjusted models saturated fat tax: $-2,717$ (95% CI $-6,596$ to $1,163$); sugar tax: $-2,041$ (95% CI $-5,695$ to $1,612$), except for the WXY condition: $-1,124$ (95% CI $-5,388$ to $2,292$) where they became weaker. Although the differences between the taxation conditions and the control group remain statistically insignificant, the outcomes appear to be in the expected direction. The sensitivity analysis including the entire study sample ($n = 210$) showed similar results.

**Saturated fat and sugar (gram) purchased**
Similar to the primary outcome, an analysis on the secondary outcomes (amount of saturated fat and sugar purchased) also did not show statistically significant effects for any of the experimental conditions (Tables II (b) and (c)). Again, similar effects were observed in the sensitivity analysis including the entire study sample ($n = 210$).

**Discussion**
The observed effects of the three taxation schemes on food purchases compared to control were statistically insignificant. This lack of a statistically significant effect is likely due to the small sample sizes included, which resulted from recruitment challenges during the study. However, the outcomes were in the expected direction (i.e. less calories, saturated fat and sugar purchased) and the results of this preliminary study suggest a potential effect of the taxes on calorie purchases (primary outcome) because 3,150 kcal anticipated in the power calculation lies within the 95% confidence interval ($-6,596$ to $1,163$). However, the current study is unable to provide firm conclusions on the effectiveness of food taxes on calories purchased. Succeeding this preliminary study, in future, more studies are needed to provide robust experimental evidence on the effects of food taxes. Moreover, future simulation modeling studies would benefit from determining different food tax approaches.

The non-significant effects were indeed in the same direction as the outcomes of previous modeling studies (Thow, 2014; Eyles, 2012). However, in line with our results, previous studies in virtual supermarket settings also did not find significant effects of taxes on overall calories purchased (Waterlander et al., 2012b; Epstein et al., 2015), although including an appropriate sample size. A study by Waterlander et al. (2012b) that combined food tax (20 percent) on unhealthy foods with a small (5 percent) discount on fruit and vegetables did not significantly discourage unhealthier food or calories purchased. A more recent experimental study by Epstein et al. (2015) also did not find an effect of taxation (12.5 and 25 percent) on high-energy dense foods on the overall calories purchased. However, purchases of the taxed foods decreased statistically significant. Also, another study using the virtual supermarket methodology revealed that a price increase of 12.4 percent of SSB would result in a statistically significant decrease of 168 kcal pp/week as a result from the decrease in
Future studies should not only reveal effects on overall purchased calories but also on the effectiveness of the taxed products specifically.

Besides the lack of an adequate sample size, another explanation of the insignificance of the results could be the design of the tax instrument used in this experiment. Comparable to previous studies (Waterlander et al., 2012b; Waterlander, Ni Mhurchu and Steenhuis, 2014), fixed cut-off values were used to tax products in this experiment; for example, both semi-fat (5 g sat. fat/100 g) and high-fat products (15 g sat. fat/100 g) were taxed equally (by 25 percent). This might be less of an incentive for individuals to substitute high-fat products to lower-fat alternatives that now are also taxed if more than 2.3 g fat/100 g. Moreover, using a relative “price change,” higher priced products are more heavily taxed (in absolute sense) and may lead to perverse substitution effects if higher priced products are healthier or of higher quality. Yet, as showed in a previous study, more expensive products are not necessarily of better nutritional quality (Waterlander, van Kouwen and Steenhuis, 2014). Future studies – but also policy makers – should consider the design of the tax instrument carefully.

Table II.
The effect of the taxation schemes on the amount of kilocalories (a), grams of sugar (b) and saturated fat (c) purchased

<table>
<thead>
<tr>
<th>Taxation Scheme</th>
<th>B</th>
<th>SE</th>
<th>95% CI low</th>
<th>95% CI high</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Effects of taxation schemes on kilocalories purchased</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saturated fat tax model 1</td>
<td>−2,009</td>
<td>1,922</td>
<td>−5,802</td>
<td>1,783</td>
<td>0.30</td>
</tr>
<tr>
<td>Saturated fat tax model 2</td>
<td>−2,527</td>
<td>1,861</td>
<td>−6,403</td>
<td>1,348</td>
<td>0.20</td>
</tr>
<tr>
<td>Saturated fat tax model 3</td>
<td>−2,717</td>
<td>1,966</td>
<td>−6,596</td>
<td>1,163</td>
<td>0.17</td>
</tr>
<tr>
<td>Sugar tax model 1</td>
<td>−1,236</td>
<td>1,797</td>
<td>−4,772</td>
<td>1,230</td>
<td>0.50</td>
</tr>
<tr>
<td>Sugar tax model 2</td>
<td>−1,718</td>
<td>1,640</td>
<td>−5,350</td>
<td>1,914</td>
<td>0.35</td>
</tr>
<tr>
<td>Sugar tax model 3</td>
<td>−2,041</td>
<td>1,851</td>
<td>−5,695</td>
<td>1,612</td>
<td>0.27</td>
</tr>
<tr>
<td>Nutrient profiling tax 1</td>
<td>−1,582</td>
<td>1,699</td>
<td>−4,934</td>
<td>1,770</td>
<td>0.35</td>
</tr>
<tr>
<td>Nutrient profiling tax 2</td>
<td>−1,147</td>
<td>1,727</td>
<td>−5,555</td>
<td>1,260</td>
<td>0.51</td>
</tr>
<tr>
<td>Nutrient profiling tax 3</td>
<td>−1,124</td>
<td>1,731</td>
<td>−5,383</td>
<td>1,792</td>
<td>0.52</td>
</tr>
<tr>
<td>(b) Effects of taxation scheme on sat fat purchased (gram)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saturated fat tax model 1</td>
<td>−52.34</td>
<td>35.71</td>
<td>−122.78</td>
<td>18.09</td>
<td>0.14</td>
</tr>
<tr>
<td>Saturated fat tax model 2</td>
<td>−56.76</td>
<td>36.00</td>
<td>−127.82</td>
<td>14.30</td>
<td>0.12</td>
</tr>
<tr>
<td>Saturated fat tax model 3</td>
<td>−59.90</td>
<td>36.02</td>
<td>−131.07</td>
<td>11.28</td>
<td>0.09</td>
</tr>
<tr>
<td>Sugar tax model 1</td>
<td>−46.75</td>
<td>33.38</td>
<td>−112.60</td>
<td>19.11</td>
<td>0.16</td>
</tr>
<tr>
<td>Sugar tax model 2</td>
<td>−55.15</td>
<td>33.75</td>
<td>−121.75</td>
<td>11.45</td>
<td>0.10</td>
</tr>
<tr>
<td>Sugar tax model 3</td>
<td>−60.51</td>
<td>33.97</td>
<td>−127.55</td>
<td>6.52</td>
<td>0.08</td>
</tr>
<tr>
<td>Nutrient profiling tax 1</td>
<td>−35.30</td>
<td>31.56</td>
<td>−97.56</td>
<td>26.96</td>
<td>0.27</td>
</tr>
<tr>
<td>Nutrient profiling tax 2</td>
<td>−22.00</td>
<td>31.66</td>
<td>−84.49</td>
<td>40.48</td>
<td>0.49</td>
</tr>
<tr>
<td>Nutrient profiling tax 3</td>
<td>−21.05</td>
<td>31.75</td>
<td>−83.72</td>
<td>41.61</td>
<td>0.51</td>
</tr>
<tr>
<td>(c) Effects of taxation scheme on sugar purchased (gram)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saturated fat tax model 1</td>
<td>54.97</td>
<td>162.62</td>
<td>−265.85</td>
<td>375.79</td>
<td>0.74</td>
</tr>
<tr>
<td>Saturated fat tax model 2</td>
<td>9.18</td>
<td>156.56</td>
<td>−297.37</td>
<td>282.43</td>
<td>0.96</td>
</tr>
<tr>
<td>Saturated fat tax model 3</td>
<td>15.97</td>
<td>168.20</td>
<td>−316.00</td>
<td>347.94</td>
<td>0.92</td>
</tr>
<tr>
<td>Sugar tax model 1</td>
<td>151.97</td>
<td>152.05</td>
<td>−451.93</td>
<td>147.98</td>
<td>0.32</td>
</tr>
<tr>
<td>Sugar tax model 2</td>
<td>136.86</td>
<td>156.56</td>
<td>−445.84</td>
<td>172.12</td>
<td>0.38</td>
</tr>
<tr>
<td>Sugar tax model 3</td>
<td>125.47</td>
<td>158.42</td>
<td>−438.44</td>
<td>187.20</td>
<td>0.43</td>
</tr>
<tr>
<td>Nutrient profiling tax 1</td>
<td>−4.07</td>
<td>143.74</td>
<td>−287.64</td>
<td>279.51</td>
<td>0.98</td>
</tr>
<tr>
<td>Nutrient profiling tax 2</td>
<td>−7.47</td>
<td>146.89</td>
<td>−297.37</td>
<td>282.43</td>
<td>0.96</td>
</tr>
<tr>
<td>Nutrient profiling tax 3</td>
<td>−3.51</td>
<td>148.08</td>
<td>−295.78</td>
<td>288.76</td>
<td>0.94</td>
</tr>
</tbody>
</table>

Notes: Model 1: corrected for household size; Model 2: corrected for household size and sociodemographic variables; Model3: corrected for household size, sociodemographic variables and impulsiveness and price perception.
An innovative aspect of the study setting was that tax salience was introduced, to reflect a more real-life situation. However, this study did not specifically examine the effect of the tax salience. In future, experimental studies need to be conducted to determine the effectiveness of the tax salience itself. Chen et al. (2015) showed that individuals decrease the intake of calories, fat, carbohydrates and sodium in a cafeteria setting due to visibility of food taxes. Future studies testing different food taxes and policy makers need to keep in mind that a disadvantage of nutrient-based taxes is that they may apply on both foods that are recommended by dietary guidelines (e.g. dairy, meat, fish) and on unhealthier foods (snacks, soft drinks). Therefore, rather than taxing nutrients, the taxation of certain foods is more often considered, like taxing snack foods or soft drinks (Cabrera Escobar et al., 2013). This corresponds to the current regulation on alcohol and tobacco (Leiceser and Windmeijer, 2004; Thow et al., 2014). Also, rather than focusing solely on health promotion, taxes that are focused on sustainability-based decisions may be of interest and may indirectly effect the healthiness of purchases positively (Wirsenius et al., 2011).

Several strengths of this initial experiment should be acknowledged. To best knowledge of the authors, this is one of the first studies testing a range of food taxes in one experiment. The taxing schemes were applied in the same highly controlled setting, providing strong internal validity. In addition, compensatory purchasing and cross-price elasticity were taken into account by analyzing the effects on the total amount of calories, saturated fat and sugar purchased as opposed to only measuring the purchases of products that were taxed. Although virtual reality settings provide great potential for taxation studies, it should be kept in mind that results of virtual supermarket studies reflect hypothetical purchasing decisions. Although the virtual supermarket was validated against real-life purchases (Waterlander et al., 2015), it is unclear to what extent these self-reported data reflect real-world decision; and studies in more ecological valid settings would strengthen the literature on food taxes.

The study also faced few weaknesses, and “lessons learned” with respect to recruitment, incentives and technology can be obtained from the current study. First, major challenges in recruitment were experienced that were not expected, based on previous studies with the virtual supermarket (i.e. Waterlander, 2012a, b). In the current study, however, much effort was put in recruiting participants (national newspapers, websites and social media) for approximately a five-month period. Though a large number of participants \( n = 323 \) were recruited, a longer recruitment period (at least \( \geq 6 \) months) and a more intensive recruitment strategy (e.g. via personal e-mail or telephone or via the use of existing consumer panels) are needed to include a sufficient number of participants. Second, the incentives in the study were not guaranteed (e.g. chance to win money) or not addressed to the participants (donation to charity). This might indicate that the used incentive was not appropriate to motivate individuals to participate initially or could explain why a considerable number of participants (14.2 percent) did not start the study after initially signing up. This confirms previous insights that a guaranteed incentive may be more beneficial than a lottery incentive (Leung et al., 2002). However, studies did indicate that altruism is an important motivator to participate (Stunkel and Grady, 2011) and therefore a larger number of individuals were expected to participate using a donation to charity as an additional incentive. Finally, a larger number of the participants than anticipated experienced problems with the virtual tool (20.8 percent), which is contradictory with our previous studies using the virtual supermarket. We experienced that compatibility with all different computer systems was a challenge, that respondents were not able to install the program themselves or gave up on/were not motivated to install the virtual tool. This shows that it is important to continue investing in this technology and making sure it is up-to-date with most recent computer systems.
Conclusions
This study explored the impact of three taxation schemes (saturated fat tax, sugar tax and nutrient profiling tax) on food purchases in the virtual supermarket. Virtual environments allow for objective observations and controlled manipulations in a “laboratory” setting, while simulating real-life environments. Non-significant effects of the tested food taxes were observed on the purchases of calories, sugar and saturated fat compared to the control group. Yet, the outcomes were in the expected direction and our study provides useful tools for the design of future food pricing trials, such as specific data on required sample size, recruitment strategies and the use of virtual reality.

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Abstract

Purpose – The purpose of this paper is to explore factors associated with body weight gain among British university students who were members of a slimming club.

Design/methodology/approach – Student members of a national commercial slimming programme completed an online survey about cooking ability, weight gain, eating habits and physical activity levels. Non-parametric statistical tests and regression analysis were employed to examine factors associated with weight gain.

Findings – The data set comprised 272 current students. The majority of students (67 per cent) reported weight gain between 3.2 and 12.7 kg during studying in university: 20.4 per cent reported to have gained >12.7 kg. Students commonly attributed their weight gain to academic stress and nearly all identified with needing support to learn to cook on a budget. Students reporting greatest weight gain had most frequent consumption of ready meals & convenience foods, take-away & fast foods and least frequent consumption of fruits & vegetables. Weight-stable students reported lowest consumption of alcohol and were most able to cook complex meals. Students who reported greatest weight gain reported lower physical activity levels. There were inter-correlations between cooking ability and lifestyle factors. In a multivariate model, low physical activity and frequent consumption of ready meals and convenience food independently predicted weight gain. Weight gain was inversely associated with diet quality, cooking ability and physical activity with reliance on ready meals & convenience food independently predicted weight gain. Prospective studies are needed to confirm these cross-sectional associations and to explore how the university setting may contribute to the effect.

Originality/value – The study adds additional perspective to understanding student weight gain at university in that it focuses on a body weight-conscious sub-group of the student population, as opposed to the general population of students.

Keywords Students, Cooking, Alcoholic drinks, Convenience foods, Fast food, Obesity

Paper type Research paper

Introduction

Approximately 25 per cent of adults in England are obese (Health and Social Care Information Centre, 2015). Obesity places a substantial burden on society, fuelling hospital admissions and annual health care costs (Ellison, 2013). As the UK attempts to reverse the
The rising trend of obesity among its adult population (Ellison, 2013), it is critical to identify population groups at particular risk and to elucidate the factors underpinning risk in order to effect and target weight management interventions.

The first year of university has been identified as an “at risk” period for body weight gain, and a “Freshman 15” phenomenon has been proposed, which posits that first-year university students gain 15 lbs (6.8 kg) (Brown, 2008). Although most studies record lesser average weight gain, weight gain is variable (0.7-3.1 kg) (Crombie et al., 2009). Furthermore, when only students who gain weight are considered, observed weight gain is greater and the range narrower (3.1-3.4 kg) (Crombie et al., 2009). North American studies predominate this literature, but UK studies have identified a similar phenomenon: an average weight change of +2.5 kg was noted among first year female undergraduate students in a single semester, with 22 per cent of students gaining in excess of 6.8 kg (Cockman et al., 2013). A multi-centre UK study recorded lesser average weight gain (0.83 kg) during the first three months of university, but body weight change was variable (−7.2 kg to +11.6 kg) (Finlayson et al., 2012). Studies among British non-student populations are not available, although US studies show lower levels of weight gain in the general population (Levitsky et al., 2004).

Despite the wealth of literature describing body weight gain at university, the factors underpinning these changes are less clear (Cockman et al., 2013). Several studies have reported increased consumption of processed and take-away foods and/or decreased consumption of fruit and vegetables among students who gain weight (Levitsky et al., 2004; Pliner and Saunders, 2008; Pullman et al., 2009); others report no association between eating patterns and weight change (Holm-Denoma et al., 2008; Kasperek et al., 2008; Racette et al., 2005). Alcohol intake has also been implicated (Adams and Rini, 2007; Butler et al., 2004; Economos et al., 2008; Lloyd-Richardson and Lucero, 2008). Counter-intuitively, most North American studies, which have employed a detailed assessment of diet have not observed increased energy intake among weight gainers (Butler et al., 2004; Jung et al., 2008; Pullman et al., 2009). Studies focusing on the psychological constructs of eating behaviour have reported a link between weight change and dietary restraint, disinhibition, history of dieting and stress (Economos et al., 2008; Finlayson et al., 2012; Girz et al., 2013; Levitsky et al., 2004; Lowe et al., 2006; Serlachius et al., 2007). The relationship between physical activity and weight change is also unclear (Butler et al., 2004; Edmonds et al., 2008; Finlayson et al., 2012; Racette et al., 2005) and lack of body composition measures often blurs interpretation. Further research is necessary to delineate the factors behind weight gain among university students.

The objective of the current study was to examine dietary habits, physical activity levels and perceived reasons for weight gain in relation to body weight gain among university students in the UK. Access to data from a national weight management programme (Slimming World, UK) afforded an opportunity to examine the issue in students who self-identified as needing to lose weight. Research to date has sampled from the general student population (Cockman et al., 2013; Finlayson et al., 2012; Nikolaou et al., 2014).

Methods
Members of Slimming World UK who were past or current university students were invited to complete an online survey during autumn 2013. The survey collected the following information: gender; age; student status (current vs former student); number of years at university; weight gain at university; body weight prior to starting university (underweight – severely overweight); perceived reasons for weight gain; previous attempts at weight loss; perceived barriers to consuming a healthy diet at university; cooking ability; self-reported understanding of a healthy diet (non-existent to very good); consumption frequency of fruits and vegetables, fast food/takeaways, and convenience foods/ready meals; perceived healthfulness of food available on campus; alcohol consumption; effect of alcohol intake on food choices; ability to cook, shop and eat healthily on a student budget; factors influencing
food choices at university; and physical activity levels at university. Participants answered all questions in relation to their behaviours at university before joining Slimming World. Response options (e.g. frequency of consumptions; categories of weight gain; factors influencing food choices) were provided for each question.

The survey was designed and administrated by staff at Slimming World Headquarters. There were no incentives for participation. A total of 1,060 Slimming World members who were either current or former university students responded to the survey. This data analysis used a subset of respondents from the original survey; students who were no longer at university (n = 781) and male students (n = 5) were excluded. The former exclusion was instigated to improve data quality, since current students would be expected to more accurately recall dietary and physical activity habits and weight gain at university than graduates. Male students were excluded because they were few in number.

Self-reported weight gain at university was categorised: 0 kg (weight-stable); < 3.2 kg (< 0.5 stones); 3.2-6.4 kg (0.5-1 stone); 6.4-12.7 kg (1-2 stones); > 12.7 kg (> 2 stones). No participant in the current study reported weight loss at university. Category of weight gain was examined against perceived reasons for weight gain at university using non-parametric tests (SPSS Statistics V23). An ordinal logistic regression model was fitted to establish the independent effect of descriptively significant variables (cooking ability, food frequency and physical activity) as predictors of weight gain category. The statistical analysis was conducted using SPSS (IBM SPSS 23.0, IBM Armonk, USA).

Results
Approximately half of the sample (47.6 per cent) was between 18 and 21 years of age and just under one quarter (22.3 per cent) of respondents were between 22 and 30 years old. The majority of responders had been members of Slimming World for less than a month (46.0 per cent) or between three and six months (29.9 per cent) at the point of survey.

Table I provides descriptive data for reported weight gain, food group consumption and physical activity. An eighth of respondents (12.5 per cent) were weight stable during their time at university, while over half (55.4 per cent) reported gaining in excess of 6.4 kg. Only 15.6 per cent of students reported no weight gain during their first year at university compared to 34.4 per cent who reported gaining more than 6.4 kg; 58.1 per cent of students reported the same level of weight gain in the two time periods while 40.7 per cent reported a higher level of weight gain overall than in first year (Wilcoxon = 193, n = 270, p < 0.001).

Table I also shows descriptive data for physical activity and food consumption. Self-reported physical activity levels at university varied from “not at all active” (14.3 per cent) to “active or very active” (14.3 per cent). Less than one in four respondents reported that they consumed fruit and vegetables every day when at university, whilst one in three indicated that they consumed fruit and vegetables once a week or less. Self-reported consumption of takeaways/fast food meals was high, with just over half the sample (50.5 per cent) reporting eating take-away and fast food several times per week or more; just under a half (47.8 per cent) of respondents reported consuming ready meals & convenience food more than three times per week, with fewer than one in five respondents (18.2 per cent) reporting consumption of these foods greater than five times per week. One-third of respondents (33.7 per cent) also reported that they consumed alcohol on “three or more nights per week”.

Table II provides information on students’ self-assessment of their ability to cook various dishes. The dishes ranged from the simple, such as cheese on toast to the complex, such as a roast dinner. While 73 (26.6 per cent) of the sample reported being able to cook all fourteen of the dishes, less than 5 per cent reported being able to cook three or less dishes. Around 40 per cent of students could not make dishes such as shepherd’s pie, homemade soup and chilli con carne. Fewest students reported being able to cook a stew/casserole, with just over half of students claiming competency. A total of 82.7 per cent of the sample agreed
with the statement “students need support to learn how to cook healthy food/meals” and 91.9 per cent agreed with the statement “students need support to learn how to eat healthily on a budget”.

There were several significant associations between cooking ability and category of weight gain (see Table III). Specifically, a significantly higher proportion of students in the weight stable group reported that they were able to cook the following meals from scratch: stir-fry, homemade burger, soup, casserole/stew and shepherd’s pie. Students who reporting greater difficulty in shopping, cooking and eating healthily on a student budget reported greater weight gain ($\rho = 0.237; df = 265; p < 0.001$).

<table>
<thead>
<tr>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>34</td>
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</tr>
<tr>
<td>24</td>
<td>8.9</td>
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<tr>
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<td>42</td>
<td>15.3</td>
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<td>39</td>
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</table>

Table I. Self-reported weight gain, eating behaviours and physical activity levels at university prior to joining slimming world
χ² tests indicated statistically significant associations between level of weight gain and several food consumption measures, as well as physical activity. These cross-tabulations are shown in Table IV. Specifically, students reporting greatest weight gain (> 12.7 kg) were more likely to be frequent consumers of ready meals & convenience foods and

<table>
<thead>
<tr>
<th>Meal</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cheese on toast</td>
<td>260</td>
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</tr>
<tr>
<td>Tinned spaghetti hoops on toast</td>
<td>235</td>
<td>93.4</td>
</tr>
<tr>
<td>Baked beans on a jacket potato</td>
<td>250</td>
<td>91.6</td>
</tr>
<tr>
<td>Scrambled eggs on toast</td>
<td>236</td>
<td>86.4</td>
</tr>
<tr>
<td>Full English breakfast</td>
<td>221</td>
<td>84.6</td>
</tr>
<tr>
<td>Stir-fry</td>
<td>214</td>
<td>78.4</td>
</tr>
<tr>
<td>Spaghetti Bolognese</td>
<td>193</td>
<td>70.7</td>
</tr>
<tr>
<td>Shepherd's Pie</td>
<td>174</td>
<td>63.7</td>
</tr>
<tr>
<td>Roast dinner</td>
<td>168</td>
<td>61.5</td>
</tr>
<tr>
<td>Homemade soup</td>
<td>166</td>
<td>60.8</td>
</tr>
<tr>
<td>Chilli con carne</td>
<td>152</td>
<td>55.7</td>
</tr>
<tr>
<td>Homemade burger</td>
<td>149</td>
<td>54.6</td>
</tr>
<tr>
<td>Curry</td>
<td>143</td>
<td>52.4</td>
</tr>
<tr>
<td>Casserole/stew</td>
<td>141</td>
<td>51.6</td>
</tr>
</tbody>
</table>

Table I. Proportion of students reporting that they are able to cook specific meals

<table>
<thead>
<tr>
<th>Weight gain</th>
<th>None</th>
<th>&lt; 3.2 kg</th>
<th>3.2-6.4 kg</th>
<th>6.4-12.7 kg</th>
<th>&gt; 12.7 kg</th>
<th>χ² test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cheese on toast</td>
<td>31</td>
<td>22</td>
<td>61</td>
<td>89</td>
<td>54</td>
<td>3.44</td>
</tr>
<tr>
<td>Tinned spaghetti hoops on toast</td>
<td>31</td>
<td>23</td>
<td>59</td>
<td>83</td>
<td>54</td>
<td>4.39</td>
</tr>
<tr>
<td>Baked beans on a jacket potato</td>
<td>29</td>
<td>22</td>
<td>58</td>
<td>84</td>
<td>54</td>
<td>5.76</td>
</tr>
<tr>
<td>Scrambled eggs on toast</td>
<td>31</td>
<td>23</td>
<td>58</td>
<td>77</td>
<td>45</td>
<td>5.12</td>
</tr>
<tr>
<td>Full English breakfast</td>
<td>32</td>
<td>18</td>
<td>58</td>
<td>77</td>
<td>43</td>
<td>9.14</td>
</tr>
<tr>
<td>Stir-fry</td>
<td>31</td>
<td>20</td>
<td>55</td>
<td>65</td>
<td>40</td>
<td>12.92</td>
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<tr>
<td>Spaghetti Bolognese</td>
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<td>16</td>
<td>52</td>
<td>64</td>
<td>33</td>
<td>8.50</td>
</tr>
<tr>
<td>Shepherd's pie</td>
<td>27</td>
<td>13</td>
<td>46</td>
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<td>35</td>
<td>10.25</td>
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<tr>
<td>Roast dinner</td>
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<td>8.44</td>
</tr>
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<td>Homemade soup</td>
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<td>13.66</td>
</tr>
<tr>
<td>Chilli con carne</td>
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<td>15</td>
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<td>44</td>
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<td>10.92</td>
</tr>
<tr>
<td>Curry</td>
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<td>13</td>
<td>38</td>
<td>42</td>
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<td>8.38</td>
</tr>
<tr>
<td>Casserole/stew</td>
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<td>13</td>
<td>38</td>
<td>37</td>
<td>26</td>
<td>15.01</td>
</tr>
</tbody>
</table>

Note: Number and percentage of column totals in parentheses
take-away & fast food and least likely to consume fruit & vegetables on a daily basis. There was also a trend \( (p = 0.058) \) for alcohol consumption to be associated with weight gain; students in the top two categories of weight gain (6.4-12.7 kg and \( > 12.7 \) kg) had the highest proportion of frequent drinkers. Weight gain at university was inversely associated with self-reported physical activity: students reporting greatest weight gain at university (\( > 12.7 \) kg) were least likely to report that were “fairly active” (60-90 minutes activity per week) or “active”/“very active”.

Cooking ability was correlated with alcohol consumption \( (\rho_s = -0.226, n = 273, p < 0.001) \), consumption of take-away & fast food \( (\rho_s = -0.241, n = 273, p < 0.001) \), fruit & vegetables \( (\rho_s = 0.380, n = 273, p < 0.001) \), consumption of ready meals & convenience food \( (\rho_s = -0.320, n = 274, p < 0.001) \) and physical activity levels at university \( (\rho_s = 0.166, n = 273, p < 0.006) \).

After multivariate adjustment (Table V) only frequency of consumption of ready meals & convenience food and physical activity were associated with weight gain. Specifically, the ordinal logistic regression model showed that the odds of weight gain increased at all lower levels of physical activity, while the odds of weight gain decreased with less frequent consumption of ready meals. The model used had a pseudo \( R^2 \) of 23.4 per cent.

There were also significant associations between pre-university body weight and weight gain at university \( (\chi^2 = 33.75 \text{ df} = 12; p < 0.001) \). The most striking difference was that

<table>
<thead>
<tr>
<th>Weight gain</th>
<th>None</th>
<th>&lt; 3.2 kg</th>
<th>3.2-6.4 kg</th>
<th>6.4-12.7 kg</th>
<th>&gt; 12.7 kg</th>
<th>( \chi^2 ) test</th>
</tr>
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<tbody>
<tr>
<td>Frequency of consumption of alcohol</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>7 (20.6%)</td>
<td>3 (8.8%)</td>
<td>4 (11.8%)</td>
<td>13 (38.2%)</td>
<td>7 (20.6%)</td>
<td>20.54</td>
</tr>
<tr>
<td>&lt; 1 night per week</td>
<td>9 (18.8%)</td>
<td>7 (14.6%)</td>
<td>11 (22.9%)</td>
<td>14 (29.2%)</td>
<td>7 (14.6%)</td>
<td>( p = 0.058 )</td>
</tr>
<tr>
<td>1-2 nights per week</td>
<td>12 (12.5%)</td>
<td>9 (9.4%)</td>
<td>30 (31.3%)</td>
<td>27 (28.1%)</td>
<td>18 (18.8%)</td>
<td></td>
</tr>
<tr>
<td>3+ nights per week</td>
<td>6 (6.5%)</td>
<td>5 (5.4%)</td>
<td>17 (18.5%)</td>
<td>41 (44.6%)</td>
<td>23 (25%)</td>
<td></td>
</tr>
</tbody>
</table>

| Frequency of consumption of takeaways & fast food |
| Never | 5 (22.7%) | 6 (27.3%) | 4 (18.2%) | 5 (22.7%) | 2 (9.1%) | 41.65 |
| Once a week | 20 (18%) | 11 (9.9%) | 29 (26.1%) | 34 (30.6%) | 17 (15.3%) | \( p < 0.001 \) |
| A few a week | 8 (6.3%) | 4 (3.2%) | 26 (22.2%) | 55 (43.7%) | 31 (24.6%) | |
| 5+ a week | 0 (6%) | 3 (27.3%) | 2 (18.2%) | 1 (8.1%) | 5 (45.5%) | |

| Frequency of consumption of fruit & vegetables |
| Never | 0 (0%) | 1 (33.3%) | 2 (66.7%) | 0 (0%) | 0 (0%) | |
| Once or less a week | 6 (7.1%) | 5 (5.9%) | 18 (21.2%) | 30 (35.3%) | 26 (30.6%) | 34.08 |
| 2-3 a week | 8 (10.4%) | 5 (6.5%) | 15 (19.5%) | 35 (45.5%) | 14 (18.2%) | |
| 3-5 times a week | 4 (10.5%) | 3 (7.9%) | 10 (26.3%) | 15 (39.5%) | 6 (15.8%) | \( p = 0.005 \) |
| Everyday | 16 (23.9%) | 10 (14.9%) | 18 (26.9%) | 15 (22.4%) | 8 (11.9%) | |

| Frequency of consumption of ready meals & convenience foods |
| Never | 7 (35%) | 3 (15%) | 5 (25%) | 4 (20%) | 1 (5%) | 44.14 |
| Once a week | 5 (12.8%) | 6 (15.4%) | 13 (33.3%) | 11 (28.2%) | 4 (10.3%) | \( p < 0.001 \) |
| 1-3 times a week | 11 (13.4%) | 8 (9.8%) | 24 (30.3%) | 29 (35.4%) | 10 (12.2%) | |
| 3-5 times a week | 8 (9.9%) | 4 (4.9%) | 15 (18.5%) | 35 (43.2%) | 19 (23.5%) | |
| More than five times a week | 3 (6.1%) | 3 (6.1%) | 6 (12.2%) | 16 (32.7%) | 21 (42.9%) | |

| Table IV. Weight gain while at university tabulated against dietary consumption measures and physical activity |
| Level of physical activity |
| Not active at all | 3 (7.9%) | 5 (13.2%) | 7 (18.4%) | 11 (28.9%) | 12 (31.6%) | 40.16 |
| Rarely active | 6 (7.3%) | 4 (4.9%) | 17 (20.7%) | 32 (39%) | 23 (28%) | \( p = 0.001 \) |
| Sometimes active | 9 (13%) | 4 (6.5%) | 12 (17.4%) | 29 (42%) | 15 (21.7%) | |
| Fairly active | 4 (9.5%) | 4 (9.5%) | 16 (38.1%) | 15 (35.7%) | 3 (7.1%) | |
| Active or very active | 11 (28.2%) | 7 (17.9%) | 11 (28.2%) | 8 (20.5%) | 2 (5.1%) | |

Note: Number and percentages of consumption categories in parentheses.
students who were weight stable at university invariably reported being overweight or severely overweight prior to starting university compared to students who gained body weight at university. Between 23.8 and 43.5 per cent of the latter groups reported being of a healthy body weight prior to starting university.

When perceived reasons for weight gain at university were examined “eating unhealthily due to stress relating to studies” was significantly associated with level of weight gain at university ($\chi^2 = 79.47; \text{df} = 4; \ p < 0.001$). A greater proportion (90 per cent) of students in the 6.4-12.7 kg group attributed their weight gain to stress compared to approximately 70 per cent of students in other weight-gaining groups. There was also only one significant association between weight gain and factors influencing food choice at university: respondents in the weight stable group were less likely to report cost as an important influence on their food choices at university ($\chi^2 = 15.25; \text{df} = 4; \ p = 0.004$).

**Discussion and conclusion**

The current study set out to examine eating habits associated with weight gain among UK university students who were members of a slimming club. This focus on a weight-gaining sub-group of the student population who have sought help from a commercial slimming organisation, as opposed to the general student population (Cockman *et al.*, 2013; Finlayson *et al.*, 2012) provides particular perspective. We found considerable variation in weight gain during the first year of university with about a third of students reporting a gain greater than 6.4 kg (equivalent to 1 stone). This level of weight gain would be considered clinically significant for an average woman weighing 71 kg (> 7 per cent of body weight) and may have important long-term health implications. Meta-analytic data record average weight
gain to be 1.36 kg over the first year of student life for all students, while the corresponding figure for students who gain weight (excluding weight stable and weight losing students) was 3.38 kg (Vadeboncoeur et al., 2015). Clearly recruitment via a slimming club selects people who have a weight problem and who have experienced substantial and greater than average weight gain. This assertion is supported by data from a separate survey of Slimming World student members, which documented that new members had on average a Body Mass Index of 31.0 kg/m² upon entry to the programme (Smith et al., 2014).

Overall, reported weight gain over the entire university time period was greater than that reported during first year, concurring with a meta-analysis of studies that assessed weight gain in students beyond the first year (Fedewa et al., 2014). However, our data also showed that rates of weight gain slowed after the first year for nearly 60 per cent of students, contrary to the meta-analytic study. Our data are in line with the expectation that membership of a slimming club may ameliorate weight gain, and Slimming World data on weight loss in student members, which recorded a weight loss of approximately 5 kg for those who were overweight and obese and 3 kg for those who were a healthy weight after 12 weeks membership (Smith et al., 2014).

We identified clear associations between weight gain and eating habits. As weight gain increased diet quality decreased, with students reporting greatest weight gain reporting least frequent consumption of fruits & vegetables and most frequent consumption of alcohol, take-away & fast food, and ready meals & convenience foods. Additionally, we identified an association between cooking ability and weight gain, and were able to discriminate students’ level of weight gain according to their ability to cook more culinary complex meals.

Interestingly, cooking ability was negatively correlated with consumption frequencies of alcohol, take-away & fast food and ready meals & convenience foods, and positively correlated with consumption of fruit & vegetables and physical activity. All these correlations were of moderate magnitude. It is evident that a constellation of lifestyle habits may be working together to increase risk of weight gain confirming the cluster analysis approach of Greene et al. in a large cross-sectional study of both male and female North American students (Greene et al., 2011).

A multivariate model revealed that weight gain was most strongly associated with frequency of consumption of ready meals & convenience food and low physical activity. An axis between poor cooking skills, consumption of ready meals and risk of obesity has previously been documented in a non-student population (van der Horst et al., 2011), and ready meal consumption has been associated with the prevalence of obesity in Brazilian women (Lobato et al., 2009). Supermarket ready meals in the UK have been criticised for their high fat and salt content (Remnant and Adams, 2015), although limited data suggest that they are not consistently high in calories (Celnik et al., 2012). More generally, convenience food consumption has been implicated in the temporal rise in obesity rates in Australia (Dixon et al., 2006). Notably, convenience food is heterogeneous in type and diverse in nutrient composition, for example it can range in type from highly processed foods such as canned ravioli to single foods such as frozen French fries and unprocessed salads (Brunner et al., 2010). The finding that low physical activity is associated with weight gain concurs with other weight gain studies of university students (Butler et al., 2004; Edmonds et al., 2008; Greene et al., 2011). Although the strongest connections between weight gain and lifestyle metrics are for low physical activity and consumption frequency of ready meals & convenience food, our internal correlations suggest that a multi-behavioural effect is influencing risk of weight gain.

Stress was identified by students as a factor leading to weight gain particularly for students gaining between 6.4 and 12.7 kg of body weight, congruent with a previous UK study (Serlachius et al., 2007). The relationship between academic stress and calorie intake is inconsistent (Barker et al., 2015), but high stress has been reported to induce a hyperphagic response and tendency to consume high-fat, high-sugar foods particularly in restrained
eaters (Habhab et al., 2009; Wardle et al., 2000). Moreover, a qualitative study exploring emotional eating behaviours among North American university students reported that female students identified stress as a primary trigger for abandonment of normal eating patterns and increased food consumption (Bennett et al., 2013). The fact that students reporting greatest weight gain were not so likely to report stress as a perceived reason for their weight gain is unclear, although one possible explanation may be that these students are less susceptible to emotional hunger cues. Psychometric measures of eating behaviour are needed to confirm this possibility.

Finally, the relationship found between body weight going to university and weight gain thereafter is likely to be an artefact of our sampling frame. Students whose pre-university body weight was in the normal range and who did not gain weight are unlikely to be included in our sample. The relationship between baseline body composition and weight change has been examined, but remains unclear (Kasparek et al., 2008; Mifsud et al., 2009; Mihaolopoulos et al., 2008; Provencher et al., 2009). It is possible that overweight students arriving at university are already engaging in practices to prevent further weight gain, whilst those who begin university at a healthy body weight are less aware of a need to engage in behaviours that promote weight stability. Greater awareness among students about the risk of body weight gain at university may therefore be necessary.

Despite the novel nature of our study focusing on a weight-gaining subgroup of the general student population, it has a number of weaknesses. Specifically, our sample was female, prohibiting extrapolation to the general student body. However, this female predominance reflects the gender split of the national Slimming World membership (Stubbs et al., 2015). Additionally, all data in the current study were gathered using self-report and retrospective measures; lifestyle information may have been particularly difficult to accurately recall given that lifestyle changes would have been promoted – and likely implemented – upon joining Slimming World. However, restriction of the data set to current students who had recently joined the programme reduced the likelihood of such error. Notably self-reported and researcher-measured body weight among university students shows strong correlation in student populations (Delinsky and Wilson, 2008; Economos et al., 2008; Lloyd-Richardson et al., 2009). There is additionally no reason to believe any form of recall bias according to weight gain group occurred, reinforcing the validity of associations. As for many dietary studies, the collinearity observed between food and lifestyle behaviours would suggest that a large sample size or complex design is necessary to unpick the independent effects of single food behaviours.

Future research should now focus on this weight-gaining sub-group of the student population to further delineate reasons for weight gain and identify students at risk. Prospective studies are necessary to strengthen findings, and qualitative methods would enhance understanding. Ultimately this research is important to inform the development of interventions to reduce clinically significant weight gain during early adulthood. Indeed while a mobile phone-based intervention programme targeting dietary behaviour and physical activity has been shown to be effective in preventing weight gain in a young Australian adults (Partridge et al., 2016), there is limited study which addresses obesity prevention in student and non-students (Allman-Farinelli, 2015). British research investigating weight gain among a comparable non-student population is also pertinent to determine the extent to which the university setting is responsible for weight gain.

References


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What makes restaurateurs adopt healthy restaurant initiatives?
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Abstract

Purpose – The purpose of this paper is to uncover what affected restaurateurs in their intention to participate in the healthy restaurant initiative.

Design/methodology/approach – In all, 53 restaurateurs who participated in healthy restaurant initiatives in Korea responded to a survey. Multiple regression analysis was conducted to reveal the influences of perceived innovation characteristics (PICs), attitudes, subjective norm, and perceived behavioral control (PBC) on the intention to sustain a healthy restaurant.

Findings – The results showed that PBC, attitudes toward healthy restaurants, relative advantage for restaurants, and complexity among PICs were significant influences on the intention to sustain healthy restaurant initiatives.

Research limitations/implications – This research has made the first attempt to evaluate healthy restaurant initiatives using the perspectives of restaurateurs who actually participated in healthy restaurant initiatives. Also, this study extends the research model testing behavior intention using the theory of planned behavior and the innovation adoption theory to investigate the influences on restaurateur intentions to sustain healthy restaurant initiatives.

Practical implications – The findings indicate that operators must have access to sufficient technical resources and a sense of self-efficacy, which encourage restaurateurs to maintain healthy restaurant initiatives. Enhancing positive attitudes and the relative advantages of the healthy restaurant initiatives also encouraged participation. Finally, voluntary and continuous participation and expansion of healthy restaurant initiatives require community and government support, a simple use of process to change, and a good understanding of the relative advantages of healthy restaurant initiatives.

Originality/value – This study first illustrates the factors that best explain the intention to sustain a healthy restaurant from the perspective of restaurateurs. PICs shed light on how complexity and relative advantage for customers helps predict intentions to sustain healthy restaurant initiatives.

Keywords Healthy eating, Theory of planned behaviour, Healthy restaurant initiatives, Innovation adoption theory, Perceived innovation characteristics, Restaurant

Paper type Research paper

Introduction

As more people dine out, they rely on restaurant foods not only for taste but also for health. Restaurant foods, however, have long been associated with increased risk for many chronic diseases like cancer, stroke, heart disease, and high blood pressure because restaurant meals often contain excessive calories, fat, and sodium (Burton et al., 2006). Healthy menus in restaurants, especially developing new healthier recipes, could be regarded as socially responsible (Cassady et al., 2004; Hanni et al., 2009). Restaurants can actually contribute to public health by providing healthy food and health-related information. Nutrition labeling can provide customers with information they need to select healthy foods, a technique tried around the world to enable customers to make healthy choices in restaurants. This global trend inspired the Healthy Restaurant Certificate, launched in Seoul, Korea, in 2005, which includes voluntary nutrition labeling and healthy menus that meet nutrition standards. Providing healthy menus that meet nutrition standards could enhance the general health of a community and thus effectively promote health in the community (Macaskill et al., 2003; Roberto et al., 2009; Sosa et al., 2012).

However, healthy restaurant initiatives cannot succeed without the active participation of restaurateurs. Several studies have indicated that restaurateurs think providing nutrition information on a menu has a negative influence on sales (Glanz et al., 2005; Macaskill et al., 2000); other studies, however, have reported no significant changes in...
sales after menus were designed to include healthy options with recommended fat and salt intake as well as nutrition labeling (Chu et al., 2014). Operators of restaurants with small profit margins, however, may resist changing their menus for fear of losing customers, thereby limiting the number of healthy items available (Nothwehr et al., 2010; Richard et al., 1999). Thus, while healthy restaurant initiatives do contribute to good health, previous research has provided inconsistent results on restaurant sales (Glanz et al., 2005; Fitzgerald et al., 2004; Horgen and Brownell, 2002). Moreover, restaurateurs are deeply concerned not just about acceptability of menus to customers but about changes in food taste when fat and salt are reduced as ingredients and recipes change (Macaskill et al., 2000). A perceived increase in operational costs was revealed as a barrier to participation in a healthy restaurant program in Canada (Maestro and Salay, 2008). If community and government intend to encourage healthy restaurant programs, they must encourage restaurateurs themselves to adopt healthy restaurant policies and then sustain those policies. Thus, for any type of long-term success for healthy restaurant initiatives, research must identify what affects the decision of restaurateurs to follow and maintain the initiatives.

Encouraging participation in a healthy restaurant initiative requires understanding the restaurateurs, specifically their attitudes, their ability to control their working environment, and their relationships with their customers and their communities. Both the theory of planned behavior (TPB) and the innovation adoption theory (IAT) offer the ability to analyze active influences on restaurateurs and their decision about following the healthy restaurant initiative. TPB posits that the most important determinant of behavior is intention; intention, in turn, is predicted by attitude, subjective norm, and perceived behavioral control (PBC) (Ajzen, 1991). Thus, the intention to run a healthy restaurant is not only influenced by the attitudes and the responses of family members, friends, and colleagues, but also by how much of the working environment of the restaurant is under the actual control of the restaurateur, whether that is the work space, the resources needed to make the change, or the self-efficacy of the restaurateur. The IAT allows us to analyze restaurateurs for the innovative characteristics that would make the decision to change to a healthy restaurant easier for the operator (Chou et al., 2012; Lim, 2009; Gao et al., 2008; Quaddus and Hofmeyer, 2007). According to Rogers (1995, 2004), innovation characteristics like relative advantage, compatibility, complexity, observability, and trialability influence how easily a restaurateur can adapt to innovation. When restaurateurs have these innovation characteristics, they more easily accept change or perceive such changes positively, which means they have behavioral intentions to choose innovations (Rogers, 1995), such as the healthy restaurant initiatives in this study. However, difficulty in changing a restaurant operation (e.g. adjusting menu recipes and offering menu information) can interfere with a restaurateur’s intention to maintain healthy restaurant initiatives. Adopting innovation in organizations, such as restaurants, depends on the characteristics of the innovation, cost, complexity, and relative advantage (Rogers, 1995). Complexity, for example, can represent an intellectual challenge in understanding an innovation, as in differences between marginal and knowledge-based innovations or low-technology and high-technology innovations (Damanpour and Gopalakrishman, 2001).

Healthy menu initiatives in the restaurant industry have attracted research interest of late research scholars (Macaskill et al., 2003; Hwang and Lorenzen, 2008). However, few studies have examined restaurateur intentions, especially the impact of adopting innovations involving healthy menu practices in restaurants. Our study focuses on consumer behavior toward healthy restaurants from the perspective of the restaurateur. We identify factors that best explain a restaurateur’s intention to operate a healthy restaurant, which should allow us to offer suggestions for policy makers to encourage restaurateurs to participate in healthy restaurant initiatives. More specifically, our research
uncovers the relative importance of each perceived innovation characteristic (PIC), as well as attitude, subjective norms, and PBC. In this study, we evaluate the three-year-old healthy restaurant initiative in Korea from the perspective of restaurateurs themselves. Moreover, this research should deepen our understanding of what determines a restaurateur’s intention to sustain the healthy restaurant initiative by examining how PIC, attitude, subjective norms, and PBC influences the intention to run healthy restaurant.

**Literature review**

*Importance of a healthy menu program in the restaurant industry*

Many consumers are unaware of the high levels of calories, fat, saturated fat, and sodium in many restaurant menu items (Burton et al., 2006). Consequently, nutrition labeling for menu items has become an important part of deciding which menu item to order for healthy eating (Drichoutis et al., 2006). Restaurants that serve healthy meals are in great demand around the world, especially if they provide nutrition and health information on the menu (Yepes, 2014). However, some studies suggest conflicting or mixed outcomes in the impact of nutrition labels and healthy options; some show marginal or uncertain effects of nutrition labeling on consumer behavior in some types of restaurants and among some customers (Elbel et al., 2011; Parikh and Behnke, 2015). Without doubt, mandatory nutrition labeling for restaurants is gaining global visibility and has attracted the attention of many governments, policy agencies, and public health advocates in the USA (Patient Protection and Affordable Care Act, 2010).

Healthy eating practices have been widely addressed in the restaurant industry through healthy menus and nutrition labeling. Restaurants should take responsibility for the impact they have on customer health. Empirical studies have demonstrated that healthy menus and nutrition labeling in restaurants do result in customers who are more aware of health issues; they also have competitive advantages and engender customer satisfaction and loyalty (Burton et al., 2009; Hwang and Lorenzen, 2008). Hwang and Lorenzen (2008) argued that nutrition labeling was necessary, so customers could see healthy menu choices; healthy menu choices increase consumer choices and induce other restaurants to participate in healthy restaurant initiatives. Several studies have found that consumers were more likely to purchase healthy foods with fewer calories or less fat when nutrition information was provided on the menu (Burton and Creyer, 2004; Kozup et al., 2003).

**PICs**

Some restaurateurs are innovative, however, while others are not. Understanding what makes restaurateurs accept innovation, accept healthy restaurant initiatives, for instance, is an essential part of encouraging restaurateurs to change menu items, making the food healthier. The IAT can help reveal characteristics of an innovation that allow some people to more readily accept change. Research over the past 50 years has revealed some of what makes people likely to innovate, how they time adopting innovative plans, and the processes involved in adopting new ideas. Beyond the influence of environment and organization, certain characteristics of innovation are typically important (Damanpour and Schneider, 2009). The characteristics of innovation explain many differences among restaurateurs who are considering changing to a healthy menu and influence the rate at which innovations diffuse throughout the market. Innovation characteristics make individuals react differently to new ways of working, with some adopting change readily while others resist (Rogers, 2004). Empirical studies have generally found that innovation characteristics affect both the speed at which new ideas diffuse and the rate at which innovations are adopted (Damanpour and Schneider, 2009). Choosing a new system works best when the perceived characteristics of the innovation are positive or easily accepted. Therefore, we needed to investigate how individuals perceive the characteristics of an
innovation like a healthy restaurant initiative. Understanding this can help in identifying strategies that would ensure the initiatives’ success. Restaurateurs may be reluctant to innovate because of their uncertainty about changes in price and circumstance, even if innovation can improve their environment or business (Frambach and Schillewaert, 2002; Lin et al., 2007; Lim, 2009; Marcati et al., 2008).

According to Rogers (1995, 2004), innovation characteristics like relative advantage, compatibility, complexity, observability, and trialability provide information people need before they choose to adopt the innovation. A review of 75 studies of the relationships between the perceived characteristics of an innovation and adopting the innovation identified three characteristics (compatibility, relative advantage, and complexity) that are most consistently significant in relationships to adopting an innovation (Damanpour and Gopalakrishnan, 2001).

Relative advantage is the degree to which an innovation provides more benefits than its predecessor, showing increased efficiency and effectiveness, economic benefits, and enhanced status (Rogers, 1995). Profit and social benefit enhance the status of the organization (Rogers, 1995; Schneider, 2007). Relative advantage, thus, positively influences adopting innovation, because if the innovation had a strong relative advantage that innovation will help an organization achieve its strategic objectives and meet its performance goals. Thus, if a restaurateur perceives that an innovation has strong relative advantages that restaurateur will choose to innovate (Jeon et al., 2006; Lin et al., 2007). In general, healthy menu practices have clear overall organizational benefits, particularly in improved image and value, which tend to encourage restaurateurs to adopt healthy menus in their restaurants.

Compatibility describes how well an innovation fits existing organizational values, previous experiences, and current needs (Rogers, 1995). If organizational policy allows restaurateurs to understand innovation in a more familiar context, they are more likely to accept the change (Rogers, 1995). Moreover, a good fit between healthy menus and restaurant atmosphere and employee abilities or facility would motivate restaurateurs to develop new ideas. Thus, when restaurateurs perceive healthy menus as compatible with restaurant policies and goals, they are more likely to change and then to sustain the change.

Complexity describes the degree to which an innovation is difficult to understand, learn, or use (Rogers, 1995). New skills, technology, or knowledge can actually hinder acceptance of an innovation (Lin et al., 2007). The difficulty in acquiring the expertise necessary for new technology, for instance, can keep restaurateurs from choosing improvements without outside influence (Rogers, 2004). Prior research has used measures of complexity that show the difficulty of using an innovative device, the length of the operator’s manual, and special skills required. Healthy menu recipes and nutrition criteria can be complex, making any innovation hard to accept (Macaskill et al., 2000). Previous studies have also indicated that complex innovation requires more resources and skill, as well as increased cognitive effort from the restaurateur, all of which reduce the likelihood that a restaurateur will adopt the innovation (Verhoef and Langerak, 2001; Sia et al., 2004). Generally, complexity is widely recognized as a key barrier to behavioral intention.

Observability refers to whether the effects of the innovation can be clearly observed, described, or understood by potential users; it is positively related to adopting an innovation (Le et al., 2006). Observability is positive if potential users understand the innovation, see it well described, and choose it specifically. Trialability considers whether potential users can experience, try, or see the innovation before actually adopting it. Individual behavior was affected by these innovation characteristics. Innovations that are difficult to implement, less observable, and less trialable are less likely to be adopted because their success is more uncertain and their contribution to organizational performance is less likely (Damanpour and Gopalakrishnan, 2001; Rogers, 1995).
TPB
According to the TPB (Ajzen, 1991), individual behavior depends on behavioral intention, which is predicted by three determinants: attitude toward the behavior, subjective norm, and PBC. Attitude refers to the feelings of favorability toward a behavior, so when restaurateurs think healthy restaurants are meaningful, they are more likely to intend to offer healthy menus. Subjective norm, the normative influences or the perceived social pressure to perform or not perform a behavior, suggests that the approval of significant referents is also a factor in behavior. According to Ajzen (2002), PBC as determined by resources and opportunities can either facilitate or inhibit behavior, particularly as related to self-efficacy and controllability. In adopting innovation, the conditions of self-efficacy, resources, and technology were considered as PBC. Consistent with PBC, previous studies have identified knowledge and ability with technology (Montalvo, 2008; Jeon et al., 2006), resource sufficiency (Chan, 2008; Wan et al., 2005), and self-efficacy (Chan and Wong, 2006) were all three considerations in adopting innovative ideas. Thus, we used self-efficacy, organizational resources, innovative beliefs, and environmental features to represent PBC in this study.

Research hypotheses
We integrated the TPB and IAT in an attempt to reach a more comprehensive understanding of behavioral intention in adopting innovation, in this study, healthy restaurant initiatives (Chou et al., 2012; Lim, 2009). The specific research hypotheses were as follows:

H1. Perceived innovative characteristics positively affect the intention to sustain healthy restaurant initiatives.

H2. Attitude positively affects the intention to sustain healthy restaurant initiatives.

H3. Subjective norm positively affects the intention to sustain healthy restaurant initiatives.

H4. PBC positively affects the intention to sustain healthy restaurant initiatives.

Methodology
Healthy restaurant initiatives in Korea
This study focused on healthy restaurant initiatives for implementing healthy menus in restaurants. The Korea FDA, Seoul Metropolitan health district, and Seocho County in Seoul, Korea developed voluntary menu initiatives to highlight healthy menu options for restaurant customers. The initiatives were launched in 2005 in five restaurants and by 2010 had increased participants to 85 restaurants. The basis of these initiatives was adjusting menu recipes to meet Korean nutrition standards. Both local and chain restaurants were invited to participate and qualified as healthy restaurants if they modified menu items to meet nutrition criteria. Participating restaurants received promotions in the form of media messages, written educational materials, and recognition on the local government website. Restaurants were asked to display a certificate declaring them healthy restaurants at their entryway and on the menu. The logo highlights the menu items deemed healthier because they met the criteria outlined by the County Health District. Registered dietitians in the health district helped restaurateurs select menu items to modify and change the recipes to fit nutrition criteria. To be designated healthy, the menu item had no more than 700 calories, 20 g of total fat, or 1,400 mg of sodium. Menu recipes were revised within dietary guidelines for Koreans; items were analyzed for nutrients, calories, fat, and sodium. In addition, nutrition labels with calories, fat, and sodium were provided, and a designated healthy menu
was promoted by the local government website as well as brochures or menu board, table
tents, posters, or pamphlets. The County Health District supported these procedures with
financial aid and human resources.

Sample and data collection
In all, 85 restaurateurs participating in the healthy restaurant initiatives were selected as the
population of this study. Before administering the survey, researchers visited restaurants to
explain the purpose and procedure and asked restaurateurs if they were willing to participate
in the study. Data were collected through self-administered questionnaires via mail. A total of
52 healthy restaurants participated, and the response rate was 67 percent.

Survey questionnaire
The main survey questionnaire used PIC, attitudes toward healthy restaurants, subjective
norms, PBC, and behavioral intentions to sustain healthy restaurant initiatives. In all,
17 measurement items for PIC were generated using a literature review (e.g. restaurant
initiatives will help improve the image of my restaurant; the recipe changes are easy to
make; healthy restaurant initiatives are compatible with atmosphere of my restaurant)
(Chou et al., 2012; Jeon et al., 2006; Wan et al., 2005). Some new items were developed
reflecting the observability to fit healthy restaurant initiatives (e.g. Nutrition labeling of
menu is helpful to customer’s health). Ten PBC items (e.g. I have effective control over
healthy restaurant initiatives; I have enough technical resources to implement healthy
restaurant initiatives; my employees are required to implement healthy restaurant
initiatives) were generated to evaluate innovative beliefs or knowledge about technology
(Montalvo, 2008; Jeon et al., 2006), organizational resource and environmental features
(Chan, 2008; Wan et al., 2005), and self-efficacy (Chan and Wong, 2006). All items were
measured using a five-point Likert-scale, ranging from “strongly disagree” (1) to “strongly
agree” (5). Questions about restaurant business characteristics included operation type and
business period.

Data analysis
Descriptive analysis evaluated the process of establishing healthy restaurant initiatives and
noted changes in restaurant customers and sales. The exploratory factor analysis was
conducted to examine the dimensionality of PIC, and the confirmatory factor analysis
was conducted to check the validity of dimensions. Instrument reliability was assessed
using Cronbach’s $\alpha$. Before modeling the multiple regression, correlation analysis and
multi-collinearity test was conducted. In addition, to better explain the need to integrate the
TPB and IAT theory, this study used three multiple regression models: one with only
the TPB model, one with only the IAT model, and an integrated model with both the TPB
and IAT. The $R^2$ of all three models were compared. The multiple regression analysis of
integrated model was conducted to investigate the influences of PIC, attitudes, subjective
norm, and PBC on the intention to sustain a healthy restaurant.

Results
Sample profile
More than half the restaurants used in the study were independently operated. Most served
Korean food. These restaurants tended to be small, usually with fewer than 200 customers
per day and 41 percent of restaurants had monthly sales between $35,000 and $40,000 per day.
Many of these restaurants were operated by five or fewer employees. See Table I for further
descriptive characteristics.
Exploratory and confirmatory factor analyses for PICs

A series of exploratory factor analyses with principle component and varimax rotation reduced the number of dimensions and identified the underlying factors for PIC. Five items with low factor loadings (less than 0.40), high cross-loadings with other items (more than 0.40), or low communalities (less than 0.30) were deleted. Five factors with 15 items were extracted and labeled “relative advantage for restaurants,” “relative advantage for customers,” “compatibility,” “observability for change requirement,” and “complexity” with 76.94 percent of variance explained. The loadings of items for each PIC factor were all more than 0.50 (Table I). Relative advantage dimension in previous studies was divided by “relative advantage for restaurants” and “relative advantage for customers.” Five dimensions of PIC were confirmed by the confirmatory factor analysis (Table I). The fit index of the confirmatory factor analysis of PIC was satisfactory: $\chi^2/df = 95.025/32 = 2.969; p < 0.05; CFI = 0.961; TLI = 0.945; RMSEA = 0.089; SRMR = 0.039. Also, the reliability of the measurement items for all constructs was assessed using Cronbach’s $\alpha$. The $\alpha$ values of all constructs ranged from 0.72 to 0.96, showing satisfactory levels of internal consistency (Table I).

Multiple regression model

Before modeling multiple regression, we conducted correlation analysis and a multi-collinearity test. The results showed that eight predictors of multiple regression model are not correlated with each other based on correlation coefficient, VIF, and tolerance, indicating that this model could proceed with parameter estimation (Tables II and III). The results of two multiple regression models with only the TPB model and only the IAT model are shown in Table II.
model found that the $R^2$ of the models using only the TPB was 0.47 and only IAT was 0.34 (Table III). The $R^2$ of integrated model with the TPB and IAT had the $R^2$ of 0.55, higher than either alone. The results indicated that integrating the two theories better explained intentions to sustain healthy restaurant initiatives. A multiple regression analysis model that incorporated a TPB model and IAT was estimated to test $H1$-$H4$. Relative advantages for restaurants ($\beta = 0.266$, $p < 0.001$) and complexity ($\beta = -0.237$, $p < 0.001$) had significant influence on intention to sustain healthy restaurant initiatives (Figure 1). However, compatibility, observability for change requirement, and relative advantage for customers had no significant relationship with intentions. Thus, $H1$ was partly supported. The estimates of the standardized coefficients indicated that the linkage between attitudes toward healthy restaurant and intention to sustain a healthy restaurant initiatives was significant ($\beta = 0.328$, $p < 0.001$), supporting $H2$. Subjective norm was not positively associated with intention to sustain a healthy restaurant ($\beta = -0.176$, $p < 0.001$). Therefore, $H3$ was not supported.
For the relationship between PBC and intention to sustain healthy restaurant initiatives, the standardized path coefficient was 0.556, supporting H4 (Figure 1). In summary, PBC had the strongest influence on intention to sustain healthy restaurant initiatives.

**Discussion and implications**

This study focused on the perspectives of restaurateurs who use healthy restaurant initiatives, especially their decision to run a healthy restaurant; healthy restaurant initiatives cannot succeed without active operator participation. When restaurateurs saw healthy menus as advantageous and felt they could manage change, they tended to believe they could sustain the healthy restaurant initiative in their own business. PBC was most important, but attitudes were also influential in making the change and maintaining the change. Regression analysis results revealed that PBC had the strongest significant antecedents of intention to sustain healthy restaurant. They were also more likely to sustain a healthy restaurant when they perceived positive attitudes toward healthy restaurants. Our findings showed the importance of PBC in, for example, self-efficacy, organizational resources, innovative beliefs, and

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**Figure 1.** Research model results for intentions to sustain healthy restaurant initiatives
environmental features. The more effective control over the restaurant initiatives, budgets, technical resources, and cooperation from the district, the higher intention to sustain healthy restaurant initiatives. This result mirrors other studies. Adopter features, social networks, and environmental situations have been identified as antecedents of innovation adoption (Frambach and Schillewaert, 2002). Government support and the level of knowledge about innovation technology (Jeon et al., 2006) better explain the adoption of innovations. Thus, if PBC is a strong determinant of intention, improving self-efficacy, belief in innovation, and knowledge of environmental resources are essential to make changes. While attitudes and PBC helped explain behavioral intention in this situation, subjective norm was not a factor. Positive perception of the family, customers, employees, and other restaurateur regarding healthy restaurant initiative did not affect restaurateur’s intention to implement and sustain a healthy restaurant operation.

The usefulness of the TPB model was confirmed, but PIC have received little attention from researchers. This study extended the existing literature by empirically testing behavior intention using the TPB model and the IAT theory. Using innovation characteristics, this research showed that restaurateurs generally believed that healthy restaurant initiatives have benefits in image and value of restaurants; they also did not consider healthy restaurant initiatives complex. The relative advantages for restaurants among PIC such as improving image and value, increasing sales, and attracting new customers showed positive relationship with intentions. Complexity, one innovation characteristic, negatively affected behavioral intentions, similar to the studies of Verhoeof and Langerak (2001) and Sia et al. (2004). Thus, reducing complexity in providing healthy menus should strengthen the intention to maintain a healthy restaurant.

Academic contributions
To date, a considerable body of research has sought to explain how health information on menus and healthy food affects customer attitudes, value, satisfaction, and behavior intentions (Burton et al., 2006; Burton and Creyer, 2004; Kozup et al., 2003; Cranage et al., 2004). In addition, some research shows that most restaurateurs want their restaurant to be viewed as a place where customers can find healthy options (Macaskill et al., 2003; Hwang and Lorenzen, 2008). While published research provides a number of important insights, especially on providing nutrition information, it devotes scant attention to customer food choices at restaurants. Moreover, few studies have examined restaurateur intentions, especially the effect of innovation on healthy menu practices in restaurants. In particular, research on the perspectives of restaurateurs who have initiated healthy options is notably lacking. This research contributes to the literature by setting up a research model integrating perceived characteristics of innovation, attitude, subjective norms, and PBC among restaurateurs who run healthy restaurant initiatives. Moreover, this research should deepen our understanding of the intention of a restaurateur to sustain healthy restaurant initiatives by exploring the relative importance of innovation, attitude, subjective norms, and PBC. We sought to fill this gap by examining what influences restaurateurs to maintain healthy restaurant initiatives using perceived characteristics of innovation in a TPB model. Thus, one significant contribution of this research is that it has extended the existing literature by empirically testing behavior intention using the TPB model and the IAT theory.

Implications for practitioners
This study suggests the following implications for government policy makers to encourage healthy eating practices in the restaurant industry. First, as is obvious from the results, restaurateurs must perceive that they are in control of the situation (PBC) when asked to participate in healthy restaurant initiatives. The Health District can present the initiatives using PBC characteristics such as self-efficacy, technical resources, and
environmental features to convince restaurateurs of the feasibility of changing their menus to include healthy recipes and posting nutrition information. This means government and Health District should use the principles of PBC when developing strategies to keep restaurateurs interested in maintaining healthy restaurant initiatives and to attract other potential restaurateurs to invest time and effort in healthy restaurant initiatives. Government and community need to maintain support and rapport with restaurateurs, so restaurateurs perceive that they have the technical resources to implement healthy menu practices.

Second, favorable attitudes among restaurateurs are important because intention usually follows positive attitude. Third, one benefit of the healthy restaurant initiatives seems to be in sales; restaurants, as part of the initiatives, attracted new customers and kept old customers. Some work must still be done to increase sales and attract new customers. Studies have found that consumers had a positive attitude toward food and their purchase intentions increased when they were given nutrition information on the healthfulness of the menu (Hwang and Lorenzen, 2008). Healthy menus must not sacrifice taste for healthfulness, or the restaurant's business may decline; restaurants must address what consumers see as a connection between healthy and lack of flavor. Voluntary participation with minimal changes to menus would thus be better than extreme change in promoting healthy restaurant initiatives. Restaurants are in business to earn a profit, so economic benefits are essential, either through increased sales or reduced costs. Restaurateurs and local governments should try to motivate customers, particularly new ones, to try healthy menu options. Restaurateurs know their most important priority is profit, so they will offer healthy food options if consumers demand it. Fourth, complexity was important; if changes are too complex, restaurateurs will not maintain a healthy menu. Government action should actively focus on making changes simple and user friendly. To reduce the complexity level of healthy restaurant initiatives, the government may dig into those parts of the initiative that make operators reluctant to undertake changes and identify ways to make changes simpler. Personal interviews or focus group interviews might help expose the inside story of the restaurants.

This research indicates a healthy restaurant council would be helpful, one consisting of government and health district officials, as well as restaurateurs who could meet at least quarterly to address concerns. Any concerns on the part of restaurateurs should be communicated to the local government, which should, in turn, immediately address the concern. Strong ties among restaurateurs are important, and support from government agencies is also important. Increasing the effort to allow restaurants some flexibility in suggesting ideas for new opportunities and fostering positive interaction would help lay the groundwork for introducing healthy restaurant initiatives. If government and community leadership demonstrate respect for the opinions of restaurateurs, most restaurateurs will have higher self-efficacy and PBC, both of which are necessary to the success of these types of initiatives. Maintaining good communication with restaurateurs and incorporating their ideas into the initiatives would enhance commitment to the program.

Limitations and future study
Despite the significant theoretical and managerial implications, the results of this study have several limitations. Although this study was an initial step toward exploring intentions of restaurateurs to operate healthy restaurants, this study used a specific sample: those who were already participating in healthy restaurant initiatives in Seoul, Korea. Thus, this result might not generalize to other cultures, which may have differences in perceptions and behavior intentions. Future research would benefit from a more diverse population, especially from different countries, which may reveal different perceptions of healthy restaurant initiatives. To fully understand the detailed mechanism of motivating
restaurateurs to run healthy restaurants, future studies might need to examine the perspectives of corporate social responsibility in restaurants and to consider the effects of policy and environmental changes to increase public-private partnerships. Such future studies could provide detailed and practical implications for spreading healthy restaurant initiatives.

References


**Further reading**


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Dual pillars of hotel restaurant food quality satisfaction and brand loyalty

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Abstract
Purpose – The purpose of this paper is to investigate the impact of service quality (physical quality and staff behaviour) and brand equity (brand quality, brand awareness and brand image) on hotel restaurant food quality satisfaction and brand loyalty among international and local travellers in Malaysia.
Design/methodology/approach – A total of 354 valid questionnaires were collected to assess the measurement and structural model for reflective latent constructs using the two steps of covariance-based structural equation modelling.
Findings – The research findings suggest that while travellers’ nationality moderates the path between physical quality, staff behaviour and brand image on food quality satisfaction, it does not moderate the relationship between brand quality and brand awareness on food quality satisfaction. This finding further suggests that towards enhancing service quality and brand equity on food quality satisfaction, it does not moderate the relationship between brand quality and brand awareness on food quality satisfaction. This finding further suggests that international and local travellers’ nationality moderates the path between physical quality, staff behaviour and brand image on food quality satisfaction, it does not moderate the relationship between brand quality and brand awareness on food quality satisfaction. This finding further suggests that towards enhancing service quality and brand equity on food quality satisfaction, it does not moderate the relationship between brand quality and brand awareness on food quality satisfaction.
Originality/value – Previous studies have mostly examined the impact of brand equity and service quality towards tourist satisfaction and very few studies have examined the impact of restaurant service quality and brand equity on consumer satisfaction and brand loyalty specifically among international and local travellers. This paper is one of the first few studies providing empirical evidence and discussions in this area.

Keywords Brand equity, Service quality, Restaurants, Brand loyalty, Tourist satisfaction,
Hotel restaurant food quality

Paper type Research paper

1. Introduction
Service quality has been progressively defined as the main element in service distinction (Baker and Magnini, 2016) that plays a key role in customer satisfaction, employee satisfaction and profit in contrast to their rivals who are not concerned with their service quality. Looking at the services context and more specifically restaurant industry there is still limited empirical research for this claim. In the marketing literature, the brand is presented as a robust mechanism for the distinction of products. The increased competition between various restaurant companies with similar characteristics makes the brand a key differentiating factor (Callarisa et al., 2012; Harrington et al., 2017). However, there are a limited number of studies on the importance and role of restaurant brands (Callarisa et al., 2012; Hemsley-Brown and Alnawas, 2016; Kayaman and Arasli, 2007).

Customer loyalty and satisfaction is considered to be a significant metric for the industry due to its favourable implications on market share and financial performance. Service providers have a diverse image, and each customer has different impression and experiences. A solid brand image improves corporate esteem, financial performance and profitability (Fung et al., 2013; King, 2017). Most of the studies have investigated the
relationship between tourists’ satisfaction and intention but few studies have investigated brand equity and loyalty, which are influenced by customer satisfaction in the restaurant industry. Towards addressing this gap, this study aims to examine the impact of service quality factors (physical quality, staff behaviour) and brand equity factors (brand quality, brand awareness and brand image) on food quality satisfaction and brand loyalty of Malaysian restaurants from international and local travellers’ perspectives. First, the importance of service quality and brand equity is discussed. Second, the theoretical research framework and research hypotheses are presented. Third, the research methodology employed for this study is explained. Next, study results are presented and discussed. Finally, conclusions and recommendations emerging from this study are provided.

2. Theoretical background and hypothesis development

Figure 1 presents the theoretical research framework developed for this study, which is established based on service quality research (Ekinci et al., 2008), brand equity model (Aaker, 1996) and consumer-based brand equity (Nam et al., 2011). According to Keller (1993), consumer-based brand equity refers to a favourable memory and unique brand association held by consumers. The model of Aaker (1992) mainly includes centres of brand equity, such as brand association, brand awareness, perceived quality and brand loyalty.

According to Baumgarth and Schmidt (2010), the brand identity notion was originally established by Aaker (1996). Several definitions of the brand equity concept have been discussed in the literature but still, there is no common agreement about its measurement. In order to understand service quality and its measurement, several models and frameworks such as SERVQUAL have been proposed (Parasuraman et al., 1988). In particular, SERVQUAL pays more attention to the service and the facility in which the service is provided. As the level of quality perception increases, it can influence consumer perception, food quality satisfaction and loyalty.

2.1 Service quality factors

Previous studies found a positive link between the quality of services and satisfaction (Nam et al., 2011; Min and Min, 2006), and also satisfaction is connected with quality and value service perception. Service quality is found to have a direct and indirect impact on customer satisfaction. It positively and directly influences behavioural intention. It is also affected...
indirectly via satisfaction (Min and Min, 2006; Kashif et al., 2015; Khudri and Sultana, 2015). Meanwhile, service quality is essentially a cognitive assessment of customer perception, which is the main factor in developing a strong brand service to improve and make a unique brand in the market (Nam et al., 2011). Therefore, the service quality factor in this study consists of physical quality and staff behaviour, which was proposed by Ekinci et al. (2008).

2.1.1 Physical quality. Behavioural intention is positively and indirectly affected by perceived service quality. Satisfaction is positively influenced by service quality perception (Hutchinson et al., 2009), and significantly affects tourist satisfaction and loyalty. Consumer satisfaction along with brand experience is positively impacted by physical quality, which is one of the elements of service quality (Nam et al., 2011). Thus, the following is hypothesised:

\( H_1 \). There is a positive relationship between physical quality and food quality satisfaction in the restaurant industry.

2.1.2 Staff behaviour. Service quality depends on the emotional side of the customers in terms of quality and the interaction between customers and service providers. The service behaviour of employees is an important factor for assessing service quality (Ekinci et al., 2008). According to Chen (2008), the abilities of employees include items such as eagerness of staff to assist, good manners of staff, quick and great services, cleanliness, effective booking, excellent checking in and a great image of safety.

Previous studies (Chen, 2008; Nam et al., 2011) have examined the relationship among consumer variables that include customer satisfaction, value and purchase intention with service quality. Customer satisfaction along with brand experience is positively affected by staff behaviour and employee satisfaction (Nam et al., 2011). High level of service quality can cause a higher satisfaction, and positive behavioural intention (Chen, 2008). Furthermore, employee satisfaction precisely impacts customer loyalty, which, in turn, results in management services and policies that enable employees to transfer the outcome to the customers. Thus, the following is hypothesised:

\( H_2 \). There is a positive relationship between staff behaviour and food quality satisfaction in the restaurant industry.

2.2 Brand equity model
Brand equity is a method to assess the contribution of the brand name to the whole value of the product. A high degree of brand equity raises consumer satisfaction, repurchasing intent and level of loyalty (Kim et al., 2008) even though customer satisfaction does not always lead to loyalty (Lee and Back, 2008). Therefore, in this study, these factors are considered to have a positive impact on food quality satisfaction in restaurants.

2.2.1 Brand quality. Brand quality is one of the main attributes of brand equity (Callarisa et al., 2012). It can improve customer loyalty and lead to a better market share. The significance of the perception of quality as the main source of customer brand equity has already been identified as the motivating power behind the business to business branding technique (Chen et al., 2011; Ponnam and Balaji, 2015). Seven other attributes of service quality that are used in the customer brand equity model are features, quality confirmation, performance, durability and reliability, style serviceability, and, finally, design (Callarisa et al., 2012). The outcome suggests that a higher level of brand equity can enhance more pleasant measurement. In the context of hospitality, it shows that perceived quality decides the brand value of the trip and destination, and, in turn, has a positive impact on brand loyalty (Callarisa et al., 2012; Harrington et al., 2017). Thus, the following is hypothesised:

\( H_3 \). There is a positive relationship between brand quality and food quality satisfaction in the restaurant industry.
2.2.2 Brand awareness. Brand awareness is one of the most significant elements for the retrieval of information about the brand and is considered as a first and essential, but not sufficient step leading to trial and repeat intention (Callarisa et al., 2012). Brand awareness indicates whether the individual customer can remember or identify a brand easily, or just simply find out if they know or have heard of the brand before (Huang and Sarigöllü, 2012). Furthermore, consumer decision-making is influenced by brand awareness and consumers generally utilised brand awareness as an exploratory decision (Huang and Sarigöllü, 2012).

Brand awareness refers to an image of any particular destination that is created in the minds of consumers (Ferns and Walls, 2012), which is related to the power of the brand node (Lee and Back, 2008). Based on Lee and Back (2010), brand awareness positively influences satisfaction. The brand name is the most crucial factor of brand awareness. The outcome shows a positive relationship between brand awareness and brand equity (Huang and Sarigöllü, 2012). A brand with a higher rank in awareness in any particular industry could be considered as a set of potential customers (Baumgarth and Schmidt, 2010). Likewise, brand awareness relates positively to industrial brand equity (Chen et al., 2011). Therefore, the value is added to the products or services of brand equity that can raise customer satisfaction, and, eventually, result in higher profit for the restaurant business (Ferns and Walls, 2012). Thus, the following is hypothesised:

\[ H_4. \] There is a positive relationship between brand awareness and food quality satisfaction in the restaurant industry.

2.2.3 Brand image. Previous studies suggest that brand image is an emotional factor of a brand that follows a relative network in the mind of the consumers. Brand image is anything connected to the customer memory that applies to brand (Namkung and Jang, 2013). The restaurant environment and the quality of the food positively affect brand image and leads to further satisfaction. According to Beristain and Zorrilla (2011), the image of the store positively impacts on the loyalty. Moreover, brand equity is impacted positively by brand image. Dolbec and Chebat (2013) suggest that the image of the store could affect the variables of the brand, such as brand attitude, attachment and equity through brand experience. From the consumer’s point of view, there is evidence showing that brand image influences customer choice and their perceptions of customer value (Callarisa et al., 2012). Brand image can be translated into what customer can gain. Thus, the following is hypothesised:

\[ H_5. \] There is a positive relationship between brand image and food quality satisfaction in the restaurant industry.

2.3 Brand loyalty

Brand loyalty is the “dependency of the customers on brands” (Aaker, 1992, p. 65). It demonstrates the repeated non-random purchase that is shown over time and could be the result of a psychological process, such as cognitive, emotional or conative (Beristain and Zorrilla, 2011). Brand loyalty is about customer intention to pay a high range of prices and spend more on some special type of brand and also customers recommending it to other people around them (Ferns and Walls, 2012). Namkung and Jang (2013) identified the significance of customer satisfaction in order to establish a brand, while other researchers found that brand loyalty is a variable of customer brand equity. However, Lee and Back (2008) found that satisfaction does not essentially steer to a high level of repurchase. According to Ekinci et al. (2008), consumer satisfaction will positively impact on the overall attitude of the consumers to the service sector as well as
positively influence the revisit intention. Customer loyalty is the main attribute of brand equity (Callarisa et al., 2012). Thus, the following is hypothesised:

\[ H_6. \] There is a positive relationship between food quality satisfaction and brand loyalty in the restaurant industry.

### 2.4 The moderating role of international and local travellers

The tourism industry in Malaysia has shown a strong growth and has become a significant source of income that is devoted to sustainable development for the economy. The Malaysian Government considers tourism as a source of employment, foreign exchange, devoted to the progress in the economy, drawing attention to investments and also enhancing the services account of the payment level. With the rapid predicted progress of the hospitality and tourism industries, previous literature recommends a necessary prerequisite, which is to source an adequate amount of trained staff for this sector (Goldsmith and Zahari, 1994). Local and international travellers’ expectations of hotel and restaurant service quality have been acknowledged as being an important factor. Despite the fact that tourists consider hospitality as a dominant element in determining the overall satisfaction level, empirical findings (Mey et al., 2006) reveal that tourist perceptions towards service quality in Malaysia were lower than what they expected. Thus, the followings are hypothesised:

\[ H_7. \] There is a significant difference between international and local travellers in determining the impact of (a) physical quality; (b) staff behaviour; (c) brand quality; (d) brand awareness; (e) brand image on food quality satisfaction; and (f) food quality satisfaction on brand loyalty in the restaurant industry.

### 3. Method

#### 3.1 Instrument design

To measure the exogenous and endogenous reflective constructs, the scales were adopted from previous studies as a methodological norm (Westland, 2015). A seven-point Likert scale, anchored from “strongly disagree” to “strongly agree” was used to measure the reflective latent constructs. To measure physical quality, three items were adopted from Ekinci et al., (2008) and to measure staff behaviour, five items were adopted from Ekinci et al. (2008) and Hyun (2009). In addition, to measure brand quality, brand awareness, and, finally, brand image, three items for each were adopted from a previous study (Liao and Cheng, 2014). Food quality satisfaction was measured by seven items (Ariffin, 2013; Ekinci et al., 2008) and brand loyalty by six questions (Buil et al., 2013). The questionnaire also asked the respondents regarding the endogenous and exogenous variables in this study.

#### 3.2 Sampling and data collection

The target population in this study was international and local travellers who visited a restaurant in Kuala Lumpur City, Malaysia. The non-probability sampling technique was employed. In addition, among the different types of non-probability sampling technique, purposive sampling was deployed to empirically test the hypotheses of the study. Following a previous study (Ariffin, 2013), local and international travellers respond to study questionnaire. A pilot test (\(N = 29\)) of respondents was conducted before distributing the questionnaires, to determine whether the questionnaire was suitable for capturing the required data. In addition to the pilot test that was conducted to establish whether the questionnaire was easy to understand by the respondents, content validity and face validity were considered in this study. Following previous studies’ guidelines (Babin and Burns, 1998),
A careful consideration was given to the face validity of the proposed measurements of constructs. First, three experts were consulted concerning the domains of the proposed dimensions and second, a focus group was selected to further explore whether the research constructs were reasonable and meaningful from a typical respondent’s point of view.

3.3 Data analysis

Once all the data were collected, it was keyed into the statistical package for social sciences software version 17.0 (SPSS-Version 17.0). SPSS software was used in order to analyse the data in Section 1 (characteristics of respondents) and for preliminary statistical analysis in Section 2 (missing value treatments and t-test). To examine the relationship between hypotheses in Section 2, measurement and covariance-based structural equation modelling were performed. AMOS version 21.0 was used to conduct statistical analysis. Following Hair et al. (2009), the two-step analytical procedure was employed in which the measurement model was evaluated first and then the structural model was assessed.

We assessed the models of outer loadings, composite reliability (CR), average variance extracted (AVE = convergent validity) and discriminant validity. Moreover, from AMOS software, the assessments were achieved for the purpose of structural model relationships (path coefficients = b), which demonstrates the hypothesised relationships among variables. A common problem in survey studies and methodology is the missing values, which researchers should deal with to confirm that the conclusions are valid (Schafer and Olsen, 1998). In this study, we performed the expectation maximisation algorithm to impute missing values and handle missing values using SPSS software.

3.4 Common method variance (CMV) and non-response bias

This study addressed the potential threat of CMV by using guidelines proposed by Podsakoff et al. (2003). In addition to CMV, non-response bias is also a concern in survey methodology since it limits the generalisability of the research findings (Rezaei and Ghodsi, 2014). To address non-response bias, we assessed the analysis of known characteristics and wave analysis according to the continuum of resistance theory (Lin and Schaeffer, 1995). Therefore, CMV, non-response bias was not found to be an issue or concern in this study.

4. Results

In total, 400 paper-and-pencil questionnaires were distributed among tourists, of which 362 questionnaires were collected. Out of the 362 questionnaires, eight questionnaires were not properly completed. Thus for this study, 354 questionnaires were obtained with a response rate of 88.5 per cent. Table I presents the demographic characteristics of the respondents.

4.1 Measurement model

Table II presents the confirmatory factor analysis (CFA) results for the measurement model. The internal reliability, measured by Cronbach’s α (Cronbach and Meehl, 1955) and Hair et al. (2009), shows high reliability for all constructs since all the values were above 0.7. However, items PQ6, SFB5, CS3 and BL3 were removed due to low loading (below 0.60). Furthermore, all factor loadings were above 0.7, CR was above 0.8 and AVE values were above 0.5, which shows that there is convergence among the research constructs. In addition to the convergent validity, discriminant validity of constructs was assessed and the results show that the square root of the AVE found relatively higher than its correlations with all other research constructs. Accordingly, the diagonals which represent the square root of AVE and the other entries represent the squared correlations, discriminant validity was established among the research constructs since the correlation
values between constructs range from 0 to 1. Therefore, content validity, face validity, construct validity, convergent validity and discriminant validity were conducted to ensure the findings are highly reliable.

4.2 Structural model
After the measurement model and CFA was assessed and established, the second step was to assess the structural relationship. Using the maximum likelihood method (MLE), the structural model was established (Table III). The fit statistics are above the recommended values showing a good model fit in which the model explains 55 per cent of the variance in food quality satisfaction and 59 per cent for brand loyalty. Accordingly, df is 303 with $\chi^2 = 92.723$ and $\chi^2/df = 2.114$. Moreover, GFI = 0.929, AGFI = 0.882, CFI = 0.947, RMSEA = 0.007 and NNFI (TLI) = 0.914, which, relatively, comply with the threshold recommended values. Furthermore, the research hypotheses were assessed, as shown in Table IV (direct effect) and Table V depicts multigroup moderation results (international vs local travellers).

5. Discussion
This study sought to investigate the influence of service quality elements, of physical quality and staff behaviour; and brand equity factors comprising brand quality, brand awareness and brand image on food quality satisfaction and to understand consumer satisfaction and brand loyalty in the restaurants in Malaysia. As discussed earlier, most of the previous studies examined tourist behavioural intention, satisfaction and loyalty (Lee et al., 2011) towards the combination of accommodation and restaurant services. Very few studies have examined the value that a brand creates for a restaurant business. Furthermore, very few previous studies have examined service quality and brand equity factors on food quality satisfaction and brand loyalty among local and international travellers.
While the findings of this current study offer support to previous studies, they also provide additional insights and make a contribution to the body of knowledge. According to the study findings, physical quality positively influences food quality satisfaction. As conceptualised by Brady and Cronin (2001), physical quality defines the basis for service quality perceptions, which is consistent with the research findings of this study.

Table II.
Results of CFA for measurement model

<table>
<thead>
<tr>
<th>Research Construct</th>
<th>Item</th>
<th>Cronbach’s α(^a)</th>
<th>Loading</th>
<th>Composite reliability (CR)(^a)</th>
<th>AVE(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PQ</td>
<td>PQ1</td>
<td>0.94</td>
<td>0.82</td>
<td>0.908</td>
<td>0.663</td>
</tr>
<tr>
<td></td>
<td>PQ2</td>
<td>0.85</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PQ3</td>
<td>0.80</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PQ4</td>
<td>0.78</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PQ5</td>
<td>0.82</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SFB</td>
<td>SFB1</td>
<td>0.91</td>
<td>0.81</td>
<td>0.888</td>
<td>0.664</td>
</tr>
<tr>
<td></td>
<td>SFB2</td>
<td>0.82</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SFB3</td>
<td>0.82</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SFB4</td>
<td>0.81</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BQ</td>
<td>BQ1</td>
<td>0.85</td>
<td>0.878</td>
<td>0.706</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BQ2</td>
<td>0.83</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BQ3</td>
<td>0.84</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BA</td>
<td>BA1</td>
<td>0.89</td>
<td>0.82</td>
<td>0.669</td>
<td>0.690</td>
</tr>
<tr>
<td></td>
<td>BA2</td>
<td>0.87</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BA3</td>
<td>0.84</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BI</td>
<td>BI1</td>
<td>0.91</td>
<td>0.81</td>
<td>0.851</td>
<td>0.657</td>
</tr>
<tr>
<td></td>
<td>BI2</td>
<td>0.81</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BI3</td>
<td>0.84</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CS</td>
<td>CS1</td>
<td>0.91</td>
<td>0.86</td>
<td>0.910</td>
<td>0.670</td>
</tr>
<tr>
<td></td>
<td>CS2</td>
<td>0.81</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CS4</td>
<td>0.84</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CS5</td>
<td>0.80</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CS6</td>
<td>0.78</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BL</td>
<td>BL1</td>
<td>0.93</td>
<td>0.84</td>
<td>0.906</td>
<td>0.706</td>
</tr>
<tr>
<td></td>
<td>BL2</td>
<td>0.86</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BL4</td>
<td>0.81</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BL5</td>
<td>0.85</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: PQ, physical quality; SFB, staff behaviour; BI, brand image; CS, consumer satisfaction; BL, brand loyalty. \(^a\)Composite reliability = (square of the summation of the factor loadings)/((square of the summation of the factor loadings) + (square of the summation of the error variances)); \(^b\)AVE = (summation of the square of the factor loadings)/((summation of the square of the factor loadings) + (summation of the error variances)); Items PQ6, SFB5, CS3 and BL3 were removed due to low loading (below 0.60); \(^d\)according to Cronbach and Meehl (1955) and Hair et al. (2009)

Table III.
Fit indices and recommended values

<table>
<thead>
<tr>
<th>Fit measures</th>
<th>Results</th>
<th>Recommended values*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Df</td>
<td>303</td>
<td>na</td>
</tr>
<tr>
<td>(\chi^2)</td>
<td>92.723</td>
<td>na</td>
</tr>
<tr>
<td>(\chi^2/df)</td>
<td>2.114</td>
<td>(\leq3.00)</td>
</tr>
<tr>
<td>GFI</td>
<td>0.929</td>
<td>(\geq0.90)</td>
</tr>
<tr>
<td>AGFI</td>
<td>0.882</td>
<td>(\geq0.80)</td>
</tr>
<tr>
<td>CFI</td>
<td>0.947</td>
<td>(\geq0.90)</td>
</tr>
<tr>
<td>RMSEA</td>
<td>0.007</td>
<td>(\leq0.08)</td>
</tr>
<tr>
<td>NFI (TLI)</td>
<td>0.914</td>
<td>(\geq0.90)</td>
</tr>
</tbody>
</table>

Source: Hair et al. (2009)
Using SEM analysis, Ryu et al. (2012) also confirmed that physical quality determines the restaurant image and customer overall perception of value and satisfaction. Thus, it is concluded that physical quality is important and critically creates value and food quality satisfaction among Malaysian local and international tourists.

Staff behaviour is also found to significantly contribute to service quality and food quality satisfaction. Gustafsson et al. (2006) found that staff quality and behaviour significantly influence consumer perception and perceived quality of food in restaurants. The service environment strongly predicts whether hotel meets the guest expectation and to provide value within this context. Brexendorf et al. (2010) found that the salesperson satisfaction steers towards brand loyalty by improving the brand attitude as well as the loyalty of the salesperson. In fact, the whole procedure of human resources, which had a direct impact on service quality customer perception and conversely an indirect influence via service behaviour of the employees. Nevertheless, Hutchinson et al. (2009) discovered that value and satisfaction did not have a significant impact on service quality but that the quality of service had an important influence on equity.

Consistent with the current study findings, Hyun and Kim (2011) found that brand equity attributes, such as brand awareness, image, quality and loyalty, are devoted to the whole chain of restaurants. In addition, previous studies stressed that brand awareness is an essential element of brand loyalty as well as brand image. Esch et al. (2006) claimed that intention to purchase was influenced by the brand image in a direct manner, while awareness was usually indirect. Therefore, brand awareness has a positive impact on brand satisfaction. Aaker (1992) proposed that brand awareness can strengthen brand loyalty by increasing customer satisfaction and Nam et al. (2011) confirmed that brand awareness positively affects brand satisfaction. The influence of brand image on customer satisfaction leads to brand loyalty, and in turn, achieving and maintaining brand loyalty is the main factor in order to stay competitive in markets (Brexendorf et al., 2010). Similar to this study’s findings, Ryu et al. (2012) found that brand image has a significant impact on customer satisfaction and revisit intention.

### Table IV.

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Path</th>
<th>Estimate</th>
<th>SE</th>
<th>t-value</th>
<th>p-value</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>FQS  ← PQ</td>
<td>0.34</td>
<td>0.08</td>
<td>2.17*</td>
<td>0.03</td>
<td>Supported</td>
</tr>
<tr>
<td>H2</td>
<td>FQS  ← SFB</td>
<td>0.15</td>
<td>0.06</td>
<td>2.48**</td>
<td>0.01</td>
<td>Supported</td>
</tr>
<tr>
<td>H3</td>
<td>FQS  ← BQ</td>
<td>0.22</td>
<td>0.04</td>
<td>2.43**</td>
<td>0.02</td>
<td>Supported</td>
</tr>
<tr>
<td>H4</td>
<td>FQS  ← BA</td>
<td>0.17</td>
<td>0.03</td>
<td>3.41**</td>
<td>0.01</td>
<td>Supported</td>
</tr>
<tr>
<td>H5</td>
<td>FQS  ← BI</td>
<td>0.28</td>
<td>0.09</td>
<td>6.31**</td>
<td>0.00</td>
<td>Supported</td>
</tr>
<tr>
<td>H6</td>
<td>BL    ← FQS</td>
<td>0.32</td>
<td>0.06</td>
<td>13.53**</td>
<td>0.00</td>
<td>Supported</td>
</tr>
</tbody>
</table>

Notes: One-tailed test: *1.645 (significance level = 5 per cent or 0.05); **2.326 (significance level = 1 per cent or 0.01)

### Table V.

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Path</th>
<th>Estimate</th>
<th>SE</th>
<th>t-value</th>
<th>p-value</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>H7a</td>
<td>FQS  ← PQ</td>
<td>0.090</td>
<td>0.204</td>
<td>0.366</td>
<td>0.000</td>
<td>2.764***</td>
</tr>
<tr>
<td>H7b</td>
<td>FQS  ← SFB</td>
<td>0.144</td>
<td>0.133</td>
<td>0.245</td>
<td>0.014</td>
<td>2.814***</td>
</tr>
<tr>
<td>H7c</td>
<td>FQS  ← BQ</td>
<td>0.038</td>
<td>0.627</td>
<td>0.211</td>
<td>0.047</td>
<td>1.313</td>
</tr>
<tr>
<td>H7d</td>
<td>FQS  ← BA</td>
<td>0.001</td>
<td>0.519</td>
<td>0.053</td>
<td>0.581</td>
<td>0.847</td>
</tr>
<tr>
<td>H7e</td>
<td>FQS  ← BI</td>
<td>0.715</td>
<td>0.000</td>
<td>0.530</td>
<td>0.000</td>
<td>1.739*</td>
</tr>
<tr>
<td>H7f</td>
<td>BL    ← FQS</td>
<td>0.053</td>
<td>0.201</td>
<td>0.862</td>
<td>0.000</td>
<td>2.113***</td>
</tr>
</tbody>
</table>

Notes: *p-value < 0.10; **p-value < 0.05; ***p-value < 0.01

Group 1 (international travellers) | Group 2 (local travellers) | Food quality satisfaction and brand loyalty
Customer loyalty is a significant metric for the industry due to its favourable implications concerning market share and financial performance. Whilst travellers’ nationality moderates the path between physical qualities, staff behaviour and brand image on food quality satisfaction, it does not moderate the relationship between brand quality and brand awareness on satisfaction. Furthermore, travellers’ nationality moderates food quality satisfaction and brand loyalty. This is one of the first studies providing empirical findings related to how travellers’ nationality moderates satisfaction and brand loyalty.

5.1 Practical implications
The research findings of this study confirm that the physical quality is critically important in determining service quality and tourist food quality satisfaction. The research findings suggest that in order to enhance the physical quality, restaurant managers should enhance decoration and tidiness and provide a comfortable place, lighting level and aroma. In this study, respondents rated decor as beautifully coordinated with great attention to detail, the restaurant was tidy, the restaurant provided a comfortable place, the whole restaurant environment’s lighting level was appropriate, the restaurant scent was lovely and nice but the music was not an indicator to make the restaurant a more enjoyable place. Meal experience can be justified through the quality of products and the intangible aspects such as service (Longart, 2010). The food products of the restaurant will be an essential factor to ensure customers have positive word-of-mouth regarding their meal experience. Lang (2011) suggests including friendliness of frontline staff and interaction, cleanliness and tidiness of store, the outcome of service encounter and price which is crucial satisfaction components. Malaysian managers should understand the importance of these services and try to give more than what is needed by the customers to have an advantage over other competitors.

Moreover, in order to enhance service quality, staff behaviour plays an important role in determining tourist behaviour. In general, when interacting with tourists, helpfulness, anticipation of customers, listening and understanding, expertise and responsibility of staff are important. In this study, respondents agree that staff were helpful and friendly, anticipated what they wanted, and listened to the tourists, were talented and displayed a natural expertise. Respondents were not sensitive about staff having or not having the knowledge to respond to their questions. This is because tourists do not expect staff to be very knowledgeable about all issues regarding travelling.

Brand equity was explained in three dimensions: brand quality, brand awareness and brand image. Restaurant managers should enhance the brand quality in order to increase customer food quality satisfaction and retention. Restaurants for being perceived by customers as high quality should set quality standards. It is important for tourists to know what the restaurant symbol or logo looks like and easily recognises the restaurant among other competitors. These factors and elements improve the brand awareness among local and international tourists. Accordingly, brand image plays a critical role in determining brand equity. It is critically important for managers at the restaurants to increase brand prestige to attract sophisticated people as guests, and instil in the tourists the perception that dining at a particular restaurant makes them feel special. For improving food quality satisfaction, hotels and restaurants should improve the customer service quality and brand equity. In summary, tourists should be fully satisfied and delighted with the services of restaurants. Brand loyalty can be achieved by enhancing service quality, brand equity and customer food quality satisfaction.

5.2 Limitations of study and directions for future research
This current study has several limitations. First, this study was limited to assessing how tourists experience restaurants in Malaysia. Future research should examine tourists’
behaviour and loyalty to a restaurant in other countries. Second, using survey and quantitative method, this study performed the cross-sectional data collection approach to empirically test the proposed research model. Future studies may use the longitudinal data collection approach, qualitative method or experimental design to explore tourist’s perceptions towards food quality and restaurants brand. Likewise, further studies can discuss cultural aspects of travellers belonging to various cultural backgrounds and its implications to branding, for example, Asian vs European. The main questions that can be addressed are what are the similarities and differences, and why these matter for brand marketers? How and why travellers from different backgrounds perceive brands differently? Lastly, consumer experience behaviour is considered to be a construct in the relationship between service quality and brand equity. However, future researches should investigate tourist’s dissatisfaction and actual discontinuous intention and their possible impact on hotel restaurants brand image and service quality.

References


食品质量满意度和品牌忠诚

2609

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CARVER+Shock method and its application in a catering company in Poland

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Abstract

Purpose – The purpose of this paper is to present the practical implementation of the CARVER+Shock (CS) method and describe the following steps of vulnerability assessment on the basis of a catering company, and to confirm that it can be successfully applied by the restaurant for better preparation regarding potential, intentional contamination.

Design/methodology/approach – The research method is a case study, including examining the company’s documentation and the interview with the company owner. The analysis refers to the following seven attributes: criticality, accessibility, recuperability, vulnerability, effect, recognizability and shock.

Findings – The practical application of CS method in company allows indicating the most vulnerable phases of the catering process. The values of “recuperability,” “effect” and “shock” are increasing along with the development of the catering process. The lowest risk of threat is observed at the first phases of the catering process, and the most risky were those connected with the preliminary consumption phase and with the final phase, which is arranged in the place of the event. The attributes “recognizability” and “effect” have the greatest influence on the outcome. The closer the food gets to the consumer, the higher is the risk of intentional contamination, and the harder it is to reverse its effects.

Originality/value – In the scientific literature, there is a gap observed in the subject of applying the CS method. This is the first case study presentation referring to its application in catering processes in Poland.

Keywords Poland, Catering, CARVER+Shock, Food defence, Food terrorism

Paper type Case study

Introduction

According to leading food security experts, food and water supplies are at risk of both accidental and deliberate contamination due to the wide farm-to-table continuum and to the inherent characteristics of product manufacturing, processing and distribution (Comella et al., 2007; Taylor, 2008; Manning and Soon, 2014; Davidson et al., 2017). Food terrorism in the form of malicious contamination of food for terrorist purposes is a threat that responsible governments and food companies cannot ignore, regardless of where they are in the food chain (WHO, 2008). In a special report in 2003, World Health Organization (WHO) warned of a possible contamination of food supplies by terrorist groups employing chemical or biological agents and it advised countries to strengthen their surveillances to avoid death or the contracting of serious illnesses, such as cancer (Nwoko, 2011). Food terrorism as a phenomenon is relatively widely described in literature (Badrie et al., 2005; Manning et al., 2005; Knechtges, 2012; Sekheta et al., 2006; Yoon and Shanklin, 2007; Kircher, 2014). It is a kind of intentional food contamination used by criminals (Spink et al., 2013), or by people maximizing profit by lowering production expenses (Bogadi et al., 2016), and is considered an unfortunate reality that has a considerable impact on the food industry (Gaibulloev et al., 2011; Davidson et al., 2017). It is a category of food crime (Croall, 2009a, b, 2013; Spink et al., 2013; Manning et al., 2016; Davidson et al., 2017), which is understood as an organized activity aimed at deceiving or injuring consumers via food products (Knechtges, 2012; Elliot, 2014). Food terrorism can be also defined as: a deliberate contamination of the food chain, water and its sources (Sekheta et al., 2006; Gleick, 2006; Manning et al., 2005), the use or threatened use of contaminated or poisoned food against civilians, with the objective of...
causing fear, illness or death, and most significantly for political and ideological reasons (Nwoko, 2011). WHO (2008) defines food terrorism as the act or threat of deliberate contamination of food for human consumption with biological, chemical and physical agents or radionuclear materials for the purpose of causing injury or death to civilian populations and/or disrupting social, economic or political stability. Food terrorism is not new and has many negative consequences. There are different examples explored by Dalziel (2009) or by Wiśniewska (2016). These authors in parallel have collected interesting cases from 1320-1318 B.C. to 2015, evidenced by literature and a review of reports by official agencies, including the example of the Indian Guru Bhagwan Shree Rajneesh, who almost four decades ago infected ten restaurants in The Dalles, Oregon (USA) with the potentially deadly salmonella pathogen. These examples prove that food can be used as a weapon against all food chain actors, regardless of what position they represent in the food chain. Peter (2015) who cites a risk analysis carried out by Mohtadi and Murshid (2009) shows that terrorist events with large numbers of casualties will increase over time and that there is a great likelihood that terrorists will use different methods, moving away from their traditional techniques. Coleman (2004) presents three general types of intentional threats to the food supply: the use of food or water as a delivery mechanism for pathogens, chemicals and/or other harmful substances for the purpose of causing human illness or death, the introduction of anti-crop or anti-livestock agents into agricultural systems and the physical disruption of the flow of food/water as the result of the destruction of transportation or other vital infrastructure. Moreover, among the varieties of food terrorism one can distinguish: bioterrorism (Klietmann and Ruoff, 2001; Carus, 2001; Borelli, 2006), chemical terrorism (Morse, 2003), agroterrorism (Monke, 2007; Caldas and Perz, 2013; Wiśniewska and Czernysszewicz, 2014), eco-terrorism (Govern, 2009; Kharlamova, 2011), aqua-terrorism (Gleick, 2006) and cyber-terrorism (Wiśniewska, 2016).

Intentional contamination gained special significance after September 11, 2001. The answer to this threat is the development of food defense methods or programs, such as CARVER +Shock (CS), Threat Assessment Critical Control Point – presented in Publicly Available Specification – PAS 96:2014, and the Hazard Analysis and Risk-Based Preventive Control method, incorporated in the USA into the Food Safety Modernization Act on July 4, 2012. Food defense can be understood as putting measures in place that reduces chances of the food supply from becoming intentionally contaminated by using a variety of agents or other substances by people who want to cause harm (USDA/FSIS, 2008). As researchers observe, the literature addressed food crime, in general (Fassam and Dani, 2017) and food defense, in particular (Manning and Soon, 2016), is regarded as evolving very fast. Based on it one may conclude that the term food defense is not only used to define national strategy toward intentional food adulteration, but also is applicable at the supply chain and organizational level. Manning and Soon (2016) emphasize that food defense reflects the protection programs, activities and/or the security assurance process or procedure that deliver product safety with regard to intentional contamination. These approaches and programs (processes, procedures, methods) can be defined as countermeasures.

In this manuscript, the attention is focused on the CS method – an offensive targeting prioritization tool that can be used to assess the vulnerabilities within a system or infrastructure to an attack. It allows thinking like an attacker by identifying the most attractive targets for attack. In the context of food terrorism, vulnerability is a weakness in the design, processing, handling or storage facility or operation that would allow for deliberate contamination of a food product. Vulnerability measures the ease with which threat agents can be introduced in quantities sufficient to achieve the attacker’s purpose (Kastner, 2011).

The aspect of food defense in the food industry is a rather new phenomenon in many European Union countries as opposed to the USA where the concept of food defense originated (Bogadi et al., 2016). It is advised by the US Government to be implemented by...
different food entities, including caterers and restaurants. But it still needs the dissemination among enterprises worldwide, regardless of what link they are in the food chain. It seems to be crucial because food retailers and other institutional customers require their suppliers to introduce procedures for assessing vulnerability to terrorist attack. Vulnerability assessment (VA) is a prerequisite for further cooperation with a particular food or food services provider. In the scientific literature, there is a gap observed in the subject of applying the CS method. This paper, as one of the few publications, is about the use of the method in the potato industry enterprise (Wiśniewska and Maszota, 2011). Bearing in mind the lack of papers dealing with the CS application, and the importance of the topic, the aim of the manuscript is to present the practical implementation of the CS method and describe the following steps of VA on the basis of a catering company, and to confirm that it can be successfully applied by the restaurant for better preparation regarding potential, intentional contamination. The cases referring to food terrorism indicate that this area is not free from such threats (Dalziel, 2009; Wiśniewska, 2016). The threat certainly increases when the food services are offered during large-scale events (Tsouros and Efstathiou, 2007; Stratton, 2013).

Materials and methods
The research object was the catering company – ZET and the research method is the descriptive case study, particularly – the examination of the company documentation as well as a direct interview with the company’s owner. Case study analysis is one of the methods widely used in different sciences. Its specificity fits with the idiographic research approach and the qualitative context of scientific research, allowing at the same time description of the selected phenomena in the organizational reality (Matejun, 2012). This type of case study is used to describe an intervention or phenomenon and the real-life context in which it occurred.

The case study seems to be the best method in that context and situation, taking into account the fact that in Poland, so far among the restaurants there has been only one company with documented implementation of CS. Like it was years ago with Hazard Analysis and Critical Control Point (HACCP) implementation examples, the first examples of the case studies referring to the application of new methods became a good basis for the development of new knowledge and experience in the subject of food defense. Not without significance is the dissemination and comparison of any good practices in this regard among both researchers and practitioners.

CS backgrounds
CARVER was originally developed by the US military to identify areas that may be vulnerable to an attacker. This method in the form of CS was adapted, modified and developed for the food and agriculture sector through the Strategic Partnership Program Agroterrorism Initiative as a joint effort of the Department of Homeland Security, the Federal Bureau of Investigation, the United States Department of Agriculture (USDA), the Food and Drug Administration (FDA) and the Food Safety and Inspection Service. CS is an acronym for the following attributes used to evaluate the attractiveness of a target for attack (Benesh, 2013; Bogadi et al., 2016; Kastner, 2011):

1. Criticality – refers to the impact of an attack on public health and the economy.
2. Accessibility – refers to the ability to physically access and egress from the target.
3. Recuperability – refers to the ability of a system to recover from an attack.
4. Vulnerability – refers to the ease of accomplishing an attack.
(5) Effect – refers to the amount of direct loss from an attack as measured by loss in production.

(6) Recognizability – refers to the ease of identifying a target.

The seventh attribute is a shock. It assesses health, economic and psychological impacts of an attack on the food industry. The attractiveness of a target can then be ranked on a scale from 1 to 10 on the basis of scales that have been developed for each of the seven attributes. Conditions that are associated with a lower attractiveness are assigned lower values (e.g. 1 or 2), whereas conditions associated with a higher attractiveness as a target are assigned higher values (e.g. 9 or 10). The detailed description of the CS method and CS attributes in its original, American version are presented in Table I.

Once the ranking on each of the attribute scales has been calculated for a given node within the food supply system, the ranking on all of the scales can then be totaled to give an overall value for that phase. Each node represents a change in the vulnerability of the system to contamination. When combined, the nodes represent the entirety of the process under examination. For example, each unit operation (receiving, mixing, processing, etc.) and every transfer between a unit operation count as a node. Next, each node is evaluated on each of the seven CS elements (Van Alfen, 2014). The formula which is used in such a situation ($R_i = C + A + R + V + E + R + \text{Shock}$), allows determining the most critical nodes understood as specific points in the food supply chain where intentional contamination has the greatest potential to cause harm and maximum damage (Pinior et al., 2015). The critical node can be also defined as a process or activity in the farm-to-table chain during which the agent could be added, undetected, in effective quantities (Acheson, 2006). What is important, based on a CS analysis, a food processor can then develop proportional preventive countermeasures for better protection of food. The methodology of CS covers the following steps (Kastner, 2011):

(1) Establishing parameters (answers the question: what are you trying to protect and what are you trying to protect from?).

(2) Assembling a team (the team should consist of experts in food production – specifically for the food process being evaluated, food science, toxicology and/or epidemiology and/or microbiology and/or medicine and risk assessment).

(3) Detailing the food supply chain (the analysis begins by developing a flow chart of the system and its phases, including the raw materials receiving area, processing area, storage area, shipping area, etc.).

(4) Assigning scores (once the system has been developed into phases, these can be ranked or scored for each of the seven CS attributes to calculate an overall score for that phase; the phases with the higher overall scores are those that are potentially the most vulnerable phases).

(5) Applying what has been learned (once the critical phases of the system have been identified, a plan should be developed to put into place countermeasures that minimize the attractiveness of the phases as targets; countermeasures might include enhancements to physical security, personnel security and operational security that help to minimize aggressor access to the product or process).

Case study – the ZET company
ZET is located in the north of Poland, and offers catering services for business meetings, weddings, baptism ceremonies and other social events. Every year it organizes a Christmas Eve party for thousands of homeless people, it regularly cooperates with the City Hall, the
Criticality: a target is critical when introduction of threat agents into food at this location would have significant health or economic impact

Criticality criteria
- Loss of over 10,000 lives OR loss of more than $100 billion\textsuperscript{a} 9-10
- Loss of life between 1,000 and 10,000 OR loss of between $10 and $100 billion (note: if looking on a company level, loss of between 61 and 90% of the total economic value for which you are concerned) 7-8
- Loss of life between 100 and 1,000 OR loss of between $1 and $10 billion (note: if looking on a company level, loss of between 31 and 60% of the total economic value for which you are concerned) 5-6
- Loss of life less than 100 OR loss of between $100 million and $1 billion (note: if looking on a company level, loss of between 10 and 30% of the total economic value for which you are concerned) 3-4
- No loss of life OR loss of less than $100 million (note: if looking on a company level, loss of < 10% of the total economic value for which you are concerned) 1-2

Accessibility: a target is accessible when an attacker can reach the target to conduct the attack and egress the target undetected. Accessibility is the openness of the target to the threat. This measure is independent of the probability of successful introduction of threat agents

Accessibility criteria
- Easily accessible (e.g. target is outside building and no perimeter fence). Limited physical or human barriers or observation. Attacker has relatively unlimited access to the target. Attack can be carried out using medium or large volumes of contaminant without undue concern of detection. Multiple sources of information concerning the facility and the target are easily available 9-10
- Accessible (e.g. target is inside building, but in unsecured part of facility). Human observation and physical barriers limited. Attacker has access to the target for an hour or less. Attack can be carried out with moderate to large volumes of contaminant, but requires the use of stealth. Only limited specific information is available on the facility and the target 7-8
- Partially accessible (e.g. inside building, but in a relatively unsecured, but busy, part of facility). Under constant possible human observation. Some physical barriers may be present. Contaminant must be disguised, and time limitations are significant. Only general, non-specific information is available on the facility and the target 5-6
- Hardly accessible (e.g. inside building in a secured part of facility). Human observation and physical barriers with an established means of detection. Access generally restricted to operators or authorized persons. Contaminant must be disguised and time limitations are extreme. Limited general information available on the facility and the target 3-4
- Not accessible. Physical barriers, alarms, and human observation. Defined means of intervention in place. Attacker can access target for less than 5 minutes with all equipment carried in pockets. No useful publicly available information concerning the target 1-2

Recuperability: a target’s recuperability is measured in the time it will take for the specific system to recover productivity. The effect of a possible decrease in demand is considered in this criterion

Recuperability criteria
- > 1 year 9-10
- 6 months to 1 year 7-8
- 3-6 months 5-6
- 1-3 months 3-4
- < 1 month 1-2

Vulnerability: a measure of the ease with which threat agents can be introduced in quantities sufficient to achieve the attacker’s purpose once the target has been reached. Vulnerability is determined both by the characteristics of the target (e.g. ease of introducing agents, ability to uniformly mix agents into target) and the characteristics of the surrounding environment (ability to work unobserved, time available for introduction of agents). It is also important to consider what interventions are already in place that might thwart an attack

Vulnerability criteria
- Target characteristics allow for easy introduction of sufficient agents to achieve aim 9-10
- Target characteristics almost always allow for introduction of sufficient agents to achieve aim 7-8
- Target characteristics allow 30 to 60% probability that sufficient agents can be added to achieve aim 5-6
- Target characteristics allow moderate probability (10 to 30%) that sufficient agents can be added to achieve aim 3-4

Table I.
CARVER+Shock method’s attributes (continued)
local university, the Agricultural Market Development Agency and the local Forestry Commission. The company is small and its owner employs 30 staff members. ZET complies with the requirements of HACCP system and with Good Manufacturing Practices/Good Hygienic Practices. The system documentation includes an HACCP plan referring to the production process in the restaurant. The flow diagram covers all phases from reception of raw materials to serving meals. For the purpose of the study, attention has been focused on the catering service offered for Tall Ships Regatta. The event is cyclical, held in Gdynia (a city by the Baltic Sea) and it promotes the culture of the countries around the Baltic area. It is organized under the leadership of Sail Training International. Meals for the event are usually prepared for 2,000 guests, including the crews of vessels as well as the

Target characteristics allow low probability (less than 10%) sufficient agents can be added to achieve aim

Effect: effect is a measure of the percentage of system productivity damaged by an attack at a single facility. Thus, effect is inversely related to the total number of facilities producing the same product. The system productivity affected must be based on damage, not on the number of agents added. Effect criteria Scale

<table>
<thead>
<tr>
<th>Percentage of Production Impacted</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater than 50%</td>
<td>9-10</td>
</tr>
<tr>
<td>25-50% of the system’s production impacted</td>
<td>7-8</td>
</tr>
<tr>
<td>10-25% of the system’s production impacted</td>
<td>5-6</td>
</tr>
<tr>
<td>1-10% of the system’s production impacted</td>
<td>3-4</td>
</tr>
<tr>
<td>Less than 1% of system’s production impacted</td>
<td>1-2</td>
</tr>
</tbody>
</table>

Recognizability: a target’s recognizability is the degree to which it can be identified by an attacker without confusion with other targets or components. Recognizability criteria Scale

<table>
<thead>
<tr>
<th>Recognizability</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>The target is clearly recognizable and requires little or no training for recognition</td>
<td>9-10</td>
</tr>
<tr>
<td>The target is easily recognizable and requires only a small amount of training for recognition</td>
<td>7-8</td>
</tr>
<tr>
<td>The target is difficult to recognize or might be confused with other targets or target components and requires some training for recognition</td>
<td>5-6</td>
</tr>
<tr>
<td>The target is difficult to recognize. It is easily confused with other targets or components and requires extensive training for recognition</td>
<td>3-4</td>
</tr>
<tr>
<td>The target cannot be recognized under any conditions, except by experts</td>
<td>1-2</td>
</tr>
</tbody>
</table>

Shock: shock is the combined measure of the health, psychological and collateral national economic impacts of a successful attack on the target system. Shock criteria Scale

<table>
<thead>
<tr>
<th>Shock Impact</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target has major historical, cultural, religious or other symbolic importance. Loss of over 10,000 lives. Major impact on sensitive subpopulations, e.g., children or elderly. National economic impact more than $100 billion</td>
<td>9-10</td>
</tr>
<tr>
<td>Target has high historical, cultural, religious or other symbolic importance. Loss of between 1,000 and 10,000 lives. Significant impact on sensitive subpopulations, e.g., children or elderly. National economic impact between $10 and $100 billion</td>
<td>7-8</td>
</tr>
<tr>
<td>Target has moderate historical, cultural, religious or other symbolic importance. Loss of life between 100 and 1,000. Moderate impact on sensitive subpopulations, e.g., children or elderly. National economic impact between $1 and $10 billion</td>
<td>5-6</td>
</tr>
<tr>
<td>Target has little historical, cultural, religious or other symbolic importance. Loss of life less than 100. Small impact on sensitive subpopulations, e.g., children or elderly. National economic impact between $100 million and $1 billion</td>
<td>3-4</td>
</tr>
<tr>
<td>Target has no historical, cultural, religious or other symbolic importance. Loss of life less than 10. No impact on sensitive subpopulations, e.g., children or elderly. National economic impact less than $100 million</td>
<td>1-2</td>
</tr>
</tbody>
</table>

Note: The monetary values, which are included in the table were adapted to the conditions in Poland according to the rule: $100 million = PLN 100 thousand. Source: Based on: www.fda.gov/Food/FoodDefense/FoodDefensePrograms/ucm376791.htm. (accessed April 2, 2016)
representatives of the City Hall. The serving of meals takes place in a tent located by the sea. In regard to difficult political and economic times, WHO (2008) warns that every link in the food production and each operator may be exposed to the threat of a terrorist attack. For this reason, the owner of the company, to protect its reputation and the welfare of its customers, decided to implement a CS approach. The analysis had a qualitative character and was considered as preliminary. According to literature, qualitative assessment in many cases is commonly used (Mortimore and Wallace, 2013), mainly in the preliminary analysis, and can assist a manager in a priority setting making a policy decision, such as decisions to allocate resources (Coleman and Marks, 1999). According to Creswell (2009), if a concept or phenomenon needs to be understood because little research has been performed on it before (ZET is the first example described), then it merits a qualitative approach. Therefore, a qualitative research approach was chosen by ZET in this case.

**Establishing the parameters and assembling a team**

To resolve the problem of a potential attack, the first step of the analysis was to establish the parameters. To do so a CARVER+Shock team (CST) was assigned. To ensure a high level of competence, the CST consisted of not only the company owner and two cooks (food technology specialists), but also external experts, recommended by the local official authority for food safety: a certified food safety expert – a food terrorism specialist, and a food safety central authority representative – a recognized expert on microbiology and epidemiology. The parameters (including threats) taken into account by the team are presented in Table II.

**Detailing a food supply chain**

The next requirement was to develop a flow chart of the production process and its phases, starting from receiving raw materials and ending in serving meals (see Figure 1).

The typical catering process in such events is handled by 30 people, including the owner, cooks, cook helpers, waitresses, drivers and internal security guards. The process of meal preparation begins one day before the event due to the need to maintain adequate freshness and the quality of the products until their release. The goods are ordered at cooperating

<table>
<thead>
<tr>
<th>Type</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>The supply chain</td>
<td>The following steps of the process are taken into account: receiving raw materials, transportation of raw materials, storage of raw materials, preparation of meals, packing of meals to the means of transport, transportation of meals, unpacking, preparation and placement of meals on the tables and serving meals</td>
</tr>
<tr>
<td>Raw materials such as:</td>
<td>vegetables, fruits, chicken, fish and meat</td>
</tr>
<tr>
<td>Endpoint of concern</td>
<td>Foodborne illness, death (consumers, own staff), economic impact (own company), psychological impact (consumers, own staff) (Kastner, 2011). Certain groups – infants and children, pregnant women, and older persons – are deemed biologically and clinically more susceptible to food safety risks. This susceptibility stems in part from altered or adversely affected immune systems or chemical kinetics, the sensitivity of developing organ systems to toxicological insult, or the effects of age-related diseases, treatments, and declining physiological function (Kendall et al., 2006; Hayashi, 2009)</td>
</tr>
<tr>
<td>Attacker/attack</td>
<td>Internal (disgruntled employees), external (individuals or groups, including supplier) (Dalziel, 2009; Badrie et al., 2005; Motarjemi and Wallace, 2014)</td>
</tr>
<tr>
<td>Potential agent used</td>
<td>Biological, chemical, physical and radiological. All these agents can be delivered as liquid, aerosols or solid (Badrie et al., 2005; WHO, 2008; Bogadi et al., 2016)</td>
</tr>
<tr>
<td>Motivation</td>
<td>Political and/or ideological. Political changes and conflicts in Poland are observed as well as the increase of nationalism (WHO, 2008; Cordell and Jajecznik, 2015; Manning and Soon, 2016; Bogadi et al., 2016)</td>
</tr>
</tbody>
</table>

Table II. Parameters taken into account in the CARVER+Shock analysis
certified suppliers. The raw materials, after receipt, are transported by their own means of transport, stored and, finally, subjected to appropriate treatment, according to a predetermined schedule. Then, the food is packed, prepared for transportation and appropriately secured. Food to be served warm is transported by cars in thermoses, heaters and kettles. Food to be served cold is delivered by thermal isolation cars in special containers. Along with the food there are delivered plates, trays, disposable cutlery as well as napkin dispensers. The food is unpacked on-site and placed in a serving area. The cooks are responsible for serving meals, while the waitresses and cook helpers are control inventories and orders in a tent. The food is prepared and placed on the tables by the restaurant staff in a special banquet tent, which is located in the open air. In addition to restaurant employees, there are usually external security workers hired by the organizers of the event in the tent. During this phase, due to the mass scale of the event and its outdoor character, one cannot exclude the presence of potential consumers, the guests of the event, who may observe the preparation activities and gather around the tent although the preparation area is restricted and accessed only for authorized persons. Delivered food is unpacked, if necessary, heated, stored in heaters and, finally, placed on the tables. Food served cold and in portions as well as fruits are displayed on platters. Warm dishes are served to guests directly by cooks and waitresses. Other dishes are permanently available to consumers in a self-service style.

Assigning the scores
The scores (ranks), the process of the analysis, alongside with the reasons and arguments taken into account during assessment are presented in Table III.

After the analysis of the whole catering process, it was possible to gather data and to present them in the summary table (see Table IV). Additionally, based on PAS 96 (2014), CST proposed to indicate the differences between the individual risks, regarding the attribute and the phase of the process. It helped to decide where to allocate the relevant resources and countermeasures to protect the whole process and its safety.

Applying what has been learned
After the analysis, and taking into account the scientific literature, to better ensure food defense, CST suggested some countermeasures in the current process, to be applied in the company:

- To hire more staff to improve process control and supervision of the most vulnerable phases: “unpacking, preparation and placement of meals on the tables” (phase 8) and “serving meals” (phase 9). Maintaining the process is critically important because an out-of-control food process can result in a public health crisis (Knechtges, 2012).
<table>
<thead>
<tr>
<th>Attribute</th>
<th>Reasons and arguments</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Receiving raw materials</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Criticality</td>
<td>At this phase the “criticality” attribute as the measure of public health in an attack does not refer to the loss of life (“no loss of life”), but rather to health problems among the restaurant’s workers (drivers) caused by direct contact with contaminated and unpackaged products, such as vegetables and fruits. Other products are originally packed and direct contact is not possible.</td>
<td>2</td>
</tr>
<tr>
<td>Accessibility</td>
<td>During the process access by unauthorized and suspected persons, is unlikely, but not excluded (“access generally restricted to operators or authorized persons”), because of the possibility of sabotage carried out by company drivers or by suppliers.</td>
<td>3</td>
</tr>
<tr>
<td>Recuperability</td>
<td>Raw materials are not in the restaurant yet, so it may be rather easy and quick (“&lt; 1 month”) for the restaurant to recover from the potential attack. The only impact may be stress and/or anxiety among the staff.</td>
<td>1</td>
</tr>
<tr>
<td>Vulnerability</td>
<td>It is rather not possible to work unobserved during the receiving, and the time available for eventual agent (a, c or p) introduction seems also to be very short. CST, however, found that the “target characteristics (the raw materials ready for shipment exclusively to the studied restaurants) allow moderate probability of sufficient agents to be added to achieve aim (10%-30%)” because contamination by the supplier or by own staff in the form of sabotage cannot be excluded.</td>
<td>4</td>
</tr>
<tr>
<td>Effect</td>
<td>For the same reasons, the effect of an attack – will be “less than 1% of system’s production impacted”.</td>
<td>1</td>
</tr>
<tr>
<td>Recognizability</td>
<td>The target is rather easy to recognize, also by the supplier’s staff, who might be interested in intentional food contamination.</td>
<td>8</td>
</tr>
<tr>
<td>Shock</td>
<td>It was concluded that the target in this phase “has no historical, cultural, religious or other symbolic importance,” and eventual loss is low.</td>
<td>1</td>
</tr>
<tr>
<td><strong>2. Transportation of raw materials</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Criticality</td>
<td>The materials are transported by own means of transport without stops. Cars are checked by the drivers before shipment and during the transportation they are locked and protected from unauthorized access. It was concluded that “criticality” can be assessed similarly as in the first phase because of the same threats and impacts.</td>
<td>2</td>
</tr>
<tr>
<td>Accessibility</td>
<td>The second attribute may be regarded as moderate because cars are protected during the whole transportation process (“access generally restricted to operators or authorized persons”). Nevertheless, the possibility of contamination cannot be excluded due to possible sabotage carried out by drivers.</td>
<td>3</td>
</tr>
<tr>
<td>Recuperability</td>
<td>The restoration of means of transport to use and/or buy a new car as well as the restoration of inventory may take one month (“1-3 months”)</td>
<td>2</td>
</tr>
<tr>
<td>Vulnerability</td>
<td>The target characteristics (the transported materials) allow for little chance (“less than 10%”) of sufficient agents to achieve the aim. However, it cannot be excluded because of sabotage.</td>
<td>2</td>
</tr>
<tr>
<td>Effect</td>
<td>Since ZET has three means of transport, one of which is usually used during this phase, the contamination of one car excludes one third of them from use (“25-50% of the system”). The re-purchase of raw material and disposal of the contaminated raw material also need to be taken into account.</td>
<td>7</td>
</tr>
<tr>
<td>Recognizability</td>
<td>It is rather easy to distinguish the target (“the target is easily recognizable and it requires only a small amount of training for recognition”), especially by own staff planning the sabotage, but also by other people, since the cars have the restaurant’s logo.</td>
<td>8</td>
</tr>
<tr>
<td>Shock</td>
<td>“There is no historical, cultural, religious or other symbolic importance” and eventual loss in that case is rather low.</td>
<td>1</td>
</tr>
<tr>
<td><strong>3. Storage of raw materials</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Criticality</td>
<td>Materials are stored in raw materials warehouses, properly arranged and separated, according to the type of the products. Most of them are packed (like fish, chicken and meat) and some of them are stored unpacked, such as fresh vegetables and fruits. The warehouses are protected from unauthorized access and they are locked when unused.</td>
<td>2</td>
</tr>
</tbody>
</table>

Table III. Results of the vulnerability assessment of the catering process steps (continued)
<table>
<thead>
<tr>
<th>Attribute</th>
<th>Reasons and arguments</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accessibility</td>
<td>This attribute has been considered as moderate (&quot;access generally restricted to operators or authorized persons&quot;). Nevertheless, the possibility of the contamination cannot be excluded due to a possible sabotage carried out by own staff</td>
<td>4</td>
</tr>
<tr>
<td>Recoverability</td>
<td>The recovery from an attack will take some time (&quot;1-3 months&quot;). The introduction of contaminated food into the warehouses can affect all the stored materials and/or the infrastructure. It requires the removal of suspected goods, a thorough inspection carried out by the owner of ZET, the need to notify the competent authorities, disinfection and/or the purchasing of a new infrastructure</td>
<td>4</td>
</tr>
<tr>
<td>Vulnerability</td>
<td>Since raw materials are stored in warehouses open to all authorized restaurant staff, it was concluded that &quot;target characteristics almost always allow for the introduction of sufficient agents to achieve aim&quot;, mainly by the act of potential sabotage</td>
<td>7</td>
</tr>
<tr>
<td>Effect</td>
<td>It was concluded that &quot;10-25% of the system might be impacted&quot;</td>
<td>6</td>
</tr>
<tr>
<td>Recognizability</td>
<td>The target is not easy to be recognized by third parties, but it is very easy to be recognized by own staff with potential dishonest intentions (&quot;the target is clearly recognizable and requires little or no training&quot;)</td>
<td>9</td>
</tr>
<tr>
<td>Shock</td>
<td>The same reasons and arguments as phase 1</td>
<td>1</td>
</tr>
</tbody>
</table>

4. Preparation of meals

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Reasons and arguments</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criticality</td>
<td>The preparation of meals was regarded as the most critical from the staff’s safety point of view, because food operators, such as cooks and cook helpers have direct contact with food, which, if infected, may affect all of them (i.e. while touching and testing the food) (&quot;the loss of life less than 100&quot;)</td>
<td>4</td>
</tr>
<tr>
<td>Accessibility</td>
<td>During the preparation of meals phase access to the kitchen is generally restricted to operators or other authorized persons (4 people), but the possibility of sabotage cannot be omitted (&quot;access generally restricted to operators or authorized persons&quot;)</td>
<td>4</td>
</tr>
<tr>
<td>Recoverability</td>
<td>The recovery from the attack, if possible, might not be easy. It requires not only new meal preparation, the safe disposal of suspected food, but also the cleaning and disinfection of the kitchen. It will be also important to recognize precisely the causes of the incident and to report the incident to the relevant authorities. One cannot exclude the need to buy and replace part of the kitchen infrastructure. CST concluded that this situation may require time (&quot;3-6 months&quot;)</td>
<td>5</td>
</tr>
<tr>
<td>Vulnerability</td>
<td>Since the meal preparation area is open to all authorized restaurant staff, it was concluded that &quot;target characteristics almost always allow for the introduction of sufficient agents to achieve aim,&quot; mainly by the act of potential sabotage</td>
<td>7</td>
</tr>
<tr>
<td>Effect</td>
<td>The above led CST to rank the &quot;effect&quot; attribute as 8 (&quot;25-50% of the system’s production impacted&quot;)</td>
<td>8</td>
</tr>
<tr>
<td>Recognizability</td>
<td>The target is not easy to be recognized by third parties, but it is very easy to be recognized by own staff with potential unfair intentions (&quot;the target is clearly recognizable and requires little or no training&quot;)</td>
<td>9</td>
</tr>
<tr>
<td>Shock</td>
<td>The same reasons and arguments like at phases 1 and 2</td>
<td>1</td>
</tr>
</tbody>
</table>

5. Storage of meals

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Reasons and arguments</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criticality</td>
<td>CST took into consideration similar threats as at the “storage of raw materials” (phase 3)</td>
<td>2</td>
</tr>
<tr>
<td>Accessibility</td>
<td>Food is packed, placed in refrigerators, according to its character, and direct contact with food, if contaminated, regardless of the type of the contaminating agent, is limited only to authorized persons. The warehouse is protected against unauthorized access; however, the act of a potential sabotage has been also taken into account</td>
<td>4</td>
</tr>
<tr>
<td>Recoverability</td>
<td>The recoverability attribute has been assessed as 4, similarly to the phase connected with the “storage of raw materials” and for the same reasons</td>
<td>4</td>
</tr>
<tr>
<td>Vulnerability</td>
<td>The same reasons and arguments as in phase 3</td>
<td>7</td>
</tr>
</tbody>
</table>

(continued)

Table III.
According to CST, the expected level of losses may reach 50% (“25-50% of the system’s production impacted”). Such a situation results in losses in food, in infrastructure and in the production system as well as time spent on food preparation and storage. It is likely to cause large financial losses.

The disposal of the contaminated cars and affected food has to be taken into account. The recovering process will be a difficult situation for ZET since it might be impossible to prepare the same amount of food, which will be ready for transport in less than one day. In addition, contamination can be spread to the cars. Then, they may require disinfection and temporary exemption from use. This situation also requires the precise recognition of the causes of the incident identified during this phase and the relevant food safety authorities need to be included in that process, which takes time, probably “3-6 months”.

There are three cars transporting meals, therefore two thirds of them may be excluded from use (“greater than 50% of the system impacted”). The situation may also ruin the reputation of the catering company because of the delay and failure to comply with the ordered food services.

The “recognizability” attribute received a rank of 9, as in the earlier phase (“storage of meals”) and for the same reasons.

The Tail Ships Regatta has a long tradition and is very important for the region, but CST concluded that a delay in transportation or the lack of service may have “little historical, cultural or other symbolic importance.” A “shock” arises and refers to the symbolic aspects of the Regatta, but it still has little influence on the final customer and rather influences the reputation of the restaurant.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Reasons and arguments</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effect</td>
<td>According to CST, the expected level of losses may reach 50% (“25-50% of the system’s production impacted”). Such a situation results in losses in food, in infrastructure and in the production system as well as time spent on food preparation and storage. It is likely to cause large financial losses. The disposal of the contaminated cars and affected food has to be taken into account. The recovering process will be a difficult situation for ZET since it might be impossible to prepare the same amount of food, which will be ready for transport in less than one day. In addition, contamination can be spread to the cars. Then, they may require disinfection and temporary exemption from use. This situation also requires the precise recognition of the causes of the incident identified during this phase and the relevant food safety authorities need to be included in that process, which takes time, probably “3-6 months”. There are three cars transporting meals, therefore two thirds of them may be excluded from use (“greater than 50% of the system impacted”). The situation may also ruin the reputation of the catering company because of the delay and failure to comply with the ordered food services. The “recognizability” attribute received a rank of 9, as in the earlier phase (“storage of meals”) and for the same reasons.</td>
<td></td>
</tr>
<tr>
<td>Shock</td>
<td>The same reasons and arguments as in phase 3</td>
<td>1</td>
</tr>
<tr>
<td>Effect</td>
<td>The same reasons and arguments as in phase 3</td>
<td>9</td>
</tr>
<tr>
<td>Recognizability</td>
<td>The same reasons and arguments as in phase 3</td>
<td>9</td>
</tr>
<tr>
<td>Shock</td>
<td>The same reasons and arguments as in phase 3</td>
<td>1</td>
</tr>
</tbody>
</table>

6. Packing of meals to the means of transport

Criticality: This attribute has been ranked as 2 (“no loss of life”) because the restaurant’s staff have limited direct contact with open food during this phase. Meals are placed in packages and containers. This is due to the fact that the staff has little possibility to be affected by potentially infected food if the contamination has been introduced at earlier phases.

Accessibility: During the process of packing “access is generally restricted to operators or authorized persons.” However, a possible sabotage carried out by drivers has to be taken into account.

Recuperability: The disposal of the contaminated car and affected food has to be taken into account. The recovering process will be a difficult situation for ZET since it might be impossible to prepare the same amount of food, which will be ready for transport in less than one day. In addition, contamination can be spread to the cars. Then, they may require disinfection and temporary exemption from use. This situation also requires the precise recognition of the causes of the incident identified during this phase and the relevant food safety authorities need to be included in that process, which takes time, probably “3-6 months”.

Vulnerability: CST identified that the target characteristics (meals packed into transport means) “allow the moderate probability of sufficient agents to be added to achieve aim: 10%-30%.” Contamination by third parties was excluded. Nevertheless, there was a need to consider potential sabotage carried out by own staff.

Effect: There are three cars transporting meals, therefore two thirds of them may be excluded from use (“greater than 50% of the system impacted”). The situation may also ruin the reputation of the catering company because of the delay and failure to comply with the ordered food services.

7. Transportation of meals

Criticality: The same ranks as in the “transportation of raw materials” phase were assigned. The same threats and impacts were identified.

Accessibility: The same ranks as in the “transportation of raw materials” phase were assigned. The same threats and impacts were identified.

Recuperability: The disposal of the contaminated cars and affected food need to be taken into account. The recovering process will be a difficult situation for the company. The cars may require disinfection and temporary exemption from use. This situation also requires the precise recognition of the causes of the incident identified during this phase and the relevant food safety authorities need to be included in that process, which takes time, probably “3-6 months”.

Vulnerability: The same ranks as in the “transportation of raw materials” phase were assigned. The same threats and impacts were identified.

Effect: The same ranks as in the “packing of meals to the means of transportation” phase were assigned. The same threats and impacts were identified.
Attribute Reasons and arguments Rank

Recognizability The same ranks as in the “transportation of raw materials” phase were assigned. The same threats and impacts were identified 8

Shock This attribute has been rated in the same way as in the “packing of meals to the means of transport” phase. Its value stems from the fact that such a situation does not have a direct impact on the final consumer 3

8. Unpacking, preparation and placement of meals on the tables

Criticality The “criticality” attribute was assessed as 4 for the same reasons as the “preparation of meals” phase. During that process, only restaurant staff may be affected by potentially contaminated food (while tasting or touching). Meals may be poisoned by own personnel and the deliberate activity of the external security staff hired by the organizers also cannot be omitted. This may affect at “loss of life less than 100%” 4

Accessibility The rank of the “accessibility” attribute increases greatly at this phase, since there are many people around, for example, external security staff or event guests. The only access restriction is the rope around the tent (“target is outside building and no perimeter fence”) 9

Recuperability Having in mind the “recuperability” criteria and the consequences for ZET (the suspension and withdrawal of services, ruined image, the loss of reputation, of infrastructure, of food, the need for the safe disposal of contaminated food, the need for tests carried out by relevant food safety authorities), CST decided that the recovery process might be very difficult and long (“> 1 year”) 10

Vulnerability In the banquet tent and around it, there may be more people potentially interested in food poisoning, including external security staff and own staff. For these reasons, it was concluded that “target characteristics almost always allow for introduction of sufficient agents to achieve aim.” The introduction of contaminants into food can be also fostered by the possible lack of attention and/or by a rush that normally occurs during such occasions as mass events 7

Effect The suspension and withdrawal of services (“greater than 50% of the system impacted”) may occur due to the suspected contamination of food, the signs of nervousness, anxiety and delay associated with waiting for the release of food that can cause anxiety among the guests, their dissatisfaction and even their resignation from participation in the whole event 10

Recognizability During the catering process “the target is clearly recognizable and it requires little or no training for recognition.” In fact, the delivery of the food is very distinctive, visible from afar and well-marked. In addition, the tent and tables are easily accessible 10

Shock The Tall Ships Regatta event (together with associated services, such as catering) “has moderate historical, cultural or other symbolic importance.” The “shock” attribute has been assessed more severely than previously. Its value stems also from the fact that any negative situation connected with food contamination may have a direct impact on the final consumer and on the image of the whole event 6

9. Serving meals

Criticality Potential food contamination may affect almost 2,000 people present during the event. For that reason, the “criticality” attribute was assessed as 7 (“the loss of life is between 1,000 and 10,000”) 7

Accessibility At this phase food is easily accessible (“target is outside the building and there is no perimeter fence; limited physical or human barriers or observation; the attacker has relatively unlimited access to the target; an attack can be carried out using medium or large volumes of contaminant without undue concern of detection; multiple sources of information concerning the facility and the target are easily available”) 10

Recuperability It may take a long time for ZET, the Regatta organizers and the customers to recover from such a situation, if one considers a probable long illness, stress, anxiety and even the loss of life (“> 1 year”) 10

(carried on)
To train all staff in terms of food terrorism and food defense, for the company’s efficiency in the implementation of new methods, tools and systems depends on the level of employee education (Bogadi et al., 2016). Restaurant employees who undergo training are better able to respond to questions on food safety knowledge and behavior than untrained employees (Roberts et al., 2008; Webb and Morancie, 2015).

To prepare a food defense plan, the instructions and the self-assessment criteria for food defense purposes, including the selection and control of the external staff. Self-assessment should be conducted periodically, at least annually. The main objectives of the self-assessment are to identify and verify the most vulnerable components of the restaurant's operations and determine how to use resources and instructions most effectively to reduce identified risks. The development of the food defense plan is the best way to reduce the risk of food terrorism (Yoon and Shanklin, 2007). A food defense plan has to be effective (Selamat and Iqbal, 2016) and to meet this condition it should be developed, written, implemented, tested, assessed and maintained if it is to be functional and take into account the following core elements: prevention, intervention and response (Yoe et al., 2008).

To implement and test the recall program to track suspected products and manage the food recall process and behaviors (Barach, 2017), and to avoid or limit panic, chaos,

### Table III.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Reasons and arguments</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vulnerability</td>
<td>It was concluded that during such a mass event “target characteristics allow for the easy introduction of sufficient agents to achieve aim.” There are many people and many of them, while unobserved, can contaminate food placed on the tables. CST took also into account the possibility of sabotage</td>
<td>10</td>
</tr>
<tr>
<td>Effect</td>
<td>It was concluded that there is a great probability for the catering system to be affected (“greater than 50% of the system impacted”)</td>
<td>10</td>
</tr>
<tr>
<td>Recognizability</td>
<td>“The target is clearly recognizable and it requires little or no training for recognition.” Food service is very distinctive, visible from afar and well-marked. The tent and tables are easily accessible</td>
<td>10</td>
</tr>
<tr>
<td>Shock</td>
<td>The “target has moderate historical, cultural or other symbolic importance,” but, this time, when there is a consumption phase, the “loss of life might be between 1,000 and 10,000.” Mass panic and anxiety cannot be excluded mainly among “children and elderly”</td>
<td>8</td>
</tr>
</tbody>
</table>

### Table IV. Summary of the CARVER+Shock vulnerability analysis results

<table>
<thead>
<tr>
<th>Phase (potential target area)</th>
<th>The attribute and its rank</th>
<th>Risk indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>The attribute and its rank</td>
<td>C  A  R  V  E  R  Shock</td>
<td></td>
</tr>
<tr>
<td>1. Receiving raw materials</td>
<td>2  3  1  4  1  8  1</td>
<td>20</td>
</tr>
<tr>
<td>2. Transportation of raw materials</td>
<td>2  3  2  2  7  8  1</td>
<td>25</td>
</tr>
<tr>
<td>3. Storage of raw materials</td>
<td>2  4  4  7  6  9  1</td>
<td>33</td>
</tr>
<tr>
<td>4. Preparation of meals</td>
<td>4  4  5  7  8  9  1</td>
<td>38</td>
</tr>
<tr>
<td>5. Storage of meals</td>
<td>2  4  4  7  8  9  1</td>
<td>35</td>
</tr>
<tr>
<td>6. Packing of meals to the means of transport</td>
<td>2  3  5  3  9  9  3</td>
<td>34</td>
</tr>
<tr>
<td>7. Transportation of meals</td>
<td>2  3  5  2  9  8  3</td>
<td>32</td>
</tr>
<tr>
<td>8. Unpacking, preparation and placement of meals</td>
<td>4  9  10 7 10 10 6</td>
<td>56</td>
</tr>
<tr>
<td>on the tables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Serving meals</td>
<td>7  10 10 10 10 10 8</td>
<td>65</td>
</tr>
<tr>
<td>Attribute (total)</td>
<td>27  43 46 49 68 80 25</td>
<td>25</td>
</tr>
</tbody>
</table>

Notes: 9-10 – very high risk; 7-8 – high risk; 5-6 – moderate risk; 3-4 – low risk; 1-2 – small risk
anxiety and fear, which are observed among employees and customers in a crisis situation (Bruemmer, 2003; Hall et al., 2004). Preparing people and organizations for terrorism and crisis response and recovery requires understanding such behaviors (Ursano et al., 2006).

- To introduce a regular food defense audit. In general, when food safety systems are out of control, it is also likely that there are inadequate food defense systems in place (Park, 2006/2007).

- To promote food safety culture, by creating food safety awareness and responsibility. Food safety culture can be understood as a way in which an organization or a group of people reaches the level of food safety in their minds and behaviors (Sarter et al., 2010). In a negative culture any attempts by individuals to improve safety may be ineffective (Clayton and Griffith, 2008). Researchers have investigated the impact of food safety culture on employees’ motivation to follow handling procedures (Arendt et al., 2011; Fatimah et al., 2014) and employees’ attitude and behavioral intention (Lee et al., 2013), as well as actual behaviors (Chapman et al., 2010). Employee knowledge, beliefs and attitudes as well as training influence terrorism preparedness response and recovery (Ursano et al., 2006).

- To maintain vigilance, responsibility and caution among the staff and to increase food defense awareness, the owner of the ZET company hung in a visible place a display with the FIRST principle: Follow the company’s food defense plan and procedures; Inspect your work area and surrounding areas; Recognize anything out of the ordinary; Secure all ingredients, supplies, and finished product; Tell the company owner if you notice anything unusual or suspicious. Employees FIRST is an FDA initiative that food industry managers can include in their ongoing employee food defense training programs. Employees FIRST educates front-line food industry workers from farm to table about the risk of intentional food contamination and the actions they can take to identify and reduce these risks (www.fda.gov). Alpas and Ciracoglu (2010) emphasize that food service managers can use the FIRST tool kit as a part of ongoing employee food defense training programs. It not only educates first line workers about the risk of contamination but also provides food services with countermeasures to consider and implement to reduce these risks.

Discussion and conclusions
Depending on the size of a food company, food defense and vulnerability assessment can be implemented on the level of its management, human resources, purchasing department, receipt and storage of raw materials, production, quality control, packaging and labeling, storage of finished products, transport and distribution (PAS 96, 2014; Bogadi et al., 2016). Among the vulnerable food supply food chains, meat and dairy supply chains are observed as the most frequently identified (Paloviita et al., 2016); however, it can be confirmed that intentional food contamination may occur during the whole production process, regardless of its nature (WHO, 2008; Manning and Soon, 2016). The catering process is not free from the threat (Hui, 2006; Dalziel, 2009; Peter, 2015; Fijnaut, 2016). Taking into account the presented case study, as it can be seen in Table IV, the most critical nodes are those connected with food consumption, i.e. the preliminary phase – “unpacking, preparation and placement of meals on the tables” – and the final phase – “serving meals.” Similarly to accidental contamination, during those phases it is very difficult to reverse the negative effects of the contamination, for the consumers are considered the weakest link in the food chain with regards to food quality and safety (Joshi et al., 2010). Moreover, this situation refers to the fact that food is prepared and served for mass consumption and in the open air, under
severe conditions (Tsouros and Efstathiou, 2007; Stratton, 2013). It is also very difficult to avoid the recognizability of the target (Tsouros and Efstathiou, 2007). Another important factor is accessibility, which, due to the mass nature of the event, is a great convenience to a potential attacker (Stratton, 2013). The relatively high rate of the risk has been identified for "preparation of meals," carried out at the restaurant by own staff. The value of this indicator is the result of a relatively high vulnerability to infection and the easy identification of the target by own staff, who might be potentially interested in sabotage. Sabotage is typically manifested through disgruntled or aggrieved employees (Klietmann and Ruoff, 2001; Khan et al., 2001), and may result in loss of life and health of consumers, of own staff, and company reputation and business continuity (Khan et al., 2001; Durocher, 2003; PAS 96, 2014). Regarding the above “receiving raw materials,” “transportation of raw materials” and “storage of raw materials” are not as risky as the rest of the phases, but the probability of sabotage has not been ruled out since this negative situation is probable at any phase of the process (Durocher, 2003; Klietmann and Ruoff, 2001; Khan et al., 2001). Taking into account the overall results among the analyzed attributes, “recognizability” and “effect” have the greatest influence on the outcome, because of their total value, which once again confirms that during mass events it is not difficult to recognize the target and it is very easy to be effective (Nacos, 2006). What seems important is that the values of such attributes as “recuperability,” “effect” and “shock” are increasing along with the development of the catering process. The closer the food gets to the consumer, the higher is the risk of intentional contamination (Van Alfen, 2014). It means that the farther in the process, the harder it is to reverse the effects of contamination, including the loss of health, the loss of life, the loss of reputation and confidence as well as the loss of money (Hussain and Dawson, 2013; Alum et al., 2016).

As can be observed and documented, in times of the political, economic and social turbulence, the possibility of deliberate food contamination is very real and probable (Fassam and Dani, 2017; Manning and Soon, 2014, 2016; Davidson et al., 2017). This study has shed an interesting light on the awareness level and practices that need to be followed by caterers. Having in mind the 1984 incident in the restaurants in Oregon by the Rajneesh group, and other examples (Dalziel, 2009; Wiśniewska, 2016), the analysis presented above also suggests that food services might be a very attractive target for terrorists. According to WHO (2008), food service operations are very vulnerable for criminal attacks. For that reason, it may be necessary to put into place a food defense program and supervision to deter deliberate contamination. In order to counter food terrorism, a strong surveillance system is needed, and the CS method proposed and recommended by the USDA and the FDA seems to meet these expectations. The case study presented in this manuscript confirmed that the practical application of the CS method in the catering company ZET allowed to indicate the most critical nodes in the food service process and showed that it is not free from attack. Food services are exposed to many threats (Durocher, 2003; Nwoko, 2011), mainly those which are offered during mass events, to mass consumers (Unnevehr, 2003; WHO, 2008). Regarding the results of the case study, from the perspective of consumer safety, the lowest risk of threat is observed at the first phases of the catering process, and, among the analyzed phases of the catering process, the most risky were those connected with the preliminary consumption phase and with the final phase, which is arranged in the place of the event. Two attributes have the greatest influence on the outcome, i.e. “recognizability” and “effect,” which confirms that during mass events, considering the terrorists’ intentions, it is not difficult to recognize the target and it is very easy to be effective (Unnevehr, 2003). It is also evident that the burden caused by an attack can be very costly to any community, region or country (Hall et al., 2004).

Contamination may come not only from outside the company because one cannot exclude sabotage, which is possible along the continuum from farm to table (Khan et al., 2001; WHO, 2008). To avoid it or to reduce its risk, there is a need for the
careful recruitment of personnel (internal and external), examining their origin, criminal records and references, as well as conducting training to increase the awareness in this regard. To protect food against malicious contamination coming from the outside it is crucial to elaborate a food defense plan, to provide adequate resources, tangible and intangible, and introduce countermeasures based on creating food safety culture, responsibility and vigilance among staff. Park (2006/2007) emphasizes that food safety and food defense are approached and managed in different contexts, and small-to medium-sized enterprises (SMEs) might find it difficult to develop and implement a comprehensive food defense plan. Large companies balk at dedicating full-time staff and extra resources to manage food defense and vulnerability issues, particularly when considering the external terrorist threat. Therefore, according to the approach described by Yoe et al. (2008), SMEs might consider Hazard Analysis Critical Control and Defense Points (HACCDP) system, which covers the vulnerability assessment aspects and is proposed as an extension of HACCP. The similarities between HACCP and HACCDP are very clear, which provides an opportunity to build up a successive approach against intentional contamination. However, there is one condition of the success – the ability to identify the critical nodes and the consequences of the attack (Norman, 2016), which are more severe and more difficult to predict than while assessing the probability of accidental contamination that may go undetected in the context of recently developed and industry-practiced HACCP plans. The same can be said about the CS approach. The presented case study confirmed its usefulness and the CS method can be recommended for food service managers to protect their customers, their image and processes.

Limitation and future research directions
Although this case study has several implications for ways to improve and protect the catering process during a mass event, it still has some limitations that need to be fixed. Since the research data were based on a specific process implemented in specific conditions in Poland, future studies focused on the CS method applied in larger restaurants and in restaurants from other countries, mainly those more vulnerable to terrorism attacks, could be valuable in conducting a cross-cultural and political comparison. The next limitation of the results obtained during the study can be a kind of subjectivity of the assessment carried out by the team. To reduce or to minimize it, there is a need to supplement educated and experienced members of the team with certain knowledge, representing the main phases of the process and to have regular contact with external experts who may verify the results of the assessment, taking into account the context of the organization. There is also a need to repeat the vulnerability analysis.

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Further reading

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Whistleblowing as a countermeasure strategy against food crime

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Abstract

Purpose – The purpose of this paper is to undertake a two-phase desktop review of literature sources in order to conceptualise, frame, and critique existing whistleblowing models and strategies and consider how whistleblowing strategies form part of an effective food crime management system (FCMS) especially for small and medium sized organisations.

Design/methodology/approach – Existing literature from academic sources, financial, healthcare, food industries has been reviewed and critiqued in order to construct a conceptual framework that can inform future empirical research.

Findings – Whistleblowing strategies can form an effective part of a FCMS. Appropriate regulatory protection of those who whistleblow is crucial to not only safeguard individuals but also to mitigate food crime and protect consumers from loss and potential harm. Barriers to whistleblowing exist and if these are not addressed then individuals will be reluctant to report food crime. Further empirical research is required to assess the influence of these and other factors identified in this research and how they can be overcome.

Originality/value – The framework will provide food industry practitioners with guidance on the effective application of whistleblowing strategies within a FCMS.

Keywords
Consumer protection, Whistleblowing, Food, Crime, Countermeasures

Paper type
Conceptual paper

1. Introduction

Whistleblowing can be a mode of ethical resistance (Glazer and Glazer, 1989); a vehicle to promote rights through movements such as consumer issues (Greenwood, 2015); or a process to give a voice to animal rights and environmental concerns with regard to an organisation’s practices. Whistleblowers are seen as either individuals who undertake heroic and noble deeds; or as malcontent, trouble-makers and misfits for exposing wrongdoing (Zakaria, 2015). The term “whistleblow” was coined by Nader et al. (1972) as disclosure by organisational members of illegal, immoral, or illegitimate practices that are executed under the control of their employers, to persons or organisations that may be able to effect action as a result of that disclosure (Miceli and Near, 1984, 1985; Near and Miceli, 1995, 2016). Publically Available Specification (PAS) 1998 (2008, p. 9) Whistleblowing arrangements: Code of practice defines a whistleblowing concern as a “reasonable and honest suspicion an employee has about a possible fraud, danger or other serious risk that threatens customers, colleagues, shareholders, the public or the organisation’s own reputation”.

The authoritative individual that whistleblowers disclose to can be either internal to the organisation: e.g. a supervisor (Soeken, 2014), manager (Miller, 2015; The Economist, 2015), or someone in the direct chain of command, or external such as regulatory officers or independent supervisory bodies, inspectors, auditors, the police, MPs, consumer/citizen groups, undercover reporters (Evans, 2014; Tang and Babich, 2014) or the media (Harris and Barrett, 2009; PAS 1998, 2008). The Ethics Resource Centre (2012) report that 84 per cent of
Organisations can implement a range of measures to reduce risk associated with criminal behaviour, such as implementing additional or upgrading existing procedures. The costs of a missed opportunity to address a criminal threat can be great: fines, requests for compensation, higher insurance premiums, a regulatory investigation, lost jobs, lost profits and even lost lives (PAS 1998, 2008). External parties including regulators can benefit too from saved resources to investigate illicit activities, prosecution and public services costs. The positive consequences of whistleblowing have been synthesised (Figure 1).

The aim of this research was to undertake a two-phase desktop review of literature sources in order to conceptualise, frame, critique existing whistleblowing strategies and to consider how whistleblowing strategies could be integrated within an effective food crime management system (FCMS). The scope of the review included peer-reviewed articles, trade publications and online news items. Regulatory sources were reviewed to provide examples of legislative frameworks adopted to provide protection to whistleblowers. The second phase of the review included analysis of literature sources to provide an evidence base for historic examples of disclosure of criminal activity in the food chain and to critique the context in which they had occurred. This analytical approach led to a preliminary conceptual characterisation of whistleblowers and the factors that influence them. Lastly, the value of whistleblowing strategies in the food sector was considered and critiqued. In this context food crime has a wide focus and illegal activity can span food safety and food quality issues as equally as illicit activity and behaviour. The aim of this paper is not to contextualise what constitutes food crime specifically, but to look at the use of formal whistleblowing strategies within a FCMS to mitigate and, where possible prevent, illegal activity. If the food industry wants to effectively counter illicit and illegal practice, it must

**Figure 1.** Positive consequences of whistleblowing

Source: Adapted from Bowers et al. (2012)
proactively ensure that internal reporting channels are available for staff. If these protocols do not exist, there is increased risk that external channels will be used to disclose wrongdoing and prevent an organisation from rectifying the problem internally first (Near and Miceli, 1985). This highlights the importance of whistleblowing as a management control mechanism to identify, mitigate and where possible deter wrongdoing. The next section of the paper focuses on examples of whistleblowing in the food industry.

2. Whistleblowing and whistleblowers

Previous studies of whistleblowing mostly involve corporate or public sector malpractice such as corruption (Schultz and Harutyunyan, 2015), police agencies (Park and Blenkinsopp, 2009; Rothwell and Baldwin, 2006), accounting and financial reporting (Hwang et al., 2008, 2013), auditing (Alleyne et al., 2013; Arnold and Ponemon, 1991; Brennan and Kelly, 2007; Maroun and Solomon, 2014), government agencies (Cho and Song, 2015), and healthcare (Philipsen and Soeken, 2011). Within the health setting, McDonald and Ahern (2000) reported that health workers who reported misconduct were subjected to severe official reprisals including demotion, reprimand and referral to a psychiatrist. There were also instances of individuals experiencing threats, rejection by peers, pressure to resign and being treated as a traitor, or experiencing a lack of progression in their career. Hwang et al. (2008, 2013) assert that personal relationships, fear of retaliation and also media coverage discourage whistleblowing in Chinese society. Vinten (1996) associated the act of whistleblowing to a “bee-sting phenomenon” suggesting the approach can only be used once, before the act itself jeopardises the career of the whistleblower. Thus it is a high-stakes action and the potential consequences post-reporting (both positive and negative) will influence an individual's decision to either remain silent or to blow the whistle.

The PCAW (2013) report “Whistleblowing – The Inside Story” reviewed 1,000 cases between August 2009 and December 2010 across all industry sectors. Food and beverage cases represented just 3 percent of the total cases so the results cannot be critiqued to reflect the food supply chain specifically, however overarching themes associated with whistleblowing can be determined. The whistleblowers' position was identified as executives (2 per cent), managerial (15 per cent), professional (26 per cent), skilled (27 per cent) unskilled (13 per cent) and administrative (8 per cent). This complies with the conclusions of Miceli et al. (2008) that whistleblowers are more likely to be older, have more experience, work at supervisory levels, with higher pay, and feel a sense of responsibility for reporting wrongdoing, and have greater knowledge of appropriate internal channels. Whistleblowers can be motivated by moral purposes, professional integrity (Motarjemi, 2014), courage (Zakaria, 2015), internal locus of control (Chiu, 2003) and being proactive (Bjørkelo et al., 2010). Whistleblowers tend to have more positive reactions to their work, be male and belonged to larger work groups (Miceli and Near, 1988) with knowledge of circumstances and the individuals involved in fraudulent practices (Zakaria, 2015). These characteristics highlight the individual or personal factors that encourage whistleblowing a theme drawn upon later in the paper.

Wider constructs of organisational culture and subjective norms will influence the intention to whistleblow. Subjective norm is the perceived social pressure to engage, or not in a given behaviour in this case whistleblowing. Alleyne et al. (2013) suggest that norms provide implicit guidelines and team norms are a moderating variable that create legitimate, socially shared standards against which an individual's behaviour is measured (see Chatman and Flynn, 2001). Thus a whistleblower on the one hand can be seen as a member of a team or group who then goes against such team norms and attempts to change improper group behaviour (Miceli and Near, 1984 cited by Greenwood, 2015) or alternatively follows an organisational, team or group culture that welcomes whistleblowing. In previous research, the theory of planned behaviour (TPB) see Fishbein and Ajzen (1975), Ajzen and Fishbein (1980) and the theory of reasoned action (TRA) see Ajzen (1985, 1991) have been
used to study how attitudes and subjective norms affect an individual’s behaviour towards food handling, consumption and purchase (Bianchi and Mortimer, 2015; Irianto, 2015; Mullan et al., 2015), but not whistleblowing specifically in the food sector and this is worthy of further study and explored further in this paper.

Historic whistleblowing cases in the food industry suggest that whistleblowers themselves suffer negative personal consequences including: depression and symptoms of extremely poor mental health (Motarjemi, 2015a, b); altered responsibilities (Dyck et al., 2010), refusal of pay increment, lack of peer support (Curtis, 2006), removal from usual duties (Soeken, 2014), loss of employment (Motarjemi, 2014; Motarjemi, 2015a; Philipsen and Soeken, 2011), stigma associated with being a “troublemaker” (Philipsen and Soeken, 2011); psychological harassment (Motarjemi, 2015a); resignation under duress (Dyck et al., 2010), threats of revenge and isolation (Tan and Ong, 2011), and possibly even murder (Zhuang, 2012). Ponemon (1994) suggest that the nature and extent of the retaliation imposed by the organisation’s management or co-workers against the whistleblower is perhaps the most significant determinant of a whistleblower’s intention to disclose wrongdoing. Furthermore, if whistleblowers seek personal redress from organisations for the personal consequences of their disclosure, in the event that the case comes to court, corporate bodies if they so choose have significant financial resources to “buy witnesses, delay the legal processes and exert political pressure” leaving the employee in question unable to progress with new employment or to have closure (Motarjemi, 2015a).

As part of this research a range of contemporary whistleblowing case studies across the food industry have been drawn together. The cases reflect issues such as potential animal welfare violations, bribery, corruption, and negligence with regard to food safety and food quality issues (Table I). Disclosure was conducted both internally and also externally to parties such as regulators or the media.

The breadth of the scope of examples shown in Table I demonstrates that it is difficult to draw boundaries around, define and contextualise types of illicit behaviour associated with the food chain and that need to be addressed within an organisation’s FCMS. Illicit behaviour is not binary in terms of products, activities or actors and often reflects an acceptance of customary illegality i.e. the acceptance and tolerance of illicit activities by predominantly legal economic actors (Gregson and Crang, 2016). Factors that can drive customary illegality including market competition and resource scarcity, inadequate governance, lack of sanctions and low probability of discovery, rapid development of systems, logistics and technology, data swamping and opacity (Charlebois et al., 2016; Manning et al., 2016; Manning, 2016; Marvin et al., 2016). Opacity, even food crime itself, is driven by market dynamics and seeking to survive in market economies with organisations that have better economies of scale or operate as oligopolies (Manning et al., 2016).

2.1 Food crime

Many illicit practices go undetected by both regulatory authorities and senior management in food businesses. Hence, the discovery of such practices often relies on individuals who report wrongdoing. Illicit activities elude formal enumeration and measurement and circumvent institutional systems, regulations and associated enforcement penalties (Feige, 1990). Further, the types of process verification activities undertaken in market-focussed second party audits and third party certification audits are constrained by the scope of the system standards used, the planned nature, the time available and the frequency of the audits, and the volume of data to be assessed (Manning, 2013; Manning and Soon, 2014). Illicit behaviour in the food supply chain arises as a result of misrepresentation associated with:

- product integrity: the intrinsic quality attribute of totality or completeness (Manning and Soon, 2014);
<table>
<thead>
<tr>
<th>Year</th>
<th>Description of whistleblower</th>
<th>Internal Whistleblower (WB)</th>
<th>External (Official) WB</th>
<th>External (Media) WB</th>
<th>Description</th>
<th>Outcome</th>
<th>References</th>
</tr>
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<tbody>
<tr>
<td>2006</td>
<td>Ongoing</td>
<td>Food safety manager of Nestle</td>
<td>Request for audit of her department was turned down. The former food safety manager is claiming $2million compensation plus an allowance for lost earnings</td>
<td>Claims of acts of reprisal including being “treated like a child” and being humiliated. Both the former food safety manager and Nestle failed to agree on a settlement and the case went to trial</td>
<td>Miller (2015), The Economist (2015)</td>
<td></td>
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<tr>
<td>2008</td>
<td>Manager at Peanut Corporation of America (PCA) (Texas processing plant)</td>
<td>Manager then reported to Texas Department of Health, and did not receive response. Subsequently, Texas authorities searched their database but found no record of emails from the manager</td>
<td>The manager finally whistleblowed to Safe Tables Our Priority (STOP) a national health organisation and went on Good Morning America</td>
<td>PCA went bankrupt and on September 2015, the former CEO of PCA was sentenced to 28 years in prison</td>
<td>Basu (2015), Harris and Barrett (2009), Near and Micelli (2016)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>Truck drivers (PCA)</td>
<td>Truck drivers whistleblowed to media</td>
<td>Packages of peanut paste burst in truck and were later shovelled up and replaced back in barrels. Shipment was rejected by one Georgia company, but PCA signed for it and accepted the delivery</td>
<td>KFC’s products were boycotted and sales plummeted 25% by early 2013. KFC stopped purchasing chickens from Liuhe Group</td>
<td>Harris and Barrett (2009)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>Local Chinese TV broadcast</td>
<td>Undercover reporting by media</td>
<td>TV reported that KFC’s supplier (Liuhe Group) in China added illegal drugs in chicken feed to accelerate their growth cycles</td>
<td>(continued)</td>
<td>Tang and Babich (2014)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year</td>
<td>Description of whistleblower (WB)</td>
<td>External (Official) WB</td>
<td>Description</td>
<td>Outcome</td>
<td>References</td>
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<td>2014</td>
<td>Local Chinese TV broadcast</td>
<td>Local Chinese broadcast blew the whistle by airing footage of workers conducting fraudulent practices</td>
<td>TV report showed Shanghai Husi Food Co. Ltd workers apparently picking up meat from the factory floor and mixing fresh meat together with expired meat; employees were overheard saying that if their clients knew what they were doing, the firm would lose its contract</td>
<td>McDonald’s and Yum Brands Inc. (owner of KFC, Pizza Hut and Taco Bell) stopped using the supplier after the broadcast. The processing plant was sealed and products seized whilst Shanghai Municipal Food and Drug Administration investigated the allegations</td>
<td>Evans (2014)</td>
<td></td>
<td></td>
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<tr>
<td>2016</td>
<td>Worker in abattoir</td>
<td>Worker secretly filmed more than 170 hours that focussed on mistreatment of animals inside an Australian abattoir</td>
<td>Video sent to animal rights group Animals Australia who forwarded to the regulatory authority, PrimeSafe</td>
<td>PrimeSafe undertook an investigation, sanctioned the business and requested removal of four staff</td>
<td>Farnsworth (2016)</td>
<td></td>
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Food crime prevention measures can utilise well-established tools such as Six Sigma and hazard analysis critical control point (HACCP) methodologies (Moyer et al., 2017), HACCP being routinely associated with food safety and legality. Similarly the use of threat analysis critical control point (TACCP) and vulnerability analysis critical control point (VACCP) methodologies such as Publically Available Specification Guide to Protecting and Defending Food and Drink from Deliberate Attack (Publically Available Specification 96, 2014) and CARVER+SHOCK have utility in addressing wider food crime. Effective countermeasures within a FCMS reduce criminal opportunity (Spink et al., 2015). Countermeasures can be developed to mitigate risk associated with food crime and illicit behaviour with regard to all four elements of food integrity: product, process, people and data. Spink et al. (2016) suggest that crime countermeasures fall into five distinct categories: detection, i.e. the identification of opportunity, mapping of the food chain to identify vulnerabilities or hotspots, deterrence by inhibiting opportunity to commit crime, prevention through promotion of the robust management systems and disruption should crime occur. Indeed there must be a holistic approach whereby detection and deterrence countermeasures operate in consort as elements of a FCMS that includes a product testing programme (Moyer et al., 2017). However, advanced product testing methods require highly technical laboratory skills and the tests incur considerable cost that supply chain pressures may not be able to bear, putting this option beyond the financial resources also be overcome by strategic, competent and knowledgeable actors, thus unless it is part of a wider integrated FCMS it can be of limited value. Detection, mapping and prevention activities can only be developed to address known issues or activities making TACCP and VACCP also of limited value with regard to emerging and novel illicit behaviour or entrepreneurial, enterprising, situational crime risk that is reactive, responsive and specific to an organisation, the products it produces and the associated supply chain.

2.2 Food crime management

Food crime is undertaken by individuals and/or groups with varying criminal and business modus operandi (Manning et al., 2016). FCMS can be both transactional and transformational in nature. Transactional processes focus on the policies, procedures and protocols, often called pre-requisites that drive formal management of food crime and illegality and minimise risk (Manning et al., 2016). Conversely, transformational processes encompass both formal and informal organisational culture and the role of employees, irrespective of formal responsibilities, in enabling the organisation to maintain legal and ethical practice and to detect, deter and disrupt criminal activity. Transformational elements of a FCMS seek to inspire staff to consider that food legality and compliance is important and to empower them to realise fully their specific role in ensuring compliance. Further employees need to be aware that there is always the potential for emerging or re-emerging crime challenges that must be effectively controlled, or where possible eliminated. Thus whistleblowing strategies need to be embedded into both the transactional FCMS to ensure that individuals are aware of the organisation’s systems and procedures and also in the transformational culture. Senior management must demonstrate both through their commitment to the FCMS in terms of both engagement and appropriate resource allocation and also in their overseeing of an effective business culture that demonstrates that in a transparent business such strategies are welcomed and adopted as part of a wider corporate
disclosure discourse. Lamming et al. (2001) determine that there is a spectrum between transparency and opacity proposing that organisations can work in a form of corporate “hinterland” in terms of their selective discourse. Therefore, crime risk increases in this hinterland where transactional controls do not operate as intended and an informal culture can not only just exist, but flourish.

Criminal organisations and networks complement and interact with traditional markets and supply chains reducing transaction costs, and providing increased business opportunities for both buyers and sellers (Williams, 2001). This entrepreneurial illicit approach (Manning et al., 2016) is in contrast to the regulatory hierarchical mindset, bureaucratic rivalry and competition, interagency antipathies, and hesitancy to share information, align databases or coordinate enforcement operations (Williams, 2001). This makes crime mitigation activities often less agile and reactive than the criminal networks they are seeking to disrupt. Whilst FCMS are of value, integrated reactive measures such as whistleblowing protocols are essential too.

3. Regulatory response towards protecting whistleblowers

3.1 European Union

The European Committee on Legal Co-operating (CDCJ) of the Council of Europe developed the Recommendation CM/Rec (2014)7 on the protection of whistleblowers (Council of Europe, 2014). Member states are encouraged to develop a robust national framework that facilitates and protects whistleblowers. The Recommendation sets out a number of key principles to ensure that: laws to protect whistleblowers cover a broad range of information that is in the public interest; individuals have access to more than one channel to report and disclose such sensitive information; mechanisms are in place to ensure reports and disclosures are acted upon promptly; whistleblowers are entitled to have their identities kept confidential by those to whom they report; and all forms of retaliation are prohibited as long as the individual whistleblower has reasonable grounds to believe in the accuracy and credibility of the information.

Four EU member states have advanced whistleblower protection laws including the UK, Luxembourg, Romania and Slovenia. Of the other twenty-three EU member states, 16 include partial legal protection for whistleblowers in the public and/or private sectors. For example, in October 2012, Italy included into its Anti-Corruption Law the country’s first ever provision intended to legally protect government employees against negative implications linked to disclosure acts of wrongdoing. Previously, Italy has no specific whistleblowing protection laws in place (World Law Group, 2012). There were cultural barriers in Italy where whistleblowing was viewed as treason (Osterhaus and Fagan, 2007) or betrayal (Dungan et al., 2015). Efforts by workers’ unions in Italy to protect whistleblowers led to the proposed amendments to Italy’s Anti-Corruption Law (G20 Anti-Corruption Action Plan, 2010). The Italian public sector can report wrongdoing as long as it is not committed out of defamation or intent to harm a person’s right to privacy. The act however, does not apply to the private sector. There has been a call by Transparency International Italia for wider protection covering employees in both public and private sectors (Worth, 2013). In France, a new anti-corruption law was adopted on December 9, 2016 (Law 2016-1691) the so called “Law Sapin II”. This strengthened the law with regard to whistleblowing particularly against discrimination or retaliation against whistleblowers. The law lays down precise requirements that provide context to whether a whistleblower would be entitled to protection under the law (WIN, 2017a). The remaining seven countries (i.e. Bulgaria, Finland, Greece, Lithuania, Portugal, Slovakia and Spain) have limited or no legal frameworks (Transparency International’s Secretariat, 2013).

In the UK, the Public Interest Disclosure Act 1998 protected workers from unfair treatment or victimisation from their employer if they reported wrongdoing in the
workplace (Food Standards Agency (FSA), 2016a). Employees, who are aware of wrongdoing within the food industry, including suspecting or witnessing of a breach in welfare of an animal at slaughter, can disclose that wrongdoing under the protection the Act affords if they raise their concerns in accordance with the Act’s provisions. A given act of disclosure is a qualifying disclosure for whistleblowing if the worker reasonably believes one or more of the following has occurred: criminal offence, breach of a legal obligation, miscarriage of justice, danger to the health and safety of any individual, damage to the environment and deliberate concealment of information is happening currently, occurred in the past or is likely to happen in the future (FSA, 2016b). In implementing this Act, the UK Food Standards Agency (FSA) has extended protection to food industry workers, whether or not the information is confidential, and whether or not the wrongdoing occurred in the UK itself (Motarjemi, 2014).

In the aftermath of the 2013 European horsemeat incident, the FSA’s National Food Crime Unit (NFCU) was created as a result of the recommendations in the Elliott Review (2014) to help ensure that prevention measures are put in place to protect consumers from food fraud (Food Standards Agency, n.d.). In addition to setting up the unit, the Elliott Review strongly recommended, first, that any incident of suspected and known food crime should be reported directly by staff to their own employers and, second, that customers can report to management any potential concerns (Elliott Review, 2014). Further there should be encouragement of a culture within the food industry that questions sourcing in its supply chain and also wider food integrity. However, the mechanisms that enable whistleblowing and reporting with the food industry, including regulatory bodies, need developing further. The whistleblowing procedures and facilities provided by the NFCU enable potential whistleblowers to disclose confidentially (FSA, 2016a, b) dishonesty at any stage within the production or supply of food, drink or animal feed (FSA, 2016b). Members of the public are encouraged to whistleblow or to report suspicions of food fraud to their local authority or the NFCU (FSA, 2016a). All intelligence received is logged on the Food Fraud Database (FFD) and the identity of the whistleblower protected at all times. Outcomes are logged on the Food Fraud Database and if requested reported back to the whistleblower (FSA, 2016a; International Meat Trade Association, 2016). Food safety and quality concerns can also be raised via the FSA’s “Report a food problem” site targeted specifically on local food businesses (FSA, 2016c). The UK FFD serves as an important source of intelligence and a tool to detect emerging patterns of fraudulent and criminal activities (FSA, 2016a, d). In 2011, there were 54 complaints and in 2012, 81 such complaints. The food fraud team handled 134 cases in 2013 that comprised sale of unfit food (42), general hygiene issues (39), mis-description (13), illegal re-dating of food (7), single cases each of adulteration and authenticity (Elliott Review, 2014).

3.2 USA

The USA has one of the most comprehensive whistleblower provisions developed in relation to the Sarbanes and Oxley Act (SOX) and was passed by the US congress to protect general public and shareholders from fraudulent practices in financial markets (Sarbanes-Oxley Act, 2002; Schultz and Harutyunyan, 2015). Under the US Food and Drug Administration, the Food Safety Modernization Act (Food Safety Modernization Act (FSMA), 2011) Section 402 prohibit retaliation by food businesses against whistleblowers who have: provided information relating to any violation of the Food, Drug and Cosmetic Act (FD&C) to the employer, the Federal Government, or the attorney general of a State; testified, assisted, or participated in a proceeding concerning a violation of the Food, Drug and Cosmetic Act (FD&C) to the employer, the Federal Government, or the attorney general of a State; testified, assisted, or participated in a proceeding concerning a violation of the FD&C or; objected to or refused to participate in any activity that he or she reasonably believed to be in violation of the FD&C (FSMA, 2011; Moy, 2015; Occupational Safety and Health Administration, 2014). This regulation has driven the development of whistleblowing procedures to comply with the US SOX (Osterhaus and Fagan, 2007).
3.3 Serbia
On 25 November 2014, the Parliament of Serbia adopted the Law on the Protection of Whistleblowers, the law coming into force in June 2015 (WIN, 2017b). The legislation clearly describes the act of whistleblowing, the rights and entitlements to protection not only of the whistleblower themselves, but also the officials who are then required to perform a duty to investigate. Indeed every employer with more than ten employees by law is required to endorse an internal whistleblowing procedure. The procedure must be in a visible, accessible location for all employees and it must also be posted on the company website if the company has one. Fines can be imposed if businesses fail to undertake this requirement. There are also strict timings set for competent authorities to adhere to in the event of external disclosure of wrongdoing.

4. Market response towards protecting whistleblowers
The UK Department of Business, Innovation and Skills issued a report in March 2015 titled “Whistleblowing: Guidance for Employers and Code of Practice” (BIS, 2015). The report states that whilst a voluntary requirement it is good business practice to create an open, transparent and safe working environment through implementing a whistleblowing policy in the workplace. Depending on the nature and size of the business, PAS 1998 (2008) outlines that overall responsibility for enabling whistleblowing should rest with either the board, chief executive, group secretary, with routine responsibility falling to the human resources department. In a small food business with both strategic and operational roles filled by one or two individuals this could prove more difficult to disassociate.

In this research the development of whistleblowing policies as a market response has been considered with three cases using publically available policies for Associated British Foods (ABF) plc, Home Retail Group (HRG) plc, and Tesco plc. ABF (2016) state that the purpose of their voluntary whistleblowing policy is to protect individuals working within their organisation when raising matters of public interest to stop malpractice and wrongdoing. The organisation outlines a five step plan:

1. step 1: inform manager or head of department;
2. step 2: raise the matter with alternative internal contacts if unable to raise with line manager;
3. step 3: initial assessment and determination of corporate action;
4. step 4: opportunity if response/outcome is not deemed sufficient to raise the matter with others internally; and
5. step 5: if steps 1 to 4 cannot be followed then contact external confidential whistleblowing hotline Expolink.

Expolink are a privately owned organisation, founded in 1995, which specialise in providing whistleblowing hotlines supporting over 20 per cent of FTSE, 100 companies, many FTSE 250 and Fortune 500 companies, local authorities, government departments, police forces and multi-national corporations (Expolink, 2016a). Expolink (2016b) report that 3.3 million employees made contact in the January-June 2016 period with an incidence rate of 1.24 reports per 1,000 employees from a range of organisations. In all, 53 per cent of the reports were anonymous, with 70 per cent made by telephone. The issues raised by order of frequency were: malpractice (9.9 per cent), fraud (5.1 per cent), theft (3.7 per cent), security (1.6 per cent), corruption (1.3 per cent), other (78.4 per cent). The frequency of theft and fraud from 2009 – 2016 (Table II) shows a reporting frequency of 10 per cent in 2009 down to 3.7 per cent of contacts in 2016 and for fraud a reporting frequency of 8 per cent in 2009 down to 5 per cent in 2016.
HRG (2016) also has a five step approach for raising issues:

- Step 1: Raise with line manager.
- Step 2: Raise with line manager’s manager either as a first contact or if individual raising issue is unhappy with the initial response in Step 1.
- Step 3: Raise at Director level if these two steps have not given the response to the individuals satisfaction.
- Step 4: Internal enquiry or more formal investigation.
- Step 5: Formal arrangements for a third party legal advice organisation in this case Public Concern at Work (PCAW). This organisation can give advice on external disclosure. PCAW are a charity established in 1993 (Public Concern at Work, 2016).

The Whistleblowing Tesco Colleague and Suppliers Protector Line Policy outline how Protector Line, a confidential telephone and e-mail service, operates for both internal and external stakeholders (Tesco, 2016). Suppliers can report concerns on a website that is managed by Expolink. Thus all three organisations have similar reporting systems using a specific external contractor to address whistleblowing that is either not raised internally, or has been raised but not addressed to the satisfaction of the person raising the concerned. It is important in all these cases to differentiate between an employment grievance and an instance of whistleblowing. PAS 1998:2008 states that an employment grievance is a dispute or private complaint regarding the employee’s own employment position and therefore it has no additional public interest dimension. These cases show that a positive whistleblowing culture and environment associated with an ethical culture practiced by the organisation encourages staff to have strong conscience to report wrongdoing (Miceli et al., 2008; Mendonca, 2011). Depending on national culture, some societies fear shame but not necessarily guilt (e.g. China is a shame-based society), hence shame can be used as an effective mechanism to enforce staff compliance (Tang and Babich, 2014). In contrast, a culture with supportive supervisors, appropriate formal structures for reporting (Brennan and Kelly, 2007) and protection afforded to whistleblowers (Cho and Song, 2015; Zakaria, 2015) will drive whistleblowers to report wrongdoing. The challenge with purely voluntary governance measures, rather than the Serbian approach, that each organisation will develop their own discrete protocols that can vary in their degree of efficacy. Thus personal (individual), organisational/cultural and situational factors (Dungan et al., 2015) are now explored further in the paper.

5. Whistleblowing models
A number of whistleblowing models exist in the literature that have been designed to address mainly corporate fraud in the financial, business and public sectors but none specifically for food industry. These have been analysed within this research (Table III). The models often reflect individual (Henik, 2015), organisational (Alleyne et al., 2013; Brennan and Kelly, 2007) and cultural factors (Hwang et al., 2008). Although many studies

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<tbody>
<tr>
<td>Theft (%)</td>
<td>10</td>
<td>12</td>
<td>7</td>
<td>7</td>
<td>5</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Fraud (%)</td>
<td>8</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>6</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Breach of company policya (%)</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>8</td>
<td>Nr</td>
<td>9</td>
</tr>
<tr>
<td>Unprofessional behaviourb (%)</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>7</td>
<td>6</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

Note: Nr, not reported; a may not be illegal
## Table III.

<table>
<thead>
<tr>
<th>Focus</th>
<th>Model</th>
<th>Description</th>
<th>Potential application in Food Settings</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public accounting</td>
<td>The Graham Model</td>
<td>Greater perceived seriousness of wrongdoing, and personal responsibility and lower perceived personal cost predicted greater whistleblowing intention</td>
<td>A positive culture (mood) in food processing environment will encourage food production workers to have a greater sense of responsibility hence increased intention to whistleblow. Having procedures in place in the food business to protect the whistleblower and effective training, coaching and mentoring of staff will also increase the likelihood of whistleblowing</td>
<td>Curtis (2006), Graham (1986), Schultz et al. (1993)</td>
</tr>
<tr>
<td>Multiple</td>
<td>Fairness-loyalty tradeoff</td>
<td>Individuals who value fairness over loyalty demonstrates increased willingness to report wrongdoings</td>
<td>Workers are motivated to whistleblow in the service of fairness and justice but can also appear disloyal to colleagues and the teams in which they operate, hence creating a dilemma that affects willingness to take action. This dilemma can be mediated by highlighting internal reporting channels and also ensuring anonymity to protect whistleblowers</td>
<td>Dungan et al. (2015), Waytz et al. (2013)</td>
</tr>
<tr>
<td>Police agencies</td>
<td>Theory of planned behaviour (TPB)</td>
<td>Attitudes, subjective norm and perceived behavioural control had positive effects on internal whistleblowing intentions</td>
<td>Park and Blenkinsopp (2009) supported the relevance of TPB in whistleblowing intention. TPB is used as the basis of understanding and enabling whistleblowing intention among food production workers by influencing perceptions and thus attitude, subjective norm and perceived behavioural control</td>
<td>Park and Blenkinsopp (2009), Rothwell and Baldwin (2006), Ajzen (1985, 1991)</td>
</tr>
<tr>
<td>Multiple</td>
<td>Theory of reasoned action (TRA)</td>
<td>Prediction of intention through beliefs, attitude and subjective norms</td>
<td>TRA can be used to predict food workers’ intent to blow the whistle</td>
<td>Ajzen and Fishbein (1980), Fishbein and Ajzen (1975)</td>
</tr>
<tr>
<td>Multiple</td>
<td>The Henik model</td>
<td>Model of the factors of influence in the whistleblowing decision making process through characterisation of potential whistleblowers into strategic moral guardians (SMG); fed-up vigilante (FUV) and servant of two masters (STM) via the influence of emotions</td>
<td>SMG retain their focus on halting wrongful activities, while FUV shift their focus to restitution. Thus, while anger is present in both cases, the goals, targets and methods of a whistleblowing disclosure depend on the source of the anger</td>
<td>Henik (2015)</td>
</tr>
</tbody>
</table>
have applied the TRA and TPB to food and food service sectors, little research has dealt with their application to whistleblowing. Table III then provides the context for the potential application within a food production or supply chain setting. Henik (2015 citing Goldberg et al., 1999) describes three types of whistleblower: the strategic moral guardian (SMG), the fed-up vigilante (FUV) and the inactive individual called in this research as the servant of two masters (STM) see Table IV.

Henik (2015) draws upon existing theory to discuss a five-stage whistleblowing model around which organisational whistleblowing strategies, such as those described in this paper for ABF and HRG can be developed.

5.1 Stage 1 – a trigger event
A trigger event is as an event that is deemed by an individual or group to be problematic (Henik, 2015). Factors that can trigger whistleblowing include internal motivation (Schultz and Harutyunyan, 2015), personal responsibility (Hwang et al., 2008, 2013), seriousness of wrongdoing (Graham, 1986; Curtis, 2006) and loyalty towards the company (Dungan et al., 2015) see Table III. An individual trigger may be clear in terms of its legality or the trigger may be opaque creating uncertainty as to whether to raise the issue with others (PCAW, 2013).

5.2 Stage 2 – determining of appropriate action
The whistleblower may be concerned whether complicity means that they themselves may face sanction and this may limit action. PCAW (2013) identify in their study that in only 8 percent of the cases they examined the whistleblower admitted that they have been involved in the issue themselves. Other factors that affect willingness to take action are fear of reprisal or retaliation, being unsure whether the activities warrant action, uncertainty over what action is possible and appropriate and the opportunity cost vs the benefit or having little faith that any corrective action will be done (PCAW, 2013; Henik, 2015 citing March and Simon, 1958; Latané and Darley, 1970; Miceli and Near, 1992). However, Henik (2015) argues it is emotion and value conflict that actually motivates action or inaction. Stage 2 is a crucial stage in the whistleblowing process as individual, organisational and situational factors play a mediating role in encouraging or discouraging potential whistleblowers.

5.3 Stage 3 – action of whistleblowing
PCAW (2013) suggest that a whistleblower’s position in an organisation will be a factor that influences the route they follow to raise their concern. The group of workers they identified

<table>
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<th>Characterisation</th>
<th>Description</th>
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<tr>
<td>Strategic moral guardian (SMG)</td>
<td>Individual who focusses on accountability and results and who are motivated by strong extra-organisational allegiances and emotion (anger) at organisational inaction following their internal reporting. They seek appropriate mechanisms that will limit personal or professional impact</td>
</tr>
<tr>
<td>Fed-up vigilante (FUV)</td>
<td>Individual who is initially motivated to advocate against wrongful activities by strong extra-organisational principles and is driven by revenge and catharsis, justice and restitution. As they may have already suffered retribution they can feel they have nothing left to lose or fear</td>
</tr>
<tr>
<td>Servant of two masters (STM)</td>
<td>Individual trying to manage conflicting values of potentially whistleblowing in order to protect victims or report wrongdoing and alternatively taking no action so that they can continue to observe activities but this might bring feelings of shame or regret</td>
</tr>
</tbody>
</table>

Source: Adapted from Henik (2015); Goldberg et al (1999)
as less likely to approach their line manager or senior management was unskilled workers. In fact their study suggested that unskilled and skilled workers were more likely to approach the individual(s) who they thought was the wrongdoer or disclose to an independent body rather than other workers, or finally a regulatory body. This highlights if people are to come forward with concerns that as well as transactional structure in the FCMS, transformational elements such as an open culture, training and coaching are required. Administrative workers were more likely to approach senior management or a union representative through and use the employment grievance procedure rather than follow a whistleblowing process or a specialist channel. This may be due to the type of trigger that they were reporting, or greater awareness of policy and practice, but they were reticent about approaching their line manager. Managers and executives were more likely to raise their concern initially to senior management and also more likely to approach the media. Ultimately, in order to prevent or reduce loss of profit, reputation and trust with customers, the food industry should aim to resolve the problems internally whilst ensuring confidentiality for the whistleblowers.

5.4 Stage 4 – organisational reaction to action

PCAW (2013) state that from their dataset whistleblowers felt that no action was taken after the first attempt of internal disclosure in 74 per cent of cases and this rose to 80 per cent when it was unskilled workers who were making the disclosure. At the third attempt in 44 per cent of cases whistleblowers felt there was no organisational reaction; this was zero cases at executive level, but still 80 per cent for unskilled workers. The work of Henik (2015) shows that the organisation needs to make sure that they do not alienate the individuals who seek to disclose potential wrongdoing especially as this can then provide personal motivation for justice and restitution. Ensuring there is full confidence in the management process surrounding whistleblowing is critical.

5.5 Stage 5 – whistleblowers response

The whistleblowers who actively report on wrongdoing are the SMG or FUV (see Table IV for definitions). Inaction can be due to conflicting emotions and values. Therefore, a FCMS encompassing both transformational and transactional approaches will be beneficial to encourage the STM to act. Henik (2015) asserts that a differentiation of emotion will influence the methods and aims of a given whistleblowing disclosure and the whistleblowers response and whilst SMG retain their focus on halting wrongful activities, FUV will focus on the desire for restitution. The causal factors that underpin the five steps outlined above and their interrelationship with an associated FCMS have been conceptualised in Table V and represented visually in Figure 2. Understanding these factors will assist food industry practitioners and regulators to develop policies, guidance and best practice. These transactional and transformational elements are now explored.

Adoption of crime countermeasures is based on unique assessment by each organisation, the organisation’s risk appetite and the unique crime opportunity of the given supply system (Spink et al., 2016). These countermeasures then need to be integrated into an effective FCMS. Countermeasures are intended to reduce criminal opportunity so if appropriate countermeasure strategies are to be developed and adopted then it is important to establish both the type of crime and the typology of the criminal (Manning, 2016; Manning et al., 2016; Spink et al., 2015). Organisations should as part of this approach recognise and accommodate effective whistleblowing channels. Failure to do so could lead to what Motarjemi (2015a) describes as “wild whistleblowing” i.e. extra-legal or illegal approaches to reporting or disclosing information through internet “leaking” type approaches. Further, a condoning of negative behaviour towards whistleblowers leads to a repressive, unhealthy management culture (Motarjemi, 2015b) that ultimately
will stifle employee loyalty, and the potential for innovation, creativity and new ideas within the organisation. 

Loehr and Kaye (2011) have proposed the use of the 5C’s framework in order to encourage and build a loyal and committed workforce. This can be extended to consider the

<table>
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<tr>
<th>Factors</th>
<th>Action</th>
<th>Inaction</th>
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<tr>
<td><strong>Individual</strong></td>
<td></td>
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<tr>
<td><strong>Personal characteristics</strong></td>
<td>Moral purpose</td>
<td>Weakness of will</td>
</tr>
<tr>
<td></td>
<td>Empathy for victims</td>
<td>Empathy for suspected respondent</td>
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<td></td>
<td></td>
<td>Awareness training during induction; ongoing and updated training in examples of food crime.</td>
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<tr>
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<td></td>
<td>Documented and implemented whistleblowing policy with associated audit and verification programme</td>
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<tr>
<td></td>
<td></td>
<td>Leading by example. Encouraging supportive, sense of belonging with a specific focus on team and group culture with common purpose</td>
</tr>
<tr>
<td></td>
<td>Loyalty to company and concern over wrongdoing and their impact on the organisation, staff and customers</td>
<td>Loyalty to wrongdoer who may be difficult to differentiate from the company</td>
</tr>
<tr>
<td>Awareness</td>
<td>Knowledge of what is illegal, unethical or immoral behaviour</td>
<td>Ignorance or uncertainty about what is illegal, unethical or immoral behaviour</td>
</tr>
<tr>
<td></td>
<td>Knowledge of reporting procedure</td>
<td>Ignorance or uncertainty of reporting procedure</td>
</tr>
<tr>
<td>Duty</td>
<td>Sense of duty to report wrongdoing</td>
<td>Belief that others will report the wrongdoing so inaction is acceptable</td>
</tr>
<tr>
<td></td>
<td>Severity of wrongdoing</td>
<td>Perception that wrongdoing is not significant</td>
</tr>
<tr>
<td><strong>Situational and organisational factors</strong></td>
<td>Positive impact e.g. to reduce future wrongdoing</td>
<td>Fear of negative consequences e.g. retaliation to whistleblowers</td>
</tr>
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<td></td>
<td>Protect confidentiality of whistleblower through effective procedures.</td>
<td>Protect confidentiality of whistleblower through effective procedures.</td>
</tr>
<tr>
<td></td>
<td>Encourage supportive, sense of belonging with a specific focus on organisational culture</td>
<td>Encourage supportive, sense of belonging with a specific focus on organisational culture</td>
</tr>
<tr>
<td>Faith in the system</td>
<td>Lack of faith in system (e.g. employer is perceived to be non-responsive to complaints)</td>
<td>Lack of faith in system (e.g. employer is perceived to be non-responsive to complaints)</td>
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</table>

**Table V.**

Causal factors for whistleblowing or to remain silent and associated countermeasures

*Source: Adapted from Yeates (2012)*
integration of a whistleblowing strategy within a FCMS. The five ‘C’s have been adapted in this context:

- commit to employees’ professional growth and success so that they feel personally invested in by the organisation and then as a result less likely to be compelled to commit food crime;
- communicate the organisational culture that is needed to minimise the potential for food crime to all levels of staff and in the context that they will understand;
- clarify organisational goals in terms of legality, product and personal integrity and their role in helping to achieve them;
- coach through providing appropriate and continuous training for employees so they feel empowered to support the organisation and ensuring the products and services are legally compliant and if necessary disclose with regard to wrongdoing; and
- create accountability through a formal yet dynamic and reactive system that has appropriate communication channels and assists employees to deliver their roles and commitments at all levels of the organisation.

The 5 Cs demonstrate the transformational infrastructure that needs to be in place to underpin the FCMS. A cultural shift towards an encouraging, and supportive environment for whistleblowing can provide a source of intelligence that can help organisations to prevent potential public health implications, loss of profit and protect the reputation of company. In the development and implementation of a FCMS, small and medium sized food companies may not have the resources and knowledge necessary to carry out risk assessments using tools such as VACCP or TACCP, but with appropriate industry guidance they can more readily implement a whistleblowing protocol within their organisation and with their suppliers.

With appropriate induction and refresher training, and ongoing coaching an effective, and reactive FCMS can be developed which is appropriate to the situational needs of every business. Indeed PAS 1998:2008 states that where the business is small and everyone is known by name, transformational management processes may be strong enough so that a complicated written protocol is not required, instead a simple statement will be of value to that simply explains: the difference between whistleblowing and a private complaint with management; how an employee can make an external disclosure and the benefits of an independent helpline that facilitates the disclosure process; that whistleblowing is not a mechanism for undermining managers; and the challenges with maintaining confidentiality.
6. Concluding remarks

Whistleblowing exposes illegal, inappropriate and fraudulent practices with the goal that private and/or public exposure will force change. Many of these criminal practices go undetected by regulatory authorities and at times senior management of an organisation. Conventional behavioural models such as TRA and TPB can be extended to include individual, organisational, cultural and situational factors to study whistleblowing intention among food production workers and this has been the approach used in this conceptual paper in developing Figure 2. Greater understanding not only the forward process, but also the feedback loops, and the situational factors of influence will assist food industry practitioners in developing effective FCMS that include a whistleblowing strategy. Therefore appropriate regulatory protection of those who engage in whistleblowing activities is crucial to both mitigate food crime and protect consumers from loss and potential harm. Without considering the specific difficulties that arise and addressing the existing barriers to whistleblowing it is unlikely that the whistleblowing can become an effective strategy for addressing food crime. Therefore further empirical research is required to assess the influence of these barriers and how they can be overcome. The model in this paper provides opportunity for such primary research.

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Further reading


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Categorization of control measures in food safety management systems

The COMECAT method

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School of Science and Technology, Hellenic Open University, Patra, Greece

Abstract

Purpose – All food safety management standards require effective control measures of food safety hazards in order to ensure that food is safe at the time of human consumption. Furthermore, ISO 22000:2005 requires a logical approach to be carried out for the selection and categorization of the control measures according to the level of effect on identified food safety hazards. The purpose of this paper is to describe the COntrol MEasures CATegorization (COMECAT) method for the categorization of control measures in food safety management systems (FSMS) in order to assist organizations to prioritize and deploy their efforts and limited resources mainly to control significant hazards.

Design/methodology/approach – A thorough clarification of the characteristics of the different control measures used in FSMS has been achieved based on the definitions and the descriptions given by the different food safety standards such as the ISO 22000, the IFS and the BRC standards. The basic approaches for the determination of control measures found in literature and web pages have been examined and the proposed methodology has been implemented in feta cheese production in order to evaluate its applicability.

Findings – A decision tree model has been proposed as the most suitable approach for the categorization of control measures in FSMS. The implementation of the proposed COMECAT method in feta cheese production revealed its applicability. The method was able to identify the different risk level of food hazards and prioritize and deploy the organization’s efforts and limited resources for their management accordingly.

Originality/value – In the literature, there is a lack of justified methodologies for the categorization of control measures in FSMS. Most of the approaches concern attempts of private companies operating in the food industry or business consultancies and which can be found in their web pages. This paper describes a well-justified model for the categorization of control measures which is easy to implement and which results in more robust decisions.

Keywords ISO 22000, HACCP, Categorization, Control measures, Food safety management systems

Paper type Research paper

1. Introduction

Regulation (EC) No 852/2004 lays down general rules for food business operators on the hygiene of foodstuffs to ensure a high level of consumer protection with regard to food safety. According to Article 3 of the Regulation, food business operators shall ensure that all stages of production, processing and distribution of food under their control satisfy the necessary hygiene requirements (Regulation Council, 2004). For this reason, all food safety management system (FSMS) standards require effective control measures to minimize the risk of food contamination.

According to ISO 22000 (2005), a control measure is defined as an action or an activity that can be used to prevent or eliminate a food safety hazard or reduce it to an acceptable level. This definition is general and can be used to describe virtually any action, step, activity, job, task, process or procedure which has the intention of addressing a food safety hazard. ISO 22000 recognizes three categories of management of control measures according to their nature, direct relationship with the process and the level of risk to the consumer should the control measure fail: Prerequisite Programs (PRPs), Operational Prerequisite Programs (oPRPs) and Critical Control Points (CCPs). Similarly, other food safety standards such as the British Retail Consortium (BRC) global standard for food safety management systems (BRC, 2007) recognize two categories of control measures: Preventive Measures (PMs) and Control Measures (CMs) with PMs being further divided into PRPs and oPRPs.
safety (BRC, 2011) and the International Featured Standards (IFS) food standard for auditing quality and food safety of food products (IFS, 2012) use similar terminology for the definition of control measures.

PRPs are defined in the ISO 22000 as the basic conditions and activities that are necessary to maintain a hygienic environment throughout the food chain suitable for the production, handling and provision of safe end products and safe food for human consumption. Similarly, BRC defines PRPs as the necessary environmental and operational programs to create an environment suitable to produce safe and legal food products. Depending on the sectors PRPs can be described in: Good Agricultural Practice (GAP), Good Veterinarian Practice (GVP), Good manufacturing Practice (GMP), Good Hygienic Practice (GHP), Good Production Practice (GPP), Good Distribution Practice (GDP) and Good Trading Practice (GTP).

An oPRP is defined by the ISO 22000 as a PRP, identified by the hazard analysis as essential in order to control the likelihood of introducing food safety hazards to and/or the contamination or proliferation of food safety hazards in the product(s) or in the processing environment. The IFS standard uses the term Control Point (CP) with the same meaning as the oPRPs defined in the ISO 22000 standard (IFS, 2012). Similarly, all standards define CCP as a step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

According to the above definitions, it is obvious that there is not a clear distinction among the different control measures, especially with regard to oPRPs and CCPs. Yet, ISO 22000 requires a logical approach to be carried out for the selection and categorization of the control measures according to the level of effect on identified food safety hazards. However, the standard does not clearly define such an approach for the selection and categorization of these control measures. Organizations need to establish and implement within their processes and operations the control measures which are appropriate for the specific hazards and the risk they pose to the final consumer. They must identify these potential hazards and determine their significance by applying risk assessment techniques, the output of which then allows the organization to put in place appropriate control measures.

This paper describes the COntrol MEasures CATegorization (COMECAT) method, which constitutes a new model for the categorization of control measures in FSMS and is organized into five sections. Section 2 gives insight about the characteristics of the different control measure and presents the basic approaches for the determination of control measures found in literature and web pages, while Section 3 describes the proposed model. In Section 4, an application of the proposed model is being performed to feta cheese production and the outcomes from the implementation are being described. Finally, Section 5 summarizes some concluding remarks as well as the basic advantages and assumptions of the proposed methodology.

2. Determining control measures

2.1 Characteristics of control measures

In an attempt to clarify the distinction among the control measures, it can be said that PRPs manage the basic conditions and activities. The key point in regard to PRPs is that they are usually generic to the process, do not control any specific hazard and are not focused on any particular step in the process. They also have the characteristic that their failure does not necessary lead to an immediate and imminent food safety issue. PRPs are not selected for the purpose of controlling specific identified hazards but for the purpose of maintaining a hygienic production, processing and/or handling environment. PRPs are implemented prior to the application of the HACCP-based (hazard analysis and CCPs) procedures and their role is preventive. It is the responsibility of the organization to establish and maintain its PRPs based on local regulatory requirements, customer demands and its responsibility to
manufacture safe products. Examples of PRPs in a food manufacturing environment highlighted in the ISO 22000 standard would be:

- construction and lay-out of buildings and associated utilities;
- lay-out of premises, including workspace and employee facilities;
- supplies of air, water, energy and other utilities;
- supporting services, including waste and sewage disposal;
- the suitability of equipment and its accessibility for cleaning, maintenance and preventative maintenance;
- management of purchased materials (e.g. raw materials, ingredients, chemicals and packaging), supplies (e.g. water, air, steam and ice), disposals (e.g. waste and sewage) and handling of products (e.g. storage and transportation);
- measures for the prevention of cross-contamination;
- cleaning and sanitizing;
- pest control; and
- personnel hygiene.

oPRPs are used to control those food safety hazards that hazard analysis identifies as necessary to control (significant hazards), and which are not controlled by CCPs. This control does not need or cannot be stringent because its failure may not have significant consequences and does not need immediate actions or because its timely monitoring is not feasible. Usually, measurable or observable action criteria are used for the determination that the oPRPs are in control. Controlling an oPRP does not eliminate or reduce a food safety hazard to an acceptable level. Controlling an oPRP does reduce the likelihood of introducing a food safety hazard or the proliferation of an existing food safety hazard in the products or the processing environment. oPRPs differ from PRPs in the sense that these are specific to each hazard and to a particular industry/food operation. So, oPRPs will differ within the food industry while PRPs could be more or less similar. For example, general cleaning and sanitation may be regarded as a necessary PRP to any food industry while cleaning of a particular point in the line to prevent allergen cross-contamination may be regarded as a necessary oPRP for a specific operation.

A CCP differs in the fact that it relates specifically to a step in the process, e.g., cooking, cooling, freezing and not a general activity or action. The definition also states a CCP is a step at which control can be applied. Therefore, if a CCP cannot by definition apply control, it cannot be a CCP. Another factor relating to CCPs is the risk posed by the hazard when the control cannot be exercised. For example, salmonella in cooked meat would pose a significant risk to the consumer if cooking is not carried out to an adequate temperature and time specification. In this case control is critical and designed specifically to control the hazard. Steps of the process where there are no successive control measures and there is not a need for synergy with other control measures are more possible to be managed as CCP. While measurable or observable criteria may be enough to decide whether an oPRP is under control, CCPs need more accurate measures. CCPs have specific measurable Critical Limits, which separate acceptable from unacceptable conditions. For each CCP, corrective actions should be planned in advance so that they can be implemented without hesitation when monitoring indicates a deviation from the Critical Limit. Observations or measurements must be able to detect loss of control at CCPs and provide information in time for corrective action to be taken when Critical Limits are exceeded. Such observations or measurements have to be continuous or intermittent. When observations or
measurements are not continuous, it is necessary to establish a frequency of observations or measurements which provides information in time for corrective actions to be taken and definitely before the product is used or consumed.

From the above description of the characteristics of the control measures it can be concluded that for lower risk levels, PRPs are sufficient to control the hazards. Similarly, oPRPs and CCPs can be proposed for intermediate and high levels of risks, respectively.

A summary of the characteristics of the different categories of control measures is presented in Table I.

2.2 Methods for the determination of control measures
According to ISO 22000, the organization must conduct a hazard identification followed by a hazard assessment in order to determine which hazards need to be controlled, the degree of control required to ensure food safety, and which combination of control measures is required. Based on the hazard assessment, an appropriate combination of control measures shall be selected which is capable of preventing, eliminating or reducing these hazards to defined acceptable levels. The control measures selected shall be categorized as to whether they need to be controlled through oPRPs or by the HACCP plan. The selection and categorization shall be carried out using a logical approach that includes assessments with regard to the following (ISO 22000, 2005):

(1) its effect on identified food safety hazards relative to the strictness applied;
(2) its feasibility for monitoring (e.g. ability to be monitored in a timely manner to enable immediate corrections);
(3) its place within the system relative to other control measures;
(4) the likelihood of failure in the functioning of a control measure or significant processing variability;
(5) the severity of the consequence(s) in the case of failure in its functioning;
(6) whether the control measure is specifically established and applied to eliminate or significantly reduce the level of hazard(s); and
(7) synergistic effects (i.e. interaction that occurs between two or more measures resulting in their combined effect being higher than the sum of their individual effects).

The first edition of ISO 22004 (2005) provides guidance for the categorization process:

- the impact of a control measure on the hazard level or frequency of occurrence (the higher impact there is, the more likely the control measure belongs to the HACCP plan);
- the severity on consumer health of a hazard that the measure is selected to control (the more severe it is, the more likely it belongs to the HACCP plan); and
- the need for monitoring (the more pressing the need, the more likely it belongs to the HACCP plan).

However, beside these basic rules, ISO 22000 does not clearly define an approach for the selection and categorization of the control measures, which is a weakness of the standard. ISO 22004 proposed a simple model for the determination of control measures according to the basic requirements of ISO 22000 (ISO 22004, 2005, p. 9). The model followed an approach of hazard identification and analysis, risk assessment (significance) and determination of control measures without, however, defining the way for the categorization of the control measures.
In the literature, there is a lack of justified methodologies for the categorization of control measures described in scientific journals or books. Most of the approaches concern attempts of private companies operating in the food industry or business consultancies and which can be found in their web pages. Only recently European Commission provided guidelines to facilitate and harmonize the implementation of the EU requirements on PRPs and HACCP-based procedures (Commission Notice, 2016).

<table>
<thead>
<tr>
<th></th>
<th>CCP</th>
<th>oPRP</th>
<th>PRP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definition</strong></td>
<td>A step of the process at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level</td>
<td>PRP identified by the hazard analysis as essential in order to control the likelihood of introducing food safety hazards to and/or the contamination or proliferation of food safety hazards in the product(s) or in the processing environment</td>
<td>Basic conditions and activities that are necessary to maintain a hygienic environment throughout the food chain suitable for the production, handling and provision of safe end products and safe food for human consumption</td>
</tr>
<tr>
<td><strong>Scope</strong></td>
<td>Measures related to the environment and/or product (or combination of measures) to prevent contamination, or to prevent, eliminate or reduce hazards to an acceptable limit in the end product. These measures are implemented after the implementation of PRPs</td>
<td>Measures related to creating the environment for safe food: measures impacting food suitability and safety</td>
<td>Measures related to creating the environment for safe food: measures impacting food suitability and safety</td>
</tr>
<tr>
<td><strong>Significance of hazards they control</strong></td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Relation to hazards</strong></td>
<td>Specific to each hazard or group of hazards</td>
<td>Specific to each hazard or group of hazards</td>
<td>Not specific to any hazard</td>
</tr>
<tr>
<td><strong>Focus of control measure</strong></td>
<td>Specific to particular step of the process</td>
<td>Specific to particular step of the process</td>
<td>General to the process</td>
</tr>
<tr>
<td><strong>Criteria</strong></td>
<td>Measurable critical limits</td>
<td>Measurable or observable criteria</td>
<td>–</td>
</tr>
<tr>
<td><strong>Monitoring</strong></td>
<td>Monitoring of the implementation of control measures: usually recorded</td>
<td>Where relevant and feasible</td>
<td>Corrective actions and/or corrections on the implementation of PRPs where relevant</td>
</tr>
<tr>
<td><strong>Loss of control: corrections/corrective actions</strong></td>
<td>Pre-set corrections on the product</td>
<td>Corrective actions on the process</td>
<td>Corrective actions and/or corrections on the implementation of PRPs where relevant</td>
</tr>
<tr>
<td></td>
<td>Possible corrective actions on the process</td>
<td>Possible corrections on the product (case by case)</td>
<td>–</td>
</tr>
<tr>
<td><strong>Differences of control measures among different industries within food sector</strong></td>
<td>Specific to particular industry/food operations</td>
<td>Similar to different industries within food sector</td>
<td>–</td>
</tr>
<tr>
<td><strong>Possibility to manage with the specific type of control measure when there are no successive control measures</strong></td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Possibility to manage with the specific type of control measure when there is a need for synergy with other control measures</strong></td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
</tbody>
</table>

**Source:** Adapted from Commission Notice (2016)
In general the methods now universally employed in the global food industry are based on hazard assessment, utilizing a risk evaluation procedure, followed by CCP determination. They are based on a principle that not all hazards are significant to food safety and, therefore, do not need to be controlled in a rigorous manner. Conversely, some hazards are significant and may be critical to food safety. These by definition require tighter control. The number of CCPs in a HACCP-plan depends on the product and the process. Too few CCPs may not allow for adequate control of food safety hazards. Too many CCPs may overburden the HACCP-plan (Swoffer, 2009). oPRPs and CCPs are identified once PRPs are developed, they are product or process specific and they are based on the hazard analysis taking the PRPs into account (Heggum, 2014). The above assumptions are generally implemented in methodologies consisting of the following steps:

- hazard identification;
- hazard assessment that leads to a corresponding level of risk (severity of the effect in relation to its probability) for each identified hazard; and
- categorization of control measures.

Generally speaking, the proposed methods for categorizing control measures basically include question-based formats, score-based procedures and decision trees.

Question-based approaches categorize control measures according to a series of questions concerning specific characteristics of the hazard, resulting in a decision about the type of control measure that is more appropriate. A question-based approach for the categorization of control measures used in the Danish dairy sector is presented by Heggum (2014).

Score-based procedures attribute specific points on hazards according to a set of different criteria. The final score which is calculated as the sum of these points defines the category of control measures that should be used based on predefined thresholds. Of course, this raises the question of which are the appropriate thresholds for the categorization of the control measures? Furthermore, hazards categorization in specific classes of severity according to their score may fail to be controlled with the specified control measures if they do not have the appropriate characteristics. For example, a hazard which is not feasible to be monitored could not be treated as a CCP even though it may exhibit a high score in the rest of the criteria. An example of such a score-based procedure has been proposed by the DNV GL (2014) company.

Developing decision trees is the most common approach used for the categorization of control measures and such approach is included in the ISO 22000 logic. This approach is similar with the question-based approach with regard that specific decisions made in the successive steps of the decision trees lead to specific decisions about the control measures that should be implemented for the examined hazard. They have the advantage of the visualization of the process used for the categorization of the control measures, resulting to an easier and more user friendly approach.

The Codex standard (Alimentarius Codex, 2003) for HACCP uses a decision tree in order to determine whether the hazard should be controlled as a CCP or not. It does not attempt to assist the organizations in determining what type of control shall be employed where “Not a CCP” is the outcome. This makes it limited for most modern food businesses seeking to develop a robust food safety plan.

Arvanitoyannis (2009) has tried to incorporate the Codex HACCP tree in a two-step procedure in order to improve the categorization of control measures. In his attempt to define control measures for the hazards included in a variety of foods of animal origin, Arvanitoyannis introduced the classic HACCP decision tree in order to determine whether a specific hazard should be treated as a CCP or not. The author then implemented a second
decision tree in order to determine which of the control measures can be controlled as oPRPs (Arvanitoyannis, 2009, p. 34). In this way, a kind of “filter” is used and a CCP is maintained only if an oPRP is not sufficient to control the specific hazard.

Other attempts to categorize control measures concern the decision trees developed by the Safefood 360° company and the Coca-Cola Company (Swoffer, 2009). Safefood 360° (2014) company, a provider of compliance software for the global food industry, has introduced an enhanced version of the HACCP decision tree. The model constitutes a more detailed approach to the categorization of control measures which should be employed for the different hazards. It also covers both food safety hazards and quality issues. The Coca-Cola Company in collaboration with the Michigan State University has introduced a simple but quite explicit decision model (Swoffer, 2009). According to the five-question model proposed, a hazard is controlled as a CCP only if it is significant and there is a need to establish critical limits in order to monitor the control measure in such a way that action can be taken immediately when there is a loss of control.

On July 2016, European Commission provided practical guidance on the implementation of FSMS. In the guidelines provided, a risk-based procedure for the determination of control measures is proposed as well. According to this procedure, seven risk levels are defined based on the severity or the effect of the hazard in relation to the probability in which the hazard can occur in the end product if the considered (specific) control measures are not present or are failing – taking into consideration the next steps in the process where an elimination or reduction to an acceptable level is possible, and taking into consideration the already correctly implemented PRPs (Commission Notice, 2016). For risk levels 1 and 2, no specific actions are required and control can be covered by PRPs. For risk levels 3 and 4, oPRPs are selected only if the general control measures as described in the PRPs are not enough for monitoring of the identified risk. Finally, for risk levels 5, 6 and 7, CCPs are selected unless no measurable critical limit exists where an oPRP is used instead.

3. The COMECAT model for the classification of control measures

The proposed approach utilizes the risk-based approach published by the European Commission followed by a decision tree model to assist further categorization of control measures. The model consists of five questions and it is based on other similar attempts to categorize control measures as well as the theoretical aspects and particular characteristics that the different control measures should have. It constitutes a more analytical and thorough method compared to the ones described in the previous section making it easier to implement and resulting in more robust decisions. The main idea of the model is that non-significant hazards can be controlled by definition as PRPs while significant hazards can be progressed to a CCP determination phase. On the other hand, if the hazard may be deemed to be significant it does not automatically follow that it will be controlled as a CCP. This is because not every hazard identified as significant can be controlled as a CCP. A hazard can be controlled as a CCP only if:

- the hazard has been identified as a significant one;
- the particular control measure is specifically designed to eliminate or reduce the likely occurrence of the hazard to an acceptable level;
- it is possible to define critical limits for the control measure;
- it is possible to monitor the control measure in such a way that action can be taken in time for the product to be isolated before it is used or consumed; and
- it is necessary to strictly monitor the control measure.

Following the previous principles, the model presented in Figure 1 has been developed.
The model begins with the identification of every hazard in each step of the process and the determination of their acceptable levels. International documentation, scientific publications, food legislation or experience (best practice) can be used for this reason.

Hazard assessment, based on a risk evaluation procedure, follows the identification of food hazards. The risk level is defined by the severity or the effect of the hazard in relation to the probability in which the hazard can occur in the end product if the considered (specific) control measures are not present or are failing – taking into consideration the next steps in the process where an elimination or reduction to an acceptable level is possible, and taking into consideration the already correctly implemented PRPs (Commission Notice, 2016). The risk analysis matrix presented in Table II and the qualitative scales for the

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**Figure 1.** The COMECAT model for the categorization of control measures
likelihood of occurrence and the severity of adverse health effects presented in Appendix 1 can be used for this reason. In this way, three hazard significance levels can be defined for each of the identified food hazards.

Hazards of low significance (Level 1), according to the likelihood of occurrence and the severity of adverse health effects, can be controlled as PRPs.

Q1 – Hazards of medium significance (Level 2) should be controlled as oPRPs unless the general control measure(s) as described in the PRPs is adequate enough to control the identified hazard.

For hazards of high significance (Level 3) a decision tree model is utilized to categorize control measures as oPRPs or CCPs (Questions Q2 to Q5 in Figure 1).

Q2 – Control measures specifically designed to eliminate or significantly reduce the level of hazard(s) to acceptable levels should be treated as CCPs (e.g. pasteurization). This implies that all the necessary characteristics of a CCP should exist (e.g. measurable critical limits, in time monitoring, etc.).

Q3 and Q4 refer to the required characteristics that a CCP should exhibit. More specifically:

Q3 – CCPs have specific measurable Critical Limits, which separate acceptable from unacceptable conditions. For each CCP, corrective actions should be planned in advance so that they can be implemented without hesitation when monitoring indicates a deviation from the Critical Limit. If it is not feasible to establish Critical Limits for the control measure, this control measure cannot be regarded as a CCP. In this case, oPRP(s) can be used instead.

Q4 – Observations or measurements must be able to detect loss of control at CCPs and provide information in time for corrective action to be taken when Critical Limits are exceeded. It is necessary to establish a frequency of observations or measurements which provides information in time for corrective actions to be taken and definitely before the product is used or consumed. If this is not possible or necessary (in case(s) that loss of control does not mean necessarily the provision of unsafe products), oPRP(s) can be used as control measure(s).

Q5 – Having established that the control measure exhibits the required characteristics to be categorized as CCP, the last question refers to the necessity for a strict monitoring of the performance of the specific control measure. If strict monitoring of the performance of the control measure is considered necessary, then the control measure should be categorized as CCP, otherwise as oPRP. When evaluating the required performance of the control measure to provide safe foods, factors that could be considered include.

The stability of the performance of the control measure (e.g. likelihood of failure of its functioning or significant processing variability). Where objective evidence (e.g. historical data,
literature and validation data) shows that the control measure is delivering a significantly more stringent control of the hazard than needed, the control measure can be categorized as oPRP.

Any synergistic effects: the combination of microbiological control measures is most efficient when it is multi-targeted, that is, when various individual measures are selected so that different factors effecting microbial survival are targeted, e.g. pH, Aw, availability of nutrients, etc. In many cases, a multi-targeted combination using microbiological control measures with low intensity may be more effective than one single measure with high intensity. The presence of a number of microbiological control measures inhibiting or reducing the number of micro-organisms may be synergistic, that is that interaction occurs between two or more measures so that their combined effect is greater than the sum of their individual effects. Therefore, the utilization of synergistic effects can allow for combining microbiological control measures of less intensity than would be otherwise expected from each measure individually. In such a case these control measures can be categorized as oPRPs.

According to the decision tree presented in Figure 1, the COMECAT model attempts to control as many hazards as possible as PRPs and oPRPs, leaving only a few hazards to be controlled as CCPs. In this way the limited resources of an organization are deployed mainly to control high risk hazards and the everyday application of the organization’s food safety system becomes easier.

4. Implementation of the model to feta cheese production

Feta cheese production is well described in the literature (Mauropoulos and Arvanitoyannis, 1999; Drosinos and Siana, 2007; Azar and Rofehgari-Nejad, 2009; Arvanitoyannis, 2009; Hellenic Food Authority, 2012) and it was selected for the implementation of the proposed methodology for the categorization of the control measures. In that respect, the current section focuses on the implementation of the methodology and does not expand to detailed description of the manufacturing process and/or the hazards involved.

For the purpose of this work, the following process steps in feta cheese production are considered: (1) intake of raw milk (2) cold storage of raw milk (3) centrifugal separation/standardization (4) pasteurization (5) storage at 34-36 °C (6) addition of starter cultures/rennet/CaCl₂ (7) curd cutting (8) transferring to molds (9) dry salting (10) maturation (18 °C /15 days) (11) packaging, and (12) ripening/cool storage (≤4 °C, two months).

The implementation of the COMECAT model is presented, in detail, in Table A1. The hazard identification step identified a total of 47 hazards for all the 12 process steps of feta cheese manufacturing. The implementation of the hazard assessment step, categorized 12 of the 47 hazards as of low significance (Level 1), 26 of the 47 hazards as of medium significance (Level 2) and 9 of the 47 hazards as of high significance (Level 3). According to the proposed methodology, control measures associated with hazards of low significance are managed through PRPs whilst for hazards of medium or high significance, the decision tree part of the methodology is utilized to categorize the control measures associated with those hazards in PRPs/oPRPs or oPRPs/CCPs accordingly. As a result of this approach, the overall categorization of the control measures is as follows: the associated control measures for 31 out of the 47 hazards identified are managed through PRPs, 15 out of the 47 hazards identified are managed through oPRPs and 1 out of the 47 hazards identified is managed through the CCP of the pasteurization step.

Most of the published work on feta cheese refers to the HACCP-based approach for determining CCPs and the concept of oPRPs introduced by ISO 22000 is not included (Mauropoulos and Arvanitoyannis, 1999; Drosinos and Siana, 2007; Azar and Rofehgari-Nejad, 2009; Hellenic Food Authority, 2012). According to these data, control measures at the process steps of (1) intake of raw milk (4) pasteurization and (12) ripening/cool storage are characterized as CCPs in all four publications, whilst control measures at the process steps of (3) cold storage of raw milk and (10) maturation are characterized as CCPs in three out of the four publications.
Arvanitoyannis (2009) has implemented a methodology to categorize control measures as oPRPs/CCPs for feta cheese production. According to this work, control measures at the process steps of (1) intake of raw milk (10) maturation and (12) ripening/cool storage are characterized as CCPs whilst the control measures at process steps of (4) pasteurization (6) addition of starter cultures/rennet/CaCl$_2$ and (7) curd cutting as oPRPs.

Implementation of the proposed methodology to feta cheese production led to a significant reduction to the number of CCPs, as the only CCP determined was the pasteurization step and as a result, the control measures implemented at this step should be monitored through the HACCP plan. Furthermore and as compared to Arvanitoyannis (2009), control measures at the process steps of (1) intake of raw milk (10) maturation and (12) ripening/cool storage were characterized as oPRPs.

5. Conclusions
Since the publication of ISO 22000 and the introduction of the oPRPs concept, there is a need for use of valid methodologies to categorize control measures. Following a literature review on such methodologies, the COMECAT method for the categorization of control measures was developed and implemented to feta cheese production.

For the first step of hazard assessment, the COMECAT method utilizes the risk-based approach published by the European Commission to characterize hazards in three significance levels, namely, low, medium and high. Hazards of low significance can be controlled through PRPs, whilst for hazards of medium and/or high significance the decision tree model developed provides the necessary guidance to categorize the corresponding control measures as belonging to oPRPs or the HACCP-plan (CCPs). As opposed to the European Commission approach where for hazards of high significance the only criterion for differentiating between CCP and oPRP is the feasibility to establish critical limits, the decision tree model of Figure 1 sets a set of criteria that provides the necessary robustness to reduce the number of CCPs without compromising the effectiveness of the FSMS.

The implementation of the proposed COMECAT method to feta cheese production revealed its applicability. The method was able to identify the different risk level of food hazards and significantly reduce the number of CCPs, as compared with published data. It is believed that proper utilization of the COMECAT method can lead to enhanced effectiveness and efficiency of a FSMS as the organization can prioritize and use resources for monitoring control measures in a more rational way. Implementation of the methodology to other food sectors could verify its applicability and provide useful results to interested organizations.

References


IFS (2012), IFS Food Standard for Auditing Quality and Food Safety of Food Products, Retailer and Wholesaler Branded Food Products, Berlin.


Further reading


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Appendix 1. Qualitative scales used to define the risk level of food hazards (adopted from Commission Notice, 2016)

Probability

1 = very small

- Theoretical chance – the hazard never occurred before.
- There is a next step in the production process which will eliminate or reduce the hazard to an acceptable level (e.g. pasteurization, fermentation).
- The control measures or the hazard are of such a nature that when the control measure is failing, no production is possible any more or no useful end products are produced (e.g. too high a concentration of colorants as additives).
- It is a very limited and/or local contamination.
2 = small
- The probability that due to failing or absence of the PRPs the hazard will occur in the end product is very limited.
- The control measures for the hazard are of a general nature (PRPs) and these are well implemented in practice.

3 = real
- Failing or lacking of the specific control measure does not result in the systematic presence of the hazard in the end product but the hazard can be present in a certain percentage of the end product in the associated batch.

4 = high
- Failure or absence of the specific control measure will result in a systematic error, there is a high probability that the hazard is present in all end products of the associated batch.

**Effect (or severity)**

1 = limited
- There is no problem for the consumer related to food safety (nature of hazard, e.g. paper, soft plastic and large size foreign materials).
- The hazard can never reach a dangerous concentration (e.g. colorants, *S. aureus* in a frozen food where multiplication to higher counts is highly unlikely or cannot happen because of storage conditions and cooking).

2 = moderate
- No serious injuries and/or symptoms or only when exposed to an extremely high concentration during a long period of time.
- A temporary but clear effect on health (e.g. small pieces).

3 = serious
- A clear effect on health with short-term or long-term symptoms which results rarely in mortality (e.g. gastroenteritis).
- The hazard has a long-term effect; the maximal dose is not known (e.g. dioxins, residues of pesticides, mycotoxins, etc.).

4 = very serious
- The consumer group belongs to a risk category and the hazard can result in mortality.
- The hazard results in serious symptoms from which mortality may result.
- Permanent injuries.
<table>
<thead>
<tr>
<th>Process step</th>
<th>Hazard</th>
<th>Probability</th>
<th>Probability justification</th>
<th>Effect</th>
<th>Effect justification</th>
<th>Hazard significance level</th>
<th>Control measure</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Q5</th>
<th>Categorization</th>
<th>Comments on decision tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Intake of raw milk</td>
<td>Presence and growth of pathogens (e.g. <em>Mycobacterium</em> spp., <em>Brucella</em> spp., <em>Salmonella</em> spp., <em>Listeria monocytogenes</em>, <em>Escherichia coli</em>)</td>
<td>1</td>
<td>Prob_1 - Theoretical chance - the hazard never occurred before</td>
<td>1</td>
<td>Effect_1 - The hazard can never reach a dangerous concentration (e.g. colorants, <em>S. aureus</em> in a frozen food where multiplication to higher counts is highly unlikely or cannot happen because of storage conditions and cooking)</td>
<td>1</td>
<td>Organoleptic characteristics (Taste and smell), Acceptance temperature, Total acidity, pH, Somatic cell count</td>
<td>PRP</td>
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<tr>
<td>1. Intake of raw milk</td>
<td>Presence of aflatoxins</td>
<td>3</td>
<td>Prob_3 - Failing or lacking of the specific control measure does not result in the systematic presence of the hazard in the end product but the hazard can be present in a certain percentage of the end product in the associated batch</td>
<td>3</td>
<td>Effect_3 - The hazard has a long-term effect; the maximal dose is not known (e.g. dioxins, residues of pesticides, mycotoxins, ....)</td>
<td>3</td>
<td>Screening tests for aflatoxins, Farmer and animal records</td>
<td>NO YES YES NO oPRP</td>
<td>The screening test implemented exhibits stable performance</td>
<td></td>
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<td>1. Intake of raw milk</td>
<td>Presence of veterinary</td>
<td>3</td>
<td>Prob_3 - Failing or</td>
<td>3</td>
<td>Effect_3 - The hazard has a</td>
<td>3</td>
<td>Screening tests for antibiotics,</td>
<td>NO YES YES NO oPRP</td>
<td>The screening test (continued)</td>
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<td>Hazard significance level</td>
<td>Control measure</td>
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<tr>
<td>1. Intake of raw milk</td>
<td>Presence of pesticide residues</td>
<td>2</td>
<td>Prob_2 – The probability that due to failing or absence of the PRPs the hazard will occur in the end product is very limited</td>
<td>3</td>
<td>Effect_3 – The hazard has a long-term effect; the maximal dose is not known (e.g. dioxins, residues of pesticides, mycotoxins, …)</td>
<td>2</td>
<td>Periodic control of milk for pesticide residues</td>
<td>YES</td>
<td>PRP</td>
<td>Covered by the Supplier and raw material approval and performance monitoring</td>
<td></td>
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<tr>
<td>1. Intake of raw milk</td>
<td>Presence of chemical contaminants (e.g. heavy metals, dioxins, PCBs)</td>
<td>1</td>
<td>Prob_1 – It is a very limited and/or local contamination</td>
<td>3</td>
<td>Effect_3 – The hazard has a long-term effect; the maximal dose is not known (e.g. dioxins, residues of pesticides, mycotoxins, …)</td>
<td>2</td>
<td>Periodic control of milk for chemical contaminants</td>
<td>YES</td>
<td>PRP</td>
<td>Covered by Public Authorities monitoring program and company’s periodic testing of samples (raw / finished product) for these contaminants</td>
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<th>Effect justification</th>
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<th>Categorization decision tree</th>
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<tbody>
<tr>
<td>1. Intake of raw milk</td>
<td>Presence of foreign bodies</td>
<td>1 Prob_1</td>
<td>There is a next step in the production process which will eliminate or reduce the hazard to an acceptable level (e.g. pasteurization, fermentation)</td>
<td>1</td>
<td>Filter PRP</td>
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<tr>
<td>2. Cold storage of raw milk</td>
<td>Growth of pathogens if temperature not controlled</td>
<td>2 Prob_2</td>
<td>If the temperature is not controlled, the hazard can never reach a dangerous concentration (e.g. colorants, <em>S. aureus</em> in a frozen food where multiplication to higher counts is highly unlikely or cannot happen because of storage conditions and conditions and equipment and monitoring)</td>
<td>2</td>
<td>Control PRP</td>
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<tr>
<td>3. Cold storage of raw milk</td>
<td>Growth of toxigenic organisms</td>
<td>3 Prob_3</td>
<td>Failing or</td>
<td>3</td>
<td>Temperature control</td>
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<th>Categorization</th>
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<tr>
<td>bacteria if temperature abused (e.g. <em>Staphylococcus aureus</em>)</td>
<td></td>
<td></td>
<td>lacking of the specific control measure does not result in the systematic presence of the hazard in the end product but the hazard can be present in a certain percentage of the end product in the associated batch</td>
<td>health with short-term or long-term symptoms which results rarely in mortality (e.g. gastroenteritis)</td>
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<tr>
<td>2. Cold storage</td>
<td>Contamination with pathogens from equipment</td>
<td>1</td>
<td>Prob_1 – There is a next step in the production process which will eliminate or reduce the hazard to an acceptable level (e.g. pasteurization, fermentation)</td>
<td>Effect_1 – The hazard can never reach a dangerous concentration (e.g. colorants, <em>S. aureus</em> in a frozen food where multiplication to higher counts is highly unlikely or cannot happen because of storage conditions and cooking)</td>
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<td>of raw milk</td>
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<td>2. Cold storage of raw milk</td>
<td>Contamination with cleaning/sanitizing agent residues due to</td>
<td>2</td>
<td>Prob_2 – The probability that due to failing or absence of the</td>
<td>Effect_2 – No serious injuries and/or symptoms or</td>
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Table AI. Food safety management systems
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<th>Comments on decision tree</th>
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<tr>
<td></td>
<td>improper cleaning/sanitization program</td>
<td></td>
<td>PRPs the hazard will occur in the end product is very limited</td>
<td>only when exposed to an extremely high concentration during a long period of time</td>
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<tr>
<td>3. Centrifugal Separation/Standardization</td>
<td>Contamination with pathogens from equipment</td>
<td>1</td>
<td>Prob_1 – There is a next step in the production process which will eliminate or reduce the hazard to an acceptable level (e.g. pasteurization, fermentation)</td>
<td>1</td>
<td>Effect_1 – The hazard can never reach a dangerous concentration (e.g. colibacilli, <em>S. aureus</em> in a frozen food where multiplication to higher counts is highly unlikely or cannot happen because of storage conditions and cooking)</td>
<td>1</td>
<td>Cleaning and disinfection program (CIP)</td>
<td>PRP</td>
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<tr>
<td>3. Centrifugal Separation/Standardization</td>
<td>Contamination with cleaning/sanitizing agent residues due to improper cleaning/</td>
<td>2</td>
<td>Prob_2 – The probability that due to failing or absence of the PRPs the hazard will occur in the end</td>
<td>2</td>
<td>Effect_2 – No serious injuries and/or symptoms or only when exposed to an extremely high</td>
<td>2</td>
<td>Cleaning and disinfection program (CIP)</td>
<td>NO oPRP</td>
<td>The general cleaning and sanitizing program for equipment and environment is not adequate</td>
<td>(continued)</td>
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<tr>
<td>Process step</td>
<td>Hazard</td>
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</tr>
<tr>
<td>3. Centrifugal Separation/Standardization</td>
<td>Introduction of foreign bodies</td>
<td>1</td>
<td>Prob_1 – There is a next step in the production process which will eliminate or reduce the hazard to an acceptable level (e.g. pasteurization, fermentation)</td>
<td>1</td>
<td>Effect_1 – The hazard can never reach a dangerous concentration (e.g. <em>coliforms</em>, <em>S. aureus</em> in a frozen food where multiplication to higher counts is highly unlikely or cannot happen because of storage conditions and cooking)</td>
<td>1</td>
<td>Visual inspection of equipment</td>
<td>PRP</td>
<td></td>
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<tr>
<td>4. Pasteurization</td>
<td>Survival of pathogens</td>
<td>4</td>
<td>Prob_4 – Failure or absence of the specific control measure will result in a systematic error, there is a high probability that the hazard</td>
<td>3</td>
<td>Effect_3 – A clear effect on health with short term or long term symptoms which results rarely in mortality (e.g. gastroenteritis)</td>
<td>3</td>
<td>Temperature/time (flow) control, Divert valve control</td>
<td>YES</td>
<td>CCF</td>
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<th>Probability justification</th>
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<tr>
<td>4. Pasteurization</td>
<td>Contamination with pathogens due to mixing with unpasteurized milk</td>
<td>2</td>
<td></td>
<td>Effect_3</td>
<td>A clear effect on health with short-term or long-term symptoms which results rarely in mortality (e.g. gastroenteritis)</td>
<td>2</td>
<td>Pressure differential</td>
<td>NO</td>
<td>nfPRP</td>
<td></td>
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<td></td>
<td>Monitoring of pressure differential is not covered by Prerequisite Programmes as monitoring of specific parameters is required (excess of pressure on treatment side)</td>
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<td>4. Pasteurization</td>
<td>Chemical contamination with cooling agents</td>
<td>2</td>
<td></td>
<td>Effect_3</td>
<td>The hazard has a long-term effect; the maximal dose is not known (e.g. dioxins, residues of pesticides, mycotoxins, ...)</td>
<td>2</td>
<td>Pressure differential</td>
<td>NO</td>
<td>nfPRP</td>
<td></td>
<td></td>
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<td>Monitoring of pressure differential is not covered by Prerequisite Programmes as monitoring of specific parameters is required (excess of pressure on treatment side)</td>
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<tr>
<td>5. Storage at 34-36 °C</td>
<td>Growth of pathogens if temperature not controlled</td>
<td>1</td>
<td></td>
<td>Effect_1</td>
<td>The hazard can never reach a dangerous concentration (e.g. colorants, S. aureus in a frozen food)</td>
<td>1</td>
<td>Temperature control</td>
<td>PRP</td>
<td></td>
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<tr>
<td>Process step</td>
<td>Hazard</td>
<td>Probability (e.g. pasteurization, fermentation)</td>
<td>Effect justification</td>
<td>Hazard significance level</td>
<td>Control measure</td>
<td>Q1</td>
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<tr>
<td>5. Storage at 34-36 °C</td>
<td>Growth of toxigenic bacteria if temperature abused (e.g. <em>Staphylococcus aureus</em>)</td>
<td>3</td>
<td>Prob_3 – Failing or lacking of the specific control measure does not result in the systematic presence of the hazard in the end product but the hazard can be present in a certain percentage of the end product in the associated batch</td>
<td>3</td>
<td>Temperature control</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
<td>oPRP</td>
<td>Equipment and monitoring exhibits a stable performance</td>
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<tr>
<td>5. Storage at 34-36 °C</td>
<td>Contamination with pathogens from equipment</td>
<td>2</td>
<td>Prob_2 – The probability that due to failing or absence of the PRPs the hazard will occur in the end product is very limited</td>
<td>3</td>
<td>Cleaning and disinfection program (CIP)</td>
<td>NO</td>
<td>oPRP</td>
<td>The general cleaning and sanitizing program for equipment and environment is not adequate. A specific Clean In Place Program with</td>
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<tbody>
<tr>
<td>5. Storage at 34-36 °C</td>
<td>Contamination with cleaning/sanitizing agent residues due to improper cleaning/sanitization program</td>
<td>2</td>
<td>Prob_2 – The probability that due to failing or absence of the PRPs the hazard will occur in the end product is very limited</td>
<td>2</td>
<td>Effect_2 – No serious injuries and/or symptoms or only when exposed to an extremely high concentration during a long period of time</td>
<td>2</td>
<td>Cleaning and disinfection program (CIP)</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
<td>oPRP</td>
<td>appropriate monitoring parameters (alkalinity, conductivity) is implemented. The general cleaning and sanitizing program for equipment and environment is not adequate. A specific Clean In Place Program with appropriate monitoring parameters (alkalinity, conductivity) is implemented. Addition of starter cultures/rennet/CaCl₂, dry salting, maturation and ripening consist a multi-targeted (time, temperature, salinity, pH, RH) combination of control measures that...</td>
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<tr>
<td>6. Addition of starter cultures/rennet/CaCl₂</td>
<td>Survival/growth of pathogens due to inadequate activity</td>
<td>3</td>
<td>Prob_3 – Failing or lacking of the specific control measure does not result in the systematic presence of the hazard in the end product but the hazard can be present in a certain percentage of</td>
<td>3</td>
<td>Effect_3 – The hazard has a long-term effect; the maximal dose is not known (e.g. dioxins, residues of pesticides, mycotoxins, ...</td>
<td>3</td>
<td>Control of prescription</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
<td>oPRP</td>
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<td>Process step</td>
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<td>Probability justification</td>
<td>Effect</td>
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<tr>
<td>6. Addition of starter cultures/rennet/CaCl₂</td>
<td>Contamination with pathogens from equipment</td>
<td>2</td>
<td>Prob_2 – The probability that due to failing or absence of the PRPs the hazard will occur in the end product is very limited</td>
<td>3</td>
<td>Effect_3 – A clear effect on health with short-term or long-term symptoms which results rarely in mortality (e.g. gastroenteritis)</td>
<td>2</td>
<td>Cleaning and disinfection program (CIP)</td>
<td>NO</td>
<td>oPRP</td>
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<td>The general cleaning and sanitizing program for equipment and environment is not adequate. A specific Clean In Place Program with appropriate monitoring parameters (alkalinity, conductivity) is implemented</td>
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<td>6. Addition of starter cultures/rennet/CaCl₂</td>
<td>Contamination with pathogens from personnel</td>
<td>2</td>
<td>Prob_2 – The probability that due to failing or absence of the PRPs the hazard will occur in the end product is very limited</td>
<td>3</td>
<td>Effect_3 – A clear effect on health with short-term or long-term symptoms which results rarely in mortality (e.g. gastroenteritis)</td>
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<td>GHP program</td>
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<td>PRP</td>
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<tr>
<td>6. Addition of starter cultures/rennet/CaCl₂</td>
<td>Contamination with cleaning/sanitizing agent</td>
<td>2</td>
<td>Prob_2 – The probability that due to failing or</td>
<td>2</td>
<td>Effect_2 – No serious injuries and/or</td>
<td>2</td>
<td>Cleaning and disinfection program</td>
<td>YES</td>
<td>PRP</td>
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<tr>
<td>6. Addition of starter cultures/rennet/CaCl₂</td>
<td>Residues due to improper cleaning/sanitation program</td>
<td>2</td>
<td>Prob_2 – The absence of the PRPs the hazard will occur in the end product is very limited</td>
<td>GMP/GHP program</td>
<td>PRP</td>
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<td></td>
<td>Introduction of foreign bodies (environment, equipment, personnel)</td>
<td>2</td>
<td>Prob_2 – The control measures for the hazard are of a general nature (PRPs) and these are well implemented in practice</td>
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<td>7. Curd cutting</td>
<td>Contamination with pathogens from equipment</td>
<td>2</td>
<td>Prob_2 – The probability that due to failing or absence of the PRPs the hazard will occur in the end product is very limited</td>
<td>Cleaning and disinfection program</td>
<td>YES</td>
<td>PRP</td>
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<td></td>
<td>Contamination with pathogens from personnel</td>
<td>2</td>
<td>Prob_2 – The probability that due to failing or absence of the PRPs the hazard will occur in the end product is very limited</td>
<td>GHP program</td>
<td>YES</td>
<td>PRP</td>
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<tr>
<td>7. Curd cutting</td>
<td>Contamination with cleaning/sanitizing agent residues due to improper cleaning/sanitization program</td>
<td>2</td>
<td>Prob_2 - The probability that due to failing or absence of the PRPs the hazard will occur in the end product is very limited</td>
<td>2</td>
<td>Mortality (e.g., gastroenteritis) Effect_2 - No serious injuries and/or symptoms or only when exposed to an extremely high concentration during a long period of time</td>
<td>2</td>
<td>Cleaning and disinfection program</td>
<td>YES</td>
<td>PRP</td>
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<tr>
<td>7. Curd cutting</td>
<td>Introduction of foreign bodies (environment, equipment, personnel)</td>
<td>2</td>
<td>Prob_2 - The control measures for the hazard are of a general nature (PRPs) and these are well implemented in practice</td>
<td>1</td>
<td>There is no problem for the consumer related to food safety (nature of hazard e.g., paper, soft plastic, large size foreign materials)</td>
<td>1</td>
<td>GMP/GHP program</td>
<td>PRP</td>
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<tr>
<td>8. Transferring to molds</td>
<td>Contamination with pathogens from equipment</td>
<td>2</td>
<td>Prob_2 - The probability that due to failing or absence of the PRPs the hazard will occur in the end product is very limited</td>
<td>3</td>
<td>Effect_3 - A clear effect on health with short-term or long-term symptoms which results rarely in mortality (e.g., gastroenteritis)</td>
<td>2</td>
<td>Cleaning and disinfection program</td>
<td>YES</td>
<td>PRP</td>
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<td>8. Transferring to molds</td>
<td>Contamination with pathogens from personnel</td>
<td>2</td>
<td>Prob_2 - The probability that due to failing or</td>
<td>3</td>
<td>Effect_3 - A clear effect on health with</td>
<td>2</td>
<td>GHP program</td>
<td>YES</td>
<td>PRP</td>
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<tr>
<td>8. Transferring to molds</td>
<td>Contamination with cleaning/sanitizing agent residues due to improper cleaning/sanitization program</td>
<td>2</td>
<td>Prob_2 – The probability that due to failing or absence of the PRPs the hazard will occur in the end product is very limited</td>
<td>2</td>
<td>Effect_2 – No serious injuries and/or symptoms or only when exposed to an extremely high concentration during a long period of time</td>
<td>2</td>
<td>Cleaning and disinfection program</td>
<td>YES</td>
<td>PRP</td>
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<tr>
<td>8. Transferring to molds</td>
<td>Introduction of foreign bodies (environment, equipment, personnel)</td>
<td>2</td>
<td>Prob_2 – The control measures for the hazard are of a general nature (PRPs) and these are well implemented in practice</td>
<td>1</td>
<td>Effect_1 – There is no problem for the consumer related to food safety (nature of hazard e.g. paper, soft plastic, large size foreign materials)</td>
<td>1</td>
<td>GHP program</td>
<td>PRP</td>
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<tr>
<td>9. Dry Salting</td>
<td>Survival/growth of pathogens due to weak brine</td>
<td>3</td>
<td>Prob_3 – Failing or lacking of the specific control measure does not result in the systematic presence of the hazard</td>
<td>3</td>
<td>Effect_3 – The hazard has a long-term effect; the maximal dose is not known (e.g. dioxins, residues of ...)</td>
<td>3</td>
<td>Control of Baume degrees</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
<td>oPRP</td>
<td>Addition of starter cultures/rennet/CaCl₂, dry salting, maturation and ripening consist a multi-targeted (time,</td>
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<tr>
<td>9. Dry Salting</td>
<td>Contamination with pathogens from equipment</td>
<td>2</td>
<td>Prob. 2 – The probability that due to failing or absence of the PRPs the hazard will occur in the end product is very limited</td>
<td>3</td>
<td>Effect 3 – A clear effect on health with short-term or long-term symptoms which results rarely in mortality (e.g. gastroenteritis)</td>
<td>2</td>
<td>Cleaning and disinfection program</td>
<td>YES</td>
<td>PRP</td>
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<tr>
<td>9. Dry Salting</td>
<td>Contamination with pathogens from personnel</td>
<td>2</td>
<td>Prob. 2 – The probability that due to failing or absence of the PRPs the hazard will occur in the end product is very limited</td>
<td>3</td>
<td>Effect 3 – A clear effect on health with short-term or long-term symptoms which results rarely in mortality (e.g. gastroenteritis)</td>
<td>2</td>
<td>GHP program</td>
<td>YES</td>
<td>PRP</td>
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<tr>
<td>9. Dry Salting</td>
<td>Contamination with cleaning/sanitizing agent</td>
<td>2</td>
<td>Prob. 2 – The probability that due to failing or</td>
<td>2</td>
<td>Effect 2 – No serious injuries and/or</td>
<td>2</td>
<td>Cleaning and disinfection program</td>
<td>YES</td>
<td>PRP</td>
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<tr>
<td>9. Dry Salting</td>
<td>Residues due to improper cleaning/sanitation program</td>
<td>2</td>
<td>Prob_2 – The control measures for the hazard are of a general nature (PRPs) and these are well implemented in practice</td>
<td>1</td>
<td>Effect_1 – There is no problem for the consumer related to food safety (nature of hazard e.g. paper, soft plastic, large size foreign materials)</td>
<td>1</td>
<td>GMP/GHP program</td>
<td>PRP</td>
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<tr>
<td>10. Maturation (18°C/15 days)</td>
<td>Survival/growth of pathogens due to improper maturation conditions (time, temperature, humidity, pH)</td>
<td>3</td>
<td>Prob_3 – Failing or lacking of the specific control measure does not result in the systematic presence of the hazard in the end product but the hazard can be present in a certain percentage of the end product in the associated batch</td>
<td>3</td>
<td>Effect_3 – A clear effect on health with short-term or long-term symptoms which results rarely in mortality (e.g. gastroenteritis)</td>
<td>3</td>
<td>Temperature control, control of RH, control of pH, control of production dates</td>
<td>NO YES YES NO oPRP</td>
<td></td>
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Addition of starter cultures/rennet/CaCl₂, dry salting, maturation and ripening consist a multi-targeted (time, temperature, salinity, pH, RH) combination of control measures that act synergistically in inhibiting or reducing the
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<tr>
<td>10. Maturation (18°C/15 days)</td>
<td>Contamination with pathogens from equipment</td>
<td>2</td>
<td>Prob_2 – The probability that due to failing or absence of the PRPs the hazard will occur in the end product is very limited</td>
<td>3</td>
<td>Effect_3 – A clear effect on health with short-term or long-term symptoms which results rarely in mortality (e.g. gastroenteritis)</td>
<td>2</td>
<td>Cleaning and disinfection program</td>
<td>YES</td>
<td>PRP</td>
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<td>10. Maturation (18°C/15 days)</td>
<td>Contamination with pathogens from personnel</td>
<td>2</td>
<td>Prob_2 – The probability that due to failing or absence of the PRPs the hazard will occur in the end product is very limited</td>
<td>3</td>
<td>Effect_3 – A clear effect on health with short-term or long-term symptoms which results rarely in mortality (e.g. gastroenteritis)</td>
<td>2</td>
<td>GHP program</td>
<td>YES</td>
<td>PRP</td>
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<tr>
<td>10. Maturation (18°C/15 days)</td>
<td>Contamination with cleaning/sanitizing agent residues due to improper cleaning/sanitization program</td>
<td>2</td>
<td>Prob_2 – The probability that due to failing or absence of the PRPs the hazard will occur in the end product is very limited</td>
<td>2</td>
<td>Effect_2 – No serious injuries and/or symptoms or only when exposed to an extremely high concentration during a long period of time</td>
<td>2</td>
<td>Cleaning and disinfection program</td>
<td>YES</td>
<td>PRP</td>
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<tr>
<td>10. Maturation (18°C/15 days)</td>
<td>Introduction of foreign bodies (environment,</td>
<td>2</td>
<td>Prob_2 – The control measures for</td>
<td>1</td>
<td>Effect_1 – There is no problem for the consumer</td>
<td>1</td>
<td>GMP/GHP program</td>
<td>PRP</td>
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<tr>
<td>11. Packaging</td>
<td>Contamination with pathogens from packaging</td>
<td>2</td>
<td>Prob_2 – The probability that due to failing or absence of the PRPs the hazard will occur in the end product is very limited</td>
<td>3</td>
<td>Effect_3 – A clear effect on health with short-term or long-term symptoms which results rarely in mortality (e.g. gastroenteritis)</td>
<td>2</td>
<td>GMP/GHP program</td>
<td>YES</td>
<td>PRP</td>
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<tr>
<td>11. Packaging</td>
<td>Contamination with pathogens from personnel</td>
<td>2</td>
<td>Prob_2 – The probability that due to failing or absence of the PRPs the hazard will occur in the end product is very limited</td>
<td>3</td>
<td>Effect_3 – A clear effect on health with short-term or long-term symptoms which results rarely in mortality (e.g. gastroenteritis)</td>
<td>2</td>
<td>GHP program</td>
<td>YES</td>
<td>PRP</td>
<td></td>
<td></td>
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<tr>
<td>11. Packaging</td>
<td>Introduction of foreign bodies (environment, equipment, personnel)</td>
<td>2</td>
<td>Prob_2 – The control measures for the hazard are of a general nature (PRPs) and these are well implemented in practice</td>
<td>2</td>
<td>Effect_2 – No serious injuries and/or symptoms or only when exposed to an extremely high concentration during a</td>
<td>2</td>
<td>GMP/GHP program</td>
<td>YES</td>
<td>PRP</td>
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<tr>
<td>12. Ripening/ Cool storage (≤4°C, 2 months)</td>
<td>Survival/ growth of pathogens due to improper ripening conditions (time, temperature, humidity, pH)</td>
<td>4</td>
<td>implemented in practice</td>
<td>3</td>
<td>long period of time</td>
<td>3</td>
<td>Temperature control, control of RH, control of pH, control of production dates</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
<td>oPRP</td>
<td></td>
<td>Addition of starter cultures/ rennet/CaCl₂, dry salting, maturation and ripening consist a multi-targeted (time, temperature, salinity, pH, RH) combination of control measures that act synergistically in inhibiting or reducing the number of microorganisms</td>
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Table AI.
Audit results of UK meat companies – critical analysis

Konstantinos Vassilios Kotsanopoulos and Ioannis S. Arvanitoyannis
School of Agricultural Sciences,
Department of Agriculture Ichthyology and Aquatic Environment,
University of Thessaly, Volos, Greece

Abstract

Purpose – The purpose of this paper is to analyze the results of several food safety audits carried out by the Food Standards Agency in meat and poultry-processing companies and slaughterhouses in the UK and audits in aquacultures carried out by the Aquaculture Stewardship Council and the Marine Scotland.

Design/methodology/approach – Specifically, both a quantitative and a qualitative review were carried out.

Findings – It was revealed that in meat and poultry companies, the highest average proportion of major non-conformities (MNCs) within the total number of companies was recorded in slaughterhouses, while based on the type of product, the corresponding percentage of MNCs was found in poultry companies. Both in meat/poultry companies and aquacultures, small-sized companies presented the highest average percentage of MNCs. It was also revealed that a very high percentage of MNCs and minor non-conformities were recorded in relation to “record keeping.”

Research limitations/implications – The limitations of the present study can be summarized into the fact that although a high number of audit reports were taken into account, and record keeping and past actions were reviewed as part of the audits, the audit represents only a snapshot in time and can heavily depend on the skills of the auditors.

Originality/value – To the best of the authors’ knowledge, there is very limited literature available that analyzes the results of audits and looks for trends in the food industry in the UK. The conclusions of this study can be of significant value to both the auditors and the industry by enabling a more targeted approach in the conduction of audits.

Keywords Aquacultures, Audit results, Major non-conformities, Meat establishments, Minor non-conformities

Paper type Research paper

1. Introduction

The food industry currently faces the need to demonstrate absolute transparency across its processes and the supply chain. Consumers’ concerns in relation to food safety have triggered the development of thorough regulation. Consumers now demand excellent quality and the food companies have responded by establishing systems for measuring, managing and improving product quality in a more efficient way. Simultaneously, a change in the traditional relationship between the industry and the regulators is now observed. The previously established approach relied on a pattern based on which regulators develop and enforce the standards that determine the requirements, and food companies respond retrospectively to any non-conformities (NCs) identified during the inspections. It is now accepted that this approach was highly inflexible and reactive and a new system is necessary to enable food manufacturers to take greater responsibility for the safety and quality of their products (Dillon, 2011).

In accordance with the EU food hygiene legislation, enforced on January 1, 2006 (The Food Hygiene (England) Regulations 2006), food business operators (FBOs) procedures and applied controls in approved meat establishments must be subjected to audits. Audits in meat plants requiring veterinary controls (e.g. slaughterhouses, cutting plants and game handling plans) are conducted in Great Britain by the Food Standards Agency (FSA). The FSA, in cooperation with the food industry, has developed an audit risk assessment plan that is used for meat establishments that are subject to veterinary controls. This scheme takes into account risk criteria dictated by the food hygiene legislation and is formed of risk factors related to the
establishments that take into account the activities and nature of the establishments (expressed as fixed scores that depend on the risk induced by the nature and activities of the business) and risk factors that depend on the FBOs' actions and statutory requirements. A score is awarded for each of these factors. The total score determines the audit category, which then determines the frequency of auditing required for each facility (FSA, 2011).

The Aquaculture Stewardship Council (ASC) was founded in 2010 by the World Wide Fund for Nature (WWF) and IDH (Dutch Sustainable Trade Initiative) and acts as an independent non-profit organization. It is one of the world's principal certification and labeling organizations for responsibly farmed seafood. Its role is focused on managing the global standards of responsible aquaculture, as established by the WWF Aquaculture Dialogues. ASC acts in cooperation with aquaculture producers, seafood processing companies, retail and foodservice companies, scientists, conservation groups and consumers toward: the recognition and reward of responsible aquaculture through its certification program and seafood labeling, the promotion of responsible environmental and social choices in the seafood market and the contribution to the development of more sustainable seafood markets. The final audit reports and certificates are published on the ACS website, while establishments that do not pass the certification process or decide to withdraw are also listed on the same website (ASC, 2016a).

Finally, Marine Scotland is a Directorate of the Scottish Government and is responsible for the integrated management of Scotland’s seas. Marine Scotland aims at preserving the environmental conditions through marine planning, licensing and other functions, as well as by promoting the environmentally sustainable economic growth of the marine industry. It also promotes the sustainability, profitability and optimum management of freshwater fish and fisheries resources, the development and delivery of policies, planning and services, the enforcement of compliance, etc. (www.gov.scot/Topics/marine/About).

The aim of this study was the analysis of a high number of audit reports performed in the UK by the FSA, the ASC and the Marine Scotland, across the poultry, meat and aquaculture industries and the qualitative and quantitative evaluation of the results extracted. The audits aimed at ensuring that FBOs comply with food law requirements and ensuring that they meet relevant standards in relation to public health and in animal health and welfare. Publicly available results provided on the websites of the organizations mentioned above were only used.

2. Methodology
In order to collect the data used in this paper, the reports of 150 audits conducted in the UK by the FSA in meat and poultry-processing companies and slaughterhouses and audits in UK aquacultures carried out by the ASC and the Marine Scotland were reviewed. The audit reports reviewed were sampled from the websites of FSA (2014), ASC (2016b) and Marine Scotland (www.gov.scot/Topics/marine/About). Throughout this review, information was recorded with regard to the name, and the activity (cutting, processing, slaughterhouse and production) of the companies audited, the size of the companies, the year at which each audit was carried out, the type of products handled by each company and the major non-conformities (MNCs) and minor non-conformities (mNCs) recorded during the audits. The total numbers of MNCs and mNCs found in each audit were recorded. Specifically in FSA audits, “active compliance” was considered as conformance to the standard, “broad compliances” as mNCs, while “weak” and “poor compliance” were considered to be MNCs for the purposes of this study. To facilitate the analysis and presentation of the data, a reference number (RN) (1-72) was allocated to each area, documentation or process audited for which mNCs or MNCs were raised. The subjects audited and their RNs are presented in Table I. In the case of companies handling products of meat and poultry origin, 4.2 percent of these companies were cold stores, 45 percent were cutting and processing facilities, 25.8 percent were cutting facilities only, 11 percent were slaughterhouses and 14.2 percent
Reference number Subject audited

1 Record keeping and its suitability
2 Legally required temperature controls
3 Separation arrangements for packed and exposed products
4 Suitable structure and size of facilities
5 Supply of potable water – relevant record keeping
6 Validation and verification to ensure the correct implementation of the measures mentioned above
7 Minimization of potential animal disease contaminants spread – operator controls in restricted areas
8 Sufficient number of trained welfare personnel if animals are present on site
9 Maintenance calibration of machinery
10 Management commitment policy/statement present
11 Equipment effects to the wildlife
12 Effective traceability system in place (one step forward and one step backward in the supply chain)
13 Efficient removal of by-products to prevent cross-contamination
14 Supervision, instruction and/or training staff in food hygiene and implemented procedures as applicable
15 Procedure for notifying the authorities not considered
16 Correct identification of animals with required documentation (passports, FCI, trained hunters' declaration) in slaughterhouses
17 Pre-slaughter fitness checks of animals
18 Slaughterhouse operators transporting poultry/lagomorphs use suitable crates/modules.
19 Disinfection and cleaning of equipment used for collection/delivery
20 Plant structure supports animal welfare
21 Suitable unloading facilities (ramps, rails, etc.)
22 suitable holding pens (water/food availability, species segregation, densities)
23 Crates/modules are properly maintained and handled
24 Action is taken upon identification of visible signs of abuse or neglect on animals and carcasses
25 Animals to be slaughtered are subjected to inspection at least twice daily, and suffering is relieved wherever required
26 Stunning box/head restrainer are used correctly
27 Adequate setting and times of electric stunner, proper electrode position and measuring
28 Provision of backup stunning and manual backup for equipment
29 Slaughterer license in place for all species, licenses for instrumentation and personnel as required
30 Provision of welfare coding and guidelines
31 Animals for slaughter are cleaned and/or HACCP is put in place to prevent cross-contamination of products
32 All processes including slaughtering are carried out properly to prevent contaminated meat and offal from entering to the supply chain
33 Contaminated products are removed immediately by trimming or other equally effective methods
34 Pieces of slaughtered red meat animals correctly presented for inspection
35 Carcass and offal are kept chilled. Storage and dispatch under appropriate hygiene storage conditions
36 Health mark or identification mark available for all products as required
37 Controls in place to avoid cross-contamination and establishment of measures if cross-contamination occurs
38 Permitted ingredients are only used for all meat products
39 Statutory microbiological testing is performed as required and any necessary actions are followed up
40 No cross-contamination from rapping and packaging materials occurs. Hygienic storage and handling of all such materials
41 Re-usable packaging materials for food products can be easily cleaned and disinfected and are properly cleaned before use

(continued)
were slaughterhouses and cutting and/or processing facilities. Considering the size of these companies, 12.5 percent of them were large-sized companies, 41.7 percent were medium-sized companies, while 45.8 percent were small-sized companies. Finally, as regard the types of products handled by these companies, 51.7 percent of them handled meat, 14.2 percent handled poultry and 34.2 percent handled both meat and poultry products. The audits were held in various regions of the UK from 2010 to 2015 and were based on the requirements of the FSA (for meat establishments) and the requirements of the ASC and the Marine Scotland (for aquacultures). The industries were categorized as small, medium and large as per the categorization used by FSA. Industries that are more likely to market

<table>
<thead>
<tr>
<th>Reference number</th>
<th>Subject audited</th>
</tr>
</thead>
<tbody>
<tr>
<td>42</td>
<td>Identification marking is in compliance with all regulations</td>
</tr>
<tr>
<td>43</td>
<td>Products intended to be cooked before use are labeled in accordance with the legislation</td>
</tr>
<tr>
<td>45</td>
<td>Critical limits are properly controlled: pasteurization and cooling requirements are established for RTE products</td>
</tr>
<tr>
<td>46</td>
<td>The plant is designed to facilitate good hygiene practices and prevent contamination at all times</td>
</tr>
<tr>
<td>47</td>
<td>Procedures in place to ensure that potable water is always available in sufficient quantities</td>
</tr>
<tr>
<td>48</td>
<td>Procedures in place to ensure that the plant and the machinery are adequately maintained</td>
</tr>
<tr>
<td>49</td>
<td>Procedures in place to ensure an adequate degree of cleanliness/disinfection of premises and equipment</td>
</tr>
<tr>
<td>50</td>
<td>All operating procedures are implemented effectively and appropriate record keeping can be demonstrated</td>
</tr>
<tr>
<td>51</td>
<td>A pest-control operating procedure is in place</td>
</tr>
<tr>
<td>52</td>
<td>Operating procedures are established covering the training of train staff responsible for developing and maintaining HACCP</td>
</tr>
<tr>
<td>53</td>
<td>A documented HACCP plan is in place covering all food materials and any requirements specific to slaughterhouse operations</td>
</tr>
<tr>
<td>54</td>
<td>HACCP team and product(s) description(s) are available</td>
</tr>
<tr>
<td>55</td>
<td>Flow diagrams describing the manufacturing process have been developed</td>
</tr>
<tr>
<td>56</td>
<td>Identification of all hazards to be covered by the HACCP plan has been carried out</td>
</tr>
<tr>
<td>57</td>
<td>Critical limits in place to meet legal requirements and/or clearly segregate between acceptable from non-acceptable materials</td>
</tr>
<tr>
<td>58</td>
<td>Monitoring procedures are established for all CCPs following the requirements of HACCP</td>
</tr>
<tr>
<td>59</td>
<td>Records are in place to serve as evidence of good monitoring procedures</td>
</tr>
<tr>
<td>60</td>
<td>Procedures for corrective action procedures are in place and are followed when a CCP or control point is not under control</td>
</tr>
<tr>
<td>61</td>
<td>Corrective actions can effectively bring CCPs or control points under control. Record keeping of all these actions is in place</td>
</tr>
<tr>
<td>62</td>
<td>Microbiological sampling and analysis are carried out where necessary</td>
</tr>
<tr>
<td>63</td>
<td>Verification procedures, covering microbiological sampling, are effectively carried out and recorded</td>
</tr>
<tr>
<td>64</td>
<td>Recorded procedures for the day-to-day control of food safety hazards are in place and up-to-date</td>
</tr>
<tr>
<td>65</td>
<td>Records in place for any day-to-day checks and measures in place for all controls covered by HACCP</td>
</tr>
<tr>
<td>66</td>
<td>Management records are followed to cover supervisory checks/corrective actions</td>
</tr>
<tr>
<td>67</td>
<td>Reviews of HACCP plans are carried out as dictated by HACCP and external factors</td>
</tr>
<tr>
<td>68</td>
<td>Leak-proof, closable animal by-product and waste containers are used and kept in a hygienic, pest-proof condition</td>
</tr>
<tr>
<td>69</td>
<td>Correct identification, segregation and categorization of animal by-products</td>
</tr>
<tr>
<td>70</td>
<td>Correct staining of animal by-products where required</td>
</tr>
<tr>
<td>71</td>
<td>Animal by-products are only supplied to approved premises that have in place all relevant commercial documents</td>
</tr>
<tr>
<td>72</td>
<td>Measures in place to ensure that all meat entering the food chain specified risk material-free</td>
</tr>
</tbody>
</table>

Sources: Adopted from FSA (2014), ASC (2016b) and Scottish Government (2013)
their products locally were categorized as small, companies with enough production to market nationally or internationally were categorized as large, while as medium were categorized industries that fall between the previously mentioned categories.

A quantitative review of the data was initially conducted, in which the percentages of MNCs and mNCs per company size and activity within the total number of companies were calculated. A qualitative review was also conducted to record the MNCs and mNCs detected in particular areas (represented by RNs) and the results were critically assessed and compared with the literature.

3. Results
3.1 Quantitative analysis
It is important to differentiate between the primary and secondary production due to the completely different production environments and therefore the different hazards that can be identified in factory and open aquaculture operations. Because of that, in this study the results obtained from aquaculture companies were studied separately.

Therefore, as regard the secondary production only (meat and poultry companies), the MNCs and mNCs recorded were 55 and 497, respectively. Considering the different activities of each processing plant, the average proportions of MNCs per company activity within the total number of companies were ≈58, 32, 6 and 4 percent for slaughterhouses, slaughteringhouses and cutting and/or processing, cutting/cutting and processing and cold stores, respectively, while the corresponding average proportions of mNCs were 39, 23, 22 and 16 percent for slaughterhouses and cutting and/or processing, cold stores, slaughteringhouses and cutting/cutting and processing, respectively.

Based on the type of product, the same average percentage of MNCs was found in poultry and meat and poultry companies (≈39 percent) followed by meat companies (≈22 percent). The average percentages of mNCs in the total number of companies were 39, 32 and 29 percent for poultry, meat and meat and poultry companies.

Based on the size of the companies, the average proportions of MNCs per size of company within the total number of companies were 56, 27 and 17 percent for small, medium and large-size companies, respectively. The corresponding average proportions of mNCs were 36, 33 and 31 percent for large, small and medium-sized companies, respectively.

In the case of the aquacultures (30 plants), it was not possible to distinguish between mNCs and MNCs because no differentiation was made in all reports that were taken into account (ASC and Marine Scotland reports). A total of 61 deviations from the acceptable standards were noted. Based on the size of the companies, it was shown that companies of small and medium sizes presented a higher percentage of deviations (35 and 38 percent, respectively, in the total number of companies) than companies of larger size (27 percent in the total number of companies).

3.2 Analysis per RNs
The analysis of the MNCs and mNCs per RN (meat and poultry industries only) indicated that a high number of mNCs was recorded for the RN1 regardless of the size of the company. Both in small and medium-sized companies, most mNCs per RN were recorded in relation to RN1 (10 and 9.85 percent of the total number of mNCs of small and medium-sized companies, respectively), while in large companies most mNCs were recorded in relation to RN6 (11.84 percent) followed by RN1 (10.53 percent). In small and medium-size companies, most MNCs were raised in relation to RN32 (11.3 percent) and RN1 (25 percent), respectively, while in large companies, MNCs were recorded only in relation to RNs 22, 32 and 52 (33.33 percent each). Figures 1-3 present the number of MNCs and mNCs for each RN per company size. In the case of the aquacultures, in large companies, 2.38 percent of deviations were recorded in relation to each one of the following RNs: 8, 9, 10, 11, 14, 15, while 4.76, 9.52,
Audit results of UK meat companies

Figure 1. Number of major and minor non-conformities recorded per reference number in small-sized companies

Figure 2. Number of major and minor non-conformities recorded per reference number in medium-sized companies
14.30, 23.80 and 33.33 percent of deviations were recorded in relation to the RNs 13, 12, 1, 10 and 14, respectively. In medium-size companies, three out of four deviations were recorded in relation to RN7 while a deviation was recorded in relation to RN8. In small-sized companies, 2.38 percent of deviations were recorded in relation to each one of the following RNs: 6, 9, 10, 11, 14, 15, while 4.76, 9.52, 14.3, 23.81 and 33.33 percent of deviations were recorded in relation to the RNs 13, 12, 1, 8 and 7, respectively.

With regard to the different types of products processed/handled by each company, it was shown that in meat and poultry companies as well as in companies that handled both meat and poultry, most mNCs were recorded in relation to RN1. In meat companies the RNs with the highest numbers of MNCs were RN1, RN32 and RN50, with four MNCs recorded in relation to each one of them. As regard the poultry companies, the RNs with the highest numbers of MNCs were RN1 and RN52 with two MNCs recorded in relation to each one of them. Figures 4-6 present the number of MNCs and mNCs for each RN per product type handled.

With regard to the company activity (secondary production), it was again shown that a high number of mNCs was recorded in relation to the RN1. In slaughterhouses, most MNCs were recorded in relation to the RN1 and RN50, while in slaughterhouses that are also cutting and/or processing plants, most MNCs were recorded in relation to RN32. In cutting and/or processing plants, most MNCs were recorded in relation to RN1, RN32 and RN66. Figures 7-9 present the number of MNCs and mNCs for each RN per company activity.

4. Discussion
It is therefore apparent that the highest average percentage of MNCs was found in slaughterhouses (≈58 percent) and could therefore be concluded that slaughterhouses are less likely to implement controls as effectively as the meat processing companies. The same
Audit results of UK meat companies

Figure 4. Number of major and minor non-conformities recorded in meat companies per reference number

Figure 5. Number of major and minor non-conformities recorded in poultry companies per reference number
Figure 6.
Number of major and minor non-conformities recorded in companies handling both meat and poultry per reference number

Figure 7.
Number of major and minor non-conformities recorded slaughterhouses per reference number
Number of major and minor non-conformities recorded in companies acting as slaughterhouses and cutting and/or processing plants per reference number.

Figure 8.

Number of major and minor non-conformities recorded in cutting/cutting and/or processing plants per reference number.

Figure 9.

Audit results of UK meat companies.
pattern was followed in the case of the mNCs with slaughterhouses presenting the highest average number in comparison to other types of plants. This can be attributed to the fact that slaughtering activities present the risk of the presence of fecal matter from slaughtered animals, which can lead to contamination of meat with high levels of bacteria (e.g. *Escherichia coli*, *Salmonella* and *Campylobacter*) or food safety risks like bovine spongiform encephalopathy (GCP, 2015).

Companies handling poultry products presented the highest numbers of MNCs and mNCs. This outcome though was not in agreement with the results of a study conducted by BRC (2015). In this study, data collected during the audits of 17,113 sites in 120 countries (covering all food categories) were analyzed. The audits were carried out in the first half of 2014 and it was shown that 86.3 percent of poultry companies audited presented the lowest number of NCs and raw poultry producers were found to have the highest food safety standards among all food sectors. Pinillos and Jukes (2008) also mentioned that the standards in white meat plants appear to be slightly better than those in red meat plants, a fact that was mainly attributed to the stricter controls applied in the red meat industry. However, Habib et al. (2012) who examined inspection results of Belgian slaughterhouses, mentioned that *Campylobacter* was detected in 51.9 percent of broiler carcasses tested, while the level of contamination in 20.6 percent of them was > 1,000 cfu/g.

Nevertheless, the nature of these products could itself explain the difficulty in implementing effective food management systems. A microbiological survey of *Campylobacter* contamination in fresh whole UK-produced chilled chickens at retail sale conducted by FSA (2015) proved that all chickens, regardless of the retail outlet they were sold from, were at risk of being contaminated with *Campylobacter*. The study of Katsande and Govender (2014) aimed at determining the microbiological status of poultry and red meat processed at abattoirs in Gauteng Province in South Africa. In total, samples from 198 red meat and 680 poultry carcasses from 30 red meat and 22 poultry registered abattoirs were taken between 2009 and 2010. The results of the lab analyses showed that the average cfu/cm² of poultry samples (116,508 cfu/cm²) was considerably higher than that of red meat samples (352, 3,263 and 1,113.1 cfu/cm² for bovine, porcine and ovine samples, respectively), which is also an indication of the high-risk nature of these products.

The present study showed that most MNCs were recorded in relation to small companies. This can be explained by the fact that large companies can more easily find the necessary resources that are required for the implementation of robust food safety systems. This was also supported by Taylor (2001) who reported that although large companies have technical departments leading the food safety systems, smaller companies could not financially support such dedicated departments. Furthermore, Mensah and Julien (2011) also stated that the financial challenges encountered during the development, implementation and maintenance of food safety management systems arise from several factors such as the need for continuous training (general or specialized), internal audits, validation and verification activities, etc. These challenges cannot be easily overcome by small or medium-sized companies due to the high cost of implementing such measures and standards.

However, the opposite pattern was observed in the case of mNCs, with large companies presenting the highest numbers of mNCs. It is therefore apparent that although large companies are able to implement effective measures to limit the most serious deviations, they still present a higher number of mNCs in comparison to smaller companies, which could potentially be attributed to the fact that a larger area and more complicated processes are audited. Mensah and Julien (2011) used a survey and case study methodology to examine the response of food manufacturing enterprises to food safety regulation, and used statistical techniques to investigate the effects of enterprise size on the drivers for, benefits of, and challenges to compliance. The findings of this study showed that the size of the
enterprises did not have a significant effect on the drivers, benefits and challenges toward compliance with food safety regulation. The aim of the study of Jayasinghe-Mudalige and Henson (2007) was the identification of the factors motivating adoption of systematic food safety controls in red meat and poultry-processing companies in Canada. Most federally registered and large provincially licensed companies reported that activities such as systematic record keeping and training should be continuous and are of paramount importance, while many smaller companies were not able to recognize any real benefits. Moreover, several large companies perceived the costs associated with the development of systematic food safety and quality systems to be a good investment, while many small companies claimed that these costs are prohibitive.

Considering the company size, it was shown in this study that a very high number of MNCs and mNCs were recorded in relation to RN1 (record keeping and its suitability) while in small companies a high number of MNCs was recorded in relation to RN32. Most mNCs were again recorded in relation to RN1 in all types of companies, when the type of products handled was considered. Validation and verification (RN6) was also a significant area from the point of view of recorded mNCs in large companies. These results are in agreement with the study of Pasqualone and Milella (2011) who analyzed NCs recorded during food safety and quality audits carried out in 26 companies across different sectors. According to Fairman and Yapp (2004), among the most important barrier preventing food safety improvements as identified by the FSA is the record keeping that companies frequently consider being something very complicated and heavily bureaucratic. Mensah and Julien also mentioned that one of the most difficult challenges companies face during the implementation and maintenance of food safety management systems is people related. The unwillingness or inability of people to follow the rules can be the result of several factors such as inadequate training and low education level, incompetence, low morale, resistance of employees to changes, etc.

The fact that improper record keeping (RN1) generally seems to be an issue in these audits is in agreement with the findings of Govender and Genis (2010) who reported that MNCs in relation to thermo control and meat inspection records were recorded in relation in 100 percent of the abattoirs they examined while MNCs in relation to training records, sanitation records and personnel records were recorded in, respectively, 80, 70 and 90 percent of the abattoirs examined.

Finally, in the study of Masanganise et al. (2013), the audits of five selected slaughterhouses in Zimbabwe were analyzed. The main NCs reported were the insufficient maintenance of equipment, inadequate sterilizing methods and hot water supply, lack of protective clothing and detergents, improper waste disposal, inadequate maintenance of proper hygiene conditions, non-labeling and an increased microbial load on carcasses and equipment. The main mNCS were the insufficient training and a primary focus on the maximization of profit at all costs resulting in low quality standards. This is in agreement with the results of the current study as regard the improper implementation of HACCP, and the fact that the required processes were not followed effectively to fully prevent the introduction of contaminated meat in the supply chain (RN32 and 70). Similar results were presented in the study of Bonnauad and Coppalle (2013) who examined the implementation of hygiene practices in French slaughterhouses. Amongst the NCs recorded were the visible contamination of carcasses with hair and fecal matter, poorly shaved pig carcasses, poorly maintained equipment, accumulation of waste in certain areas of the slaughterhouses and poor personal hygiene. The need to focus more on quality rather than quantity has been highlighted in the study of Bekman (1998). As also shown in the audits examined in the present study, key areas that should be carefully controlled are the safety and quality of the products, the production methods used, the protection of the environment as well as human and animal health and welfare.
5. Conclusions

Food companies can use the results of this study during the implementation and maintenance of food safety management systems to allow more emphasis to be given to the most frequently recorded mNCs and MNCs. This approach could potentially reduce the negative findings; thus, facilitating continuous improvement based on proper infrastructures, trained personnel and record keeping. It could therefore improve the performance of the food businesses by reducing the risk and establishing higher food safety standards. The results of this study could also be useful for auditors of food companies that belong to the animal product sector by enabling them to be more careful when verifying that the requirements of the food safety systems are met and allowing them to focus on the most problematic areas. This study could also encourage the conduction of similar data analyses that examine the results of audits in industries dealing with other categories of products. The fact that no similar studies conducted in the aquaculture field could be found is an indication that this primary production would also need to be examined as part of future studies.

References


FSA (2015), “Year 1 of a UK-wide survey of campylobacter contamination on fresh chickens at retail (February 2014 to February 2015).”


Further reading

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Do consumers care about European food labels? An empirical evaluation using best-worst method

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Abstract
Purpose – The purpose of this paper is to investigate Spanish consumer preferences for several food-labelling schemes on semi-cured, pasteurised sheep milk cheese. In particular, the authors used three labels regulated by the European Union regulation (European organic logo, protected denomination of origin (PDO) and nutritional fat content), and the remaining four have been introduced to the European food market by private initiatives (local, carbon footprint, food miles and animal welfare).

Design/methodology/approach – A Best-Worst Discrete Choice approach was applied in Spain during Fall 2011 by administering a survey to 549 consumers.

Findings – The results suggest that the most valued labels are the PDO, followed by the organic logo and the nutritional panel. The least valued are food-miles labelling and carbon foodprint labels, while local-origin labels and animal welfare are in the middle position.

Originality/value – This study is the first to value consumer preferences for cheese products bearing several public and private European food-labelling schemes since literature on consumer preferences for food labels has only dealt with a comparison of a few (two or at most three) food-labelling schemes. In addition, the added value of this paper is also the use of the BWC approach that has the advantage of providing the best way to discriminate the degree of importance given by respondents to each food labels by overcoming the problem of bias caused by differences in the use of rating scales.

Keywords Food labels, Preferences, Best-worst approach

1. Introduction
Generally, lack of information about the nutritional content, origin and method of production of food products represents one of the greatest concerns of European consumers when shopping (Grunert, 2006). To illustrate this, demand for nutritional information could be linked to the high level of obesity around the world, leading to the coinage of the now popular term “obesity epidemic”. In particular, obesity contributes to an increased risk of cardiovascular disease, hypertension and type 2 diabetes, which represent some of the major causes of death, accounting for 75 per cent of deaths in the world by 2020 (World Health Organization (WHO), 2003). Therefore, following a healthy diet by limiting salt consumption and saturated-fat intake is
considered some of the main determinants to prevent the obesity epidemic and its related non-communicable diseases (Popkin, 2003). In addition, standardisation owing to globalisation, the increase in greenhouse gas emissions, as well as food scandals have contributed to an intensified search for quality food attributes (e.g. protected designation of origin (PDO)), sustainable attributes (e.g. local, organic, food miles) and method of production (e.g. animal-welfare standards), perceived by individuals as being higher quality, healthier and fairer socially and economically (de-Magistris and Gracia, 2016a).

In this context, to guarantee that consumers have access to complete information on the content, origin and composition of products, as well as to protect their health, the European Union has a significant amount of legislation, laying down rules on foodstuff labelling schemes. Examples of these regulations are EEC No. 2091/92 (1992) on organic production EEC No. 2081/91 (1991) on PDO, and EEC Regulation EEC No. 194/2006 (2006), on the provision of nutritional food information.

However, areas not covered by European legislation have been tackled via more or less coordinated private initiatives. New types of private labelling schemes have been proliferating in the food market thanks to modern processors and retailers, who have created and adopted private standards in order to establish themselves as the main market standard, and which could work better than, or even make public initiatives redundant. For example, the industry has developed private and voluntary labels such as carbon footprint labels, indicating the total carbon dioxide emission created by the manufacturing, transporting, or disposing of a product, and food-miles labels identifying the number of miles that a product has travelled from its place of production to the place of consumption. These labels provide information to consumers about the climate and environmental impact of the food products they eat. Finally, the provision of animal welfare practices beyond the legal minimum required by current regulations is normally left to private initiatives, even though the EU has been developing animal-welfare legislation comprising different regulations at the farm, transport and slaughter stages of the supply chain.

In the current literature, there are several studies focussed on consumers preferences towards public and private labels (Scarpa and Del Giudice, 2004; Olesen et al., 2010; Pouta et al., 2010; Andersen, 2011; Gracia et al., 2014; Aprile et al., 2012; Resano et al., 2012; Øvrum et al., 2012; Koistinen et al., 2013; Schröck, 2014; Van Loo et al., 2014; de-Magistris and Gracia, 2014; Denver and Jensen, 2014; de-Magistris and Lopez-Galán, 2016; de-Magistris and Gracia, 2016a; b; Gracia and de-Magistris, 2016; Rimpeekool et al., 2017; Kumar and Kapoor, 2017; Lin et al., 2017). In general, these studies reported that public labels are more valued than private labels. In particular, within public labelling schemes, PDO labels are more valued than organic labelling and nutritional claims are more valued when compared to organic labelling. In addition, carbon footprint and food-mile labelling are the least valued. Finally, most studies also pointed out those preferences for food-labelling schemes are heterogeneous across consumers (among others Rimpeekool et al., 2017; Kumar and Kapoor, 2017; Lin et al., 2017). For example, Platania and Privitera (2006), Vecchio and Annunziata (2015) and de-Magistris and Gracia (2016b) reported that gender was positively associated with the likelihood of using organic or typical food products. In addition, other authors like Cicia et al. (2002), de-Magistris and Gracia (2009, 2012, 2016b), Honkanen et al. (2006), Loureiro and Hine (2002), Radman (2005), Thøgersen (2007) and Zepeda and Li (2007) showed that the main determinants of positive valuation of organic food products were the education, lifestyle and environmental attitudes towards organic products.

In addition, Govindasamy and Italia (1999), Guthrie et al. (1995), Kim et al. (2001a, b) and McLean-Meyinsse (2001), Rimpeekool et al. (2017) reported that consumers with a higher education level used nutritional labels more often because they were able to process the information included in the label better. Finally, while women used nutritional labels more than men, older individuals preferred to buy products with a reduction of the fat content.
In the context of multiple food-labelling schemes, the objective of this study is to contribute to the debate on consumers’ preferences for food labelling, by assessing the most preferred and the least preferred food label, using seven European food labels carried by semi-cured cheese products. In particular, we are interested in investigating the extent to which Spanish consumers valued these food labels, where three labels are regulated by the European Union regulation (European organic logo, PDO and nutritional fat content), and the remaining four have been introduced to the European food market by private initiatives (local, carbon footprint, food miles and animal welfare). Moreover, given the increasing complexity of consumer preferences for different food-labelling schemes, we also investigate heterogeneity in preferences, based on the consumer’s socio-demographic and personal characteristics.

We undertake this study using data from a survey conducted in Spain among 540 cheese consumers, where a best-worst choice (BWC) task was used to measure consumer preferences. The current study presents several novelties. First, to our knowledge, our study is the first to value consumer preferences for cheese products bearing several public and private European food-labelling schemes. Generally, although the literature on consumer preferences for food labels is large it has only dealt with a comparison of a few (two or at most three) food-labelling schemes. For example, Scarpa and Del Giudice (2004), Aprile et al. (2012) and Schröck (2014) compared consumer preferences for only two labels (organic and PDO), while Øvrum et al. (2012) compared PDO and low saturated-fat content. Likewise, in Gracia and de-Magistris (2016) several food labels were analysed, but without any association with a real food product. In addition, the added value of this paper is also the use of the BWC approach. Most studies assessed consumer preferences using a rating scale and/or the hypothetical discrete choice experiment approach (DCE). However, in this study the use of BWC task has the advantage of providing the best way to discriminate the degree of importance given by respondents to each item, by overcoming the problem of bias caused by differences in the use of rating scales (Finn and Louviere, 1992; Goodman, 2009). In fact, the BWC answers present less variability than ranking alternatives since individuals are able to identify extreme options. This has a direct effect on diminishing confidence internally, thus parameters become more accurate and it is possible to make more precise inferences about consumer preferences. Hence, the BWC approach is very useful for measuring overall preferences, as well as the degree of preference heterogeneity across individuals.

2. Material and methods

2.1 Data gathering and questionnaire

Data were collected from a survey conducted in Zaragoza, in Spain during the Autumn of 2011. Prior to the main survey, this questionnaire was validated using a pilot survey of 20 consumers to test for understanding and interview length. The technique chosen for framing the sample was probabilistic proportional sampling, stratified by age and sex and, consumers were selected randomly across the city A total sample of 549 individuals was collected.

Target respondents were food shoppers, and interviews were carried out face to face. The questionnaire contained questions about socio-demographic characteristics (i.e. gender, age, education and income), health-related lifestyles, environmental and ethical beliefs, and the BWC task. Specifically, seven choice sets with different combinations of food labels were included. Some importance of the validated scale Lindeman and Vaananen (2000) were used to measure environmental and ethical beliefs. Respondents were asked their level of agreement or disagreement with different sentences related to food-label information. Summary statistics for the socio-demographic and economic characteristics of the sample are presented in Table I.
About half the respondents were female (53 per cent) living in households of three members on average. The average age in Zaragoza is 47 years, nearly 18 per cent of the sample belonged to high-income groups and 42 per cent of the subjects had a university degree.

### 2.2 BWC method

The BWC methodology was introduced by Finn and Louviere (1992) and formalised more recently by Marley and Louviere (2005). Generally, the BWC consists of a task where respondents are asked to choose the most preferred (or important) and the least preferred (important) items from a series of choice sets (or named also best-worst questions) that contain a combination of the items Laureiro and Dominguez Arcos (2012). In our case, the items are the food labels attributes.

As showed in Table AI, the experimental design in this study consisted of seven food labels present in the European market: EU organic logo; designation of origin (PDO); nutritional fact panel; local origin; carbon footprint; food-miles indicator; and improved animal-welfare label. These were shown and explained to respondents before the choice task. Moreover, semi-cured cheese was selected as the carrier product for the labels. A cheese product was chosen because of its importance in Spanish consumption: annual per capita cheese consumption is 9.3 kg, with an associated expenditure of 60 euros per year, which represents 30 per cent of the total per capita expenditure on dairy products (Mercasa, 2014).

The total number of choice sets in the experiment was designed a 7 and “Sawtooth MaxDiff Designer” software was employed to carry out simulations with different combinations of the food labels to obtain the best experimental design properties. An example of one of the best-worst questions used in our study is presented in Table II.

### Table I. Sample characteristics (percentage) and definition of variables

<table>
<thead>
<tr>
<th>Variable definition</th>
<th>Sample</th>
</tr>
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<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>47.0</td>
</tr>
<tr>
<td>Female</td>
<td>53.0</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
</tr>
<tr>
<td>18-35 years</td>
<td>27.8</td>
</tr>
<tr>
<td>35-54 years</td>
<td>38.2</td>
</tr>
<tr>
<td>55-64 years</td>
<td>14.9</td>
</tr>
<tr>
<td>Over 64 years</td>
<td>19.1</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
</tr>
<tr>
<td>Primary School</td>
<td>20.0</td>
</tr>
<tr>
<td>High School</td>
<td>37.7</td>
</tr>
<tr>
<td>University</td>
<td>42.0</td>
</tr>
<tr>
<td><strong>Average household monthly net income</strong></td>
<td></td>
</tr>
<tr>
<td>Between 900 and 1,500 euros</td>
<td>28.7</td>
</tr>
<tr>
<td>Between 1,501 and 3,500 euros</td>
<td>53.5</td>
</tr>
<tr>
<td>More than 3,500 euros</td>
<td>17.8</td>
</tr>
</tbody>
</table>

### 2.2.1 Example of BW choice set as presented to respondents

<table>
<thead>
<tr>
<th>Most important</th>
<th>Least important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon footprint</td>
<td></td>
</tr>
<tr>
<td>Organic</td>
<td></td>
</tr>
<tr>
<td>Denomination of origin</td>
<td></td>
</tr>
</tbody>
</table>
The respondent was asked to tick the “best” option and the “worst” option when shopping for cheese with different food labels.

2.3 Econometric analysis

Best-worst choice experiment (BWCE) is routed on the Random Utility Theory of Thurstone’s (1927). This theory suppose that one person \((q)\) has a determined utility with an alternative \((i)\) and this utility can be separated in a systematic component \((V_{iq})\), that can be observed and measured by the researcher, and the random component \((e_{iq})\), that captures the measurement errors of the model is shown in the following equation:

\[ U_{iq} = V_{iq} + e_{iq} \]  

(1)

Additive functions consider that total utility of the systematic term is influenced by all products’ characteristics. These influences are captured by the \(\beta\)'s of the following equation, where the total utility of alternative \(i\) is the sum of the partial utility from each attribute-level:

\[ V_{iq} = \sum_{k=1}^{K} \beta_{ik}X_{ik} \]  

(2)

Finn and Louviere (1992) presented the first publication dealing with Best-Worst method at beginning of 1990s, nevertheless the formal statistical and measurement properties were presented by Marley and Louviere (2005). Basically, in a BWCEs, respondents have to state what are the best (the most preferable or important) and the worst (the least or less important) options in a choice set.

Formally, BWCE in this study assumes that subject \((q)\) identifies and calculates the difference in utility for every pair of \((U_{q,j} - U_{q,k})\) available food labels in the choice set and select that pair that maximise utility difference between food labels \((U_{q,j} - U_{q,k})\). Note that, besides to maximise the utility difference, respondents are also stating what food label is the best and the worst in the following equation:

\[ Y_{q,jk} = U_{q,j} - U_{q,k} + e_{q,jk} \text{ for } j, k = 1, \ldots, n \text{ and } j \neq k \]  

(3)

Hence, when individuals are asked to answer best-worst questions, they choice those two food labels that maximise their difference on an underlying scale of importance. If a choice set has \(J\) food labels, then there are \(J(J-1)-1\) possible best-worst combinations of food labels that an individual could choice. The specific pair of food labels chosen by the individual as best and worst, then, represents a choice out of all \(J(J-1)-1\) possible pair that maximises the differences in importance.

In accordance with Lusk and Briggeman (2009), \(\lambda_i\) represents the location of value \(j\) on the underlying scale of importance, and let the latent unobserved level of importance for individual \(i\) be given \(L_{ij} = \lambda_{ij} + e_{ij}\), where \(e_{ij}\) is a random error term.

The probability that respondent choices a food label \(j\) and another food label \(k\), as the best and worst, respectively, out of a choice set with \(J\) items, is the probability that the difference in \(L_{ij}\) and \(L_{ik}\) is greater than all other \(J(J-1)-1\) possible differences in the choice set. If the \(e_{ij}\) are independent and identically distributed across \(j\) food labels and \(q\) individuals with extreme value type I (EVI) distribution, then the probability takes the multinomial logit (MNL) form.
The probability of consumer $q$ choosing best $j$ and $k$ chosen worst is given:

$$\text{Prob}(q \text{ is chosen}) = \frac{\exp(\lambda_j - \lambda_k)}{\sum_{j=1}^{J} \sum_{m=1}^{J} \exp(\lambda_i - \lambda_m) - J - 1} \quad (4)$$

The parameters $\lambda_j$ are estimated by maximization of the log-likelihood function based on the probability in Equation (4). The dependent variable of choice takes the value of 1 for the pair of food labels chosen by respondents as best and worst, and 0 for the remaining $J(J-1)-1$ pairs of food labels in the choice set that were not chosen as best and worst. The estimated $\lambda_j$ represents the importance of food label $j$ relative to that food label that was normalised to zero (Lusk and Briggeman, 2009).

The MNL model assumes preference homogeneity in the sample, i.e., all individuals in the sample place the same level of importance on each externality, implying that all coefficients of the utility expression in Equation (4) are the same across individuals. In contrast, in the Latent Class Model (LCM) model, consumers are assumed to belong to different segments, each of which is characterised by unique class-specific utility parameters. In other words, within each segment, consumer preferences are homogeneous but preferences vary between segments, allowing for a more in-depth understanding of heterogeneity (Hynes et al., 2008). Thus, for the given segment membership, the choice probability that individual $q$, conditional on belonging to class $s (s = 1, \ldots, S)$, chooses food labels $j$ and $k$ as the most and the least important food labels from a particular set $J$, is represented as:

$$P_{q, jk|s} = \prod_{t=1}^{T} P_{q, jk|s} \quad (5)$$

where $P_{q, jk|s}$ is the allocation of individual $q$ to the $s$ class (probability of class $s$) and $P_{q, jk|s}$ is the choice probability that individual $q$, conditional to belonging to class $s (s = 1, \ldots, S)$, selects the attribute $i$ and the attribute $k$ as the most and the least important attributes, respectively, out of a choice set with $J$ food labels, on a particular choice occasion $t$ (Greene and Hensher, 2003).

2.4 Preference heterogeneity

Estimated parameters for the LCM for each of the participants were then utilised to segment consumers. The obtained segments were characterised by the consumer's personal characteristics, beliefs, food-related lifestyles and environmental and ethical beliefs. This characterisation was done using a $\chi^2$.

3. Results

3.1 Descriptive analysis

The first step in our descriptive analysis was to calculate the number of times each food label was chosen as the most ($B$) and least ($W$) important by Spanish consumers. The best-worst score for each attribute and each respondent was calculated.

The results are shown in Table III. It is noted that Spanish consumers consider the denomination of origin (PDO) the most important attribute, followed by the nutritional panel (NUTRI) and the organic logo (ORGANIC). Similarly, animal welfare (WELFARE) and locally produced (LOCAL) labels present negative values and were very close to zero. This finding implies that Spanish consumers are indifferent towards them. Finally, food-miles (NMILES) and carbon footprint labels (CARBON) show negative signs, with...
3.2 Consumers heterogeneity from LCM
In order to take into consideration heterogeneity across individuals towards food labels, different Latent Class (LC) models were estimated. Moreover, to select the number of segments to be considered in LC modelling, different criteria were calculated. As shown in Table IV, the minimum Akaike Information Criterion (AIC), the modified Akaike Information Criterion (AIC3) and the minimum Bayesian Information Criterion (BIC) were calculated for two, three, and four LC specifications, but we found that they were constantly increasing or decreasing. We noticed that when considering three classes, the value of the estimated parameters started to deteriorate, owing to larger standard error, which is considered an indication to stop looking for more classes (Louviere et al., 2000). In the model with three classes, we noticed that some food-label attributes were not statistically different from zero. Finally, we calculated the negentropy statistic following Ramaswamy et al. (1993) to measure the separation of segments. This statistic is similar to the $R^2$ statistic in that the model is said to “better” identify the segments, the closer the value is to unity. A negentropy value of 0.8 or higher indicates that the segments are well separated. Based on the negentropy values (0.83, 0.35 and 0.30 for the two, three and four segments models, respectively) we selected the two-segment model. The results for the LC model with two segments are presented in Table IV, and the parameter estimates for the one-segment model are included for comparison.

Results for the one-segment and two-segment models are presented in Table V. In all models the carbon footprint label is set as a reference. Looking at the one-segment model, we see that all estimated parameters are statistically different from zero. Consumers considered the designation of origin (PDO) the most important label, followed by the nutritional fact panel and the organic label. The local and animal-welfare labels were next in terms of preference, and food miles presented an estimate coefficient close to zero, implying that...
Consumers did not express a preference for this label. Since the carbon footprint label is the reference attribute, however, which has a negative sign, this means that this label is the least important, and it is statistically significant at 5 per cent. On the other hand, results from the one-segment model are not the best representation of consumer behaviour, as the LC model with two classes was found to have better statistical properties.

The two-class LC model identified a first segment that included 65 per cent of respondents who considered the designation of origin the most important label, followed by the nutritional fact panel and the organic label. The second segment consists of 35 per cent of consumers. Contrary to the first segment, consumers consider the organic label most important, followed by animal welfare and the nutritional panel. For this segment, the food-miles label was not significantly statistically different from zero at the 5 per cent significance level. This last result suggests that Spanish consumers are indifferent towards this label because they do not perceive it as either best or worst.

Consumers in the second segment value the labels that provide information on process of production process (organic and animal welfare) and health characteristics (nutritional panel) more highly. On the other hand, the least valued labels were those related to the geographic origin of production (local and regional DOP).

Finally, to profile the two consumer segments, we conducted a $\chi^2$ or analysis of the variance tests for some consumer socio-demographic characteristics and lifestyles. The characteristics found to differ statistically between segments are included in Table III.

From the consumer socio-demographic characteristics only age and income were found to be statistically different between clusters. Segment 1 consists of older consumers and Segment 2 consists of better-off consumers. Some health-related lifestyles and environmental beliefs were also statistically different between segments: while Segment 1 showed healthier lifestyles than Segment 2, the latter presented more environmental concerns (Table VI).

4. Discussion
The results from this study indicated that consumers value the different analysed food labels positively, but they value the public labels more highly than the private ones, since the most valued labels were the designation of origin followed by the organic logo and the nutritional panel. Food-miles labelling and carbon footprint labels were the least preferred, occupying the last positions, and the local-origin and animal-welfare labels were in the middle position. These results are in accordance with the existent literature (de-Magistris and Gracia, 2016a, b; de-Magistris and Gracia, 2014; Aprile et al., 2012; Gracia et al., 2014; Scarpa and Del Giudice, 2004), which reported that consumers valued PDO certification more than organic, local or other private labels. On the other hand, our results are also in accordance with Cavaliere et al. (2015) and Schultz and Hannahn (2013), who reported that consumers preferred products with hedonic labels (e.g. PDO label) in comparison to products bearing health labels (e.g. nutritional claims and organic). Moreover, our study also reported that Spanish consumers valued locally

<table>
<thead>
<tr>
<th>Variable</th>
<th>One-segment model</th>
<th>Segment 1</th>
<th>Segment 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coef.</td>
<td>z-Ratio</td>
<td>Coef.</td>
</tr>
<tr>
<td>Organic</td>
<td>1.447</td>
<td>28.00</td>
<td>2.056</td>
</tr>
<tr>
<td>PDO</td>
<td>1.657</td>
<td>31.2</td>
<td>2.87</td>
</tr>
<tr>
<td>Nutri</td>
<td>1.628</td>
<td>30.87</td>
<td>2.639</td>
</tr>
<tr>
<td>Local</td>
<td>0.862</td>
<td>17.74</td>
<td>1.251</td>
</tr>
<tr>
<td>Miles</td>
<td>0.332</td>
<td>6.12</td>
<td>0.649</td>
</tr>
<tr>
<td>Welfare</td>
<td>0.828</td>
<td>17.99</td>
<td>1.022</td>
</tr>
<tr>
<td>Class probability (%)</td>
<td>65</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table V. Parameter estimates: latent class choice model with two segments
grown products positively, and we can affirm that these findings are in agreement with
Yue and Tong (2009), Hu et al. (2009) and James et al. (2009). The findings are also similar to
Grebitus et al. (2013), de-Magistris and Gracia (2014, 2016a) who indicated that people
negatively valued goods that had travelled longer distances.

Overall findings show that consumers value labelling schemes that are regulated by EU
law highly, suggesting that if food labelling is based on regulations that lay down stringent
requirements to guarantee the standards of the labelled food product and ensures that those
standards match specifications by established control requirements, then consumers
prefer products carrying these labels. Since the most preferred food labels in this study
are also those found to be the most prevalent in the European market (Ipsos and
London Economics (EAHC), 2013) where this result suggests that the prevalence of public food-
labelling schemes in the European context could influence European citizens to prefer them
because they are more known than private ones.

Finally, our findings revealed that consumer preferences for food labels are
heterogeneous across consumers since two segments were identified. Therefore, we can
give food companies useful information on the consumer characteristics of the segments
when their marketing strategies are implemented.

The first segment consists of older people showing more healthy lifestyles and preferring
more products carrying PDO and nutritional information. However, the second segment is a
small group of younger consumers with stronger environmental concerns who, regardless of
the regulation behind the label, value more highly those labels related to the way the product
has been produced (organic and animal welfare) and the nutritional content. Results suggest
that the most preferred labels for the largest segment are those which are regulated by
European Union legislation. There is also a smaller group of younger consumers with
environmental concerns who prefer the labels that provide information on the way the
products have been produced and on the nutritional content, placing less preferred on the
geographical origin of the production. On the other hand, as the nutritional fact panel is one of
the most preferred labels for both consumer segments, our study confirms that the decision
made by the European Commission in regulation (EU) No. 1169/2011, on the provision of food
information to consumers to make the nutritional panel mandatory, was appropriate in order
to meet the needs of European citizens.

5. Conclusion
The demand for food has undergone profound changes over the last two decades, with high
heterogeneity in consumer preferences. This has led to a strong differentiation of

Table VI. Factors explaining segment differences

<table>
<thead>
<tr>
<th></th>
<th>Segment C1</th>
<th>Segment C2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segment size</td>
<td>65%</td>
<td>35%</td>
</tr>
<tr>
<td>Older</td>
<td>67%</td>
<td>33%</td>
</tr>
<tr>
<td>High income</td>
<td>32.9%</td>
<td>67.1%</td>
</tr>
<tr>
<td>Health-related lifestyles**&lt;br&gt; Health: “I try to avoid snacking”</td>
<td>4.01</td>
<td>3.80 &lt;br&gt; Health: “I try to follow a healthy diet”</td>
</tr>
<tr>
<td>Environmental concerns**&lt;br&gt; Food products would be produced respecting animal welfare</td>
<td>4.1</td>
<td>4.45 &lt;br&gt; Food products would be produced in environmentally friendly way</td>
</tr>
</tbody>
</table>

Notes: *Health-related lifestyles** used a Likert scale, where 5 means “I am totally in agreement”;<br> **Environmental concerns* used a Likert scale, where 5 means “I am totally in agreement”*
experiential eating quality and credence attributes related to environmental and other social outcomes. In particular, there is increased demand for those food labels related to health, environmental conservation, product origin, support local rural communities, animal welfare, and so on. While consumer preferences towards some public and voluntary food labels have been studied extensively using DCE, there is no empirical work on consumer preferences, which investigates whether European consumers value public or private food labels more highly, using a best-worst approach. This is the aim of our study, taking into account the valuation of the joint provision of the seven food labels for the same food product (semi-cured cheese).

Three out seven are under European regulation, such as the organic logo, denomination of origin and nutritional content. However, the other four food labels are private initiatives: local, carbon footprint, food-miles and animal-welfare labelling. The results from this study indicate that consumers value the different analysed food labels positively, but they value the public labels more highly than the private ones, since the most valued labels are the designation of origin followed by the organic logo and the nutritional panel. Moreover, two segments were identified: the first consists of older people who follow a healthy lifestyle and prefer PDO and organic cheese products, while the second belongs to younger people who are more concerned about environmental and ethical issues, and so prefer organic and welfare labels.

Since this study was carried out in only one European country and in 2011, to check whether these results hold further studies should be replicated also in other countries and on other food products to provide external validity for our results. Moreover, the use of pictures of the products instead of real products could drive a possible bias because the use of real products evoke a pleasure hedonic response to participants owing to an associated cue (e.g. smell), and increase attention towards hedonic labels rather than other ones. Therefore, further studies could use real products instead of pictures and test whether differences exist in preferences between conventional BW methods and a “real” BW approach.

References


**Further reading**

Appendix

Organic logo indicates a way of producing food that respects natural life cycles. It indicates that the product contains no chemicals, and that these products come from animals for which drugs, hormones and genetically modified organisms are prohibited.

Denomination of origin (PDO) label indicates that the product is produced, processed and prepared in a given geographical area using recognised know-how, which defines the quality or characteristics of the product.

Food-miles label indicates the number of kilometres that the product has travelled from area of production to area of consumption.

Nutritional fact panel indicates the amount of calories and nutrients in a serving of food.

Local-origin label “product from my farm” indicates that local farmers sell the products directly, without any intermediary.

Carbon footprint label reports all greenhouse gases (GHG) that have been released into the atmosphere (measured in units of carbon dioxide (CO₂) equivalent dioxide) in the production and marketing of food.

Animal-Welfare label “more respectful of the animal welfare product” indicates that farm animals have been well reared, treated, transported and slaughtered, with everything respecting their welfare.

Table AI.

<table>
<thead>
<tr>
<th>European food labels</th>
</tr>
</thead>
<tbody>
<tr>
<td>2711</td>
</tr>
</tbody>
</table>

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Adolescents’ trust in food messages and their sources

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Abstract

Purpose – The authors used role-playing with subsequent focus group interviews in order to explore how adolescents negotiate conflicting food messages they encounter in their everyday lives. The purpose of this paper is to describe adolescents’ perceptions about different messages and their sources and to explore the trust they place in such sources.

Design/methodology/approach – In total, 31 adolescents aged 15-16 years participated in role-playing with subsequent focus group interviews. A qualitative content analysis was used to analyse the data.

Findings – The adolescents depicted an everyday life with multiple and different messages about food and eating. In addition, they stated that these messages were conveyed by a wide range of sources at different levels, for example, by parents, teachers, sports coaches and media. The messages from different sources were conflicting and covered many different perspectives on food and eating. When negotiating food choices in the role-playing and in the focus group discussing how to handle different and conflicting messages, trust became visible. The trustworthiness of messages and trust in their sources were associated with several important aspects in regard to whether or not the messages were based on knowledge about food and nutrition, care for the person receiving the messages, and/or commercial interest. In addition, the results indicate that the situation and the social relationship to the person providing the message were of importance for trustworthiness.

Originality/value – This study is novel as it uses role-playing as a research method and describes the trust adolescents place on food messages and their sources. To understand the factors that enhance such trust is important for the development and provision of education, information, and other health-promotion activities related to food in order to support and strengthen adolescents’ critical reflections on food messages from different sources.

Keywords Adolescents, Trust, Consumer perceptions, Food messages, Role-playing

Paper type Research paper

Introduction

We live in a late-modern society characterised by an overflow of information about what choices are the “right” ones (Giddens, 1991). In regard to their daily food choices, people are exposed to and guided by multiple messages. There are alarming reports about foods that may be bad for human health; other messages describe pleasure related to food, foods that can be purchased at a discount to save money, and the temptations surrounding “luxury” foods. In addition to these messages, there are expectations concerning ethical choices, for example, making responsible food choices related to environmental sustainability. Thus, people encounter an abundance of information to process regarding food and eating in their daily lives (Järvelä et al., 2006).

With modern technology, people are exposed to food and food messages from all over the world as well as their own regions. People can no longer rely on local knowledge, traditions, habits or observations of others’ practices to manage their everyday lives. Instead, they need to place their trust in technical and professional knowledge and in anonymous experts providing such knowledge (Giddens, 1991). Most foods are produced by agribusinesses and industries rather than by people themselves, leading to a gap between producers and consumers where consumers have limited insight and knowledge about the production of the foods they consume (Van Kleef et al., 2006; Wilson et al., 2013; Meyer et al., 2012; Bildtgård, 2008). This makes trust highly important in relation to food, as trust is the bridge...
between lack of knowledge and uncertainty (Meyer et al., 2012; Tonkin et al., 2015). While consumers are dependent on expert advice and the food industry, there are also elements that can challenge their trust in the food system, for example, media coverage of food scares (Coveney, 2008; Holmberg et al., 2010).

Generally speaking, we can distinguish between two different kinds of trust in the literature in relation to food (Wilson et al., 2013; Tonkin et al., 2015). On the one hand, there is interpersonal trust and, on the other, trust in institutions and expert systems (Kjærnes, 2013; Wilson et al., 2013). Examples of interpersonal trust are consumers’ trust in social networks that surround locally produced and retailed foods (Eden et al., 2008; Green et al., 2003; Meyer et al., 2012), while consumers’ trust in food-regulation policies is an example of institutional trust (Jackson, 2015; Kjærnes, 2013; Henderson et al., 2012). The main focus of most research on food and trust has focused on an adult population (e.g. Bearth et al., 2014; Hunt and Frewer, 2001; Rosati and Saba, 2004; Henderson et al., 2012; Holmberg et al., 2010; Tonkin, Meyer, Coveney, Webb and Wilson, 2016). Few studies have looked at adolescents’ trust in different sources of food messages. A British study showed that adolescents place their trust on various sources, rating family at the top followed by teachers and medical sources as the sources they most trust to provide truthful information about food safety (Coulson, 2002). Parents, teachers and factual books have also been rated as trustworthy sources by adolescents regarding nutrition information (Larsen and Martey, 2011), while media have been perceived as a less-reliable source, partly because they provide insufficient, biased or confusing information (Dorey and McCool, 2009; Larsen and Martey, 2011).

The studies noted above illustrate that not only the content of messages about food and eating is important for trust but also the sources of messages. However, knowledge is scarce regarding the underlying reasons for trusting various messages and their sources, especially in a Nordic context. In order to be able to adequately support adolescents’ critical reflections about food messages and to empower adolescents to become critical consumers, more knowledge is needed about the different food messages to which they are subjected and how they value these messages and their sources. Increased awareness is important for teachers and other professionals involved in education in order to be responsive to the perspectives of adolescents (Sommer et al., 2011). However, previous studies have mainly provided implications for the food industry and policy makers to build or rebuild consumers’ trust in food (Tonkin, Webb, Coveney, Meyer and Wilson, 2016; Wilson et al., 2013, 2016). In the present study, we used role-playing with subsequent focus group interviews to explore how adolescents negotiate conflicting food messages they encounter in their daily lives. The aim was to describe adolescents’ perceptions about different messages and their sources and to explore the trust they place on them.

Methodology
This study used an interpretive approach. Interpretive inquiries attempt to explore and understand how individuals feel, perceive and experience the world (Chen et al., 2011; Denzin and Lincoln, 2003; Willis et al., 2007). The researchers’ interest are in the participants’ subjective interpretations of the world rather than the objective world (Chen et al., 2011). In the present study, role-playing with subsequent focus group interviews was chosen as the method for gathering data, as it enables social interaction and reflection among adolescents and gives them the ability to express their understanding about food messages and their sources. When using the term “food messages,” we refer to all kinds of messages, i.e. written and verbal information, as well as information or messages delivered in pictures and peoples’ actions. Thus, sources of messages include actors as persons or institutions, as well as artefacts including books, advertisements, films and the Internet. In regard to trust, we analysed all statements about or signs of trust and perceived trustworthiness in negotiations in the role-playing and in the adolescents’ discussions regarding messages and their sources.
Participants

The participants were chosen through a purposive sample (Polit and Beck, 2012), which means that comprehensive schools were chosen from a population as heterogeneous as possible considering neighbourhood characteristics regarding ethnic diversity, socioeconomic status, etc. The study was conducted at the local university; therefore, schools located within a reasonable distance for the adolescents were chosen. Nine comprehensive schools in Western Sweden were contacted, and four agreed to participate. A total of 31 adolescents ages 15-16 years old consisting of boys (11) and girls (20) in the ninth year of compulsory school agreed to participate in the study. The adolescents gave written informed consent prior to participation, and the study was assessed by the Regional Ethical Review Board (Dnr: 062-12).

We assumed that participants knowing each other would increase their chances of feeling confident and thus would freely speak their minds and participate in role-playing (c.f. Hill, 2006). Therefore, the participants for each data-collecting occasion came from the same school class so they knew each other and were the students in each class who had voluntarily applied to participate. This resulted in five groups (two groups were from the same school) with 5-7 participants in each group. All groups consisted of both boys and girls.

Data collection

Data were collected through role-playing and subsequent focus group interviews and took place during late-spring and autumn 2012. In role-playing, participants take on roles and act based on events they have experienced from their worlds (Yaacob and Gardner, 2012). In a research setting, the researcher prompts participants to take part in specific role-playing with the intention of capturing participants’ perspectives on the area of interest (Gardner, 2016). To our knowledge, role-playing as a method for gathering data in scientific studies is quite rare. However, it has been used, for example, in studies regarding how children learn to read by role-playing a lesson (Gardner, 2016); adolescent conflict resolution (Borbely et al., 2005); how people manage a foreign language (Demeter, 2007); and research on preschoolers’ perceptions of tobacco and alcohol use (Dalton et al., 2005). In previous food-related studies, using role-playing, pictures or “imaginary” foods have been used, and the settings have been place in fictive restaurants or stores (e.g. Bataller Fuster, 2013; Dalton et al., 2005). The present study differs because the participants chose and purchased actual food items in a real grocery store and then prepared and ate it. This allowed participants to experience authentic interactions with foods. The settings for the data collection were a fully equipped kitchen used for education and cooking at the local university and a grocery store near the university. The kitchen location was chosen based on the need to be able to cook and to be away from their school and homes where, for example, teachers and parents might be present.

Two pilot studies were conducted to test the study design. The data collection started with a discussion about where the adolescents received messages about food and eating (see Figure 1, phase 1). The first author gave a definition of food as anything you could eat or drink and, when requested by the adolescents, an explanation of what was meant by food messages. Sources of messages were identified by the adolescents, and then they negotiated which sources should be portrayed in role-playing. In phase two, the adolescents were asked to plan a lunch together and, in phase three, to purchase the needed food items in a grocery store. In both these phases, the adolescents were acting in different roles. Then in phase four, they prepared and ate the meal without playing the character. The final phase consisted of a focus group interview where the participants reflected on playing a role by developing, explaining and discussing actions in the role-playing. In this phase, the adolescents also discussed how they valued sources and messages. In greater detail, two themes were discussed: first, the role-play, i.e. how they experienced carrying out their roles and whether they wanted to explain or comment on something in the role-playing; and
second, food messages in their everyday lives, i.e. which messages they usually comply with, which sources they usually trust, and how they handle contradictory messages. The focus group discussions enabled reflection about what had been said and done in the role-playing as well as reflections about food messages related to the adolescents’ own experiences and perceptions. In the focus group, the first author acted as a moderator and an observer took notes about the procedure. Each data-collecting session with role-playing and a focus group interview lasted 3-4 hours. All five phases were audiotaped using MP3 players, with one player per participant during the grocery store scenes.

During each phase, the adolescents were encouraged to explain the reasons for their statements, choices and actions in order to reveal as much as possible about their thoughts.
and perceptions. The moderator sought to use terminology similar to that of the adolescents to minimise the hierarchical adult-child relationship (Hill, 2006). Several "ground rules" were clarified before the role-playing and focus group interview started to create a congenial atmosphere: everyone should have an opportunity to speak; there is no right or wrong; and all thoughts and opinions are equally important (Morgan et al., 2002; Wibeck, 2014). In addition, the researcher emphasised that the study's focus was on the adolescents' perceptions and not their knowledge about food.

Data analysis
All the audio-recorded material from phases 1, 2, 3, 5 of the data collection (see Figure 1) was transcribed verbatim, which resulted in 269 pages. Phase 4, when the adolescents were cooking, was not transcribed but listened to, and notes were made because very little of the conversations was related to the study's aim. The transcripts were analysed using a qualitative content analysis (Graneheim and Lundman, 2004). The audiotaped material was carefully listened to a number of times, the notes (from phase 4 and the observer's notes), and transcripts were thoroughly read to provide an overall impression. The transcripts were reread to identify sentences expressing a central meaning (meaning units) in relation to the content of the messages, how the adolescents portrayed their characters' roles and how trust was represented in the adolescents' discussions and descriptions of the sources of messages. The meaning units were abstracted and labelled with a code that described their content, and then the different codes were compared according to differences and similarities and sorted into tentative categories. The tentative categories were reviewed and discussed several times and then encoded. Finally, the underlying meanings of the categories were formulated as themes. The first author extracted and labelled the data, which was then brought to discussion with the other three authors and revised to reach consensus in the research team. The authors have competencies in the sociology of food, the sociology of health, nutrition, and home and consumer studies, and thus they brought different experiences to the discussion. We argue that the discussions, involving the four authors, throughout the analysis phase contributed to the trustworthiness of the study.

Results
Home and consumer studies (HCS) teachers, parents, friends, sports coaches and media were the most frequently mentioned sources of food messages. These sources were also portrayed in the role-playing by more than one group of participants, as shown in Table I. The initial discussion included several sources that were identified to convey messages about food but that did not become characters in the role-playing. The sources of these messages were doctors, dieticians, scientists, advertisements, TV shows, movies, documentaries, newspapers, text on food packages, models and bloggers. Throughout the negotiation of role-playing characters, the adolescents chose different ways to illustrate the media. One group chose to portray media in general rather than having it represented by a specific person, while other groups decomposed media into celebrities from TV, journalists, the Internet, books and sports stars to make the role-playing more manageable. The following results will be illustrated by quotations. When participants spoke as characters in the role-playing, this is indicated in quotes. The participant group in which the discussion took place is also given.

The adolescents portrayed messages of diverse reasons for food choices, preparation and eating. The messages concerned: promoting physical well-being; providing an experience of palatability and luxury; managing resources, e.g. time and financial resources; promoting sustainability with regard to the protection of the natural environment; promoting athletic performance and a strong body; and promoting weight loss. Because of the different content in the messages, there were long and intense discussions and negotiations about which
foods to choose. The following quotations from the role-playing illustrate how the characters argued about what to eat:

Friend: I’m really craving tacos! Tacos are tasty!

Sports coach: There’s a lot of protein in the meat. But we should not have vegetables, which isn’t good.

Journalist: I prefer to have vegetables since meat is bad for the environment.

Sports coach: Is it bad? But it helps build muscles, and we all need muscles.

HCS teacher: We could have lentils and beans instead of meat (Group 2).

**Important aspects of trust in messages and their sources**

Negotiations about what to eat led to discussions about what messages or sources of messages to trust. The role-playing and the subsequent focus group discussions revealed several aspects involved in why the adolescents valued messages as trustworthy and placed their trust on the sources of messages. These aspects can be summed up in two themes. First, trust was related to whether and to what extent the messages were based on care for the person or group receiving the message; on knowledge about food, eating and the consequences of consumption; and on commercial interest. Second, trust was dependent on the adolescent’s social relationship to the person conveying the message and on the situation in which the message was conveyed and acted on.

Thus, care was one aspect related to trust. Messages based on care were perceived to be conveyed because of concern for the people receiving them, in this case, the adolescents. To care about someone was to be interested in that person’s preferences, needs, health and well-being. The adolescents emphasised care and concern as crucial aspects for actually trusting and listening to the messages, which is illustrated in the following discussion:

- You don’t listen to some people, I know that.
- No, it depends on who they are.
- Yes, you listen to your parents.
- Yes, you listen to the ones that say something with love and care (Focus group 3).
Care was something that the adolescents connected mostly to their parents. Parents were perceived to show concern and care in many ways. This could be about restricting the intake of sweets and snacks to specific days or occasions, or ensuring that the children ate nutritious food that promoted health and growth, while also offering tasty food cooked with love. This concern of parents involved many aspects of food which is shown in a quote from the role-playing:

Parent: The children are very fond of tacos; they are quick [to make] and the kids like them. My kids need to get a lot of nutrition, although it should be tasty and quick [to make] (Role-play group 5).

The trustworthiness of a message was also affected by whether it was considered to be knowledge-based or not. Knowledge was something that the adolescents related mainly to education or occupation, implying that through education or occupation, a person has gained the relevant knowledge and expertise required. On the basis of this, the adolescents associated HCS teachers, sports coaches, doctors, dieticians and scientists with knowledge. Because of the knowledge and education attributed to these professions, they and their messages were valued as trustworthy. A discussion about the HCS teacher illustrates this:

– Well, you learn, they are teaching, they are educated to teach you stuff.
– Yes, they should know what they are talking about.
– Yes, well if they kind of teach you stuff you believe in it because they are teachers and they should know (Focus group 5).

In most cases, the agents who were perceived as having knowledge were also portrayed as having a responsibility to transfer this knowledge in their occupations. For example, the HCS teacher was depicted as having a responsibility to educate pupils regarding different aspects concerning food, as illustrated by the following quotes from two role-playing sessions. This could be about making correct and well-balanced food choices according to nutritional recommendations, making choices in regard to environmental aspects like organic food, or developing cooking skills:

HCS teacher: It has to be eco-friendly and at the same time healthy (Role-play group 1).
HCS teacher: I feel that we need to do some cooking that we can learn from (Role-play group 5).

A person outside the school also characterised as taking responsibility for giving information about food and nutrition was the sports coach, who was perceived to have knowledge and expertise even if not necessarily having an education in nutrition or working as a coach by profession[1]. The sports coach was portrayed as responsible for leading the team to victory and success. To accomplish this goal, the coach’s assignment was to create physically strong players and provide advice about food that promoted this. Food was considered a way to reach the goal of a strong body, while other aspects like palatability and health were considered less important. The sports coach was portrayed as one who talked about food explicitly as a means for performance and whose messages were one-dimensional and peremptory:

Sports Coach: Tasty […] I don’t care if it is tasty; it should be good for the body. Hockey players should build muscles; that’s what it’s all about (Role-play group 2).

Parents were also accredited with having knowledge about which foods were good for their own child, and this was related to being a responsible caretaker with experience and familiarity. However, the adolescents were reflexive about trust in this kind of knowledge. In the quotations below, the adolescents argue about whether those who want the best for you actually know what is best for you:

– Well, I can say like this, I trust the one who wants what’s best for me.
– Who is that?
– It could be the coach, the parents; it could be different at different occasions.
– But, does he know what’s best?
– If he gives you really bad food and claims he wants what’s best for you, is that a good thing?
– But, then he doesn’t want what’s best for me.
– But maybe he doesn’t know that (Focus group 1).

There were also discussions related to knowledge that involved some aspects of the media like TV documentaries, the Internet and daily newspapers. These were perceived by a majority of the adolescents to be sources that provided knowledge and were relatively trustworthy. Using the Internet or a search engine such as Google, in particular, to identify facts about food was perceived to be a reliable source. However, the adolescents’ apprehension regarding documentaries was not unanimous. Some claimed that documentaries were factual and trustworthy, while others perceived them to be exaggerated.

Other aspects of media, e.g. the TV chef, were perceived to convey messages that were based on a commercial interest because of their eagerness to persuade and “sell” their products or concepts. The adolescents found this sales approach a bit suspicious, as if the media were trying to dupe them, which resulted in these sources being perceived as unreliable. This is illustrated by quotes from their discussion:
– I don’t trust media because media are all about making as much money as possible.
– To sell it, they say that it is really good (Focus group 2).

The sense of an underlying commercial interest was linked not only to advertisements, commercials and business operations but also to companies like McDonald’s and media personalities such as TV dieting coaches and TV chefs advocating with ulterior motives.

In summary, the adolescents’ discussions revealed three important aspects of trustworthiness of messages and trust in sources: knowledge, care and commercial interest. However, it was not obvious that one or two of these aspects were more crucial for trust than the others. Nor can we say whether trustworthiness increased if two or more aspects were present from the results of the present study. If the source of the message was a person, another important aspect of trust was the adolescent’s social relationship to that person. When the adolescent had a close relationship to the person conveying the message, this enhanced trust, while the opposite was true for distant social networks. Those described as having close relationships to the adolescents varied, but parents, teachers, sports coaches and friends were mentioned, while those who were perceived as distant were, for example, school nurses and personnel who were responsible for the mandatory school lunch. The school nurse and school lunch personnel were perceived to have responsibility and knowledge based on their professions, similar to teachers. Nevertheless, the adolescents did not trust or pay much attention to these persons because of the distant social relationship they had to them. Instead, these persons were perceived as relatively anonymous. However, trust was also dependent on situation. For example, health personnel were described as trusted because of their medical knowledge in situations where the adolescents were ill.

Discussion
The results revealed the challenging task of assimilating differentiated and often-conflicting messages about food presented from a number of sources. As shown in previous studies, conflicting messages can lead to uncertainty and confusion (Rangel et al., 2012; Ronteltap et al., 2012; Ward et al., 2012). Somehow, the adolescents have to cope with and evaluate these different messages and decide which to incorporate and which to ignore; they have to decide what and whom to trust. The study revealed different aspects to be of importance
when the adolescents evaluated trustworthiness. One was that professional knowledge and expertise were highly valued by the adolescents. Giddens (1991) claims that people are forced to place their trust in expert systems today because they cannot control everything themselves, which is certainly the case when it comes to food, as there is a gap between producers and consumers (Bildtgård, 2008; Meyer et al., 2012; Wilson et al., 2013). In the present study, it was obvious that the adolescents placed their trust in professional and institutional knowledge systems when they rated medical personnel and schoolteachers as trusted sources regarding food and health messages. Their trust in these persons indicated not only trust in the individual expert but also in the institution represented by the expert. In addition, the adolescents discussed trust and distrust in regard to companies and institutions. Thus, in spite of the fact that it was easier for the adolescents to act as persons in the role-playing, the results revealed their reflexivity with regard to professional and institutional knowledge.

Kjærnes (2013) noted that previous studies have primarily addressed trust related to food safety in food production and food companies. She recognises two distinct grounds for trust in the literature: familiarity and confidence. Familiarity relies on specific personal networks, while confidence refers to more abstract and general institutions and institutional procedures (c.f. Tonkin et al., 2015; Wilson et al., 2013). Similar grounds for trust could be found in the present study; aside from trust in expertise, close and personal relationships were associated with trust. When the adolescents talked about teachers, they mentioned not only the teachers’ education but also their own personal relationship to the teacher, indicating that they do not merely represent the school as a knowledge-based institution. Moreover, parents were trusted in most situations because of their close relationship within the family and because of their genuine care. This aligns with an earlier study that showed how adolescents perceive parents as constructing rules and expectations for them because of their genuine care for their children’s safety, well-being and future success (Ispa-Landa, 2016). The adolescents in the present study discussed care in a more personal manner compared to what has been described in previous studies focusing on trust, where care has been related to the information sources’ (agencies) concerns about protecting citizens in general from possible risks related to food hazards (Rosati and Saba, 2004).

On the other hand, trust was challenged by the feeling of being persuaded. Media sources were generally perceived to have intentions to sell their products or concepts, which made the adolescents suspicious and critical. In contrast, they were much less critical of sources that they could search on their own for information, for example, from the Internet and books. That the Internet, particularly Google, is perceived as a reliable source of information by adolescents is in concordance with previous research (Wartella et al., 2015). This may imply that the adolescents are better equipped to critically review traditional advertising and media than other information channels. However, overall, the adolescents in the present study discussed food messages consciously and perceptively.

The results from the present study contradict previous studies which have concluded that consumers are not reflexive when it comes to trust on food (Henderson et al., 2012; Holmberg et al., 2010). These studies revealed that consumers trust the food supply unless they have reason not to (Henderson et al., 2012). The adolescents’ reflexivity visible in the present study might depend on the fact that they were confronted with authentic food instead of just talking about food, sources of messages and trust. The data collection design of role-playing, with a subsequent focus group interview, seems to be a suitable method for generating discussion and reflection among adolescents concerning food. In the role-playing, long and intensive discussions arose because of the different opinions of the characters about what food to eat. The intensity of the discussion increased when the adolescents were in the grocery store and in physical contact with the great variety of food items there, as the design of the role-playing included seeing, feeling, and tasting real food,
and the participants were confronted with actual decisions and choices. This illuminated not
only conflicts between different messages about food, but also conflicts between messages and
the adolescents’ own preferences and values. These conflicts were the starting point for the
adolescents’ discussions about how they handle conflicting messages, and that was where
the evaluation of trust arose. The confrontation and the handling of real food were considered to
be stimuli for discussions and negotiations about food and promoted rich data material.
When discussing the role-playing afterwards in the focus group interview, the adolescents
confirmed that it had inspired their thinking. A possible limitation of the present study might be
that it was conducted at a university. This setting may connote expertise and factual knowledge
to the adolescents, but attempts were made to prevent this by, for example, emphasising
the interest in the adolescents’ thoughts and perceptions rather than their knowledge.

Conclusions
The results show that adolescents are exposed to numerous and often-conflicting
messages about food conveyed by multiple sources. In relation to conflicting messages,
the adolescents discussed trust in food messages and their sources. The adolescents
perceived different aspects to be of importance for trust; these can be summed up in two
categories: first, trust was related to whether and to what extent the messages were based
on genuine care for the person receiving the message; on knowledge about food, eating,
and the consequences of consumption; and on commercial interest; and second, trust was
also grounded in the adolescent’s social relationship to the person conveying the food
messages and depended on the situation.

The findings have implications for health promotion. Teachers and other pedagogues
involved in education concerning food and health among adolescents need to increase their
understanding regarding how adolescents interpret and value different messages about
food in order to confront and tackle competing messages. Such knowledge and awareness is
essential in the process of empowering adolescents to be critical consumers by providing
them with support and by strengthening their critical reflections on food messages and
sources of messages. The findings emphasise the importance of knowledge and caring
about the target group in food education and health-promoting activities. Such knowledge
enables a holistic approach where other aspects besides nutrition are also considered.

Note
1. In Sweden, it is common that a parent is the coach for, for example, a football team of children or
adolescents.

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Influence of online product presentation on consumers’ trust in organic food
A mediated moderation model

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Abstract
Purpose – Against the background of industrialisation and modernisation of agriculture, food production issues and environmental hazards have become more and more obvious and consumers are increasingly concerned about food safety and health, which is strengthening demand for organic food. E-commerce provides a new channel for sales. Research on consumer trust in online organic food sales is the basis of network marketing. The paper aims to discuss these issues.
Design/methodology/approach – A laboratory experiment was used to empirically test the effects of media richness on consumers’ trust and the moderating effect of online review length. A 2 x 2 factorial design (i.e. two types of online product presentation formats (between-subject) x two levels of online review lengths (between-subject)) was used.
Findings – Media richness has a significant positive effect on consumers’ trust and that this effect is moderated by online review length. Meanwhile, perceived risk conveys the interaction effect of the media richness of online product presentation and online review length to trust.
Practical implications – E-commerce websites should aim to promote organic food by using a variety of online product presentation formats and by presenting high quality online reviews in order to reduce consumers’ perceived risk and improve their degree of trust when buying online.
Originality/value – This paper provides a new insight into consumers’ attitude of buying organic food online. The results of the research could provide proposals for promoting organic food sales online.
Keywords Organic food, Trust, Perceived risk, Online product presentation, Online review length
Paper type Research paper

1. Introduction
As problems with food safety have become increasingly prominent in recent years, demand for organic food has gradually risen in many countries (Von Meyer-Höfer et al., 2015). In China, with the industrialisation and modernisation of agriculture, food production issues and environmental hazards have become more and more obvious, and food safety incidents have occurred. Hence, consumers are increasingly concerned about food safety and health, which is strengthening demand for organic food (Xie et al., 2015). In recent decades, the market for organic food in China has developed significantly; however, it mainly comprises exports and domestic sales are very low (Loebnitz and Aschemann-Witzel, 2016).
This suggests that consumers’ strong demand for food safety is not being converted into actual purchases in China. Because organic food is different from conventional food, consumers pay more attention to its intangible values (so-called “reflection traits”) such as health, nutritional content, environmentally friendly production, and animal welfare (Torjusen et al., 2001). Consumers cannot obtain these features through their own perceptions; they need to be propagated by sellers. According to Peterson et al. (1997), a product’s intangible value proposition can increase the probability of purchase via the internet because of the advantages of E-commerce (e.g. openness, low cost, high efficiency). Hence, the intangible value proposition of organic food makes the internet a popular sales channel (Grunert and Ramus, 2005). Since the internet is being used more frequently as a source of food safety in China (Liu et al., 2014), consumers’ willingness to purchase organic food has strengthened (Zou, 2011; Cheng et al., 2016). However, the actual transaction volume remains low, as consumers may perceive higher risks (Zou, 2011; Cui, 2016). For example, the virtual nature of the E-commerce transaction process for organic food increases the risks and uncertainties that may exist in the transaction, which can lead to a lack of trust in the purchase of organic food by consumers (He et al., 2014). The large gap between consumers’ perceived and actual quality is also a major barrier to purchasing organic food online.

In view of this problem, scholars have studied the risk and trust involved in purchasing organic food online in China. Lin et al. (2015) found empirically that food quality, perceived value, logistics service quality, web design quality, communication, and propensity to trust all positively affect consumers’ trust. Cui (2016) pointed out that consumers’ perceived risks of organic food include product performance risk, financial risk, time risk, and service risk. Among these risk factors, inappropriate product display and inadequate information increase consumers’ perceived risk of product performance. Further, a rich information description can significantly reduce perceived risk and improve consumer trust (He et al., 2014; Wu, 2015). Therefore, as the way information is passed from between sellers and consumers, online product presentations may influence consumers’ perception of risk and trust.

Indeed, a variety of online product presentation formats (e.g. text, pictures, videos, virtual product experiences) significantly influence consumers’ attitudes (Park et al., 2005; Jiang and Benbasat, 2007a; Verhagen et al., 2014; Visinescu et al., 2015). However, previous research has focussed on products that have search or experience attributes, whereas organic food is characterised by having credence attributes. Hence consumers’ trusting these online product presentations when buying organic food online has been overlooked. Thus, the first purpose of this study is to assess whether online product presentation affect consumers’ trust in a website and thus influence consumers’ perceptions of the quality attributes of organic food.

Simultaneously, some scholars find that diverse online product presentations can provide consumers with more product cues, which help them further perceive online products and eliminate information asymmetry to a certain point (Jiang and Benbasat, 2007a, b). However, others believe that online presentations can deliberately make consumers form the wrong understanding of products in order to deceive them (Xiao and Benbasat, 2011). These mixed findings show that the relationship between online product presentations and consumer trust is unstable and may be adjusted by the underlying mechanisms that affect this relationship. Therefore, the second purpose of this study is to examine whether any mechanism mediates the relationship between online product presentations and consumer trust. In this study, we consider the effect of online reviews. Compared with traditional sales channels, online reviews provide an easy way for consumers to assess the shopping experiences of previous buyers, which serve as a supplement to product display. A considerable body of research shows the positive effects of online reviews on customers’ adoption of food products (Chevalier and Mayzlin, 2006; Hussain et al., 2017). However, research on the impact of online reviews on the relationship between online product presentation and consumer trust is scarce.
2. Concept background

2.1 Media richness theory

Media richness, defined as the “ability of information to change understanding within a time interval” (Daft and Lengel, 1986, p. 561), influences the communication effect. The ambiguity of the transmitted message differs by media richness. In the traditional hierarchy of media richness, face-to-face communication is considered to be the richest medium, while text communication is considered to be the leanest (Daft et al., 1987). The use of richer media is especially appropriate when a message may be confusing or regarded as ambiguous (Daft et al., 1987), because richer media lead to more abundant feedback, multiple cues, and so on (Daft and Lengel, 1986).

In recent years, media richness theory has been used to explain the validity of online product presentation (Palmer, 2002). Owing to the spatial limitations of the internet, online product presentations are an important way in which consumers form product perceptions, which is a key factor that influences their attitudes and purchase intentions (Park et al., 2005). Before making their final purchase decisions, consumers attempt to obtain information through various channels. On the internet, consumers lack sufficient awareness of products or services since they cannot be checked or trialled. Hence, online product presentation becomes an important way in which to transfer information to customers. Online merchants are constantly developing their product presentation to improve consumers’ product perceptions (Burke, 2002). The higher the media richness of the online product presentation used by the website, the more information consumers can gain (Jiang and Benbasat, 2007b).

The effect of the format of online product presentation has been studied by a number of scholars, including high and low quality pictures (Won Jeong et al., 2009), 3D images (Visinescu et al., 2015), local presence (Verhagen et al., 2014), and so on. These authors have shown that these formats are more vivid and interactive, which not only helps consumers better diagnose product quality, but also greatly enhances shopping pleasure and thus affects consumers’ perceptions, attitudes, and purchase intentions (Jiang and Benbasat, 2007a).

2.2 Cue utilization theory

Cox (1962) first proposed cue utilization theory, which states that products encompass a series of cues that indicate their quality. Olson and Jacoby (1972) extended cue utilization theory by suggesting that consumers’ purchase decisions depend on intrinsic cues and extrinsic cues. Consumers can use both intrinsic and extrinsic cues to assess product quality. However, when intrinsic cues are not easily obtained, consumers rely more on extrinsic cues (Zeithaml, 1988).

According to asymmetric information theory, product attributes can be divided into search, experience, and credence (Darby and Karni, 1973; Nelson, 1970). The search attributes of organic food include colour, size, and price, experience attributes include taste and freshness, and credence attributes include nutrition, environmental protection, animal welfare, and country of origin (Zander and Hamm, 2010). While previous studies focus on products whose salient features are either search attributes or experience attributes, consumers of organic food actually pay more attention to credence attributes (Lee and Yun, 2015). In online channels, richer media can not only eliminate space limitations when presenting the search and experience attributes of organic food, but also can present more credence attributes, which physical stores would be unable to do. Further, they can make extrinsic cues more elaborative and attractive as well as make it easier for consumers to find intrinsic cues such as nutrient content, environmental protection, and animal welfare. Thus, online product presentation can provide more cues for customers to judge the quality of organic food. Based on the foregoing, this study examines whether these online product presentations affect consumers’ trust and their perceptions of organic food.
3. Hypothesis development

In the shopping process, consumers cannot predict the results of shopping behaviour and thus perceived risks can appear (Cox and Rich, 1964). The perceived risks of online shopping include financial risk, performance risk, physical risk, psychological risk and social risk (Jacoby and Kaplan, 1972). In online shopping, consumers cannot touch and try products; they can only judge the product according to the text description on the website. Hence, accurately forming product perceptions is difficult. As some differences between actual products and consumer expectations in terms of quality may exist, consumers bear the associated risks. However, diverse online products presentation mechanisms would help consumers’ product perceptions (Gillenson and Sherrell, 2002).

The media richness of online product presentation is a key aspect in this regard. Richer media means wider sensory breadth and deeper sensory depth, which allow consumers to understand a product through more diverse channels and complementary purchase cues. Thus, consumers can integrate this large and complementary body of information to form knowledge on organic food according to their needs and preferences (Lim et al., 2000). This knowledge will dispel consumers’ perception deviations about the quality of organic food, thereby reducing perceived risk. From the above analysis, we propose the following hypothesis:

**H1.** The media richness of a website has a negative impact on consumers’ perceived risk.

Trust is a key factor in long-term interpersonal and organisational relationships, as this allows parties to make transactions in situations of risk or uncertainty (Das and Teng, 1998). In E-commerce, consumers trade with unfamiliar merchants and cannot have physical experiences with the products involved, thus making trust even more important. In the online setting, website characteristics are key factors that affect consumer trust; for example, website navigation and display have been shown to affect consumers’ trust (Shankar et al., 2002). Promoting products through different channels such as pictures and videos can help consumers get more comprehensive product information, increase the awareness of products and websites, and judge their products and websites (Jiang and Benbasat, 2007a, b). Meanwhile, a richer media website can stimulate consumers’ understanding of products and improve their shopping pleasure, which affects consumers’ perceptions of the quality of the website to a certain point (Li and Meshkova, 2013). In addition, a high media richness website that demonstrates the production details of the product allows consumers to be more likely to invest more compared with a low media richness website. According to signalling theory (Spence, 1973), only sites with high quality products improve consumers’ confidence in the site (Wells et al., 2011). Thus, we propose the following hypothesis:

**H2.** The media richness of a website has a positive impact on consumers’ trust.

The information search channels for online shopping can be divided into the business-dominant channel and non-business-dominant channel. In the non-business-dominant channel, online reviews occupy an important position in consumers’ purchase decisions as they can provide diagnosticity information (Mudambi and Schuff, 2010). Online reviews can also help consumers perceive the usefulness and social presence of the website (Kumar and Benbasat, 2006). When consumers believe online reviews are valuable, they are more inclined to accept and adopt reviewers’ information, which influences their decision making (Cheung and Thadani, 2012). A large number of studies have shown that review length is an important antecedent of an online review’s helpfulness (Pan and Zhang, 2011). Longer reviews may contain more descriptions by past buyers, such as product attributes, personal experience, and so on, which may deepen or change readers’ original attitudes, improve product or service awareness, and reduce the uncertainty of the product (Korfiatis et al., 2012). However, if online reviews are shorter, past buyers’ product descriptions and experience assessment are limited. This means...
that consumers cannot distinguish website propaganda from actual purchase information. Therefore, the length of online reviews is an important factor in measuring their helpfulness for consumers. Thus, we propose the following hypotheses:

**H3.** Review length positively moderates the relationship between media richness and perceived risk.

**H4.** Review length positively moderates the relationship between media richness and trust.

The perceived risk of online shopping has a negative effect on consumers’ trust. Corbitt et al. (2003) proposed a model of perceived risk in a B2C context, finding that the perception of risk has a negative impact on consumer trust and an indirect impact on customers’ purchase intentions through customer trust. Similarly, Lee et al. (2007) found that the perception of risk affects consumer trust in a negative way. Compared with traditional channels, shopping online involves more risks, reducing trust in the website and preventing shopping behaviour. However, if online product presentation with richer media displays a full range of products and present detailed online reviews by past buyers, customers can gain quality cues from different channels. Then, consumers’ perceived risks will be relatively low and trust is more likely to appear. Thus, we propose the following hypothesis:

**H5.** Consumers’ perceived risk plays a mediating role between the media richness online review length interaction and trust.

The research framework of the study is illustrated in Figure 1. In summary, the study proposes that media richness affects consumers’ perceived risk and trust and that the relationship between them is affected by online review length. At the same time, the impact of perceived risk transfers an interaction effect to trust between media richness and online review length.

### 4. Research method

A laboratory experiment was used to empirically test the effects of media richness on consumers’ trust and the moderating effect of online review length. A 2×2 factorial design (i.e. two types of online product presentation formats (between-subject) × two levels of online review lengths (between-subject)) was used.

#### 4.1 Media richness manipulation

Organic free range chickens were chosen as the organic food to be studied herein. Chickens and eggs are often eaten in daily life as well as sold on organic food websites; therefore, choosing organic free range chickens as the subject is reasonable. Organic free range chickens are bred outside to make full use of the natural resources and provide a good living environment for chickens to meet their biological needs. Their feed is perceived as being without chemicals and growth hormones and being natural and not intensively produced (Davies et al., 1995).

![Figure 1. Research framework](image_url)
After selecting organic free range chicken as the subject, we designed the experimental website. The aim of the experiment was to investigate whether media richness affects the level of consumer perception, rather than a particular kind of online product presentation format. According to Jiang and Benbasat (2007a) and Visinescu et al. (2015), compared with text and pictures, video and 3D images are richer media. Therefore, in the design of our website, we introduced organic free range chickens by using pictures, videos, and 3D images for the high media richness condition and only pictures for the low media richness condition.

4.2 Review length manipulation
This study decided the length of online reviews through the number of words, consistent with the research of Mudambi and Schuff (2010). According to Maheswaran and Chaiken (1991), negative evaluations dominate the overall evaluation, and thus this study assumed that online reviews were all positive. In this experiment, if the online reviews were long (i.e. more than five words), the review content involved quality information (taste, freshness, shape, size, etc.). If the online reviews were short (fewer than five words), the review content was typically only “good”, “not bad”, and so on, which did not provide the relevant quality information on organic food.

4.3 Experimental procedures
Participants \((n=120)\) were recruited at three shopping malls and offered five yuan to participate in our experiment. Their average age was 29.3 years (SD = 7.52); 48.3 per cent were men. All participants had experience of online shopping as well as a certain understanding of organic food and E-commerce. The experiment was based on the interaction of two factors in a \(2 \times 2\) design and thus it was formed of four experimental groups (Table I). All participants were randomly assigned to one experimental group in these four experiments.

Before the experiment, we first sent a card to all participants that described the process of the experiment. After all participants had finished reading and were aware of the experimental process, the experiment began. To avoid experimental error caused by completing the questionnaire without understanding the experimental situation, all participants were required to view the website for two minutes before the questionnaire was distributed. Each experiment lasted 10 minutes, and each participant only took part in one experiment to reduce the influence of maturity and learning effects.

4.4 Measurement
To ensure the reliability and validity of the study, we constructed a series of initial questions with reference to related research based on an extensive literature review. To ensure the accuracy of the translation, we used the English translation method three times to make sure the expressions were correct. The media richness scale was mainly based on the questionnaire proposed by Jiang and Benbasat (2007a), the online review scale was mainly based on the questionnaire proposed by Tokman et al. (2007), the perceived risk scale was mainly based on the questionnaire proposed by Houghton et al. (2000), and the trust scale

<table>
<thead>
<tr>
<th>Media richness review length</th>
<th>High (pictures, videos, 3D images)</th>
<th>Low (pictures)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long (more than five words)</td>
<td>High media richness</td>
<td>Low media richness</td>
</tr>
<tr>
<td></td>
<td>Long review length</td>
<td>Long review length</td>
</tr>
<tr>
<td>Short (less than five words)</td>
<td>High media richness</td>
<td>Low media richness</td>
</tr>
<tr>
<td></td>
<td>Short review length</td>
<td>Short review length</td>
</tr>
</tbody>
</table>

Table I. Experimental groups
was mainly based on the questionnaire proposed by Gefen et al. (2003). The five variables were measured on a Likert scale, where 1 meant “strongly disagree”, 2 meant “do not agree”, 3 meant “neutral”, 4 meant “agree”, and 5 meant “completely agree”.

5. Data analysis

5.1 Reliability and validity
As shown in Table II, the Cronbach’s $\alpha$ values of all the variables were above 0.7, indicating that the scale has good reliability.

The LISREL confirmatory factor analysis software was used to test the construct validity of all the variables. Table III shows that the factor loadings of all were higher than 0.61. Meanwhile, the results of the confirmatory factor analysis fit the data well ($\chi^2 = 147.65$, $df = 113$, RMSEA $= 0.05$, NNFI $= 0.99$, CFI $= 0.99$), showing the good construct validity of the scale.

6. Results

6.1 Manipulation check
In this experiment, all participants correctly completed all items, which indicated that they carefully read the test material and successful recalled the website design and review length of the experimental materials. Hence, we can assume all data were valid. We carried out the operation test to find whether participants’ perception is the same as the designed page. The results showed that the high media richness situation (Mean high media richness $= 3.725$, SD $= 0.46$), is significantly greater than the low media richness situation that the website presents products only through pictures (Mean low media richness $= 2.97$, SD $= 0.78$; $t(118) = 6.436$, $p < 0.001$). Meanwhile, the long review length situation (Mean Long review length $= 3.87$, SD $= 0.61$) is significantly greater than the short review length situation (Mean Short review length $= 2.90$, SD $= 0.62$; $t(118) = 8.275$, $p < 0.001$).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Media richness</th>
<th>Review length</th>
<th>Perceived risk</th>
<th>Trust</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cronbach’s $\alpha$</td>
<td>0.790</td>
<td>0.901</td>
<td>0.781</td>
<td>0.875</td>
</tr>
</tbody>
</table>

Table II. Reliability of the scale

<table>
<thead>
<tr>
<th>Variable</th>
<th>Media richness</th>
<th>Review length</th>
<th>Perceived risk</th>
<th>Trust</th>
</tr>
</thead>
<tbody>
<tr>
<td>MJFFD 1</td>
<td>0.72</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MJFFD 2</td>
<td>0.73</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MJFFD 3</td>
<td>0.68</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MJFFD 4</td>
<td>0.76</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZXPLZL 5</td>
<td></td>
<td>0.82</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZXPLZL 6</td>
<td></td>
<td>0.79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZXPLZL 7</td>
<td></td>
<td>0.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZXPLZL 8</td>
<td></td>
<td>0.78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZXPLZL 9</td>
<td></td>
<td>0.77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GZFX 10</td>
<td></td>
<td></td>
<td>0.82</td>
<td></td>
</tr>
<tr>
<td>GZFX 11</td>
<td></td>
<td></td>
<td>0.70</td>
<td></td>
</tr>
<tr>
<td>GZFX 12</td>
<td></td>
<td></td>
<td>0.70</td>
<td></td>
</tr>
<tr>
<td>XR 13</td>
<td></td>
<td></td>
<td></td>
<td>0.88</td>
</tr>
<tr>
<td>XR 14</td>
<td></td>
<td></td>
<td></td>
<td>0.71</td>
</tr>
<tr>
<td>XR 15</td>
<td></td>
<td></td>
<td></td>
<td>0.74</td>
</tr>
<tr>
<td>XR 16</td>
<td></td>
<td></td>
<td></td>
<td>0.61</td>
</tr>
<tr>
<td>XR 17</td>
<td></td>
<td></td>
<td></td>
<td>0.75</td>
</tr>
</tbody>
</table>

Table III. Confirmatory factor analysis
than the short review length situation (Mean \text{short review length} = 2.69, SD = 0.51: t(118) = 11.573, p < 0.001). The operation test showed that the experiments successfully manipulated participants’ perceptions of media richness and review length.

6.2 Influence of media richness on consumers’ perceived risk and trust
To test H1, we used media richness (high/low) as the independent variable and perceived risk as the dependent variable to carry out the variance analysis. Table IV shows that perceived risk in the high media richness situation (Mean \text{high media richness} = 2.74) is significantly lower than that in the low media richness situation (Mean \text{low media richness} = 3.31, F(1,116) = 38.048, p < 0.001). Thus, H1 is supported.

To test H2, we used media richness (high/low) as the independent variable and trust as the dependent variable and Table IV shows that consumers’ trust in the high media richness situation (Mean \text{high media richness} = 3.21) is significantly greater than that in the low media richness situation (Mean \text{low media richness} = 2.54, F(1,116) = 62.008, p < 0.001). Thus, H2 is supported.

6.3 Moderating effect of review length
To test H3, we used media richness (high/low) and review length (long/short) as the independent variables and perceived risk as the dependent variable. The results showed that the interaction between media richness and review length is statistically significant (F(1,116) = 20.391, p < 0.001), which demonstrates that review length positively moderates the relationship between media richness and perceived risk. Figure 2 shows that consumers’ perceived risk of the high media richness website is significantly lower in the long review length situation (Mean \text{high media richness} = 2.14, Mean \text{low media richness} = 3.19, Mean difference = 1.05), whereas it is less obviously lower in the short review length situation (Mean \text{high media richness} = 3.26, Mean \text{low media richness} = 3.42, Mean difference = 0.16). Thus, H3 is supported.

<table>
<thead>
<tr>
<th>Variable</th>
<th>High media richness</th>
<th>Low media richness</th>
<th>F value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived risk</td>
<td>2.74</td>
<td>3.31</td>
<td>38.048***</td>
</tr>
<tr>
<td>Trust</td>
<td>3.21</td>
<td>2.54</td>
<td>62.008***</td>
</tr>
</tbody>
</table>

Note: ***p < 0.001

Table IV. Influence of media richness on consumers’ perceived risk and trust

Figure 2. Moderating effect of review length on the relationship between media richness and perceived risk
To test $H4$, we used media richness (high/low) and review length (long/short) as the independent variables and trust as the dependent variable and found that the interaction between media richness and review length is statistically significant ($F(1,116) = 15.187$, $p < 0.001$), which demonstrates that review length positively moderates the relationship between media richness and Trust. As shown in Figure 3, consumers’ trust in the high media richness website is significantly higher in the long review length situation (Mean high media richness = 3.69, Mean low media richness = 2.64, Mean difference = 1.05). However, consumers’ trust in the high media richness website is less obviously lower in the short review length situation (Mean high media richness = 2.80, Mean low media richness = 2.45, Mean difference = 0.35). Thus, $H4$ is supported.

6.4 Mediated moderation effect

By using the methods proposed by Muller et al. (2005), this study verified the mediated moderation effect. First, when media richness, online review length, and their interaction term were entered into the trust regression models, the results showed that the interaction effect was significant. Second, when media richness, online review length, and their interaction term were entered into the perceived risk regression models, the results showed that the interaction effect was significant. Third, when media richness, online review length, their interaction term, and perceived risk were entered into the trust regression model, the results showed that the perceived risk effect was significant. These results are shown in Table V.

To test $H5$, we used trust as the dependent variable and media richness, online review length, and their interaction term as the independent variables for regression model 1, showing that their interaction term has a significant effect on trust ($\beta = 0.692$, $p < 0.001$). Taking perceived risk as the dependent variable and media richness, online review length, and their interaction term as the independent variables for regression model 2, we showed that their interaction term has a significant effect on perceived risk ($\beta = -0.884$, $p < 0.001$). Taking trust as the dependent variable and media richness, online review length, their interaction term, and perceived risk as the independent variables for regression model 3, we showed that perceived risk has a significant effect on trust, but their interaction term has no obvious effect on perceived risk ($\beta = 0.244$, $p > 0.050$). These findings demonstrate the moderating effect of review length through perceived risk. Hence, $H5$ is supported. Finally, Table VI summarises our propositions and findings.

Figure 3.
Moderating effect of review length on the relationship between media richness and trust
7. Discussion
In the context of the grave food safety situation and consumers’ strong demand for organic food, E-commerce provides a new channel for the sales of this category. Liu et al. (2014) found that the internet has become the most frequently used channel by Chinese consumers to obtain information about food safety. Compared with traditional channels, the internet has the capacity to present information effectively and attractively, which allows it to provide more abundant product information to consumers (Grunert and Ramus, 2005).

While previous studies have examined the media richness of online product presentation, their focus was on search or experience attributes. However, consumers of organic food are more concerned about its credence attributes. Hence, we tested whether online product presentation can effectively demonstrate the credence attributes of organic food.

The first contribution of this study is to confirm the influence of media richness on consumers’ perceived risk and trust when buying organic food online. The study finds that organic food information presented by a high media richness website can reduce perceived risk and improve the level of trust in the website. First, Meyerhöfer et al. (2015) found that the most important attributes that consumers expect from organic food are “naturalness”. In traditional channels, Chinese consumers usually receive such “naturalness” information through food labels or product descriptions (Qing et al., 2006). However, numerous studies have shown that Chinese consumers have a general distrust or suspicious attitude towards the quality of organic food and certification labels (Zhang and Wang, 2009; Liu et al., 2009). Additionally, researchers have also found that Chinese consumers have limited knowledge when identifying organic food (Liu et al., 2013; Xie et al., 2015). There is a lack of organic food product advertising in traditional channels and Chinese consumers expect improvement urgently (Xie et al., 2015). Online product presentation using a variety of media such as pictures, videos, and 3D images can vividly present products and provide information on the production process. This can stimulate the senses of consumers,
develop their interest in improving their understanding of “naturalness” attributes, and realise the characteristics and advantages of organic food compared with conventional food. Simultaneously, the information provided by various media contains more quality cues (e.g. nutritional content, production and processing methods, environmentally friendly, animal welfare), which form an important foundation for consumers to determine the food’s organic nature (Harper and Makatouni, 2002). Therefore, these quality cues can influence consumers’ attitudes and purchase intention (Hughner et al., 2007).

Hence, compared with traditional channels, a high media richness of online product presentation can reduce information asymmetry and eliminate consumers’ quality scepticism to a certain extent. In addition, a high media richness website means higher website quality, which needs more investment. Website quality has been described as a signal that can influence consumers’ perception of product quality (Gregg and Walczak, 2008; Wells et al., 2011).

The second contribution of this study is to consider the moderating effect of online reviews. When the online product presentations draw consumers’ attention, Chinese consumers are still suspicious as they place a relatively low degree of trust in food producers. They will search for other information to appraise their alternatives. According to the findings of Lee and Yun (2015), the shopping experiences of previous buyers play an important role in the sales of organic food and E-commerce consumers are able to access indirect shopping experiences through online reviews. Hence, we considered whether online reviews influence this relationship and found that the interaction between media richness and review length is statistically significant. A long review may contain more concrete information. Therefore, the more details the reviews have, the more helpful they become for effective decision making by consumers. This can boost consumers’ confidence in the decision-making process. Additionally, review length may also reflect the involvement of the reviewer. The more involved a reviewer is, the more he/she is willing to present quality information that assists others in their purchase decisions (Pan and Zhang, 2011). Finally, this result is similar to the finding of Miyazaki et al. (2005) that when two cues are consistent, they strengthen each other. If the contents provided by websites are consistent with online reviews, it will further improve consumers’ trust in the website and reduce their perceived risks.

8. Conclusion
The recent food crises in China have tremendously reduced people’s trust in food quality. Food producers should thus provide more accurate information and increase transparency. In particular, since the internet can provide more accurate, transparent, and up-to-date information, it may be the best information-providing channel. By means of experiments, the present study indicates that a high media richness of online product presentation can reduce consumers’ perceived risk and improve their trust. Simultaneously, online review length can moderate the above relationship. Thus, the credence attributes of organic food such as health, nutrition quality, environmentally friendly production, animal welfare, and place of origin should be fully shown through online product presentation with an abundance of richer media. To stimulate the consumer’s senses, organic food could also be more perceived as grown more naturally (i.e. without pesticides, growth hormones, or antibiotics) and strictly controlled in terms of transportation and storage compared with conventional food. Such beliefs could influence consumers’ attitudes and arouse their purchase interest. Meanwhile, companies should also take appropriate measures to encourage past buyers to provide detailed reviews of organic food. Consumers can look for useful information from these reviews that can help them further confirm the information provided by the website, reduce their perceived risk, and finally improve their trust in organic food available online.
This study has some limitations. First, many factors affect consumers’ trust in network environments, and we only discuss the impact of online product presentation and reviews. Therefore, it would be worthwhile conducting further research on other factors (e.g., logistics, after-sales service, information security) and their interactions with consumers’ trust. In addition, as the improvement of consumers’ purchase intention and behaviour is crucial to the marketing of organic food online (e.g., price, brand, delivery time), consumers’ trust only constitutes a research foundation in the context of E-commerce. Thus, future research should aim to investigate the influence of other factors on consumers’ purchase intention and behaviour.

References


Appendix

Except general consumer sample, we also selected MBA student sample to check the stability of our conclusion. The results obtained from MBA student sample and general consumer sample are similar, which further verified our hypotheses. The results are shown as follows.

Figure A1. Moderating effect of review length on the relationship between media richness and perceived risk

Notes: (a) Study 1 (MBA student sample); (b) study 2 (general consumer sample)

Figure A2. Moderating effect of review length on the relationship between media richness and trust

Notes: (a) Study 1 (MBA student sample); (b) study 2 (General consumer sample)
### Table AI. Influence of media richness on consumers’ perceived risk and trust

<table>
<thead>
<tr>
<th>Variable</th>
<th>High media richness</th>
<th>Low media richness</th>
<th>$F$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Study 1 (MBA student sample)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived risk</td>
<td>2.90</td>
<td>3.22</td>
<td>8.166***</td>
</tr>
<tr>
<td>Trust</td>
<td>3.24</td>
<td>2.71</td>
<td>25.568***</td>
</tr>
<tr>
<td><strong>Study 2 (General consumer sample)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived risk</td>
<td>2.74</td>
<td>3.31</td>
<td>38.048***</td>
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<td>Trust</td>
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<td>62.008***</td>
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</tbody>
</table>

**Note:** ***$p < 0.001$***

<table>
<thead>
<tr>
<th>Regression model 1</th>
<th>Regression model 2</th>
<th>Regression model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trust as the</td>
<td>Perceived risk as the</td>
<td>Trust as the</td>
</tr>
<tr>
<td>dependent variable</td>
<td>dependent variable</td>
<td>dependent variable</td>
</tr>
</tbody>
</table>

**Study 1 (MBA student sample)**

| Media richness | 0.400*** | -0.237*** | 0.269*** |
| Review length | 0.095 | -0.138 | 0.019 |
| Media richness x review length | 0.173* | -0.205* | 0.060 |
| Perceived risk | | | -0.552*** |
| $R^2$ | 0.199 | 0.117 | 0.468 |
| $\Delta R^2$ | | | 0.209 |
| $F$ | 10.605*** | 5.678*** | 27.966*** |
| $\Delta F$ | | | 64.313*** |

**Study 2 (General consumer sample)**

| Media richness | 0.353** | -0.162 | 0.271*** |
| Review length | 0.193 | -0.233 | 0.075 |
| Media richness x review length | 0.682*** | -0.884*** | 0.244 |
| Perceived risk | | | -0.508*** |
| $R^2$ | 0.484 | 0.466 | 0.646 |
| $\Delta R^2$ | | | 0.161 |
| $F$ | 36.327*** | 33.807*** | 52.407*** |
| $\Delta F$ | | | 52.375*** |

**Notes:** **$p < 0.01$; ***$p < 0.001$**

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**Mediated moderation model**

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Different shades of displeasure
When fear and anger lead to opposite consumer responses to GM foods

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Harri Tuomas Luomala
Department of Marketing, University of Vaasa, Seinäjoki, Finland

Abstract
Purpose – The purpose of this paper is to demonstrate the differential consequences of fear and anger for consumers’ responses to genetically modified (GM) foods, and to identify substantive concerns that differentiate consumers’ negative emotional responses into fear and anger in the GM food context.

Design/methodology/approach – With survey data obtained from university students (n = 267), structural equation modeling is used to assess relationships between four types of consumer concerns about the genetic modification of food, fear and anger, and two types of consumer responses to GM food products.

Findings – Intentions to make complaints about GM foods are increased by anger, but reduced by fear. Readiness to use GM foods is reduced by fear, but not by anger. Fear is strengthened by health-related concerns, while anger is strengthened by market-related concerns associated with the genetic modification of food.

Research limitations/implications – The generalizability of the findings is limited by the student sample. The study confirms the applicability of cognitive appraisal theories of emotion in the context of GM food consumption. The findings help GM food marketers and societal opinion influencers to identify consumers’ concerns that need to be addressed to manage consumers’ antagonistic or avoiding emotion-driven responses to GM foods.

Originality/value – This study is the first to show that discrete emotions of the same negative valence have distinct effects on consumer acceptance of GM foods, and to distinguish substantive concerns that in particular foster fear and anger in the GM food context.

Keywords Genetically modified food, Anger, Fear, Consumer acceptance, Complaining, Readiness to use

Paper type Research paper

Introduction
Genetic modification of food is a highly controversial issue. There is a myriad of arguments both in favor and against it. Potential benefits of using gene technology in food production include the development of crops more resistant to diseases, pests, herbicides and harsh environments, and the production of more nutritious, tastier and longer-lasting food products (Chen and Li, 2007; Miles et al., 2005; Uzogara, 2000). On the other hand, concerns have been voiced regarding unexpected alterations in the nutritional and allergenic qualities of genetically modified (GM) crops, the generation of toxins in plants and unintentional gene transfer to natural plants species which disturbs the balance of ecosystems (Frewer et al., 2004; Uzogara, 2000). Moreover, the degree to which GM food-related risks, benefits and moral considerations are emphasized vary widely geographically, for example, between USA and Europe (Frewer et al., 2013). In the light of this, it is not surprising that GM foods spark qualitatively varied range of emotional experiences in consumers.

Even though it is currently well-recognized that both positive and negative emotions are an inseparable part of food consumption (see e.g. Brown et al., 2013; Desmet and Schifferstein, 2008; Thomson et al., 2010), in the context of GM foods, past attention has mainly been fixed on the role of fear as a determinant of their acceptance among consumers (Laros and Steenkamp, 2004; Sorgo et al., 2012). Yet, other discrete emotions such as anger can also play a role here (Townsend and Campbell, 2004; Townsend, 2006). The present
research demonstrates the differential consequences of fear and anger for consumers’ responses to GM foods. This is important for many reasons.

Academically, the study contributes to GM food consumption research by generating new understanding about the applicability of cognitive appraisal theories of emotion (e.g., Frijda, 1986; Lazarus, 1991) in this context. It is proposed that differences in appraisal patterns can be used to understand why GM foods sometimes generate fear and some other times anger, and different negative emotions can induce even opposite consumer reactions toward them (Lerner and Keltner, 2001; Johnston and Glasford, 2014).

For GM food marketers, this research offers insights as regards the specific kinds of concerns that are likely to create fear and anger in consumers and the ways in which they typically try to cope with these negative emotions. Without the in-depth awareness of the particular sources of fear and anger in the context of GM foods, companies can do little or nothing to properly manage actions that either encourage consumers’ readiness to try GM foods or to discourage protesting and boycotting them. Thus, the findings of this research can help the GM food industry to enhance consumer acceptance of GM food products.

From the societal perspective, the lack of objective and unbiased information concerning GM foods and the moral acceptability of the utilization of GM food applications are the key issues. Even if many food policy-makers and experts may be convinced about the rationality and benefits of large-scale GM food production, consumers’ obvious emotional concerns related to it cannot be easily overridden. Social marketers or other public opinion influencers, as they design anti- or pro-GM food campaigns, can get guidance from the results of this study. For example, they facilitate answering the questions such as “does the alleviation of GM food-related fear and anger require separate tailored approaches” and “what issues need to be addressed.”

In the following, the research hypotheses are first developed. Then, the methodological choices of this study are presented and justified. Next, the key findings are discussed. The paper concludes with a perusal concerning the limitations and potential avenues for future research in the area of emotional influences in consumers’ acceptance of GM foods.

**Theoretical background and hypothesis development**

*Creation of fear vs anger in the GM food context*

Previous research has indicated that consumers’ risk perceptions are a key factor influencing consumers’ responses to GM foods: higher perceived risk concerning GM foods is associated with lower general acceptance and more negative attitudes and emotional responses toward them (e.g., Costa-Font and Gil, 2009, 2012; Frewer et al., 2013; Laros and Steenkamp, 2004; Townsend, 2006).

The risk perceptions generating negative consumer responses to the genetic modification of food pertain to its environmental, health-related, moral or societal implications (Costa-Font and Gil, 2009; Lassen et al., 2002). On a more abstract level, substantive concerns associated with the genetic modification of food have been categorized along the dimensions of unknown risk, and dread risk (Finucane and Holup, 2005; Gaskell et al., 2004). The former concerns unobservable and unfamiliar hazards with delayed consequences (Finucane and Holup, 2005; Slovic, 1987). In contrast, the latter is associated with uncontrollable, involuntary, and potentially catastrophic hazards with inequitably distributed effects (Finucane and Holup, 2005; Slovic, 1987).

The abstract characteristics of these risk types resemble the appraisal patterns that differentiate fear from anger, as defined by cognitive appraisal theories of emotion (Frijda, 1986; Lazarus, 1991). Therefore, it is plausible that consumers’ concerns that fall within these risk dimensions are distinctively associated with fearful vis-à-vis angry responses to the genetic modification of food.
Uncertainty is a key appraisal dimension of fear, which is characterized by an encounter with a motive-inconsistent event, and a perception of a lack of control over it (Frijda, 1986; Lazarus, 1991). Uncertainty is also a key characteristic of the unknown risk dimension (Slovic, 1987). In the GM food context, unknown risk is represented in the uncertainty that exists about the long-term effects of the genetic modification of food, for instance, on human health or environmental balance (Finucane and Holup, 2005). Thus, it is plausible that substantive concerns such as these transform consumers’ negative affective responses to the genetic modification of food into fear. Consequently, the following hypothesis is posed:

\[ H1. \] Health (a) and environmental (b) concerns associated with the genetic modification of food will induce fear in consumers.

In contrast, the elements of inequitability, involuntariness, and violation of moral standards, that characterize the dread risk dimension (Finucane and Holup, 2006; Slovic, 1987), correspond to the appraisal pattern of anger. Anger arises from a sense of certainty, external attribution of control, and unfairness associated with a motive-inconsistent event (Frijda, 1986; Lazarus, 1991). In the GM food context, dread risk is represented in the perceptions of inequitable distribution of risks and benefits in the GM-product marketplace, and the involuntary violation of consumers’ moral standards (Finucane and Holup, 2005; Lassen et al., 2002; Uzogara, 2000). Thus, it is plausible that these represent substantive concerns that refine consumers’ negative affective responses to the genetic modification of food into anger. Thus, it is hypothesized that:

\[ H2. \] Market (a) and moral (b) concerns associated with the genetic modification of food will induce anger in consumers.

Distinct effects of fear and anger on consumer responses to GM foods

The importance of understanding the antecedents of GM food-induced fear and anger becomes obvious as they have distinct implications for individuals’ behavioral responses (Gerend and Maner, 2011; Johnston and Glasford, 2014; Lerner et al., 2003; Lerner and Keltner, 2001). In a study by Johnston and Glasford (2014), both fear and anger toward an outgroup member induced harmful behavioral responses with regard to the group. However, the manifestation of the harmful responses ranged from passive (e.g. exclusion) to active (e.g. harassment) depending on whether the dominant emotional state was fear or anger. This illustrates the distinct ways that fear and anger facilitate coping with negative events and threats (Frijda et al., 1989). In the light of emotion theory and research, it is likely that fear and anger differentiate also consumers’ responses to GM foods.

In this study, it is expected that fear reduces consumers’ readiness to use GM foods. This is compatible with the tendency of fear to induce coping with threats primarily through avoidance (Frijda et al., 1989). Furthermore, as fearful individuals have been shown to make more risk-averse choices than angry individuals (Lerner et al., 2003; Lerner and Keltner, 2001), it is expected that fear has a stronger negative association with the readiness to use GM foods than anger. Thus, the following hypothesis is posed:

\[ H3. \] Fear will more strongly decrease consumers’ readiness to use GM foods than anger.

In contrast to fear, anger fosters confrontational behavior when coping with motive-inconsistent events (Smith and Ellsworth, 1985), such as complaint behavior (Soscia, 2007). In the context of GM foods, this can mean making complaints to companies that manufacture GM products, or store chains that sell them (Russell et al., 2016). Angry consumers can share their concerns and complaints with a wide audience over the internet, and they can appeal to public authorities to demand stricter regulation of GM foods (Bain and Dundachi, 2014; Dubuisson-Quellier, 2013). It is expected in this study that anger
increases consumers’ likelihood of making complaints about GM foods. Moreover, as anger has been shown to lead to more active harmful responses than fear (Johnston and Glasford, 2014), it is expected that anger enhances the tendencies to complain more than fear. Hence, the following hypothesis is posed:

**H4.** Anger will more strongly increase consumers’ intention to make complaints about GM foods than fear.

The hypothesized relationships between the four types of concerns related to the genetic modification of food, fear and anger, and the two anticipated behavioral responses are summarized in Figure 1 as a path diagram.

**Methodology**

**Sample**

The hypotheses were tested on data obtained from an internet survey. A total of 900 students of a university located in a European capital were invited to answer the questionnaire. The final sample consisted of 267 students of humanities (55.3 percent) and sciences (44.7 percent), of which 66.3 percent were women. The student sample was characterized with a relatively young age (52.4 percent aged \( \leq 25 \); 26.6 percent aged 26-30; 8.2 percent aged 31-35; 12.7 percent aged > 35).

**Measurement**

Three items were used to measure consumers’ readiness to use GM foods (see the Appendix). One was adapted from Laros (2006). In addition, two new items were specifically developed for the purposes of this study. These items were responded on a seven-point Likert-scale (strongly disagree – strongly agree).

Three items were adapted from Laros (2006) to gauge consumers’ intention to make complaints to different entities if GM foods were to enter the local consumer market.
These items assessed the likelihood of complaining on a seven-point scale (highly unlikely – highly likely).

The items reflecting the concerns associated with the genetic modification of food (see the Appendix) were adapted from the studies by Laros (2006) and Bredahl (2001). There were two items for each of the four concerns: health concern, environmental concern, market concern, and moral concern. Respondents scored the items on a seven-point scale (strongly disagree – strongly agree).

Emotion scales from Richins (1997) and Laros and Steenkamp (2005) formed the basis for measuring fear and anger, complemented with adapted emotion items. Indicator items for fear were afraid, worried, suspicious, and helpless, and for anger angry, cross, and hostile. The respondents indicated on a seven-point scale how well each item described their responses to the genetic modification of food (extremely poorly/not at all – extremely well; see the Appendix).

Results

Preliminary analyses

The data were analyzed by means of structural equation modeling with LISREL 8.8 software on covariance matrices with a total effective sample size of 245. The overall fit of a model was evaluated with six goodness-of-fit indices: the ratio \( \chi^2/df \), Root Mean Square Error of Approximation (RMSEA), Non-Normed Fit Index (NNFI), Comparative Fit Index (CFI), Standardized Root Mean Square Residual (SRMR), and Adjusted Goodness-of-Fit Index (AGFI).

The measurement model of the latent constructs showed an acceptable overall fit with the data (\( \chi^2/df = 1.97 \), RMSEA = 0.0646, NNFI = 0.987, CFI = 0.990, SRMR = 0.0353, AGFI = 0.839). The composite reliabilities (CR) that were calculated for the observed variables of each latent construct all exceeded the desirable threshold of 0.6 (Table I), thus indicating good scale reliability (Bagozzi and Yi, 1988). The average variance extracted (AVE) from the measures of the latent variables ranged from 0.553 to 0.874 (Table I), indicating adequate reliability or better (Bagozzi and Yi, 1988). Table I also presents the means and the standard deviations of the sum variables calculated for the latent constructs.

Main analyses

The hypothesized model showed an acceptable fit with the data by most of the standards (\( \chi^2/df = 2.57 \), RMSEA = 0.083, NNFI = 0.979, CFI = 0.982, SRMR = 0.0678, AGFI = 0.796).

The parameter estimates and their \( t \)-values, and the \( R^2 \) values for the endogenous latent constructs are presented in Table II. All the proposed hypotheses were supported by the initial model: fear and anger were strengthened by the particular concerns as expected, and each emotion affected the behavioral responses to a different degree.

<table>
<thead>
<tr>
<th>Table I.</th>
<th>CR</th>
<th>AVE</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Readiness to use GM foods</td>
<td>0.887</td>
<td>0.725</td>
<td>3.79</td>
<td>1.61</td>
</tr>
<tr>
<td>Intention to make complaints</td>
<td>0.954</td>
<td>0.874</td>
<td>2.01</td>
<td>1.38</td>
</tr>
<tr>
<td>Fear</td>
<td>0.906</td>
<td>0.707</td>
<td>4.16</td>
<td>1.67</td>
</tr>
<tr>
<td>Anger</td>
<td>0.939</td>
<td>0.837</td>
<td>2.65</td>
<td>1.56</td>
</tr>
<tr>
<td>Health concern</td>
<td>0.835</td>
<td>0.719</td>
<td>4.00</td>
<td>1.42</td>
</tr>
<tr>
<td>Environmental concern</td>
<td>0.888</td>
<td>0.766</td>
<td>5.02</td>
<td>1.21</td>
</tr>
<tr>
<td>Market concern</td>
<td>0.705</td>
<td>0.553</td>
<td>4.79</td>
<td>1.22</td>
</tr>
<tr>
<td>Moral concern</td>
<td>0.912</td>
<td>0.838</td>
<td>4.23</td>
<td>1.65</td>
</tr>
</tbody>
</table>

Notes: M, mean; SD, standard deviation; CR, composite reliability; AVE, average variance extracted.
Fear was influenced positively by health concern \((H1a; \beta = 0.576; t = 5.619)\) and environmental concern \((H1b; \beta = 0.295; t = 2.947)\), and anger was influenced positively by market concern \((H2a; \beta = 0.345; t = 3.527)\) and moral concern \((H2b; \beta = 0.502; t = 5.537)\). Fear had a stronger negative influence on the readiness to use GM foods \((H3; \beta = -0.576; t = -8.859)\) than anger \((\beta = -0.351; t = -5.997)\), and anger had a stronger positive influence on the intention to make complaints about GM foods \((H4; \beta = 0.557; t = 7.484)\) than fear \((\beta = 0.112; t = 1.524)\).

The modification indices provided by the software indicated that the model fit could be further improved with modifications to the initial hypothesized model. Thus, the model was revised by assessing the modification indices, and the support for the hypotheses was evaluated also in the modified model. After the revision the model fit was significantly improved \((p(\Delta \chi^2) < 0.001)\), and the fit of the modified model was more parsimonious as suggested by a lower value of CAIC (Consistent Akaike’s Information Criterion) (Schermelleh-Engel et al., 2003). The fit indices gave indications of an acceptable or a good model fit with the data (Table III; \(\chi^2/df = 1.88\), RMSEA = 0.0617, NNFI = 0.988, CFI = 0.990, SRMR = 0.0358, AGFI = 0.846). The path diagram of the modified final model is presented in Figure 2. The parameter estimates of the model and their \(t\)-values, and the \(R^2\) values for the endogenous latent constructs in the hypothesized model are presented in Table IV.

In the modified final model, some of the hypothesized associations between the emotions and their antecedents did not emerge. \(H1\) received partial support, as health concern increased fear \((H1a; \beta = 0.294; t = 2.468)\), but in contrast to \(H1b\), the influence of environmental concern on fear was not significant \((\beta = 0.072; t = 0.629)\).

\(H2\), however, was fully supported, as anger was increased by market concern \((H2a; \beta = 0.219; t = 2.535)\) and moral concern \((H2b; \beta = 0.283; t = 2.885)\). Moral concern had

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Support</th>
<th>Path</th>
<th>(B)</th>
<th>(\beta)</th>
<th>(t)</th>
<th>(R^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fear</td>
<td>(H1a)</td>
<td>Yes</td>
<td>0.700</td>
<td>0.576</td>
<td>5.619</td>
<td>0.681</td>
</tr>
<tr>
<td></td>
<td>(H1b)</td>
<td>Yes</td>
<td>0.526</td>
<td>0.295</td>
<td>2.947</td>
<td>0.626</td>
</tr>
<tr>
<td></td>
<td>(H2a)</td>
<td>Yes</td>
<td>0.960</td>
<td>0.345</td>
<td>3.527</td>
<td>0.709</td>
</tr>
<tr>
<td></td>
<td>(H2b)</td>
<td>Yes</td>
<td>0.476</td>
<td>0.502</td>
<td>5.537</td>
<td></td>
</tr>
<tr>
<td>Readiness to use GM foods</td>
<td>(H3)</td>
<td>Yes</td>
<td>-0.727</td>
<td>-0.576</td>
<td>-8.859</td>
<td>0.400</td>
</tr>
<tr>
<td>Intention to make complaints</td>
<td>(H4)</td>
<td>Yes</td>
<td>0.435</td>
<td>0.557</td>
<td>7.484</td>
<td></td>
</tr>
</tbody>
</table>

Notes: \(B = \) unstandardized parameter estimate; \(\beta = \) standardized parameter estimate. \(t > 1.960 = p < 0.05; t > 2.576 = p < 0.01\)

**Table II.** The parameter estimates and their \(t\)-values, and the \(R^2\) values for the endogenous latent constructs in the hypothesized model

<table>
<thead>
<tr>
<th>Measurement model</th>
<th>(\chi^2)</th>
<th>(\Delta\chi^2)</th>
<th>CAIC</th>
<th>RMSEA</th>
<th>NNFI</th>
<th>CFI</th>
<th>SRMR</th>
<th>AGFI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothesized model</td>
<td>317.6 (161)</td>
<td>1.97</td>
<td>0.0646</td>
<td>0.987</td>
<td>0.990</td>
<td>0.0353</td>
<td>0.839</td>
<td></td>
</tr>
<tr>
<td>Modified model</td>
<td>319.9 (170)</td>
<td>1.88</td>
<td>130.2 (5)</td>
<td>0.001</td>
<td>724.3</td>
<td>0.0617</td>
<td>0.988</td>
<td>0.990</td>
</tr>
</tbody>
</table>

**Table III.** Assessment of the fit of the measurement model, the hypothesized model, the modified model, and the model improvement with modifications.
a significant positive effect also on fear ($\beta = 0.464; t = 3.270$). This implies that Moral concern is not a differentiating factor between fear and anger, but instead it can be expected to intensify negatively valenced emotions more generally. Furthermore, anger was influenced positively by fear ($\beta = 0.379; t = 4.601$). This implies that the fear induced by the genetic modification of food can eventually evolve into angry responses.
The final model also confirmed the hypothesized associations between the emotions and the behavioral responses. $H_3$ was supported, as fear had a stronger negative influence on the readiness to use GM foods ($\beta = -0.190; t = -2.654$) than anger ($\beta = -0.096; t = -1.504$). Moreover, it is notable that the negative impact of anger on the readiness to use GM foods was not significant ($p > 0.05$). These findings imply that fear is a more dominant emotional influence in consumers’ reluctance to use GM foods than anger is. In addition to fear, the readiness to use GM foods was found to be decreased by health concern ($\beta = -0.456; t = -5.113$) and environmental concern ($\beta = -0.270; t = -3.392$).

$H_4$ was supported in the modified model as well. Anger had a significant positive influence on the complaint intentions ($\beta = 0.404; t = 4.553$). In contrast, the influence of fear on the complaint intentions was negative ($\beta = -0.221; t = -2.228$). This finding highlights the distinctive effects of fear and anger. The structural model implies that the increasing effect of the negative valence of fear on the complaint intentions was mediated through anger. On the other hand, the direct decreasing effect of fear on the complaint intentions reflects characteristic behavioral tendencies associated with fear, distinguishing it from anger. In addition to fear and anger, the intention to make complaints was influenced by health concern, which enhanced the complaint intentions ($\beta = 0.530; t = 5.382$).

Overall, the findings indicate that fear and anger toward the genetic modification of food are fostered by distinct types of substantive concerns, as expected. Furthermore, along with expectations, the findings show that fear and anger have distinctive effects on respondents’ anticipated responses to GM foods. These key findings will be discussed in the following section.

**Discussion**

**Theoretical implications**

Previous research has identified several factors that influence consumers’ acceptance of GM foods, including personal values and general attitudes (Bredahl, 2001; Honkanen and Verplanken, 2004), prior knowledge and perceived control (Klerck and Sweeney, 2007; Cook et al., 2002), and benefit and risk perceptions associated with them (Chen and Li, 2007; Costa-Font and Gil, 2009). The literature has also acknowledged the relevance of emotions, and particularly fear, in consumers’ responses to this controversial issue (Laros and Steenkamp, 2004; Townsend and Campbell, 2004).

This study adds to the understanding of consumer’s acceptance of GM foods by demonstrating that along with fear (Laros and Steenkamp, 2004; Sorgo et al., 2012), also anger exerts a critical emotional influence (Townsend and Campbell, 2004). Importantly, this study presents the novel finding that in line with cognitive appraisal theories of emotions (e.g. Frijda, 1986; Lazarus, 1991), fear and anger have distinct effects on consumer responses to GM foods, and that they can be traced to different types of concerns. These findings help the food industry, policy-makers, and NGOs to better understand the causes and consequences of consumers’ negative affective responses to GM products. Thus, societal marketers can identify what types of consumer concerns need to be addressed to have impact on consumers’ GM food choice or avoidance behaviors that are driven by fear or anger.

**Managerial and societal implications**

The introduction of GM food products to new consumer markets is in the interests of the GM food-processing industry (Lassen et al., 2002). The present findings imply that consumers’ angry responses to the genetic modification of food represent a higher barrier for market entry than fear, as anger fuels more active consumer resistance, e.g. in the form of complaining (Soscia, 2007). In the GM food markets, consumers’ active resistance toward GM has included, for instance, putting public pressure on retailers and manufacturers to exclude GM foods from their assortments or to adopt voluntary GM-labeling (Lucht, 2015;
Consumer have also taken initiatives to establish stricter legislation regarding GM foods (Bain and Dandachi, 2014). Compared to private protesting behaviors, including consumption choices, public anti-GM-campaigns can be a more effective approach to shape the attitudinal climate and market environment.

Thus, the GM food industry and associated marketers benefit from the knowledge of how to manage consumers’ anger-driven antagonism. This study is the first to identify antecedents of GM food-related anger. The findings imply that consumers’ anger-driven confrontational opposition of GM foods is not effectively dealt with by merely convincing consumers about the technological safety of GM foods. Instead, the GM food industry needs to demonstrate societally fair, responsible and transparent conduct in the development, production, and trade of GM food products to mitigate anger-related appraisals (Smith and Ellsworth, 1985) in consumers’ perceptions. This should attenuate angry consumer responses and facilitate a more receptive attitudinal environment toward meaningful GM food applications.

Another managerial objective in the GM food industry is to enhance consumers’ willingness to adopt GM foods as a part of their consumption in markets where they are available (Lassen et al., 2002). The findings of this study imply that here fear plays a more important role than anger: fear reduced the readiness to use GM foods, while anger did not. Therefore it is meaningful for GM food marketers to manage unwarranted consumer fear with regard to GM foods. Previous research has identified consumers’ concern for nature as an antecedent of the fear of GM foods (Laros and Steenkamp, 2004). The findings of this study extend current knowledge by implying that an even more relevant underlying factor of fear in the GM food context is health-related concern. The association of health-related concern, namely, with fear, as opposed with general negative affect, is highlighted by the finding that it was not an antecedent of anger. The findings imply that in markets where GM foods are available, it is of particular importance to GM food marketers to address consumers’ health-related concerns to mitigate fear-related appraisals (Smith and Ellsworth, 1985) to attenuate excessive fear and thereby facilitate product adoption.

Given the controversial nature of GM foods (Uzogara, 2000), their consumption and introduction into new markets is evidently also opposed by many consumers and societal entities (Blancke et al., 2015). The present findings provide insights to public opinion influencers who wish to activate consumers to voice their objections toward introducing GM foods into consumer markets. The empowering effect of anger is likely to provide a more efficient emotional approach to consumer activation than fear appeals: anger increases complaint tendencies (Soscia, 2007), while fear can actually attenuate such overt opinion expression as indicated by the present findings. In the light of this, anti-GM food-campaigns may benefit more from strengthening anger-related appraisals by drawing consumers’ attention to drawbacks in the operation of the market of GM foods, rather than evoking fear-related appraisals by emphasizing health-related safety aspects of the GM technology as is often done (Blancke et al., 2015).

Limitations of the study and future research
This study has certain limitations that warrant discussion. The student sample obviously limits the generalizability of the findings. Nonetheless, the essence of the findings stems from the inherent universal characteristics of fear and anger (Frijda, 1986; Lazarus, 1991). Thus, similar causal effects between consumer concerns, fear and anger, and behavioral tendencies associated with GM foods can be expected to emerge also among different populations.

This being said, the contents of consumers’ concerns that induce fear and anger toward GM foods are likely to vary across populations and over time. A key factor that determines whether these concerns induce fear and/or anger toward GM foods is the extent to which they are characterized by cognitive appraisal patterns of fear and anger. This notion can be...
employed in future research to assess the antecedents of consumers’ discrete emotional responses to the genetic modification of food among different consumer segments.

This study focused on differential roles of fear and anger in the acceptance of GM foods, but it is likely that these are not the only negative emotions that have implications for consumers’ acceptance of GM foods. Along with fear and anger, also the emotion of disgust has been suggested to be a relevant affective influence in consumers’ acceptance of GM foods (Blancke et al., 2015). Disgust relates to perceptions of unnaturalness and risk of contamination, and a sense of being too close to an indigestible object or idea (Lazarus, 1991), whereby it may be particularly relevant to consumers’ willingness to directly consume GM foods. It is recommended that further comparisons will be conducted to gain more detailed insights into the relative impacts of discrete emotions on different aspects of GM food acceptance, including also positive affect. For instance, feelings such as excitement and fascination may be key drivers for innovators and early adopters who are most prone to familiarize themselves with GM foods in a given consumer market.

References


**Further reading**


**Appendix**

**Construct measurement**

**Anticipated responses**

**Readiness to use GM foods**

- What do you think about the following statements?
  - Strongly disagree (1) – Strongly agree (7)
  - I would be ready to taste a GM food product.
  - I would be ready to consume regularly a GM food product if it meets my demands in terms of taste, price and other qualities.
  - If GM food products were introduced into the local consumer market today, I would delay purchasing them at least for now (reversed).

**Intention to make complaints about GM foods**

- What do you think about the following statements?
  - Highly unlikely (1) – Highly likely (7)
  - If GM food products are introduced into the local consumer market, I will make a complaint to the chain store that sells them.
  - If GM food products are introduced into the local consumer market, I will make a complaint to the company that produces them.
  - If GM food products are introduced into the local consumer market, I will make a complaint to another outside body, such as a consumer organization or to the Food Agency.

**Concerns**

Below you will find statements about the possible disadvantages of using gene technology. What is your opinion on them?

- Strongly disagree (1) – Strongly agree (7)

**Health concern**

- I believe that GM foods pose a threat to human health.
- I believe that GM foods will cause allergies in human beings.

**Environmental concern**

- I believe that the application of gene technology in food production disturbs the balance of ecosystems.
- I believe that the application of gene technology in food production is a threat to natural plant species.
Market concern
I believe that the use of gene technology in food production mostly benefits the producers and the retail sector.
I believe that major plant breeding companies misuse their position in the market for GM plant strains.

Moral concern
I think that the use of gene technology in food production is unnatural.
I think it is morally wrong that human beings intervene in natural phenomena by using gene technology.

Emotions
How well do the following words describe the thoughts and feelings that the genetic modification of food raises in you?
1 = Extremely poorly/Not at all; 2 = Poorly; 3 = Somewhat poorly; 4 = Cannot tell; 5 = Somewhat well; 6 = Well; 7 = Extremely well.

Fear
Afraid
Worried
Suspicious
Helpless

Anger
Angry
Cross
Hostile

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Assessment of milk consumer preferences

Identifying the choice factors through the use of a discrete logistic model

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Annamaria Passantino
Department of Veterinary Sciences, University of Messina, Messina, Italy, and
Angela Alibrandi and Carlo Giannetto
Department of Economics, University of Messina, Messina, Italy

Abstract

Purpose – The purpose of this paper is to report a survey in random-selected supermarkets in Italy in order to identify the attitudes and perceptions of consumers toward milk and in particular toward donkey milk.

Design/methodology/approach – The analysis was conducted through Google Forms platform of docs. google interviews with a sample of 705 consumers who were given a questionnaire to collect information about their economic status and their attitudes toward milk and special milk consumption.

Findings – The results were analyzed in order to identify the socio-economic and behavioral characteristics of homogeneous groups of consumers. They consume milk mainly because it is not expensive and it is possible to easily buy it in the supermarket. They consume special milk mainly because of food allergies or intolerances. They would like to buy special milk at large-scale retail trade outlets; they underline difficulties in finding and purchasing it. They think that the price of special milk is very high.

Originality/value – The results showed that those who occasionally consume special milk choose it because it is more nourishing or for health reasons; there is also a significant association between the judgment on prices of special milk and the frequency of purchase. The estimation of a generalized linear model allowed to highlight that only age and the presence of health problems/intolerances are significant predictors of special milk consumption.

Keywords Consumer behaviour, Milk, Discrete logistic model, Donkey milk, Habits and consumer preferences, Special milk

Paper type Research paper

Introduction

The literature on the consumer’s preferences highlights how the consumers’ tastes are influenced and oriented by production decisions and by motivations related to the attributes of foods and by the environment in which food products are produced. The consumer acts in a function of his own hierarchy of preferences and before making a choice he/she proceeds in advance to acquire all the necessary information which may help him make a correct purchase. By now, the modern consumer seems to be oriented toward a product with a high degree of immaterial values, represented by ethical values linked to environmental protection, and that this may be a quality product (Ronteltap et al., 2007). Before analyzing the behavior of the donkey milk consumer, we describe the reference scenario of the milk market and the evolution of consumption. Milk for human consumption is commercially produced across the globe only by a limited number of animal species: dairy cattle, sheep, goats and buffaloes (Claeys et al., 2014; Caracciolo et al., 2015). However, several regions around the world have adopted the particular species common in their area for the purpose of producing milk, such as camels, horses and donkeys. Goat, donkey and camel milk are considered to be good substitutes for human milk (Agnoli et al., 2016). Therefore, we see a process of revaluation of the milk produced by the “minor” species
(donkey and dromedary), considered as a valid alternative for people suffering from allergies or intolerances, in the light of its nutritional (Table I) (Barłowska et al., 2011) and therapeutical properties (Martelli et al., 2014).

Currently, average cow milk consumption in the EU is 61.07 liters per year, while in the USA, these data are much higher, and indeed the average consumption amounts to 83.25 liters a year. Even more specifically, in Italy 40 liters of milk on average are consumed. Therefore, these data deviate significantly both from the US average and from the community one. In the last five years, in Italy, per capita milk consumption has declined by 24.5 percent. It has to be considered that just ten years ago, people used to drink 59 liters of milk per capita. Especially during the last year, there has been a very strong decrease. From 49 liters of milk each, Italians now consume 40 liters. Recently, there has been an increasing interest in donkey milk due to its potential role in human nutrition and especially in pediatric dietetics (infants’ cow milk allergies). Donkey milk is one of the best substitutes for human milk because of its content in lactose, proteins, minerals and omega-3 fatty acids. It has the most comparable protein composition to human milk (low casein content, lack of alpha-s1-casein fraction and beta-lactoglobulin and high lysozyme content) (Vincenzetti et al., 2005; Guo et al., 2007; Tesse et al., 2009). In addition, donkey milk is characterized by a fatty acid profile, which is different from the milk of other analyzed animal species. Furthermore, the immunological properties of donkey milk have recently been investigated, showing that humans consuming donkey milk have an increased mononuclear blood cells nitric oxide release, which could be useful in the prevention of atherosclerosis (Aspri et al., 2017). The aim of this paper is to analyze milk consumer preferences through an empirical survey on milk consumption in the city of Messina. The survey was carried out by means of interviews conducted on a representative sample of the population of Messina. We intended to investigate the salient features of milk consumers in order to highlight those criteria that drive the purchase and whether consumers are interested in consuming other types of milk, different from the “conventional” one (Bertazzoli et al., 2005; Brown et al., 2009; Rahnama and Rajabpour, 2017). Given that in some areas of Italy, especially in Sicily, donkeys produce high-quality milk employed to feed infants affected by cow milk protein allergy and/or by multiple hypersensitivity, the further purpose of the present study was to develop and to validate a questionnaire to interpret the needs, habits and preferences of donkey milk consumers, and the degree of appreciation for the consumption of this product, which at the same time could find potential solutions to increase the production and sales of this food (Freibauer et al., 2011; Passantino et al., 2011; Green et al., 2017).

<table>
<thead>
<tr>
<th></th>
<th>Female</th>
<th>Camel</th>
<th>Donkey</th>
<th>Bovine</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium mg/100 g</td>
<td>33</td>
<td>114-116</td>
<td>67.67</td>
<td>122</td>
<td>Park (2007), Salimei et al. (2004)</td>
</tr>
<tr>
<td>Potassium mg/100 g</td>
<td>55</td>
<td>144-156</td>
<td>49.72</td>
<td>152</td>
<td>Park (2007), Salimei et al. (2004)</td>
</tr>
<tr>
<td>Vitamin C mg/100 g</td>
<td>5</td>
<td>33</td>
<td>3.5-5</td>
<td>0.94</td>
<td>Park (2007), Haddadin et al. (2008), Milonis et al. (2011)</td>
</tr>
<tr>
<td>Energy kJ/kg</td>
<td>2407</td>
<td>3283</td>
<td>1842-2051</td>
<td>3169-3730</td>
<td>Shamsia (2009), Guo et al. (2007)</td>
</tr>
<tr>
<td>Fat content g/l</td>
<td>21-40</td>
<td>20-60</td>
<td>3-18</td>
<td>33-54</td>
<td>Salimei and Fantuz (2010), Shamsia (2009), Haddadin et al. (2008)</td>
</tr>
<tr>
<td>Protein g/l</td>
<td>107-129</td>
<td>119-150</td>
<td>88-117</td>
<td>118-130</td>
<td>Salimei and Fantuz (2010), Shamsia (2009), Haddadin et al. (2008)</td>
</tr>
<tr>
<td>Lactose g/l</td>
<td>63-70</td>
<td>35-51</td>
<td>58-74</td>
<td>44-56</td>
<td>Salimei and Fantuz (2010), Shamsia (2009), Haddadin et al. (2008)</td>
</tr>
<tr>
<td>Casein/whey ratio g/100 g</td>
<td>0.4-0.5</td>
<td>2.7-3.2</td>
<td>1-2.8</td>
<td>4-7</td>
<td>Salimei and Fantuz (2010), Shamsia (2009), Haddadin et al. (2008)</td>
</tr>
</tbody>
</table>

**Table I.** Characteristics of female’s, camel’s, donkey and bovine milk
Materials and methods
The methodology used to conduct the research was quantitative and randomized. The random search aimed at identifying the paramount factors, from which the consumer’s buying behavior is dictated (Lanfranchi et al., 2014). The questionnaire design led to the definition of the questions regarding the perceived quality, the usual consumption, the price-quality ratio of cow’s milk, non-cow’s milk and, more specifically, donkey milk (Lanfranchi et al., 2015; Giannetto et al., 2016; Chinnici, et al., 2002). The questionnaire wanted to report the perceived quality, the regular consumption, the price-quality ratio of the milk and more specifically of donkey milk. The final questionnaire, comprising 25 questions, was subdivided into three sections. The first section included the socio-demographic characteristics of the respondents (age, sex, marital status, level of education). The second section included questions aimed at identifying the factors and specificity of milk consumption (type of milk consumption frequencies, places of purchase, place of consumption). Finally, the last section aimed at obtaining information about the perception of quality, price and preference for the specific consumption of donkey milk. The survey was conducted in the whole territory of the province of Messina (urban area) (Sicily, Italy) in the period between November 20, 2016 and January 10, 2017. It was carried out by means of an online questionnaire, specially prepared in function of the survey’s goal, which was uploaded on the Google Forms platform of docs.google. All interviewees were informed about the confidential and anonymous character of the survey. Numerical variables were expressed as mean ± standard deviation, the categorical ones as number and percentage. A profile of the typical consumer has been drawn up with reference to “cow’s milk,” “non-cow’s milk,” “donkey milk” and “lactose-free milk,” using suitable filter variables. In order to perform statistical comparison between consumers of cow’s and non-cow’s milk, respectively, we used the non-parametric Mann Whitney test (for numeric variables) and the χ² test (for categorical variables). A discrete logistic model was estimated in order to identify predictive factors of special milk consumption; in particular, a stepwise logistic regression model was estimated since the outcome of interest has a dichotomous nature (consumption: yes or no). According to the null hypothesis, there are no covariates that exert a significant influence on the outcome variable. According to the alternative hypothesis, there is at least a statistically significant covariate, which is a predictor of consumption of special milk. Statistical analyses were performed using SPSS 17.0 for Window package. p < 0.050 two sided was considered to be statistically significant (Gulseven and Wohlgenant, 2017; Kleinbaum and Klein, 2010).

Survey results
The questionnaire was administered to 705 people living in the area subject to investigation. The number is suitable for the establishment of a sufficiently representative sample for the purpose of the statistical analysis, which was carried out in order to determine the survey results. In Table II, it is possible to notice the general characteristics of milk consumers’ sample.

Analysis of milk consumption
This section was realized in order to acquire information concerning the usual milk consumption, the most frequently consumed type of milk, the average monthly consumption and the frequency of this purchase. In addition, it was realized to understand if the purchase of this product may be dependent on personal habits, or on other factors such as its higher digestibility, its nutritional content or motivations linked to health. In Italy, when talking about “milk,” due to regulatory provisions, people mean the “cow’s” one. In this case, it is not necessary to specify the animal species that for cow is not compulsory, while the specification is mandatory for the other variants. By analyzing the respondents’ interest on the consumption
of a milk which is different from the cow’s one, it has been highlighted that a good percentage is interested in sheep’s and goat’s milk (12.8 percent) and in donkey milk (11.1 percent), while a lower percentage, despite being steadily growing according to national statistics, proves to be interested in soy milk (9.4 percent). The most consumed type of milk is the semi-skimmed one (74 percent) and the whole one (11.1 percent). As regards, instead, the special type of milk consumed, the most purchased is the “lactose-free” and then the “enriched” one.

Analysis of the consumption of milk according to its characteristics and to its distribution

The collection of information regarding the frequency and reasons for consumption has allowed to analyze the milk consumer’s preferences according to the following variables: provenance, organoleptic characteristics, nutritional features, package, brand and prices. Only 26.8 percent of the respondents stated that they do not consume milk. By examining the frequencies, it is possible to observe that the choice not to consume milk is linked to reasons related to taste (48.4 percent) or due to reasons related to health (32.3 percent) (intolerances, digestibility, allergies, etc.). The consumption of fresh milk appears to be justified 32 percent by its higher digestibility and 30.1 percent by its nutritional properties (Figure 1).
As regards the part of the day when milk is consumed, 71 percent of the respondents consume it at breakfast, while a much lower percentage consume it in other moments of the day (20.6 percent) or at dinner (8.4 percent). By analyzing the consumers’ preferences according to the characteristics of milk, 57.9 percent of respondents attach a greater importance to its nutritional features, 17 percent to its taste and 13.2 percent to its freshness, 6.4 percent to its smell and 5.5 percent to its color. The most purchased type of package is tetrapak (80.9 percent); instead, the pet and glass ones are the least used with a percentage equal to 9.8 and 7.7 percent. On the basis of the frequencies shown in Figure 2, milk consumers prefer to purchase it in GDOs or in the local market, and only 0.9 percent purchase it directly from the producer.

The most purchased milk package (86.3 percent) is of one liter. Finally, as regards prices, 65.5 percent of the respondents consider them to be high, while only 11.7 percent consider them to be low. Most of the people forming the sample purchase milk when there are promotional offers (33.6 percent) and when the price is convenient (32.2 percent), while 15.3 percent of the respondents rely on the brand. The most consumed types of milk, with regard to shelf life are long-life milk (54 percent) and fresh milk (19.1 percent). Only 6.8 percent purchase pasteurized milk and 1.7 percent micro-filtered milk.

**Analysis of donkey milk consumption**

The content of this paragraph is focused on the consumer preferences when purchasing donkey milk and on his/her interest in this type of milk. The main obstacles to the purchase of this type of milk represented by high costs and by the reasons for giving up consumption are identified as well. As far as our investigation is concerned, 88.9 percent of the interviewees stated that they have never purchased donkey milk, while the remaining 11.1 percent have purchased it at least once. Furthermore, most of consumers (60.9 percent) are not interested in purchasing this particular type of milk. Figure 3 outlines that the respondents tend to consume donkey milk because it is more nutritious and for its high digestibility (34.8 and 26.1 percent).

Subsequently, the respondents were asked about what the main reasons for a hypothetical consumption of donkey milk could be. In total, 46.3 percent would purchase it for its nutritional characteristics, but the other reasons are attributable to its smell, to its therapeutic properties, to its color and taste. As regards the purchase sites, consumer would rather find donkey milk in the local market (28.5 percent), GDOs (24.7 percent), traditional retail (10.6 percent), or directly from the producer (5.1 percent). Subsequently, the main reasons that prevent consumer from purchasing this product have been analyzed. These are mainly linked to the lack of suitable
information (58.7 percent), to the difficulty of finding it (27.7 percent) and to its high costs (13.6 percent). As to this last aspect, more than 50 percent of the respondents think that the price is excessively high and, in addition to this, more than 50 percent state that the price of donkey milk is 30/50 percent higher than the price of cow’s milk.

Some considerations on the consumption of donkey milk
Food consumption at national level, over the years, has undergone a change due to several factors: income, social, demographic, cultural and traditional ones (Lazzaroni et al., 2012). As a result, in addition to changes in food consumption, associated changes also take place in the context of production, administration and marketing of food (Janssen et al., 2009; Mancini et al., 2015; Schimmenti et al., 2013). Through recent market surveys, it was found that the main factors that have led to the evolution of food consumption depended on the attention that the consumer pays to his subjective well-being, and the careful observation of illnesses and food allergies or intolerances as listed in the Regulation 1169/2011 Annex II. The consequences of this evolution have led to the development and the increased sale of the so-called functional foods (Gulseven and Wohlgemant, 2014). Other phenomena related to the change in diet are allergies and intolerances which have been increasing more and more over the last decade (Lanfranchi et al., 2014). With relation to these aspects, the questionnaire was developed in order to focus on the preferences of the consumers and on their knowledge and consumption of donkey milk (Jirillo et al., 2010). Donkey milk was chosen for its objective nutritional and chemical characteristics. Being extremely similar to human milk, it is the perfect substitute for cow’s milk in cases of infants and young children who do not have the benefit of breast feeding because they suffer from CMA syndrome (allergies to cow’s milk protein) or food poly-allergies (Jacquier et al., 2017). In this way, children can have a fundamental food for their growth, with a low risk of allergies and are able to develop a normal and complete immune system. Its use is also indicated for elderly subjects (pharma-food), for sportmen or for those on a dietary regimen. In addition, donkey milk and derived products are particularly effective in dermo-cosmetics for their effective moisturizing and cleansing agents. In this case, the valuable components of donkey milk act as an effective antioxidant, nourishing and protecting the skin. The survey carried out by us, however, reveals that consumption is still very low. The research carried out in collaboration with the Department of Economics and the Department of Veterinary Sciences has allowed us to identify the main deterents that hinder the purchase of this food. The causes are identifiable mainly in the fact that the product, as mentioned, is not well known. There is also a certain reluctance to change dietary habits and a particular reluctance to a milk different from cow’s milk. To these issues, we can also add the difficulty of finding the milk, the excessive fragmentation and atomization of the offer (business reality of the
whole national territory), the lack of regulations for selling arrangements, so far mainly limited to direct sales, and especially the price which is quite high, making it prohibitive for many families. To make a change in the trend of consumption, a series of operations are required which, in addition, could certainly benefit the breeders and increase their profits. Therefore, first we must encourage farmers to make themselves aware that they own a valuable animal, both socially and economically and with great potential. Finally, with regard to the dermo-cosmetic use of donkey milk, the channel of choice could be represented by beauty centers, beauty farms, places where the characteristics of this valuable product can be adequately conveyed (Tafaro *et al.*, 2007; Kling *et al.*, 2016).

**Statistical analysis: results**

Considering the cow’s milk consumers (153 subjects), we can define that the typical consumer is indifferently male or female (male vs female = 47.7 vs 52.3 percent), has a mean age of 34.4 ± 13.5, is graduated (57.5 percent), has an income of less than €20,000 (72.5 percent), belongs to a family with an average number of components equal to 3.5 ± 1, with an average monthly consumption of milk equal to 6.8 ± 7.4; lastly he usually consumes pasteurized milk at breakfast. Analyzing the profile of consumers of non-cow’s milk (82 subjects), the typical consumer is predominantly female (59.9 percent), has a mean age of 36.6 ± 16.8; is graduated (39 percent), has an income between €10,000 and 40,000 (75.6 percent), belongs to a family with an average number of components equal to 3.8 ± 1.1 with an average monthly consumption of non-cow’s milk equal to 6.1 ± 5.3; he usually consumes non-cow’s milk at breakfast. Examining the characteristics of the consumers of donkey milk (26 subjects), the typical consumer is predominantly male (57.7 percent), has a mean age of 38.9 ± 14.3; is graduated (61.5 percent), has an income between €10,000 and €20,000 (46.2 percent), belongs to a family with an average number of components equal to 3.9 ± 1.1 with an average monthly consumption of donkey milk equal to 5.8 ± 3.7; and usually consumes donkey milk at breakfast. The typical consumer of lactose-free milk (73 subjects) is predominantly female (57.5 percent), has a mean age of 34.3 ± 14.1; is graduated (42.5 percent), has an income between €10,000 and 20,000 (41.1 percent), belongs to a family with an average number of components equal to 3.7 ± 1.1 with an average monthly consumption of milk equal to 6.2 ± 71; lastly, he usually consumes lactose-free milk at breakfast. Examining the results obtained from the comparison between cow’s milk consumers and non-consumers of cow’s milk, there were no statistically significant differences for age (p = 0.731), and for sex (p = 0.273), for number of family components (p = 0.128) and for the monthly consumption of milk in liters (p = 0.766). Significant differences exist, however, with reference to the educational level (p = 0.018) that appears to be higher for those who consume cow’s milk and, also, with reference to income (p = 0.008): non-cow’s milk consumption appears to be mostly used by those who perceive higher incomes. Generalized linear model estimation (in this specific case the Stepwise Logistic Regression model) allowed to identify the variables that significantly influence the special milk consumption; univariate models show that age (< 60; ≥ 60 years), the number of family members (≤ 2; > 2), the income and the presence of health problems/allergies exert a significant influence on the special milk consumption; the estimated model showed that only age, the income and the presence of health problems/allergies are significant predictive factors of special milk consumption. Table III shows the results (expressed as p-value, Exp (B) and its 95 percent confidence interval) of the estimated model.

**Discussion**

The survey carried out through the analysis of consumer preferences was useful to know the consumers’ selection process on milk purchase and to explore the attitudes and perceptions that influence this choice. The research was focused on the differentiation of the
profiles of cow’s and non-cow’s milk consumers. In addition, with regard to this last category, the behavior and the preferences linked to donkey milk consumption have been investigated as well. Through data analysis, it was possible to outline the profile of non-cow’s milk consumer who differs from traditional milk consumer essentially for three variables; the application of the discrete logistic model, in fact, has allowed to verify that the decision to consume non-cow’s milk is strongly influenced by the high age band, by the belonging to a medium-high income bracket and by the presence of health problems and/or intolerances. The reason for the first and third variable is to be attributed to the acknowledged health aspect of the milk belonging to the non-cow’s “special” type or “alternative milk,” for its presumed higher digestibility compared to cow’s milk. These data are in line with the growing trend of western consumers who purchase soy milk. Although nutritionists for all age groups recommend the consumption of milk serving from cattle farming, there are consumers who, owing to their lifestyle or ethical choices do not consume cow’s milk, such as vegans. As well as this last category, we can also find a segment of consumers who suffer from intolerances or allergies to some elements present in cow’s milk. The most spread problem in western nutrition is by far the intolerance to lactose that is to say to the sugar contained in milk. This type of intolerance is a pathology particularly detected within the adult population that emerges owing to the progressive disappearance of the production of the lactase enzyme generated by the body. This motivation, resulting from the recent scientific researches in the field of medicine, corroborates the socio-economical results elaborated in the present work. In fact, as it has been said, the reason for not consuming cow’s milk for health problems and/or intolerances is more spread in the most advanced age groups (over 60), above all for the action acknowledged, especially to soy milk, of being cholesterol-lowering. From the perspective of the second “economical” variable linked to the respondents’ income, a new data related to the preference for the consumption of non-cow’s milk of the interviewees belonging to a medium-high income bracket emerges. This data recorded in the present research are in line with what happens in the international market of cow’s milk (Boatto et al., 2016). In fact, the world prices of milk since 2014 have collapsed by around 40 percent and are the lowest of the last five years. Particularly in the EU, livestock holdings, being concerned about the imbalance between costs and revenues, are protesting, calling for interventions by the Common Agricultural Policy (PAC). Take, for instance, Spain, where the average price is 27 cents per liter, the lowest figure since 2009. The collapse of prices, and therefore of the consequent revenues, occurred also because entrepreneurs were not able to “read” the market. The milk market, in the EU and even more in Italy, following the change in the strategies for support of CAP, initiated with McSharry Reform of 1992, has led to the gradual elimination of the support on prices with the aim of limiting surplus production within community territory. Subsequently, in 2003, with the mid-term review, it was decided to abolish the milk quota regime starting from 2015 and this has further aggravated price volatility, causing dramatic

<table>
<thead>
<tr>
<th>Variables</th>
<th>p-value</th>
<th>Exp (B)</th>
<th>95% CI</th>
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</thead>
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<tr>
<td>Gender</td>
<td>0.372</td>
<td>0.683</td>
<td>0.296-1.577</td>
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<tr>
<td>Age (&lt; 60; ≥60 years)</td>
<td>0.009</td>
<td>3.303</td>
<td>0.947-11.568</td>
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<tr>
<td>Education</td>
<td>0.336</td>
<td>1.316</td>
<td>0.752-2.301</td>
</tr>
<tr>
<td>Family members (≤2; &gt;2)</td>
<td>0.170</td>
<td>1.877</td>
<td>0.763-4.614</td>
</tr>
<tr>
<td>Income</td>
<td>0.005</td>
<td>1.956</td>
<td>0.868-4.406</td>
</tr>
<tr>
<td>Price</td>
<td>0.096</td>
<td>0.984</td>
<td>0.432-2.238</td>
</tr>
<tr>
<td>Taste</td>
<td>0.101</td>
<td>0.671</td>
<td>0.416-1.081</td>
</tr>
<tr>
<td>Health problems and intolerance</td>
<td>0.031</td>
<td>2.691</td>
<td>1.095-6.822</td>
</tr>
</tbody>
</table>

Table III. Results of stepwise multivariate logistic regression model

Note: Dependent variable: consumption of special milk. p < 0.05
effects on farmers. As might have been expected, the abolition of the milk quota regime, which has been regulating the mechanisms of productions and of the markets of EU countries for over thirty years, has resulted in an increase of the total production. Indeed, data analysis shows how since 2014 until today the price paid to farmers has been remarkably decreasing, by 13.72 percent from 2014 to 2015 and by 4.26 percent from 2015 to 2016. This contraction of “at the barn” prices was offset by an increase of consumer prices for the benefit of the Large organized distribution. This price rise which in the same observation period (2014-2016) settled around 1.5 percent, is the joint result on one side of the changed eating style of consumers, who reduce the per capita consumption of milk due to health problems, intolerance, hypercholesterolemia, and on the other hand of the increased milk supply. Therefore, the excess of supply over demand has generated a strong competitiveness on markets, leading to a growing reduction of farmers’ profit margins with the consequent exit from the market by small-sized companies. Price volatility is a phenomenon that has always occurred, but it had never assumed such a dimension as to progress from a conjunctural to a structural element. In spite of a high but stable demand of cow’s milk an ever-growing trend of the demand of non-cow’s milk, and in particular of drinks of plant origin is currently recorded in the world. However, the consumer price of this type of drinks is considerably higher, even though we ought to consider a price plus which can be superior to the price of cow’s milk. In spite of this limit linked to the price, the demand is constantly growing. Since 2014 in Italy, the consumption of vegetable drinks, as a surrogate of cow’s milk, has been increasing by around 22 percent. The results presented in this research provide several reflection points both for companies producing cow’s milk and for those competitors which produce a product replacing traditional milk. Indeed, agri-food companies are adjusting themselves to face this growing trend of “alternative” milk consumption. In the next years, the international scenario will be characterized by the increasingly large presence of milk industries that will try to expand themselves within the category of alternative milk products, in order to counterbalance sales of liquid milks and to benefit from the growth forecasts of the world per capita consumption of non-cow’s milk. On the other hand, the consumer, more discerning and informed, will start to ask for higher guarantees regarding the quality and the food safety of these alternative products, considering the risk of contaminations linked to genetically modified organisms, especially for soy milk. For this reason, production companies will have to equip themselves in the future, with suitable traceability systems that can guarantee the provenance and quality of the product. Indeed, food quality and safety remain indispensable pre-requisites. When talking about quality, the reference is both to the quality of the system and the quality of the product and each of them can be on a compulsory or voluntary basis. The consumer information policy is careful to correct the cases of information asymmetry and to protect the consumer through the presence of some essential requirements such as food safety, organoleptic characteristics, nutritional content, guarantee of geographical origin and environmental guarantee in the products (Grunert, 2005).

Conclusions

In summary, donkey’s milk is a product with great potential, but which unfortunately suffers from insufficient regulation and from an indifferent or even negative collective perception. Indeed, according to us, a critical point of donkey’s milk that is linked to the consumer’s difficulty in finding the product is due to the existing legislation which regulates the sale of donkey’s milk and which dates back to the Law of 1929 (Royal Decree No. 994). This regulation allows the sale of milk in adequate premises set up exclusively in the place of production of the milk itself, and therefore the most common sales channels are excluded. This penalizes the diffusion of this product inevitably reducing its trade flow, for the consumer’s clear difficulties in finding the product. It is desirable that the policymakers, as
well as carrying out a review of the national legislation in this matter, implement suitable communication strategies with regard to the health benefits of donkey’s milk which may favor a higher consumption of the product. The realization of forms of associationism is also desirable. Indeed, donkey breedings often suffer from the phenomenon of the atomism of companies where natural resources too often are not sufficiently and effectively exploited due to the absence of entrepreneurial spirit.

Acknowledgements
The work is the result of a full collaboration of the authors. However, Maurizio Lanfranchi, in addition to coordination and setting of the study, wrote the paragraphs “Materials and methods,” “Analysis of the consumption of milk according to its characteristics and to its distribution,” “Some considerations on the consumption of donkey milk” and “Discussions and conclusions.” Angela Alibrandi and Agata Zirilli contributed to the collection and elaboration of data and they wrote the paragraph “Statistical analysis: results;” Carlo Giannetto collaborated in the survey and data collection, in search of bibliographic sources and he wrote the paragraphs “Survey results,” “Analysis of milk consumption” and “Analysis of donkey milk consumption”; while Annamaria Passantino and Carlo Giannetto wrote the paragraph “Introduction;” Maurizio Lanfranchi and Carlo Giannetto wrote the paragraph “Discussion.”

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Further reading

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The empirical model of trust, loyalty, and business performance of the dairy milk supply chain

A comparative study

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Abstract

Purpose – The purpose of this paper is to measure and evaluate the relationship between collaborative communication, power dependence, price satisfaction, trust, supplier loyalty, and business performance.

Design/methodology/approach – Data used in this study were primary data which were collected through personal interviews and closed questionnaires using a five-point Likert scale ranging from 1 to 5. The sample consisted of 170 individual dairy farmer and several dairy cooperatives, which were located in Central Java Province (Boyolali and Semarang Districts) and West Java Province (West Bandung District). The study used partial least squares with the aid of the SmartPLS software program to analyze the hypothesis.

Findings – The results of hypothesis testing indicate that collaborative communication and price satisfaction had a significant positive effect on trust for Central Java and West Java Province. Meanwhile, power dependence had a significant negative effect on trust only for West Java Province. Trust had a significant positive effect on supplier loyalty for both of the two provinces. Significant positive effect of supplier loyalty on business performance was supported in Central Java Province, whereas in West Java Province, supplier loyalty had a positive but not significant effect on business performance.

Research limitations/implications – The limitation of this study is related to the number of samples, the type of scale used to measure a business performance, and the focus that is only on the relationship between the farmers and cooperative to improve the performance of cooperative without considering the role of management. So, the future research may replicate this study in another region or in the other contexts of agribusiness sector that usually depends on farmer as a producer of the raw material. It may also enhance the measurement of business performance of dairy cooperative by using a direct measure of financial performance and non-financial performance and broaden the scope of research into the role of management of dairy cooperative.

Practical implications – It is recommended that managers of dairy cooperatives always involve the farmers when making marketing decisions especially concerning prices, products, market, and promotion. As organizational stakeholders, their involvement is vital in determining the ability of the dairy to achieve its goals. The other recommendation is the managers of cooperatives must have a clear policy on the price of milk, and this policy should indicate the transparency and accountability. Then, regarding the long-term benefit of dairy cooperative, it is recommended for dairy cooperatives to add the value of the milk so they can access wider markets, which, in turn, will maximize returns to the members. Based on this recommendation, it is better if the dairy cooperative in Indonesia not only serves as a marketing cooperative, but also serves as a farm supply cooperative which may process or formulate the milk into a more valuable product.

Social implications – The research confirms that individual dairy farmer’s loyalty can benefit the business of dairy cooperative. It may encourage more dairy cooperative to tap the good relationship with the individual dairy farmer at the initial stage of the economic growth of their business. Intensifying competition between dairy cooperatives would potentially bring even better quality and quantity of milk from the loyal dairy farmer.
Originality/value – Although this research used the conceptual model from the previous study, this research will make some improvement. First, it used more indicators to measure each dimension of the construct, and the investigation was slightly more complex and broader since the object of the research was represented by two regions, namely, Central Java Province and West Java Province.

Keywords Milk, Supply chain management, Trust, Suppliers, Dairy industry

Paper type Research paper

1. Introduction

In Indonesia, the domestic production of milk was only able to supply around 25-30 percent of the nation’s demand. The remaining 70-75 percent was met by imports, mainly from the Oceania (Australia, New Zealand), EU, and the USA (Meylinah, 2007). The domestic production of milk cannot be separated from the contribution of each actor of the dairy supply chain in Indonesia consisting of the farmers (mainly smallholders), the primary and secondary cooperatives, the milk processor, the government, and the private service and input suppliers. In total, there were 192,160 dairy farmers in Indonesia (Morey, 2011), and they are owners of majority dairy cows. The milk production remains limited as the farms do not benefit from scaling technologies. Thus, the majority of milk production from dairy farmers is marketed through local cooperatives, and then they sell it to the milk processor. Besides, the dairy farmers or cooperatives sometimes also sell a small amount of fresh milk to small home industries, food hawkers or street vendors, and directly to local end consumers.

The cooperative has an important role for the dairy farmers. Dairy cooperatives were introduced by the government to link milk producers with milk processors and to provide farmers with services and inputs. The cooperative’s role is like a buffer between the dairy farmers and dairy processing industry. The cooperative is an organization that is used by farmers to improve their welfare (Sebayang, 2013). There is a broad range of support that is provided to dairy farmers by the cooperatives, such as collecting the milk from the farmers and selling it to the processing industry and also providing the dairy farmers feeds and credit (for feed and cows, for example). Also, some services like animal health advice and artificial insemination services are present to support the dairy farmers. Many cooperatives have cooling facilities at collection centers and collection points, either on loan or pre-paid by the dairy industry, supplied from donor funds, or financed by the cooperative itself. The dairy cooperative is a good entry point for improvement of dairy farming practices because of their direct relation to farmers (Morey, 2011; Wright and Meylinah, 2014).

Dairy farmers are members of local dairy cooperatives. The cooperative also deals with the principal-agent problems, which are likely to give rise to member dissatisfaction. Principal-agent problems arise because the objectives of the agent are usually not the same as those of the principal, and thus the agent may not always best represent the interests of the principal (Alchian and Demsetz, 1972; Royer, 1999; Sykuta and Chaddad, 1999). The terms of an agency relationship are typically defined in a contract between the agent and the principal (which could bind the agent to act in the principal’s interests, for example). However, even though the relationship between the two parties is defined by contract, it may be difficult for the principal to prevent the agent from acting in his own interest. The problem is complicated by the fact that no contract is perfect, and because contracts are costly to draft, maintain, and follow up (Nilsson, 2001). The principal-agent problem becomes even more crucial in the dairy cooperative in Indonesia because, usually, there is no formal contract arrangement between dairy cooperatives and dairy farmers to prevent the dairy farmers or dairy cooperative from acting in their own interest or to prevent the opportunistic behaviors of dairy farmers and dairy cooperatives in a transaction. The farmers are independent milk producers because they can decide anything related to their businesses by themselves. The day-to-day running of the dairy farms is the responsibility of the farmer members. This condition, on the one hand, makes the dairy
farmers to have a bargaining power and, on the other, the cooperative has difficulty in controlling the business and predicting and managing the quality and the continuity of the supply flows. The dairy cooperative is often unable to get the high quality of fresh milk as demanded by the processor or the national standard (Morey, 2011; Yusdja et al., 1999; Daud et al. 2015).

Thus, related to the continuity of the supply, the preliminary study was conducted by the authors in three different locations, namely, Semarang and Boyolali Districts in Central Java Province and West Bandung District in West Java Province. It is indicated that the competition among cooperatives has made the dairy farmers to have a chance to sell part of their fresh milk to another cooperative offering a better price located not far from the one of which they are members. This condition will reduce the amount of the supply of fresh milk to the cooperative, and it is the typical problem of producer cooperative. According to Hansmann (1988), the members of cooperative remain free to vary their volume of transactions with the cooperative over time and even to terminate their patronage altogether. It is thus important for the cooperatives to work more closely with the farmers through building a stronger relationship to get loyal dairy farmers who have a long-term commitment to remain patrons. In this case, without formal contract arrangement between the cooperatives and the farmers, stronger relationships can protect the cooperative from the opportunistic behaviors, thus decreasing the transaction cost or agency cost (Williamson, 1979) – the additional cost resulting from the existence of conflict of interest between the farmers and their cooperative. In the context of the dairy cooperative, including transaction cost or agency cost is the resource to regulate and monitor the behaviors of the farmers by controlling and ensuring the fulfillment of the agreement.

Moreover, according to O’Toole and Donaldson (2000), the stronger relationship is one of the important factors which is required to improve the business performance. The positive and stronger relationship between the loyal dairy farmers and business performance can be found in the research conducted by Boniface et al. (2012). In a strong relationship of dairy farmers through their loyalty, the dairy cooperatives can become subject to the factors of trust of the farmers. Berry (1993) stressed that trust is the basis for loyalty and according to Morgan and Hunt (1994), trust can lead the higher levels of loyalty to the bargaining partner. In the context of cooperative, the degree of trust is a crucial issue to overcome. The degree of trust might have fallen because over time the cooperative has expanded so much that a high degree of heterogeneity has arisen. Or, a belief has been instilled in the members that there would not be any great market failure if they should act on the market without the cooperative firm. So, the members tend to lose interest (Nilsson, 2001). Then, creating trust in the relationship was influenced by some factors, among others are collaborative communication, power dependency, and price satisfaction (Boniface et al., 2010).

So, based on the problem faced by the dairy cooperative which, in turn, suggests to a dairy cooperative to build a loyal dairy farmer as a supplier of milk, this study have several purposes. The first one is to investigate the relationship between three antecedent factors of trust (collaborative communication, power dependency, and price satisfaction) and the trust of dairy farmers to the dairy cooperatives. The second is to investigate the relationship between trust of the dairy farmer to the loyalty of dairy farmer on dairy cooperative, and the last, this study is aimed to investigate the relationship between the loyalties of the dairy farmer on the performance of dairy cooperatives. In this case, this study uses the conceptual model from Boniface et al. (2010) in building the relationship between collaborative communication, power dependency, price satisfaction, trust, and supplier loyalty. This study uses the conceptual model from Boniface et al. (2012) in building the relationship between supplier loyalty, financial and non-financial performance. This study uses the conceptual model from Boniface et al. (2010, 2012) because the structure of dairy supply
chain in Indonesia and Malaysia is relatively similar. In Malaysia, many dairy farmers sold their product to Milk Collecting Center (MCC) at the predetermined and subsidized price. However, the dairy farmers did not restrict to sell their product only to MCC; the dairy farmers could sell their product to the other buyers, such as milk processors, Indian restaurants, milk agent or direct consumers. It can be said that there was a multiple choice of dairy farmers to sell their product (Boniface et al., 2010). In Indonesia, the role and function of MCC were almost similar with the dairy cooperatives, and the dairy farmers also have a chance to sell their product to the others.

Although this study uses the conceptual model from Boniface et al. (2010, 2012) and Susanty et al. (2016) that have conducted a study about the relationship between dairy farmers and dairy cooperative in Boyolali, it will make some differences. Comparing to the studies by Boniface et al. (2010, 2012), this study will use more indicators to measure each dimension of the construct. If compared to a research conducted by Susanty et al. (2016), this study is embracing the model by adding the construct of dairy cooperative performance as an impact of loyalty of dairy farmer. Besides, this study is slightly more complex and broader since the investigation is represented by two cases of the relationship between dairy farmers and their cooperative in two different provinces, namely, Central Java Province and West Java Province. In Central Java Province, the investigation is represented by Semarang and Boyolali District, while in West Java Province, it is by West Bandung District. The dairy supply chain in each case has a visible system boundary which can be different and may have a different impact on the relationship between dairy farmers and the cooperatives. In detail, the differences between dairy supply chains in two regions can be seen in the following discussion.

2. Literature review
2.1 Dairy supply chain in Central Java and West Java provinces: a comparative study

From 2005, the number of dairy cows in Central Java has increased by an average of 1.6 percent per year to reach 123,091 cattle in 2010. Meanwhile, in West Java Province, the growth rate was 6.9 percent per year to reach 124,797 cattle in 2010. The productivity of fresh milk production in Central Java is lower than West Java. In 2010, dairy milk production in West Java reached 270,616 tons, whereas dairy production in Central Java was only 106,040 tons. The Central Java Province produced only 11.4 percent of the Indonesian total milk production while West Java Province shared 29.2 percent. The majority of the dairy cows in Central Java were located in Boyolali and Semarang Districts, while in West Java, they were located in Bandung and West Bandung (Morey, 2011).

The number of cooperatives in West Java (23 dairy cooperatives) is slightly more than that in Central Java (21 dairy cooperatives). Different with Central Java, two of the largest cooperatives in West Java, namely, KPSBS Pengalengan (Koperasi Peternak Sapi Bandung Selatan/West Bandung Dairy Cooperative) and KPSBU Lembang (Koperasi Peternak Sapi Bandung Utara/North Bandung Dairy Cooperative), have initiated producing the dairy product in small packaging since 1997 for KPSBS Pengalengan and 2006 for KPSBU Lembang. KPSBS Pengalengan uses the brand of “KPSBS” for its small package of pasteurized milk, while KPSBU Lembang uses the “Fresh Time” brand. They have been selling directly to end consumers through their outlets in Bandung region. This kind of innovation was then followed by Bogor Dairy Cooperative (Baga, 2013).

As for the geographical dispersion of dairy processing industries, from the total of 27 processing units nationally, 3 units are located in Central Java and 15 units are located in West Java. In this case, from the total of 27 processing units nationally, there are currently five main dairy manufacturers in Indonesia, namely, Frisian Flag Indonesia, Foremost Indonesia, Indolakto/Indomilk, Ultrajaya, Sari Husada/Nutricia, and Nestlé. These industries account for 90 percent of the total sales volume. Only one of them is located in
Central Java, namely, Sari Husada/Nutricia, while three of them are in West Java. This condition makes the ratios between dairy farmers to dairy processing industry and between dairy farmers to dairy cooperatives much higher in Central Java (around 12,000 to 1 and 8 to 1, respectively) than in West Java (around 1,600 to 1 and 5 to 1, respectively). The ratios could indicate the degree of dependency on the processing industry by the farmers and cooperatives (Rittgers, 2004; Meylinah and Rittgers, 2005, Nugraha, 2010).

Moreover, according to Nugraha (2010), the social norm of “ewuh pakewuh” or “pakewuh” in Javanese or “sungkan” in Bahasa Indonesia is the other factor that can influence the condition of the dairy supply chain. “Ewuh pakewuh” can be described as the polite reluctance to take any action or say something which can insult the feeling of others or lead to conflict or hurt the relationship among individuals. This norm is built on the social value of “preserving harmonious relationships” and can be associated with the other norms like politeness, empathy, and avoiding conflict or compliance. The dominant ethnic group in the dairy supply chain in Central Java is Javanese and in West Java is Sundanese, and both groups apply the same norm of “pakewuh” although it is stronger in Javanese. Sometimes this condition makes the enforcement of any rule that entails disincentive, punishment or sanction difficult. The same applies to the enforcement of product and process quality regulations involving warnings and sanctions, as well as quality/price mechanism that includes price penalty (Nugraha, 2010).

2.2 Trust and antecedent factors of trust
Trust is regarded as an important asset in an exchange relationship between supply chain members. The high level of trust has a significant contribution to the success of the supply chain performance (Kwon and Suh, 2004). This essential contribution of trust in various sectors has been proven in some empirical studies, such as Laureano et al. (2014), Wong et al. (2005), and Medina-Munoz and Medina-Munoz (2002). More specifically, the role of trust in the agribusiness sector can be seen in Tregurtha and Vink (1999), Batt (2003), Batt and Purchase (2004), and Hansen et al. (2002). Tregurtha and Vink (1999), using a case study of the South African Breweries (SAB) and the Taung barley project, have found that trust can make the relationship between the farmers and SAB better. Meanwhile, Batt (2003) and Batt and Purchase (2004) identified factors affecting the respective buyer-seller relationship and accentuated the role of collaboration and trust in various agricultural supply chains. Another study by Hansen et al. (2002) suggested that trust between members of a co-op and the co-op management is an important variable to enhance group cohesion. As for in a dairy cooperative, there must be trust among the members in mutual understanding, the feeling of community, and the common problem conceptions for the cooperative to function (Hakelius, 1996). Then, according to research conducted by Boniface et al. (2010), trust between two business partners depends on three factors, namely, collaborative communication, power dependency, and price satisfaction:

- A major precursor of trust is communication. Communication can be defined broadly as the formal as well as informal sharing of meaningful and timely information between firms (Anderson and Narus, 1990). Communication, especially timely communication (Moorman et al., 1993), fosters trust by assisting in resolving disputes and aligning perceptions and expectations (Etgar, 1979). Anderson and Narus (1990) and also Morgan and Hunt (1994) noted that past communication is an antecedent of trust. In this case, the previous communications from another party have been frequent and of high quality that is relevant, timely, and reliable to result in greater trust. Moreover, studies about the relationships between communication and trust in various inter-organizational environments can be found in Gainey and Klaas (2005),
In line with the past research conducted by Boniface et al. (2010), this research prefers to use “collaborative communication” as the antecedent factor of trust instead of just “communication.” It is to emphasize the specific type of communication in terms of the quality and intensity of the information shared by partners for building the trust.

According to Mohr et al. (1996), communication between exchange partners is said to be collaborative when it is characterized by four conditions. The first is high frequency, a substantial amount of information sharing. The second is high formality routinized interaction. The third is high reciprocal feedback, and the fourth is the use of rationality as a means of attaining influence. So, collaborative communication can be defined as a process of communication in which members share information in the process of building meaning and mutual understanding of meaning, in a shared space for a particular purpose (Schrage, 1990). It relies on the development of cooperative attitudes and processes to guide and administer the relationship, which creates an atmosphere of mutual support and respect between business partners. Also, collaborative communication influences buyer-supplier relationships by developing commitment, cooperation, and performance (Mohr, et al., 1996; Prahalinski and Benton, 2004). Therefore, it is considered a critical element to foster and maintain inter-organizational relationships (Mohr et al., 1996).

Power has been perceived as the control of one party of the supply chain over the behaviors and decisions of another party in the supply chain, such as persons, groups, and organizations (Narasimhan et al., 2009). Thus, dependence can be defined as the power of one party above the other party, frequently due to a high percentage of a supplier’s output going to one buyer or due to a lower percentage of supplier’s output going to more than one buyer (Handfield, and Bechtel, 2004). The power dependence will have an adverse impact on the level of trust between one party over another (Boniface et al., 2010), since due to power dependency one party has imbalance position compared to the other party and the party with more control over another may exhibit greater opportunism.

An important factor that has been considered in many exchange relationships is price, which is the financial value that is given out in exchange for a product. Price offered by one party to others is essential in building satisfaction in the business relationship. Price satisfaction refers to the psychological result of a difference between price expectation and price perception (Gyau et al., 2011; Matzler et al., 2006). Regarding the relationship between price satisfaction and trust, there are two opinions resulted from several studies. The first is that trust has a positive impact on the level of satisfaction in most network analysis (del Bosque Rodriguez et al., 2006). Second, the satisfaction level is one of the antecedent factors of trust in the business partner (Schulze et al., 2006; Batt, 2003). This study follows the second opinion because one of the benefits of satisfying consumers by providing honest and frank information about prices is the increasing trust with the company (Somogyi and Gyau, 2009). The literature on price satisfaction from business to business context, especially from the sellers’ perspective, has been limited. Many pieces of literature addressing the price satisfaction have exclusively been in a business-to-consumer context. Indeed, the concept of price satisfaction is of particular importance for B2B context since the level of satisfaction of B2B actors about the price they pay (or receive) for products they produce (or purchase) will potentially differ (Somogyi and Gyau, 2009). In a B2B context, channel members are highly satisfied with the economic rewards that come from the relationship related to price or sales, and the non-economic reward related to psycho-social gratification (Geyskens et al., 1999).
However, in the context of dairy farmers and cooperatives, price satisfaction is also important to retain the milk delivery. If a cooperative gives too lower price compared to the others, the dairy farmers will stop delivering milk to the cooperative and sell it to the middlemen instead. In this case, the middlemen who buy directly from the dairy farmers might have offered more attractive payment than the cooperative. Hence, cooperatives become less active, and some would cease the operation (Nugraha, 2010).

So, based on the literature review about an antecedent factor of trust and also in line with Boniface et al. (2010), this study proposes several hypotheses:

**H1.** Collaborative communication has a positive and significant effect on trust between individual farmers and the dairy cooperative.

**H2.** Power dependency has a positive and significant effect on trust between individual farmers and the dairy cooperative.

**H3.** Price satisfaction has a positive and significant effect on trust between individual farmers and the dairy cooperative.

### 2.3 Trust and supplier loyalty

Empirical research has revealed that the presence of trust will have a positive effect on the continuity of a true relationship (Garbarino and Johnson, 1999). However, many of the studies on the relationship between trust and loyalty focused on the context of a customer-buyer relationship due to the dominance of the studies on loyalty in that area. Studies about the positive effect of trust on loyalty in the context of supplier and buyer relationship, especially in the context of loyalty of suppliers to their buyers (such as dairy farmers and dairy cooperatives), are hardly found. In this area, we found the studies conducted by Schulze et al. (2006), Boniface et al. (2010), and Susanty et al. (2016). Instead of using loyalty of the supplier, Schulze et al. (2006) preferred to use the term “intention to switch buyer” as the output variables. The intention to switch buyers is related to the willingness to collaborate more strongly with the business partner, the recommendations made by other farmers, and the absence of countervailing power. So, to prove the effect of trust of dairy farmers on their loyalty to a dairy cooperative, this study proposes the following hypothesis:

**H4.** Trust of dairy farmers has a positive and significant effect on their loyalty to the dairy cooperative.

### 2.4 Supplier loyalty and financial and non-financial performance

Referring to O’Toole and Donaldson (2000) and Du and Wu (2008), in the study of the dairy milk industry in Malaysia, Boniface et al. (2012) proposed the hypothesis that gaining a loyal supplier leads to improvement in both financial and non-financial performance. This hypothesis is supported. Financial reward is related to economic rewards, such as better pricing, increase the number of milk sold to the milk processor, decrease the cost-sharing, increase the return on investment and profitability in the long term. Non-financial performance is related to the outcome of mutual interest, trust, and satisfaction of relationships, such as more flexibility and agility of the supply chain to meet demand (O’Toole and Donaldson, 2000; Boniface et al., 2012; Kohli and Jensen, 2010). Moreover, related to the performance measurement of the cooperative, the development of performance indicators, especially in Indonesia, has been done by some studies, such as Mutasowifin (2002), Padmakusumah (2012), and Ernita (2015), in which all the researchers...
used the Balanced Scorecard to develop the performance indicators. In this case, Padmakusumah (2012) developed 10 key result indicators, 80 performance indicators, and 10 key performance indicators, whereas Ernita (2015) developed 25 key performance indicators. Ernita (2015) used the Decree of the Minister of Cooperatives, Small and Medium Enterprises No.129/KEP/M/KUMKM/ XI/2002, and the regulations from the Minister of Cooperatives and SMEs No.06/Per/M ./KUKM/V/2006 as guidelines for developing the key performance indicators. Among the key performance indicators developed by Padmakusumah (2012) and Ernita (2015), some were used to measure the financial performance (such as gross income and balance ratio, return on asset, equity earnings, the growth of dividend, net profit margin, and operating profit margin). Some other indicators were used to measure the non-financial performance (such as active member ratio, level of member complaints for products from the cooperatives, the number of members who are satisfied with the products and services from the cooperatives, the level of purchasing products or services by the members of the cooperatives, and the level of repeat purchases (orders) of products and services). It can be seen that the key performance indicators used by the researchers to measure the performance of cooperatives in Indonesia are almost similar with the key performance indicators proposed by O’Toole and Donaldson (2000), Boniface et al. (2012), and Kohli and Jensen (2010). So, to prove the effect of loyalty of dairy farmers to the business performance of dairy cooperatives, this study proposes the following hypothesis:

H5. The loyalty of dairy farmers has a positive and significant effect on the financial and non-financial business performance of the dairy cooperative.

Based on the H1-H5, the conceptual model can be seen in Figure 1.

3. Method
3.1 Study area, population, and sample of research
This research was conducted at two provinces, namely, Central Java Province and West Java Province. Central Java and West Java were selected based on their capacity on dairy milk production, i.e. around 40.6 percent of dairy milk production of Indonesia comes from the two provinces. The target population of this study was the dairy farmers in each province who belong to local dairy cooperative. In this case, the dairy farmers in Central Java Province were around 30,187 in 2010, and they were members of 21 dairy cooperatives. In West Java Province in the same year, the figure was 25,375 farmers with 23 dairy cooperatives.

The sample size of this research follows the rule of thumb of partial least squares (PLS) method. According to Chin (1998), the minimum sample size should be ten times the largest number of structural paths directed at a particular latent construct in the structural model. The conceptual model of this study (see Figure 1) only has three paths;
one path directed to the dependent (latent) variable of trust, one path directed to the dependent variable of loyalty, and one path directed to the dependent variable of financial and non-financial performance. Totally, it has five paths directed to the dependent variables. Based on this condition, the minimum sample size of this study should be 50 (the number of the structural paths directed to particular latent construct). This minimum requirement has been met since the sample size taken from Central Java and West Java was 100 and 70 dairy farmers, respectively. Later, a purposive sampling technique was chosen to select individual dairy farmers from each region. For this particular method, the respondent selection is based on some suitable characteristics of the sample members. The researcher chose the individual dairy farmers who have been members of the local dairy cooperative for at least one year.

3.2 Measures
There were 33 items used in this research. They were used to measure collaborative communication (3 items), power dependence (3 items), price satisfaction (11 items), trust (9 items), supplier loyalty (3 items), financial performance (four items), and non-financial performance (2 items). Items for measuring collaborative communication, power dependence, and supplier’s loyalty are developed by Boniface et al. (2010), while those for measuring price satisfaction are developed by Matzler et al. (2006). This research uses 11 items for measuring the price satisfaction because there are six dimensions of price satisfaction which should be represented in the questionnaire, i.e., price-quality ratio, price fairness, price transparency, price reliability, price confidence, and relative price, and each dimension of price satisfaction will be represented by minimal of one item. Then, the items for measuring trust are developed by Sako (1998), Boniface et al. (2010), and Kohli and Jensen (2010). Items for measuring financial and non-financial performance are developed by Boniface et al. (2010), Kohli and Jensen (2010), and O’Toole and Donaldson (2000).

This study used a five-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, and 5 = strongly agree) to measure the condition of all those items. In addition to anticipating the differences between the issue and sector addressed by the original questionnaires with the current condition of dairy supply chain in Indonesia, the experience gained with the dairy survey was used to improve the editorial of the questionnaire. However, there were no differences in questionnaire or scale used for collecting data in two provinces since the condition of dairy supply chain in there was quite similar.

3.3 Data analysis
The data were analyzed using PLS with the aid of the SmartPLS software. The SmartPLS is usually used to assess the convergent and discriminant validity and the reliability of the instrument, and thus the PLS path method generated by SmartPLS can test the hypothesized model.

4. Result
4.1 Participant characteristic
The descriptive statistic of participant characteristics from two provinces can be seen in Table I. Apparently, many respondents were male. The dairy farmers in Central Java Province were members of nine different dairy cooperatives while those in West Java Province belonged to four cooperatives. The respondents in Central Java are, on average, older than those in West Java because many of them are 41-60 years old compared to 31-50 years old in West Java. In both provinces, the respondents were most likely to have one to five dairy cows, followed by 6-10 dairy cows, 11-15, and finally, more...
than 15 dairy cows. A large proportion of respondents from Central Java Province had worked as dairy farmers for 21-30 years whereas those from West Java had worked for less than 10 years.

4.2 Measurement test

The measurement model was assessed by convergent and discriminant validity and reliability. To ensure convergent validity, this study has eliminated any items whose factor loadings were less than 0.5 (Fornell and Larcker, 1981).

After that, the loading factor of each item from each region is re-calculated. The final loading factor of each item and the AVE-value, the composite reliability (CR), and Cronbach’s $\alpha$ of each construct can be seen in Table III. Referring to Fornell and Larcker (1981), this research still accepts a construct with AVE-value less than 0.5 if that construct has a CR value higher than 0.6. As shown in Table III, both in Central Java and West Java Province, construct power dependency and price satisfaction has the AVE-value less than 0.5 but the CR-value higher than 0.6. It means that the construct of price satisfaction and
trust is not able to explain more than half of the variance of its indicators on average. The final iteration of convergent validity test indicated that all of the constructs have the CR and Cronbach’s α values above the threshold, which is 0.7 (Akter et al., 2011; Bagozzi and Yi, 1988). Based on this condition, the value of final loading factor indicated an adequate of convergent validity of each item and the CR and Cronbach’s α values indicated the satisfactory reliability of each construct Table II.

As seen in Table III, the items which have significantly contributed to power dependency, price satisfaction, trust, and business performance are different between two provinces. There are three items significantly contributed to the power dependency in Central Java Province; whereas, in West Java Province, there are two items only. Different to that in Central Java Province, in West Java Province, the item control of dairy cooperatives on the production information is not significantly contributed to power dependency of the dairy farmers to the cooperative. Then, there are six items significantly contributed to the price satisfaction in both provinces. All of the items are the same except two items. The item of price information understandable and comprehensible by the dairy farmers is not significantly contributed to price satisfaction in Central Java; whereas, in West Java Province, the item of price changes communicated timely by the dairy cooperative is not significantly contributed to price satisfaction. In constructing trust, all of the items are significantly contributed to the construct in Central Java Province; whereas, in West Java Province, there is one item not significantly contributed to trust; namely, the farmers can depend on the dairy cooperative when the farmers deal with the unfavorable condition. Last, there are two items not significantly contributed to business performance in Central Java Province, namely, the increased sales to milk processor and the increase of long-term profitability; whereas, in West Java Province, there is only one item not significantly contributed to business performance, i.e., the increase of return on investment.

Then, this research has used the cross-loading criterion to measure discriminant validity. In this case, the loading factor of each indicator should be greater than all of its cross-loadings (Chin, 1998). The results of the discriminant validity check can be seen in Table IV. Comparing the loading factor across the columns in Table IV, we can see the existence of discriminant validity between all the constructs.

4.3 Descriptive statistics

The descriptive results for each construct and items used in the research can be seen in Table V.

The West Java dairy farmers on average indicate a higher level of confidence in collaborative communication, price satisfaction, trust, and supplier loyalty than those of Central Java. Also, the West Java cooperatives on average show a higher level of confidence in business performance as a result of supplier loyalty. In contrast, the dairy farmers of Central Java on average have a higher level of confidence in power dependency than those of West Java. A possible explanation about it can be seen from the current ratio of the dairy farmers to the dairy cooperatives in each province, which is higher in Central Java (1.437) than in West Java (1.103). As this ratio could also indicate the degree of dependency, it tells us that the degree of dependency of dairy farmers to the dairy cooperative in West Java is lower than that in Central Java. Hence, the relationship and loyalty of dairy farmers and the dairy cooperative in West Java may not be as strong or significant as they are in Central Java. This condition may also explain the higher level of data dispersion in supplier loyalty for West Java dairy farmers compared to that for Central Java. Instead of supplier loyalty, the West Java dairy farmers on average indicate a lower level of data dispersion in collaborative communication, power dependency, and price satisfaction. The explanation of this condition can also be seen from the participant characteristics. Many of the respondents in Central Java are in 41-60 years old group
<table>
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<tr>
<th>Construct</th>
<th>Items Description</th>
<th>Central Java</th>
<th>West Java</th>
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<tbody>
<tr>
<td>Collaborative communication (CC)</td>
<td>Buyer (dairy cooperative) keeps the supplier (individual dairy farmer) informed regularly</td>
<td>0.8753</td>
<td>0.870</td>
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<tr>
<td></td>
<td>Buyer (dairy cooperative) and supplier (dairy individual farmer) frequently discuss each other’s expectations</td>
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<td>Buyer (dairy cooperative) and supplier (dairy individual farmer) share information regularly with one another</td>
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<td>Power dependency (PD)</td>
<td>Supplier (individual dairy farmer) feel that there is no alternative of buyer (dairy cooperative)</td>
<td>0.8089</td>
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<td>Supplier (individual dairy farmer) feel that buyer (dairy cooperative) controls all the production information</td>
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<td>Supplier (individual dairy farmer) feels that they cannot find other buyer to buy the milk yield</td>
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<td>Price satisfaction (PS)</td>
<td>Supplier (individual dairy farmer) certainty that the price offered is favorable</td>
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<td>Supplier (individual dairy farmer) properly informed about the prices of the services</td>
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<td>Price information is understandable and comprehensible</td>
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<td>Supplier (individual dairy farmer) get a good price-quality ratio</td>
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<td>The prices that supplier (individual farmer) get from dairy cooperative are fair (equal with the quality of milk offered by dairy farmer to the dairy cooperative)</td>
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<td>I am convinced that the prices and conditions of my dairy cooperative offered are profitable</td>
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<td>Terms and conditions of my dairy cooperative are better tailored to my needs than terms and conditions of other dairy cooperatives</td>
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<td>Prices and conditions offered by dairy cooperative do not change unexpectedly</td>
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<td>Price changes are communicated timely by dairy cooperative</td>
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<td>Terms and conditions are affordable for every individual dairy farmer. Independently of the duration of dairy farmer become a member of dairy cooperative</td>
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<td>My dairy cooperative does not take advantage of my condition</td>
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<td>Supplier (individual farmer) believe that the buyer (dairy cooperative) can handle the complaints quickly</td>
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<td>When it comes to condition that are unfavorable for supplier (individual farmer). The supplier can depend on their buyer’s (dairy cooperatives’) support</td>
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<td>When supplier (individual farmer) share the problems with the buyer (dairy cooperative). The dairy farmer know that their dairy cooperative will respond with understanding</td>
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<td>Though circumstances change such as the supplier (individual farmer) cannot supply a sufficient amount of milk. Dairy farmer believe that the dairy cooperative will be ready and willing to offer some assistance and support</td>
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<td>Buyer (dairy cooperative) always keep the promises that dairy cooperatives make to supplier (individual farmer)</td>
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<td>I am confident that buyer (dairy cooperative) gives full attention to the welfare of the supplier (individual farmer). Even when the buyer (dairy cooperative) must make an important decision</td>
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Table II. Result of the convergent validity test (the initial value of loading factor)
with 21-30 years duration of working as dairy farmers while they are in the group of 31-50 years old in West Java with less than 10-year experience as dairy farmers. Those two aspects can be a reason to justify that the dairy farmer in Central Java has different opinion about building the relationship with the dairy cooperative, which in turn make the data dispersion higher.

4.4 Structural model assessment
The validity of the structural model is assessed using the coefficient of determination ($R^2$) and goodness-of-fit (GoF) index. The result can be seen in Table VI.

The $R^2$ value indicates the amount of variance in the dependent variables explained by the independent variables, Chin (1998) has advocated that the $R^2$ values 0.63, 0.33, and 0.19 show substantial, moderate, and weak levels of determination, respectively. Thus, GoF index is crucial to assess the global validity of a PLS-based complex model. PLS does not have a formal GoF since it is a variance-based structural equation modeling. Therefore, the calculation of GoF refers to Tenenhaus et al.’s (2005) suggestion. GoF is defined as the geometric mean of the average communality and average $R^2$ for all endogenous constructs. According to Tenenhaus et al. (2005), the GoF values of 0.1, 0.25, and 0.36 show substantial, small, moderate, and high global validity of a PLS-based complex model.

4.5 Results of hypothesis testing
The results of hypothesis testing are shown in Table VII and Figure 2. In this study, the result may clearly show the significant relationship between independent variable
According to the results of the hypothesis testing, $H_1$, $H_3$, and $H_4$ are supported for Central Java and West Java Provinces; whereas, $H_2$ is only supported for West Java and $H_5$ is supported for Central Java Province only. It is worth noting that $H_5$ is accepted for West Java Province but not significant.

### 5. Discussion

Using the conceptual model of Boniface et al. (2010, 2012), the purpose of this research is to measure and evaluate the relationships between collaborative communication, power dependence, price satisfaction, trust, supplier loyalty, and business performance in two provinces of Indonesia. Although this research refers to the previous conceptual model (Boniface et al., 2010, 2012), there are some differences in the findings obtained if compared to those of Boniface et al. (2010, 2012). In the case of the two provinces, the result of hypothesis testing is in line with that of Boniface et al. (2010) in measuring the effect of

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## Table IV. The result of the discriminant validity check for Central Java Province and West Java Province based on cross-loading values generated from the final iteration

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<td>0.2424</td>
<td>0.3058</td>
<td>0.2258</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FP17</td>
<td>0.2819</td>
<td>0.7872</td>
<td>0.2094</td>
<td>0.1741</td>
<td>0.2765</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FP18</td>
<td>0.0650</td>
<td>0.8750</td>
<td>0.2424</td>
<td>0.3058</td>
<td>0.2258</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FP19</td>
<td>0.2819</td>
<td>0.7872</td>
<td>0.2094</td>
<td>0.1741</td>
<td>0.2765</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FP20</td>
<td>0.0650</td>
<td>0.8750</td>
<td>0.2424</td>
<td>0.3058</td>
<td>0.2258</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Trust, loyalty, and business performance**
collaborative communication and price satisfaction on trust and the effect of trust on supplier loyalty. In this case, better collaborative communication and better price satisfaction have a critical effect on dairy farmers’ trust on the dairy cooperative, which in turn will influence their loyalty to the dairy cooperative. However, the hypothesis testing in Central Java Province fails to prove the negative and significant effect of power dependency on trust, unlike that proven by Boniface et al. (2010). Meanwhile, in West Java Province, the result fails to support another relationship, that is, the positive and significant effect of supplier loyalty on business performance.

Related to the power dependency, the result of hypothesis testing in Central Java indicates a positive and significant effect of power dependency of the dairy farmer on the dairy cooperative, or we can say that power dependency does not make a negative effect on the relationship. This result is supported by the other researchers, such as Anderson and Weitz (1992), Handfield and Bechtel (2002), Wu et al. (2004), Payan and McFarland (2005), and Park and Lee (2014). According to Anderson and Weitz (1992), for example, when there

### Table V.
Descriptive statistics of each valid item

<table>
<thead>
<tr>
<th>Construct</th>
<th>Items</th>
<th>Central Java</th>
<th>West Java</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaborative communication (CC)</td>
<td>CC1 3.84</td>
<td>0.87</td>
<td>3.94</td>
</tr>
<tr>
<td></td>
<td>CC2 3.84</td>
<td>1.09</td>
<td>4.04</td>
</tr>
<tr>
<td></td>
<td>CC3 3.75</td>
<td>0.89</td>
<td>3.96</td>
</tr>
<tr>
<td>Power dependency (PD)</td>
<td>PD1 2.75</td>
<td>0.99</td>
<td>2.26</td>
</tr>
<tr>
<td></td>
<td>PD2 3.61</td>
<td>0.83</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>PD3 3.19</td>
<td>3.18</td>
<td>0.96</td>
</tr>
<tr>
<td>Price satisfaction (PS)</td>
<td>PS1 n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>PS2 3.62</td>
<td>0.91</td>
<td>3.83</td>
</tr>
<tr>
<td></td>
<td>PS3 n/a</td>
<td>n/a</td>
<td>4.06</td>
</tr>
<tr>
<td></td>
<td>PS4 3.73</td>
<td>0.97</td>
<td>4.01</td>
</tr>
<tr>
<td></td>
<td>PS5 3.66</td>
<td>0.73</td>
<td>3.90</td>
</tr>
<tr>
<td></td>
<td>PS6 3.81</td>
<td>0.86</td>
<td>3.89</td>
</tr>
<tr>
<td></td>
<td>PS7 n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>PS8 n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>PS9 3.64</td>
<td>0.89</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>PS10 n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>PS11 3.82</td>
<td>3.71</td>
<td>0.72</td>
</tr>
<tr>
<td>Trust (TR)</td>
<td>TR1 3.67</td>
<td>0.89</td>
<td>4.04</td>
</tr>
<tr>
<td></td>
<td>TR2 3.62</td>
<td>1.07</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>TR3 3.67</td>
<td>0.83</td>
<td>4.03</td>
</tr>
<tr>
<td></td>
<td>TR4 3.31</td>
<td>0.96</td>
<td>3.93</td>
</tr>
<tr>
<td></td>
<td>TR5 3.87</td>
<td>0.69</td>
<td>3.94</td>
</tr>
<tr>
<td></td>
<td>TR6 3.53</td>
<td>0.88</td>
<td>3.83</td>
</tr>
<tr>
<td></td>
<td>TR7 3.37</td>
<td>0.98</td>
<td>3.76</td>
</tr>
<tr>
<td></td>
<td>TR8 3.74</td>
<td>0.81</td>
<td>3.91</td>
</tr>
<tr>
<td></td>
<td>TR9 3.89</td>
<td>3.63</td>
<td>0.86</td>
</tr>
<tr>
<td>Supplier loyalty (SL)</td>
<td>SL1 3.46</td>
<td>0.66</td>
<td>3.64</td>
</tr>
<tr>
<td></td>
<td>SL2 3.77</td>
<td>0.75</td>
<td>3.79</td>
</tr>
<tr>
<td></td>
<td>SL3 3.48</td>
<td>3.57</td>
<td>0.78</td>
</tr>
<tr>
<td>Business performance (BF)</td>
<td>FP1 4.19</td>
<td>0.63</td>
<td>4.41</td>
</tr>
<tr>
<td></td>
<td>FP2 n/a</td>
<td>n/a</td>
<td>4.44</td>
</tr>
<tr>
<td></td>
<td>FP3 n/a</td>
<td>n/a</td>
<td>4.79</td>
</tr>
<tr>
<td></td>
<td>FP4 3.60</td>
<td>0.64</td>
<td>4.60</td>
</tr>
<tr>
<td></td>
<td>NF1 3.74</td>
<td>0.97</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>NF2 4.12</td>
<td>3.91</td>
<td>0.77</td>
</tr>
</tbody>
</table>

Note: Shaded cell indicate mean and deviation standard of the construct

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is a low level of dependence among the parties, there is no effort to enhance interaction, and the development of mutual trust between the partners is reduced. In contrast, high-dependency relationships entail information exchanges and extensive interaction, which in turn can enhance the trust between two parties. Wu et al. (2004) found that dependence provides the platform on which process integration can be developed. In other words, when a party is dependent, it should value the relationship and want to maintain it.

The explanation about the positive effect of power dependency on trust can be related with one of the potential sources of bias in research findings, namely, social desirability. It is important to know the sources of bias and, especially, when the bias is likely to be a problem. According to Crowne and Marlowe (1960), social desirability refers to the need for social approval and acceptance and the belief that can be attained using culturally acceptable and appropriate behaviors. It is viewed as the tendency of individuals to present themselves in a favorable light, regardless of their true feelings about a topic or issue. It is problematic, not only because of its potential to bias the answer of the respondent (i.e. to change the mean levels of the response) but also it may mask the true relationship between two or more variables (Ganster et al., 1983). In this research, social desirability is related with the norm of “pakewuh.” Internalization of this norm in individual behaviors is more intensive in Central Java than in West Java. This norm necessitates harmonious so reaction regarding potential conflicts should be avoided. In this situation, the more the dairy farmers

<table>
<thead>
<tr>
<th>Relationship</th>
<th>Central Java Province Loading factor</th>
<th>West Java Province Loading factor</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1 CC → TR</td>
<td>0.290 3.228 (0.000)</td>
<td>0.200 2.424 (0.015)</td>
<td>Accepted and significant for Central Java*** and West Java Province**</td>
</tr>
<tr>
<td>H2 PD → TR (−)</td>
<td>0.272 3.404 (0.000)</td>
<td>−0.17 1.799 (0.073)</td>
<td>Accepted and significant for West Java Province*; not accepted for Central Java Province</td>
</tr>
<tr>
<td>H3 PS → TR</td>
<td>0.425 5.198 (0.000)</td>
<td>0.477 5.683 (0.000)</td>
<td>Accepted and significant for Central Java and West Java Province***</td>
</tr>
<tr>
<td>H4 TR → LS</td>
<td>0.324 3.250 (0.001)</td>
<td>0.573 5.958 (0.000)</td>
<td>Accepted and significant at for Central Java and West Java Province***</td>
</tr>
<tr>
<td>H5 LS → BF</td>
<td>0.534 8.459 (0.000)</td>
<td>0.253 1.3948 (0.164)</td>
<td>Accepted and significant for Central Java Province***; accepted but not significant for West Java Province</td>
</tr>
</tbody>
</table>

**Notes:** Shaded cells indicate the differences of hypothesis acceptance between West Java and Central Java Province. *p-value < 0.1; **p-value < 0.05; ***p-value < 0.01

Table VI. The $R^2$ value and GoF index for hypothesized model

<table>
<thead>
<tr>
<th>Relationship</th>
<th>Central Java Province Loading factor</th>
<th>West Java Province Loading factor</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>SL → BP</td>
<td>0.285 (weak)</td>
<td>0.195 (weak)</td>
<td></td>
</tr>
<tr>
<td>TR → SL</td>
<td>0.195 (weak)</td>
<td>0.327 (moderate)</td>
<td></td>
</tr>
<tr>
<td>CC.PD.PS → TR</td>
<td>0.511 (moderate)</td>
<td>0.421 (moderate)</td>
<td></td>
</tr>
<tr>
<td>Complete (main effects) model</td>
<td>0.406 (large of global validity)b</td>
<td>0.438 (large of global validity)b</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:** The $R^2$ values 0.63, 0.33, and 0.19 show substantial, moderate, and weak levels of determination (Chin, 1998); the GoF value 0.1, 0.25, and 0.36 show substantial, small, moderate, and large of global validity of a PLS-based complex model (Tenenhaus et al., 2005)
depend on the dairy cooperative, the more the value of the relationship to be maintained by
the dairy farmers, which in turn they will trust the dairy cooperatives to avoid the conflict.
So, it is most probably that the norm of “pakewuh” shares to the bias of the Central Java
farmers when answering the questionnaire, which in turn masks the true relationship
between two or more variables.

Finally, related to the relationship between supplier loyalty and business performance,
the result of West Java indicates a positive effect of the loyalty of dairy farmers on the
business performance of the dairy cooperatives, but this effect is not significant. According
to Silvestro and Low (2006), the lack of correlation between loyalty measures and revenues
may be due to the customers’ perception on few market alternatives, and therefore their
willingness to stay with or recommend the company does not drive revenues. In the context
of this research, the lack of correlation between loyalties of dairy farmers to the business
performance of dairy cooperatives may also be due to the same reason and so is the
consequence. Even when dissatisfaction levels of dairy farmers are high, this may not
translate into a willingness to switch due to the dairy cooperative’s strong position (as the
majority of the dairy farmers cannot sell their product to the milk processor directly) and
the dearth of competitive alternatives. Explanation about this condition can also come from
the current situation of the dairy supply chain in Central Java and West Java Provinces. For
long-term profitability, some of the cooperatives in West Java (such as KPBSU Lembang)
have engaged in dairy processing activities as they are aware that much of the value-added
is created in the chain function.

This study has some implications for the dairy cooperative. Our research shows that
having supplier loyalty is one of the important factors to overcome the agency problem.
Without legally binding contract, the loyal dairy farmers may reduce their opportunism
behavior, which in turn can have positive impact on their business performance through
intention to supply better quality and quantity milk. Then, since trust is an important factor to make supplier loyal, and there are slightly different significant factors relevant to build trust on the dairy farmers in each province, it is better if the management of the dairy cooperatives in each province understands the critical factor to build trust of the farmers. In this sense, a collaborative communication with the dairy farmers through sharing information, discussing each other’s expectation, and also providing credible information about the relationships between offered price and the milk quality is needed. So, it is recommended that managers of dairy cooperatives always involve the farmers when making marketing decisions especially concerning prices, products, market, and promotion. As organizational stakeholders, their involvement is vital in determining the ability of the cooperative to achieve its goals.

Another recommendation is the managers of cooperatives must have a clear policy on the price of milk, and this policy should indicate the transparency and accountability. Other than satisfying their dairy farmers with the collaborative communication and price offered, it is recommended for the management of West Java cooperatives to balance the power between the farmers and the cooperative. The power balance may increase the trust of the dairy farmers since they believe that the cooperative will not act opportunistically to them. In contrast, as the social norm of “pakewuh” in Central Java has made the power dependency significant on increasing trust, it is recommended for the management of a cooperative to build positive dependency of the dairy farmers to the cooperative. Then, about the long-term benefit of the dairy cooperative, it is recommended for dairy cooperatives to add the value of the milk so they can access wider market, which in turn will maximize returns to the members. Based on this recommendation, it is better if the dairy cooperative in Indonesia not only serves as marketing cooperative but also as farm supply cooperative, which may process the milk into more valuable products.

6. Limitations and future research directions
This research has several limitations. First, the results of the study are not generalizable since the context of the study is the dairy industry with a limited number of samples. So, the conclusion may not be applicable to other regions or other types of industry. Second, the scoring method is only the Likert scale that can be the source of bias in expressing the level of business performance achieved by the dairy cooperative from the supplier loyalty. Third, this study has not discussed the improvement of business performance of dairy cooperative from the management side, which can also become a serious problem. So, the recommendations resulted from this research are limited to some efforts that should be made by the cooperative to improve the business performance through stronger relationship with the dairy farmers. In response to the limitations, a future research suggestion may lie in trying to replicate this study in other regions or contexts in the agribusiness sector such as the sugar industry, beef and livestock industry, and enhance the measurement of business performance of the dairy cooperative using a direct measurement of financial and non-financial performances rather than an indirect approach through the management’s perceptions of the cooperative’s performance. Moreover, future research may also broaden the scope, including the role of the management in improving the performance of dairy cooperatives.

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Measuring and explaining multi-directional inefficiency in the Malaysian dairy industry

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Chair Group Business Economics, Wageningen University and Research, Wageningen, The Netherlands

Abstract

Purpose – The purpose of this paper is to measure the technical inefficiency of dairy farms and subsequently investigate the factors affecting technical inefficiency in the Malaysian dairy industry.

Design/methodology/approach – This study uses multi-directional efficiency analysis to measure the technical inefficiency scores on a sample of 200 farm observations and single-bootstrap truncated regression model to define factors affecting technical inefficiency.

Findings – Managerial and program inefficiency scores are presented for intensive and semi-intensive production systems. The results reveal marked differences in the inefficiency scores across inputs and between production systems.

Practical implications – Intensive systems generally have lowest managerial and program inefficiency scores in the Malaysian dairy farming sector. Policy makers could use this information to advise dairy farmers to convert their farming system to the intensive system.

Social implications – The results suggest that the Malaysian Government should redefine its policy for providing farm finance and should target young farmers when designing training and extension programs in order to improve the performance of the dairy sector.

Originality/value – The existing literature on Southeast Asian dairy farming has neither focused on investigating input-specific efficiency nor on comparing managerial and program efficiency. This paper aims to fill this gap.

Keywords Malaysia, Dairy industry, Multi-directional efficiency analysis, Technical inefficiency

Paper type Research paper

Introduction

The demand for dairy products in the Asian region (including Malaysia) has doubled over the past decade. Currently, Malaysia still relies heavily on imports to satisfy its domestic demand for dairy products. Although milk production increased over the past decade, the growth was insufficient to meet the growing domestic demand for fresh milk. In 2012, domestic production accounted for only 14.06 percent of total consumption (DVS, 2012). Even though Malaysia does...
not have a comparative advantage in dairy production, the government uses tariffs to protect domestic markets and there is no export of dairy products to international markets (Peng and Cox, 2006). Recently, the dairy sector was selected by the Malaysian Government as an Entry Point Project (EPP) under the National Key Economics Area program. The EPP aims among other things to reduce Malaysia’s dependence on imported fresh milk in order to increase food security by forming dairy clusters under anchor companies to produce milk on a large-scale basis. The dairy industry can increase its production among others by improving the technical efficiency of the use of inputs such as land, feed, and labor. It remains a question though how dairy farms can improve their technical efficiency. Moreover, what factors determine the technical efficiency and for what inputs specifically can savings be obtained?

Dairy farming in Malaysia is practiced in two main types of production systems: the intensive and semi-intensive system (note that in practice, some farms might hinge on the borderline between them of course). In the intensive system, grazing animals are confined to a small area on which no feed is produced and the animals are fed on stored feed. Farmers feed their cattle following a schedule. In the semi-intensive system, animal graze on land that is also used for crop production. Ruminants, such as buffalo, cattle, and goats, are free to move under crop production, such as palm oil and rubber estate. This type of system uses less concentrated feed and labor, but requires more land than the intensive system. Intensive farms are more likely to have higher operational costs compared to semi-intensive farms. Hence, an analysis of technical efficiency of the Malaysian dairy industry should distinguish technical efficiency given the system under which the farm operates (intensive vs semi-intensive) from efficiency differences between the two systems. In what follows, this paper refers to the efficiency within a system as managerial efficiency whereas differences in efficiency between systems are referred to as program efficiency. This approach of program (and managerial) efficiency was conceived by Charnes et al. (1981). Agricultural program efficiency has been considered by, for example, Gómez-Limón et al. (2012), who estimated the program efficiency of traditional rain-fed mountain groves, traditional rain-fed plain groves, and irrigated intensive groves. Using the same approach, Beltrán-Esteve and Reig-Martínez (2014) assessed conventional and organic citrus grower efficiency in Spain.

According to Koopmans (1951), a producer is technically efficient if output can only be increased when at least one other output is reduced or at least one input is increased, or if a reduction in any input requires an increase in at least one other input or a reduction in at least one output. Producers directly benefit from improvements in input usage because more efficient farms tend to generate a higher income and have a better chance of staying in business (Bravo-Ureta and Rieger, 1991; Dartt et al., 1999; Lawson et al., 2004). Non-parametric methods, such as data envelopment analysis (DEA), calculate the individual efficiency scores of decision-making units – such as dairy farms – by relating each farm’s performance to a benchmark of the best practice farms (Tauer, 1993; Weersink et al., 1990). This paper uses a multi-directional efficiency analysis (MEA) instead, as this enables us to investigate in greater detail potential differences in input utilization. By calculating both managerial and program input-specific efficiency scores, this approach allows us to present a detailed overall idea about the differences among inputs and between farming systems. There are studies focusing on the technical efficiency of farms in Malaysia, for example, Serin et al. (2008) identified the efficiency of the resources used in the beef cattle production in Johor and Inuma et al. (1999) estimated the technical inefficiency of carp pond culture in Peninsula Malaysia. The existing literature on Malaysian dairy farming, however, has not investigated the efficiency of the use of inputs. Also, no study compared the managerial and program efficiency of Malaysian dairy farms. Performing such an analysis would provide valuable information to policy makers and business actors that aim at decreasing the dependence of Malaysia on dairy imports.

Therefore, the objectives of this study are: to estimate the input-specific technical inefficiency of Malaysian dairy farms in terms of both managerial and program inefficiency
and to identify the factors affecting the technical inefficiency scores. For the first step, the paper uses an MEA. For the second step, the managerial MEA inefficiency scores are regressed on potential determinants using a single-bootstrap truncated regression model. This is the first paper to analyze the inefficiency of dairy farming in Malaysia, using an MEA framework and a single-bootstrap truncated regression approach to explain observed differences in managerial inefficiency. Scrutinizing the role of technical inefficiency in Malaysian dairy production can serve as an example to other Asian countries, especially in Southeast Asia. First, they have a similar climate which is tropical-hot and humid all year round with plentiful rainfall. Second, most of the dairy herds in Asia are owned by smallholders. Finally, in most of the Asian tropics, cattle production systems are also primarily grass based with cows either allowed to graze freely or confined and provided with cut-and-carry harvested forages (Herath and Mohammad, 2009).

Materials and methods
This research adopts a two-stage approach. First, we employ MEA to measure technical inefficiency for specific inputs used in the production of milk on dairy farms in Malaysia. Second, a single-bootstrap truncated regression model is used to explain the determinants of technical inefficiency in Malaysian dairy farming. As there are two distinct production systems in our sample, we run the regression analysis separately for each system.

Multi-directional efficiency analysis
Following Bogetoft and Hougaard (1999) and Asmild et al. (2003), we identify a set of \( k = 1, \ldots, K \) farm observations. Each farm uses \( N \) inputs, \( x = (x_1, \ldots, x_N) \) and produces one output, \( y \) (total revenue). We assume a constant technology of production and that all farmers produce a homogenous product. In input-oriented MEA, an ideal point \((x^*, y^0)\) for the farm under analysis \((x_0, y_0)\) is first identified by considering sub-vector efficiencies for each dimension of the inputs separately, i.e. by solving five linear programming problems for \( i = 1, \ldots, N \) as follows:

\[
x_i^* = \min_{x_i} \lambda^i x_i
\]

s.t.:

\[
\sum_{k=1}^{K} \lambda^i_k x_i^k \leq x_i
\]

\[
\sum_{k=1}^{K} \lambda^i_{k-1} x_i^k \leq x_i^0
\]

\[
\sum_{k=1}^{K} \lambda^i_k x_i^k \geq y_i^0
\]

\[
\sum_{k=1}^{K} \lambda^i_k = 1
\]

\[
\lambda^i_k \geq 0, \quad k = 1, 2, \ldots, K,
\]

where \( \sum_{k=1}^{K} \lambda^i_k = 1 \) imposes variable returns to scale. Solving Equation (1) for each input provides the input coordinates of the ideal point, \( x^* = (x_1^*, x_2^*, x_3^*, x_4^*, x_5^*) \). Note that \( x^0 = x^* \) implies that \( x^0 \) is an efficient farm. Unlike DEA, where input adjustments are made in proportion to the input mix, MEA considers adjustments in proportion to the improvement.
potentials ($x^0 - x^*$) (Asmild et al., 2016). Thus, a vector of input-specific efficiencies is found by solving the following linear programming problem:

\[ \beta^* = \max_{\beta, \lambda} \beta \]

s.t.:

\begin{align*}
\sum_{k=1}^{K} \lambda^k x^k_i & \leq x^0_i - \beta (x^0_i - x^*_i), \quad i = 1, 2, 3, 4, 5 \\
\sum_{k=1}^{K} \lambda^k y^k & \geq y^0 \\
\sum_{k=1}^{K} \lambda^k & = 1 \\
\lambda^k & \geq 0, \quad k = 1, 2, \ldots, K
\end{align*}

and input-specific MEA inefficiency scores for farm $(x^0, y^0)$ are calculated as:

\[ i e_i = \frac{\beta^* (x^0_i - x^*_i)}{x^0_i}, \quad i = 1, 2, 3, 4, 5 \]

The inefficiency scores $(ie_i)$ take values between 0 and 1, where a value of 0 indicates no improvement potential on the variable in question when a firm is efficient, and 1 otherwise.

We follow Asmild et al. (2016), by using the MEA approach to estimate managerial and program inefficiency. The MEA managerial inefficiency scores are found by applying Equations (1) and (2) to each sub-sample of intensive and semi-intensive farms. Then, we replace the observations by their sub-sample-specific MEA benchmarks, $\tilde{x}_i^0 = (1 - i e_i x^0_i)$ for all $i$ to obtain a new set of observations. Running Equations (1) and (2) for this new set of observations provides the program inefficiency scores. Figure 1 illustrates the concept of MEA managerial and program inefficiency for two sub-groups ($K^1$ and $K^2$). In Figure 1, $x^0$ in $K^1$ is first projected onto frontier $K^1$, in the direction of the MEA ideal point, resulting in projection $\tilde{x}^0$. The difference between $x^0$ and $\tilde{x}^0$ is the absolute managerial inefficiency in each of the input dimensions. $\tilde{x}^0$ is subsequently projected onto the frontier of the full sample, $K = K^1 \cup K^2$, resulting in the projection $\tilde{\tilde{x}}^0$, and the difference between $\tilde{x}^0$ and $\tilde{\tilde{x}}^0$ is the absolute program inefficiency in the input dimension.

### Single-bootstrap truncated regression model

The single-bootstrap truncated regression method, developed by Simar and Wilson (2007), is used for the second stage of the analysis. Estimated DEA efficiency scores are serially correlated (Simar and Wilson, 2007; Xue and Harker, 1999) and hence using these scores in a standard ordinary least squares regression analysis results in a violation of the basic assumption of independence within the sample values (Simar and Wilson, 2011). Assuming that MEA scores are also serially correlated, we use a single-bootstrap regression model with left truncation to determine the factors affecting managerial inefficiency. The model for the single-bootstrap truncated regression is as follows:

\[ \hat{\delta}_i = Z_i \beta + e_i \]

where the dependent variable $\hat{\delta}_i$ is the estimated technical inefficiency score, $Z$ is a vector of independent variables, $\beta$ its associated vector of coefficients, and $e_i$ the
idiosyncratic error term. The intensive and semi-intensive systems have different management practices, thus we assume that the independent variables may affect inefficiency differently in each system. Hence, we run the single-bootstrap truncated regression separately for each system.

According to Simar and Wilson (2007), the confidence intervals for the coefficients of the second-stage regression, which are appropriate for inference, can be constructed as follows (Algorithm I):

1. Perform the MEA approach to get inefficiency score, \( \hat{\delta}_i \), for each firm \( i = 1, \ldots, n \).
2. Regress \( \hat{\delta}_i \) on the independent variables, \( Z_i \), using left truncation at 0 (i.e. only the inefficient observations are included) to obtain estimates \( \hat{\beta} \) and \( \hat{\sigma}_e \) of the parameters \( \beta \) and \( \sigma_e \).
3. Repeat the following three steps below \( B \) (1,000 bootstrap iterations) times to obtain a set of bootstrap estimates \( B^n = \{ (\hat{\beta}^*, \hat{\sigma}^*_e) \}_{b=1}^B \):
   - For each \( i = 1, \ldots, n \), draw \( \varepsilon^*_i \) from the \( N(0, \hat{\sigma}^2_e) \) distribution with left truncation at \( 0-Z_i \hat{\beta} \).
   - For each \( i = 1, \ldots, n \), compute \( \delta^*_i = Z_i \hat{\beta} + \varepsilon^*_i \).
   - Regress \( \delta^*_i \) on the independent variables, \( Z_i \), using left truncation at 0 to obtain \( \hat{\beta}^*_b \) and \( \hat{\sigma}^*_{e,b} \).
4. Obtain the mean and 95\% confidence interval of the \( \beta \)s and \( \sigma \).

Notes: For any point \( x^0 \) belonging to sub-group \( K^1 \), projecting it onto frontier \( K^1 \) results in projection \( \hat{x}^0 \); the difference between \( x^0 \) and \( \hat{x}^0 \) represents the absolute managerial inefficiency in each of the input dimensions. When \( \hat{x}^0 \) is subsequently projected onto the frontier of the full sample \( (K=K^1 \cup K^2) \), the projection \( x^0 \) is obtained; the difference between \( x^0 \) and \( \hat{x}^0 \) represents the absolute program inefficiency in each of the input dimensions.
Data description
We collected original data from Malaysian dairy farms using a two-stage stratified sampling design. First, we purposely selected four distinct production regions in Malaysia based on the most representative milk production: Johor (43), Negeri Sembilan (54), Selangor (42), and Melaka (61). Within each region, respondents were then chosen using two types of sampling: convenience sampling and random sampling\[1\]. For the convenience sampling, we waited for the farmers who were going to sell their milk to the PPIT. In order to reach our target sample of 200 respondents, we then turned to random sampling by randomly choosing dairy farmers from the complete list of dairy farms which was provided to us by the Department of Veterinary Services. Personal interviews were conducted among these owners or managers of dairy farms between February and June 2015. The questionnaire includes the use of dairy inputs and outputs, farm revenue, the material and equipment used for farming, socio-economic factors, farm characteristics, and transaction cost variables. Our final sample consists of 200 Malaysian dairy farms, classified into the intensive ($n = 100$) and semi-intensive ($n = 100$) systems. Our data are one-time cross-sectional data which reflect the activities of farmers in the production year 2014.

Data for the MEA
For the MEA, we consider one output and five inputs. Summary statistics for these variables are shown in Table I.

Output is total revenue calculated as the sum of annual sales of milk and cattle, other sales, and own consumption. The first two components are estimates provided by the farmers in the local currency Ringgit Malaysia (MYR). Own consumption, however, is measured as the product of average consumption per capita (36.89 liter in 2007, Food and Agriculture Organization), the number of family members, and the average selling price in the sample for milk sold to the state-owned enterprise, Dairy Industry Service Centre, and milk sold directly to consumers. The inputs are land, labor, herd size, feed, and other expenditure.

Land size is measured as the number of hectares used by the farmer for farming activities. Land also includes land rented for dairy activities. The land size ranged from 0.1 ha to 323.7 ha. The large variation in land size is due to the differences between intensive and semi-intensive systems.

Labor is defined as the total labor used for dairy activities, including family and hired labor but excluding the farm operator, measured in number of persons. Labor ranged from 0.1 to 12 persons.

Herd size is defined as the number of cows that a farmer owned and it is measured in tropical livestock units. Using tropical livestock units, we assumed that 1 calf is equivalent to 0.2 cow.

Feed is defined as the total cost of purchased feed for cattle and measured in MYR. The total value was obtained by asking farmers how much they spent annually on a few types of feed typically used for dairy farming in Malaysia (including an option “other”) and then adding all components.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unit</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total revenue</td>
<td>MYR10,000</td>
<td>13.95</td>
<td>11.81</td>
</tr>
<tr>
<td>Land</td>
<td>10 ha</td>
<td>7.07</td>
<td>13.71</td>
</tr>
<tr>
<td>Labor</td>
<td>Persons</td>
<td>3.09</td>
<td>1.51</td>
</tr>
<tr>
<td>Herd size</td>
<td>10 cows</td>
<td>3.15</td>
<td>1.92</td>
</tr>
<tr>
<td>Feed</td>
<td>MYR10,000</td>
<td>3.95</td>
<td>4.29</td>
</tr>
<tr>
<td>Other expenditure</td>
<td>MYR10,000</td>
<td>1.39</td>
<td>1.26</td>
</tr>
</tbody>
</table>

Note: Sample size = 200

Table I. Mean and standard deviation of output and inputs used in the multi-directional efficiency analysis (MEA) model
Other expenditures (in MYR) are defined as expenditures on other goods and services, which include farmers’ estimates of breeding expenses, veterinary services and medicines, farm maintenance, and other expenses.

Data for the single-bootstrap truncated regression model

The existing literature suggests that farming efficiency might be affected by variables such as age of the farmer (Binam et al., 2003; Heriqbaldi et al., 2014), years of experience (Tzouvelekas et al., 2002; Amaza and Olayemi, 2002), family size (Binam et al., 2003), off-farm employment (Wang et al., 2013), access to credit (Mlote et al., 2013), and availability of extension services (Mutai et al., 2013). The following paragraphs discuss each determinant considered in this study and its measurement in more detail. Table II presents summary statistics of the independent variables for our sample.

Farmer’s age may have a positive relation with technical inefficiency. Older farmers may not be up to date with new technology, machinery, and equipment, and may have less energy to conduct farm activities. For example, Coelli et al. (2002) found that younger rice farmers in Bangladesh were more efficient than older rice farmers. In this study, farmer’s age is measured as the age of the farmer in the year 2015.

Experience in dairy farming is expected to negatively affect inefficiency as it can be considered as informal training for farmers. Thus, an increase in experience is assumed to decrease the technical inefficiency of dairy farming. Singbo and Oude Lansink (2010) showed that technical inefficiency was negatively affected by the number of years of experience in lowland farming in Benin. Gelan and Murithi (2012) found that experience had a positive effect on the efficiency of dairy farms in East Africa. Experience is measured as the number of years the farm operator has been operating the dairy farm.

Hallam and Machado (1996) argued that there is little evidence that higher levels of facilities, machinery, or equipment (such as milking parlors and free-stall housing) are associated with increased efficiency. However, Filipovic and Kokaj (2009) found that using a milking machine instead of hand milking can increase work efficiency on small family farms in Croatia. Thus, having a larger number of portable milking machines is expected to decrease the technical inefficiency of dairy farms. We measured this variable as the number of portable milking machines available to farmers.

At the start of the development of the Malaysian dairy industry, the sector was heavily subsidized by government (Wells, 1981). However, in recent years, the government has gradually reduced subsidies to limit government dependency. Erjavec et al. (2003) showed that subsidies that are provided as a supplement to farm income can – as an unintended consequence – increase the level of technical inefficiency, as farmers might reduce their efforts. Similarly, Bojnec and Fertő (2013) showed that subsidies negatively impact farm technical efficiency, as acquiring subsidies makes the farmer less motivated. In this study, government finance is thus expected to have a positive influence on technical inefficiency. This variable is measured as the proportion of finance received from the government in total revenue (including the finance received from the government). Introducing subsidies in this way prevents any potential multicollinearity with the number of portable milking machines and allows for easy interpretation of its coefficient.

Table II.
Mean and standard deviation of variables used in the truncated bootstrap regressions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unit</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Years</td>
<td>44.25</td>
<td>11.2</td>
</tr>
<tr>
<td>Experience</td>
<td>Years</td>
<td>17.72</td>
<td>10.6</td>
</tr>
<tr>
<td>Portable milking machines</td>
<td>Number of machines</td>
<td>1.26</td>
<td>1.17</td>
</tr>
<tr>
<td>Government finance</td>
<td>Share of government finance in total farm revenue</td>
<td>0.06</td>
<td>0.09</td>
</tr>
</tbody>
</table>

Note: Sample size = 200
Results and discussion

Managerial efficiency analysis results

Using the General Algebraic Modeling System (2013) software package, MEA was applied to each sub-sample to determine the managerial inefficiency score for the intensive and semi-intensive systems. The mean and median scores of MEA input-specific managerial inefficiency are provided in Table III. As the distributions for all inputs are negatively skewed, we also provide the median values, which may give a better representation of central tendency than the mean. Intensive farms, on average, have input-specific managerial inefficiency scores of 0.590, 0.555, 0.499, 0.513, and 0.545 for land, labor, herd size, feed, and other expenditure, respectively. These results suggest that the intensive farms in our sample can reduce the use of land by 59 percent, labor by 56 percent, herd size by 50 percent, feed costs by 51 percent, and other expenditure by 55 percent and still produce the same level of revenue. The semi-intensive farms in our sample, on average, can reduce land by 62 percent, labor by 44 percent, herd size by 51 percent, feed by 57 percent, and other expenditure by 54 percent and still produce the same level of revenue.

This finding indicates the intensive farms are more managerially efficient than the semi-intensive farms for all inputs, except labor and other expenditure. For the intensive farms, land is the most inefficient input, followed by labor and other expenditure. Herd size has the lowest score for managerial inefficiency as expected because this system keeps animals in the shed, which makes it more convenient for a farmer to manage more animals. For the semi-intensive system, land has the highest score for managerial inefficiency, followed by feed, other expenditure, and herd size. Labor has the lowest score for managerial inefficiency for the semi-intensive system.

Overall, the MEA results show that the Malaysian dairy farms in both systems are technically inefficient in their use of inputs. This indicates that substantial amounts of input can be saved while maintaining the current level of output. Technical inefficiency of land is high for both systems. This can be explained by the routines of the farmers, as the farmers who have land are hesitant to use it for other activities such as planting a grass or other crop. Most farmers do not grow their own pasture. They tend to purchase feed or obtain it from abandoned land. Some of the farmers operate a large land area, especially in the semi-intensive system, and should consider having their own pasture area to maximize their land usage. For the intensive system, on average, labor has the second-highest inefficiency level, whereas labor has the lowest inefficiency level for the semi-intensive system. This was expected because the intensive system is more labor-intensive than the semi-intensive system. This implies that intensive farms can reduce labor by 56 percent and still produce the same output. Therefore, farmers could allocate this labor to other productive activities. Feed has the second-highest inefficiency in the semi-intensive system. This result implies

<table>
<thead>
<tr>
<th>Farming type</th>
<th>Land</th>
<th>Labor</th>
<th>Herd size</th>
<th>Feed</th>
<th>Other expenditure</th>
<th>Land</th>
<th>Labor</th>
<th>Herd size</th>
<th>Feed</th>
<th>Other expenditure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensive</td>
<td>Mean</td>
<td>0.590</td>
<td>0.555</td>
<td>0.499</td>
<td>0.513</td>
<td>0.545</td>
<td>0.013</td>
<td>0.001</td>
<td>0.011</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>0.713</td>
<td>0.647</td>
<td>0.581</td>
<td>0.597</td>
<td>0.657</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Semi-intensive</td>
<td>Mean</td>
<td>0.618</td>
<td>0.441</td>
<td>0.511</td>
<td>0.569</td>
<td>0.540</td>
<td>0.189</td>
<td>0.054</td>
<td>0.083</td>
<td>0.040</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>0.696</td>
<td>0.485</td>
<td>0.577</td>
<td>0.635</td>
<td>0.584</td>
<td>0.078</td>
<td>0.000</td>
<td>0.038</td>
<td>0.000</td>
</tr>
</tbody>
</table>

**Notes:** Sample size = 100 for each system. Managerial efficiency scores explain differences in efficiency within one system, whereas differences in efficiency between systems are reflected by the program efficiency scores. The addition of both scores presents the overall differences in inefficiency.

<table>
<thead>
<tr>
<th>Management type</th>
<th>Land</th>
<th>Labor</th>
<th>Herd size</th>
<th>Feed</th>
<th>Other expenditure</th>
<th>Land</th>
<th>Labor</th>
<th>Herd size</th>
<th>Feed</th>
<th>Other expenditure</th>
</tr>
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<td>0.000</td>
</tr>
<tr>
<td>Semi-intensive</td>
<td>Mean</td>
<td>0.618</td>
<td>0.441</td>
<td>0.511</td>
<td>0.569</td>
<td>0.540</td>
<td>0.189</td>
<td>0.054</td>
<td>0.083</td>
<td>0.040</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>0.696</td>
<td>0.485</td>
<td>0.577</td>
<td>0.635</td>
<td>0.584</td>
<td>0.078</td>
<td>0.000</td>
<td>0.038</td>
<td>0.000</td>
</tr>
</tbody>
</table>

**Table III.** Mean and median of managerial inefficiency and program inefficiency scores for intensive and semi-intensive systems.
that farmers can reduce feed by 63 percent and still produce the same output. This was expected, as farmers purchase large amounts of feed even though cattle are allowed to graze by themselves. This result suggests the farmers can limit their purchases of feed by better monitoring the amount of daily feed needed in order to better predict the total amount of feed required. The results also show that only nine farms in the intensive system and six farms in the semi-intensive are efficient.

Figure 2 shows the distribution of managerial inefficiency scores for the intensive and semi-intensive systems. The upper panel of Figure 2 shows that the patterns of inefficiency scores are quite similar across the different inputs in the intensive system. Farmers are mostly clustered at the 0.7 inefficiency level, especially for feed. The distribution of farmers is flatter in the middle classes (0.1 to 0.3). At the same time, there is a cluster of the most-efficient farmers at the 0 technical inefficiency level. The differences between average and median values in both systems suggest that distributions of inefficiency for all inputs are negatively skewed. The lower panel of Figure 2 shows that the patterns of inefficiency scores are less similar across inputs in the semi-intensive system. There is clustering of the most-efficient farmers at the 0.7 inefficiency level, especially for feed. The distribution of farmers is flatter in the middle classes (0.1 to 0.3). At the same time, there is a cluster of the most-efficient farmers at the 0 technical inefficiency level. The differences between average and median values in both systems suggest that distributions of inefficiency for all inputs are negatively skewed.
farmers at the 0 technical inefficiency level, especially for labor. The distribution of technical inefficiency scores is flatter (platykurtic) for labor compared to the other inputs. The difference in the distributions of technical inefficiency indicates that farmers perform differently in managing their inputs in the intensive and semi-intensive systems.

Program efficiency analysis results
The average program inefficiencies for the intensive and semi-intensive systems are shown in Table III. The program efficiency can be assessed by comparing managerial efficient units to the frontier spanned by both farm types. The program inefficiency scores for the intensive systems are very close to 0. Accordingly, the frontier for the intensive system is almost identical to the pooled frontier. This implies that the intensive system can be considered best practice in general. By considering program inefficiency, MEA shows that there are significant differences not only between farm types, but also between inputs. Across these two farm types, the highest – both managerial and program – inefficiency is on land, which suggests that farmers generally have enough land available to them but do not optimize the use of land. Intensive farms, on average, have lower program inefficiency scores than semi-intensive farms. This means that intensive farms perform better than semi-intensive farms. As the intensive system also has the lowest managerial inefficiency compared to the semi-intensive system, we conclude that the intensive system is the best-performing farm system. This may be due to differences in the mode of production, quality of feed, and breed of cattle. For the intensive system, the program inefficiency score of labor is the lowest, whereas the managerial inefficiency scores of labor are the second highest. For the semi-intensive system, land has the highest score for program inefficiency and other expenditure has the lowest program inefficiency score.

As the intensive system is already the preferred farming type in Malaysian dairy farming – 70 percent of dairy farmers run their farm using this system – there is some, albeit limited, scope for specific policies aimed at encouraging farmers to move from the semi-intensive to the intensive system. In addition, our results suggest that the program efficiency of the semi-intensive system could be improved as well, for example, through research on novel production technologies tailored to the semi-intensive setting and targeted training on farming activities.

Single-bootstrap truncated regression results
A single-bootstrap truncated regression model was estimated using the Stata software package (StataCorp., 2011). The results in Tables IV and V show the factors affecting the input-specific managerial technical inefficiency of dairy farming in Malaysia, for the intensive and semi-intensive systems. For the intensive system (Table IV), the number of portable milking machines has a negative relation with the inefficiency of land and herd size. This result implies that the number of portable milking machine units in dairy farming makes farmers more efficient in the use land and herd. This result is in line with a previous study by Castro et al. (2012), who found that use of an automatic milking machine (in this paper we refer to a portable milking machine) can increase milk production in Galicia, Spain. However, Steeneveld et al. (2012) found that an automatic milking machine did not affect the efficiency of Dutch dairy farms. The age of farmers has a positive relation with the technical inefficiency of labor. This result indicates that older farmers are ceteris paribus more inefficient. This result is in line with the study by Lachaal et al. (2002) in Tunisian dairy production, indicating that older farmers who lack motivation are less efficient. However, the result is inconsistent with the study by Zhengfei and Oude Lansink (2006) for Dutch agriculture. Experience has a negative relation with the technical inefficiency of other expenditure. This result indicates that more experience decreases the technical inefficiency
<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Land Lower</th>
<th>Land Upper</th>
<th>Labor Lower</th>
<th>Labor Upper</th>
<th>Herd size Lower</th>
<th>Herd size Upper</th>
<th>Feed Lower</th>
<th>Feed Upper</th>
<th>Other expenditure Lower</th>
<th>Other expenditure Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.003</td>
<td>-0.002</td>
<td>0.011</td>
<td>0.008</td>
<td>0.001</td>
<td>0.014</td>
<td>0.004</td>
<td>-0.002</td>
<td>0.009</td>
<td>0.001</td>
<td>-0.004</td>
</tr>
<tr>
<td>Experience</td>
<td>-0.006</td>
<td>-0.013</td>
<td>0.002</td>
<td>-0.005</td>
<td>-0.013</td>
<td>0.002</td>
<td>-0.005</td>
<td>-0.012</td>
<td>0.001</td>
<td>-0.002</td>
<td>-0.008</td>
</tr>
<tr>
<td>Portable milking machines</td>
<td>-0.050</td>
<td>-0.104</td>
<td>-0.000</td>
<td>-0.013</td>
<td>-0.068</td>
<td>0.039</td>
<td>-0.049*</td>
<td>-0.099</td>
<td>-0.007</td>
<td>-0.031</td>
<td>-0.075</td>
</tr>
<tr>
<td>Government finance</td>
<td>0.101</td>
<td>-0.519</td>
<td>0.695</td>
<td>-0.061</td>
<td>-0.737</td>
<td>0.558</td>
<td>0.151</td>
<td>-0.378</td>
<td>0.659</td>
<td>0.241</td>
<td>-0.302</td>
</tr>
<tr>
<td>Constant</td>
<td>0.617</td>
<td>0.348</td>
<td>0.880</td>
<td>0.356</td>
<td>0.047</td>
<td>0.644</td>
<td>0.518</td>
<td>0.273</td>
<td>0.743</td>
<td>0.552</td>
<td>0.319</td>
</tr>
<tr>
<td>σ</td>
<td>0.276</td>
<td>0.233</td>
<td>0.323</td>
<td>0.276</td>
<td>0.234</td>
<td>0.324</td>
<td>0.233</td>
<td>0.199</td>
<td>0.268</td>
<td>0.233</td>
<td>0.197</td>
</tr>
</tbody>
</table>

**Notes:** Sample size = 100. Lower and upper represent the bounds of a 95% confidence interval. Number of truncated observations: 9. We have no indication of the presence of multicollinearity (mean VIF = 1.29). *Significant at 5 percent level.
### Results of the truncated bootstrap regression model explaining differences in input-specific managerial inefficiency scores of semi-intensive farms

<table>
<thead>
<tr>
<th>Variables</th>
<th>Land</th>
<th></th>
<th>Labor</th>
<th></th>
<th>Herd size</th>
<th></th>
<th>Feed</th>
<th></th>
<th>Other expenditure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Lower</td>
<td>Upper</td>
<td>Mean</td>
<td>Lower</td>
<td>Upper</td>
<td>Mean</td>
<td>Lower</td>
<td>Upper</td>
</tr>
<tr>
<td>Age</td>
<td>0.005</td>
<td>-0.002</td>
<td>0.012</td>
<td>-0.003</td>
<td>-0.011</td>
<td>0.003</td>
<td>0.004</td>
<td>-0.002</td>
<td>0.010</td>
</tr>
<tr>
<td>Experience</td>
<td>-0.005</td>
<td>-0.012</td>
<td>0.003</td>
<td>-0.008</td>
<td>-0.002</td>
<td>0.006</td>
<td>0.004</td>
<td>-0.008</td>
<td>0.004</td>
</tr>
<tr>
<td>Portable milking machines</td>
<td>-0.070*</td>
<td>-0.143</td>
<td>-0.011</td>
<td>-0.054</td>
<td>-0.133</td>
<td>0.003</td>
<td>-0.035</td>
<td>-0.090</td>
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<tr>
<td>Government finance</td>
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<td>-0.037</td>
<td>1.375</td>
<td>-0.047</td>
<td>-0.814</td>
<td>0.687</td>
<td>0.562</td>
<td>-0.018</td>
<td>1.113</td>
</tr>
<tr>
<td>Constant</td>
<td>0.558</td>
<td>0.287</td>
<td>0.805</td>
<td>0.664</td>
<td>0.422</td>
<td>0.911</td>
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</tr>
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<td>0.265</td>
<td>0.221</td>
<td>0.321</td>
<td>0.230</td>
<td>0.193</td>
<td>0.268</td>
</tr>
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</table>

Notes: Sample size = 100. Lower and upper represent the bounds of a 95% confidence interval. Number of truncated observations: 6. We have no indication of the presence of multicollinearity (mean VIF = 1.29). *Significant at 5 percent level.
of a farmer in managing other expenditures. This is expected, because experience helps the farmers to better estimate the cost of other expenditures.

For the semi-intensive system (Table V), the number of portable milking machines has a negative relation with land and other expenditures. The coefficient of portable milking machines suggests that having more portable milking machines can reduce the technical inefficiency of land and other expenditure. Government finance has a positive association with technical inefficiency for feed. This result means that the greater the proportion of finance coming from government support, the greater the technical inefficiency of managing feed. As finance from the government is not only specific for feed, farmers can use it for other farming activities and this could result in a lower efficiency in managing feed. This result is in line with Karagiannis and Sarris (2002) for wheat and mixed arable crop in Greece, Zhu and Oude Lansink (2010) for German, Dutch, and Swedish crops farms, and Iraizoz et al. (2005) for Spanish livestock farms.

Conclusions
The objectives of this study were to investigate the technical inefficiency, decomposed into managerial and program inefficiencies, of dairy farming in Malaysia, and to identify the sources of managerial inefficiency. MEA was used to estimate technical inefficiency for individual inputs under variable returns to scale. The results for managerial inefficiency suggest that intensive farms can maintain their current production level and save 59 percent of land, 56 percent of labor, 50 percent of herd size, 51 percent of feed, and 55 percent of other expenditures. Semi-intensive farms, on average, can save 62 percent of land, 44 percent of labor, 51 percent of herd size, 57 percent of feed, and 54 percent of other expenditures and still produce the same level of output. The application of the MEA approach shows that there are substantial input-specific production inefficiencies among farms for both systems and these dairy farms could increase their production through the improvement of technical efficiency. These results show that valuable insight can be gained from the input-specific inefficiency scores, which are obtained using MEA, which could help farmers to identify which inputs were overused and hence should be reduced.

Our program efficiency MEA results furthermore show that there are significant differences not only in the levels of inefficiencies of the different inputs, but also between the two main farming types in Malaysia. Of the 100 dairy farms sampled for each system, only 9 percent of intensive farms and 6 percent of semi-intensive farms were fully efficient. Based on the percentage of fully efficient farms, farms are similar in efficiency between the two systems. Semi-intensive farms have higher inefficiency scores for all inputs except labor and other expenditure. Semi-intensive farms also have higher program inefficiency scores for all inputs. We therefore conclude that semi-intensive farms are managerially inefficient (except for labor and other expenditure; labor has the lowest inefficiency score among inputs for both systems) and also program inefficient. This may be because of different practices between the intensive and semi-intensive systems. The lower program inefficiency of semi-intensive farms suggests that additional efforts are needed to improve its performance, e.g. by additional research and development into improving technologies tailored to this system. Alternatively, policy makers could use this information to improve the efficiency of Malaysian dairy farmers by advising them to convert to the intensive system.

In the second stage of this study, single-bootstrap truncated regression models were used to investigate the factors affecting the input-specific managerial inefficiency scores. The results of the single-bootstrap truncated regression models for intensive system show the following: the number of portable milking machines has a negative relation with technical inefficiency scores of land and other expenditure, age has a positive relation with labor inefficiency, and experience has a negative relation with other expenditure. For the semi-intensive system, the number of portable milking machines has a negative relation
with technical inefficiency scores of land and other expenditure and government finance has a positive relation with the technical inefficiency score of feed. Government finance does not appear to improve farm efficiency, especially regarding feed input. This outcome suggests that the government should redefine its policy for providing farm finance. The government could consider providing portable milking machines instead of credit or other subsidies. In this case, extension officers can provide guidance to the farmers on how to use portable milking machines, as these farmers may not be familiar with this technology. Our results further suggest that Malaysian policy makers should target young farmers when designing training and extension programs.

The limitations of this study are that we have a limited number of observations and variables available to explain the differences in technical inefficiency. Future research could use samples stratified to not only get good estimates of input-specific inefficiency scores, but also to maximize observed differences in terms of explanatory variables. Future work could also focus on measuring (input-specific) technical inefficiency of production over time and explore additional explanatory variables that can explain the technical inefficiency scores in the single-bootstrap truncated regression analysis.

Note
1. The combination of convenience sampling and random sampling was chosen in favor of full random sampling in order to optimally make use of the time and budget available. The target sample size of 200 respondents was determined in the same vein and is in line with similar program/managerial inefficiency analysis studies (e.g. Gómez-Limón et al., 2012; Beltrán-Esteve and Reig-Martínez, 2014).

References


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Abstract

Purpose – The purpose of this paper is to estimate the elasticities of demand for different dairy products, such as fresh milk, powdered milk and yoghurt, in urban China.

Design/methodology/approach – The household survey data are drawn from the annual Urban Household Survey in a Chinese province from 2007 to 2009 by applying a three-stage budgeting approach with zero consumption.

Findings – The major findings show that fluid milk is the most popular dairy product among urban households in Guangdong province, China. Demand for fresh milk is price elastic with the highest value being −1.043, indicating that price-cutting promotion programs could be carried out by dairy enterprises to increase dairy consumption. With improvements in the living standards, the demand for dairy will lead to an expansion in the size of the dairy market and will simultaneously open up new development opportunities for dairy enterprises.

Originality/value – This study adopts an Almost Ideal Demand System model inserted into inverse Mills ratios in the third stage to resolve the common problem of obtaining censored data on zero consumption observations. The research findings will provide a reference for policy makers and for enterprises in developing some price-cutting promotion programs.

Keywords Dairy consumption, Inverse mills ratio, Multistage budgeting, Quadratic AIDS, Zero consumption

Paper type Research paper

1. Introduction

Recent economic growth has typically been accompanied by an increase in food expenditure among urban households. Meanwhile, rapid income growth is greatly changing the structure of Chinese food expenditure, as shown in the increased dairy demand (Bai et al., 2010). Based on detailed data from the China Statistical Yearbook, per capita annual purchasing of dairy products among urban households has increased from 4.63 kg in 1990 to 20.91 kg in 2012 – a 3.52-fold increase – due to greater awareness of the nutritional value of dairy. However, compared to the world average level (above 100 kg), per capita consumption of dairy products in China is still relatively low (Fuller et al., 2004). A considerable portion of urban households rarely or never consume dairy products, possibly due to the fact that low income households cannot afford healthy dairy products (including fresh milk, powdered milk and yoghurt),
or due to consumption habits and preferences. Hence, when investigating dairy consumption among urban households, we should not neglect the special group that consumes no dairy products.

Many previous studies on food consumption have concentrated on the influencing factors affecting Chinese households. For example, Bai et al. (2008) consider household income and dairy prices as two main factors influencing dairy consumption. Additionally, householder’s age, education level and household size are other important indicators shown to affect consumer behaviour. Wang et al. (2005) indicated that both younger and elderly members tend to consume more dairy products than do other household groups because dairy products are treated as nutritional supplements for children and the elderly. Few studies have captured the effects of regional dietary habits (regional culture) on consumption of dairy products. We will examine these factors to analyze the dairy demand among urban households in China.

In terms of the research method, some studies have adopted the linear expenditure system model, Almost Ideal Demand System (AIDS), or relevant extended forms to analyze the consumer behaviour (Katchova and Chern, 2004), but these models can hardly capture the non-linear relationship between food expenditure share and total household expenditure. In addition, few studies have obtained an unbiased estimation due to the difficulty of obtaining censored data on the consumption expenditure (Deaton and Irish, 1984; Cragg, 1971). For any given household, if there is zero expenditure on dairy products, implying a censored-dependent variable, we should not reduce these samples at will. This would result in a sampling bias. Therefore, the subsequent-biased elasticity will also lead to inaccurate guidance for government and the dairy industry. To address the problem of censored household survey data, we adopt a multistage budgeting approach, where a two-step procedure developed by Heien and Wessells (1990), namely, the HW two-step procedure is used to resolve the problem of zero consumption.

Although there have been many studies on consumer behaviour and food consumption demand in Jiangsu and Shanghai (Zheng and Henneberry, 2010), few studies have examined the regional consumption demand in urban households for different dairy products using the household survey data in Guangdong province, China. Therefore, the objective of this study is to estimate the elasticities of demand for different dairy items (i.e. fresh milk, powdered milk, and yoghurt) in urban areas of Guangdong province, China.

Guangdong, located in the southern region of China and adjacent to Hong Kong, is a major province with its gross domestic product (GDP) accounting for about 10.7 per cent of China’s national GDP. Guangdong’s per capita GDP was ranked 8th among 31 provinces in 2016. Guangdong offers, to some extent, urban households the convenience to consume imported milk. However, the level of dairy consumption among urban households is relatively low, indicating there is great potential for an increase in such consumption. According to the China Statistical Yearbook, the per capita annual consumption expenditure on dairy products in 2009 was 220.52 yuan (Chinese Renminbi) by urban households in this province, which is approximately 24.38 yuan higher than the national level (196.14 yuan), but approximately 141.21 yuan lower than that of similar metropolitan cities, such as Shanghai (361.73 yuan), for the same time period. Hence, investigating dairy consumption in the urban cities of Guangdong province may be representative and can provide insights into whether dairy consumption was affected by the 2008 Chinese melamine-tainted milk scandal (Qian et al., 2011).

In the following sections, the materials and methods are presented with a description of the sample data and selected variables, as well as the methodology of the multistage budgeting approach. The empirical results are given in Section 4; and finally, the last section summarizes the main empirical findings with a brief discussion of the policy implications.
2. Data

2.1 Data collection

The observation units of the sample data are drawn from the annual urban household survey conducted by NBS. The samples cover pooled data from 7,426 randomly selected households in urban areas of Guangdong province spanning the period of 2007-2009.

NBS conducts a nationwide urban household survey annually. Since 2002, the surveyed sample has included households registered in urban areas and those living there for at least six months but registered elsewhere, indicating that current survey data are more representative (Zheng and Henneberry, 2010). However, the data do not allow distinguishing between permanent urban households and migrants from rural areas. The samples in Guangdong province are distributed over 15 cities and prefectures, such as Guangzhou (829; the value in parentheses denotes the sample size hereafter), Shenzhen (1296), Dongguan (515), Foshan (733), Zhuhai (484), Heshan (454), Huizhou (454), Zhaoqing (300), Shantou (414), Puning (224), Zhanjiang (567), Dianbai (127), Shaoguan (486), Lianzhou (141) and Meizhou (591).

The survey presents information not only on demographic characteristics (i.e. household size and educational level), but also on total household income, living expenditure (including expenditure for different food items), and regional characteristics. The sampled households are supposed to indicate their total expenditure on food and non-food items, where the food items are divided into six categories: cereal, oil and fat, meat, dairy, egg, vegetable and fruit. Then, the three sub-items of fresh milk, powdered milk, and yoghourt are indicated as dairy items. The corresponding food prices, household expenditure, and total incomes are deflated by the consumer price indices based on 2007 data. In the samples, we derived a price for each food item by dividing expenditure by the corresponding quantity, a procedure followed in many previous studies (Pitt, 1983; Yen et al., 2004).

2.2 Dairy consumption in sampled households

As observed in all the sample data, the total food expenditure for six categories had increased from 6,918.95 to 8,085.62 yuan, in correlation with rising household income, increasing from 55,773.29 to 65,294.07 yuan during the period of 2007-2009. Per capita annual purchasing of dairy products among urban households had also increased from 423.01 yuan in 2007 to 595.96 yuan in 2009, a rise of 40.89 per cent.

Due to the greater purchasing power and changes in consumption preferences of urban households, dairy consumption has gradually become a part of the Chinese diet, but consumption levels are lower than that in developed countries, with vegetable and fruit, cereal, and meat being the main food items consumed in the sampled households. In general, the annual average dairy consumption was 35.18 kg in sampled households, with a maximum of 395.70 kg. A total of 1,261 households had purchased less than 10 kg of dairy products for consumption (a sample fraction of 16.98 per cent).

As for specific dairy items, the highest consumption was fresh milk, and the average consumption per capita by household was 26.49 kg, followed by yoghourt (6.42 kg) and powdered milk (2.27 kg). More specifically, about 232 households indicated no expenditure on fresh milk, accounting for 3.12 per cent of the surveyed samples during the three years, while a total of 585 households had purchased less than 1 kg of dairy products. As to powdered milk, approximately 20.56 per cent of the households had not purchased powdered milk for consumption. For a given urban household, the maximum demand for powdered milk consumption was 83.50 kg per year. In terms of yoghourt, there were 989 households that did not report that they consumed yoghourt (about 13.32 per cent), and the highest consumption in our samples was 234.50 kg.

With regard to the dairy consumption structure, urban households in Guangdong province purchased mostly fluid milk (including fresh milk and yoghourt), and fresh milk was more popular with the highest consumption proportion due to changes in consumer
tastes and preferences affecting consumer behaviour. Nevertheless, the average consumption of powdered milk was lower than other dairy items. It may be the case that only those families consume powdered milk who have younger and elderly members, as they are more susceptible to various health problems and believe that drinking powdered milk will strengthen their bones. Consequently, exploring the factors that affect urban households’ consumption of dairy products is important.

3. Method
To analyze the demand for dairy products, we use a three-stage budgeting approach. This approach addresses a common problem in empirical estimation of demand system models including a sizeable number of equations (Jabarin, 2005). Budget allocation in our case includes three stages, where the first one is composed of the choice between food and non-food products. In the second stage, cereal, oil and fat, meat, dairy, egg, vegetable and fruit are combined into the food category. The third stage contains the different kinds of dairy products, which are clustered into three main groups: fresh milk, powdered milk, and yoghurt (Figure 1). From this budgeting framework, we can see that households allocate their total expenditure in sequential stages, and there is likely to be zero consumption in some specific categories for urban households. Thus, the common problem of censored data on zero consumption observations should be considered in the empirical model to avoid estimated bias (Yen and Lin, 2006).

3.1 Stage 1: Engel model for food expenditure
In the first stage, we established an Engel model for food expenditure as follows:

\[
M = \Gamma_0 + \Gamma_1 \ln Y + \Gamma_2 (\ln Y)^2 + \Gamma_3 FS + \sum_{k=1}^{2} d_{t_k} Edu_k + \delta C + \sum_{k=1}^{3} d_{t_k} Time_k + \sum_{k=1}^{3} dz_k Zone_k + \zeta
\]

where \(M\) is the food expenditure share in total expenditure in the urban cities of Guangdong province; \(\ln Y\) the natural logarithm of average total annual family income, and its quadratic

![Figure 1. A three-stage budgeting framework for estimation of dairy demand](image-url)
form $\ln Y^*$ is also included in Equation (1) to capture the nonparametric Engel curve for food shares. $FS$ denotes the family size (number); $Edu_k$ the dummy variable indicating the householder’s education level. $Edu_1$ represents those householders who have a middle level of education, and $Edu_2$ shows the householders who have a high school (or equivalent) level of education, compared to those with up to three years college (or higher) education ($Edu_3$). $C$ denotes the urban household structure, which equals 1 if a family has elderly or young; and 0 if otherwise. $Time_k$ represents the time dummy variables from 2007 to 2009 ($2007 = 1$), and $Zone_k$ are the economic zones divided into four groups: the east ($Zone_1$), the west ($Zone_2$), the mountains of northern Guangdong province ($Zone_3$) and the Pearl River Delta ($Zone_4$) as the reference group. $G_0, G_1, G_2, G_3, dt_k, \delta, dz_k$ and $dz_k$ are the corresponding parameters to be estimated. $\zeta$ is the stochastic disturbance term.

Based on Equation (1), food expenditure elasticity with respect to total household income ($\Omega$) is calculated as:

$$\Omega = (\Gamma_1 + 2 \times \Gamma_2 \times \ln Y)/M + 1 \quad (2)$$

3.2 Stage 2: quadratic AIDS model for dairy expenditure

We adopt the quadratic Almost Ideal Demand System (QUAIDS) model to analyze the share of dairy expenditure in the second stage. Because Poi (2002) had figured out that the model selection between AIDS and QUAIDS can be done by using a hypothesis testing – if all parameters of the quadratic expenditure terms are jointly significant – the QUAIDS model is preferable. In our sampled households, the quadratic food terms are statistically significant. As for a more flexible extension of AIDS model, the QUAIDS model includes a quadratic expenditure term (Blundell et al., 1993; Garcia et al., 2005). Many previous studies have used the linear expenditure system or AIDS model to analyze how households are influenced in their choices of food, but these models can hardly capture the non-linear patterns (Katchova and Chern, 2004), especially when the income gap among households is a little higher. This model could be better used to show the non-linear relationship between share of expenditure on food items and total food expenditure.

Therefore, the QUAIDS model for the share of food expenditure can be expressed as:

$$w_i^f = x_i + \sum_{j=1}^{k} \gamma_{ij} \ln P^j_f + \beta_i \ln \left[ \frac{m}{P(\bar{p})} \right] + \lambda_i \left( \ln \left[ \frac{m}{P(\bar{p})} \right] \right)^2 + \Gamma_i FS$$

$$+ \sum_{j=1}^{2} \delta_{ij} Edu_k + \delta_i C + \sum_{j=1}^{2} dt_{ij} Time_j + \sum_{j=1}^{3} dz_{ij} Zone_j + \zeta_i \quad (3)$$

where $w_i^f$ is the expenditure on food item $i$ for urban household in Guangdong province, and must be satisfied by using the restriction: $\sum_i w_i^f = 1$; $\alpha$, $\gamma_{ij}$, $\beta_i$, $\Gamma_i$, $\delta_{ij}$, $dt_k$, $\delta_i$, $dz_k$ and $dz_{ij}$ are the parameters to be estimated; $\zeta_i$ the stochastic disturbance term; $P^j_f$ the price of food item $j$; $P(\bar{p})$ the general price index, defined by:

$$\ln P(\bar{p}) = x_0 + \sum_{i=1}^{k} z_i \ln P_i + 1/2 \sum_{i=1}^{k} \sum_{j=1}^{k} \gamma_{ij} \ln P_i \ln P_j \quad (4)$$

where $k = 1, 2, 3, \ldots, n$; and $b(\bar{p})$ can be obtained by: $b(\bar{p}) = \prod_{i=1}^{k} P_i^{b_i}$.  

In Equation (3), $m$ denotes the total food expenditure, and can be obtained as: $m = M^e$, to resolve the measurement error problem, where $M^e$ is the predicted value of food expenditure share ($M$) in stage one and $e$ is the total household expenditure (Blundell and Meghir, 1987; Dey et al., 2011). Other variables are defined in Equation (1).
The following restrictions of the consumer theory are imposed on the parameters of the QUAIDS model:

**Adding-up:**

\[ \sum_{i=1}^{k} \alpha_i = 1, \quad \sum_{i=1}^{k} \beta_i = 0, \quad \sum_{i=1}^{k} \lambda_i = 0, \quad \sum_{i=1}^{k} \gamma_{ij} = 0, \]
\[ \sum_{i=1}^{k} \Gamma_i = 0, \quad \sum_{i=1}^{k} \delta_i = 0, \quad \sum_{i=1}^{k} d_i = 0, \quad \sum_{i=1}^{k} d_j = 0. \]  

(5)

**Homogeneity:**

\[ \sum_{j=1}^{k} \gamma_{ij} = 0 \]  

(6)

And symmetry:

\[ \gamma_{ij} = \gamma_{ji}, \quad i \neq j \]  

(7)

The expenditure elasticity, Marshallian (uncompensated) and Hicksian (compensated) elasticities can be calculated from the estimated parameters of the QUAIDS model using Equations (8), (9), and (12), respectively.

**Dairy expenditure elasticity with respect to food expenditure (conditional expenditure elasticity):**

\[ e_{ij}^m = \mu_{ij}/w_i^f + 1 \]  

(8)

**Marshallian elasticity:**

\[ e_{ij}^m = \mu_{ij}/w_i^f - \delta_{ij} \]  

(9)

where \( \delta_{ij} \) is the Kronecker delta, for \( i = j, \delta_{ij} = 1 \); for \( i \neq j, \delta_{ij} = 0, \mu_i \) and \( \mu_{ij} \) can be computed as:

\[ \mu_i = \frac{\hat{c}w_i^f}{\partial \ln m} = \beta_i + \frac{2\lambda_i}{b(p)} \left\{ \ln \left[ \frac{m}{P(p)} \right] \right\} \]  

(10)

\[ \mu_{ij} = \frac{\hat{c}w_i^f}{\partial \ln p_j^f} = \gamma_{ij} - \mu_i \left( \gamma_j + \sum_k \gamma_{jk} \ln p_k^f \right) \frac{\lambda_i \beta_j}{b(p)} \left\{ \ln \left[ \frac{m}{P(p)} \right] \right\}^2 \]  

(11)

**Hicksian elasticity:**

\[ \delta_{ij} = e_{ij}^c + e_{ij}^m w_i^f \]  

(12)

As specified above, the QUAIDS model includes six simultaneous equations. The adding-up conditions imply a singular variance-covariance matrix for the disturbances if all the \( n = 6 \) demand equations are estimated simultaneously. The normal procedure is to delete one of the equations, since the parameters of that relation can be computed residually from the others by virtue of the formula for the adding-up restriction. Barten (1969) showed that it makes no differences which equation is dropped. In our study, the equation for vegetable and fruit is arbitrarily dropped and the share equations are estimated by means of the non-linear seemingly unrelated regression (NSUR) method. The parameters for the deleted equation can
be estimated by the restrictions shown in Equations (5), (6), and (7). Then, the expenditure
elasticity, Marshallian and Hicksian price elasticities for the last food item are calculated using
the following adding-up restrictions (Deaton and Irish, 1984; Zheng and Henneberry, 2010):

$$
\sum_{i=1}^{N} w_i x_i = 1, \sum_{i=1}^{N} w_i e_i = 1, \sum_{j=1}^{N} e_{ij} + e_i = 0
$$

(13)

According to Equations (2) and (8), we can obtain the dairy expenditure elasticity with
respect to total household income (unconditional expenditure elasticity) in urban Guangdong province as below:

$$
\theta_i = e_i \Omega
$$

(14)

3.3 Stage 3: HW two-step procedure for a specific dairy item
The third stage is determining how households allocate their dairy expenditure according to
specific dairy item i, where 19.83 per cent of the surveyed households had zero expenditure
on powdered milk, and approximately 13.25 per cent did not consume yoghurt. Thus, the
estimation procedure for this stage takes into account the correction of the sample selection
bias created by the presence of zero consumption of certain dairy categories. Following
Dey et al. (2011) and Garcia et al. (2005), we utilize the extended Heckman procedure
(namely HW estimation procedure) to resolve the issue of zero consumption.

The HW estimation procedure has two steps. First, a probit model is used to determine
whether household i consumes dairy items, and is given by:

$$
H_i = f \left( m^*, p_j, FS, Edu_k, C, Time_k \right)
$$

$$
= \tau_0 + \tau_1 \ln m^* + \sum_{j=1}^{3} \tau_{ij} \ln p_j + \tau_2 FS + \sum_{k=1}^{2} \tau_{ek} Edu_k + \tau C + \sum_{k=1}^{2} \tau t_k Time_k + u_i
$$

(15)

where the binary variable $H_i$ is equal to 1, if the ith household consumes the ith dairy item;
otherwise $H_i = 0$ (e.g. $i =$ fresh milk, powdered milk, yoghurt). $p_j$ is the corresponding price
for any one of the three dairy items; $\tau_0, \tau_1, \tau_2, \tau_{ij}, \tau_{ek}$ and $\tau$ are parameters to be estimated;
u_i is the stochastic disturbance term. The remaining variables are defined as follows, where
$m^*$ denotes the total dairy expenditure, and can be computed as: $m^* = e M$, to remove the
measurement error biases (Blundell and Meghir, 1987; Dey et al., 2011); and e is total household expenditure; $M$ is the predicted value of dairy expenditure share derived from the
following Equation (16) to resolve the possibility of the existence of expenditure endogeneity
(Zheng and Henneberry, 2010):

$$
M = \theta_0 + \theta_1 \ln Y + \theta_2 (\ln Y)^2 + \theta_3 FS + \sum_{k=1}^{2} \theta_{ek} Edu_k + \theta C + \sum_{k=1}^{2} \theta t_k Time_k
$$

$$
+ \sum_{k=1}^{3} \theta_{sk} Zone_k + \zeta
$$

(16)

According to Equation (15), the inverse Mills ratios (IMRs) for each household that
consumes the ith dairy are derived as follows:

$$
IMR_i = \frac{\phi \left( m^*, P_j, FS, Edu_k, C, Time_k \right)}{\Phi \left( m^*, P_j, FS, Edu_k, C, Time_k \right)}
$$

(17)
where \( \phi \) and \( \Phi \) are the standard normal density and cumulative distribution functions, respectively. The IMR for those households that do not consume the \( i \)th dairy is obtained as follows:

\[
IMR_i = \frac{\phi(m^*, P_j, FS, Edu_k, C, Time_k)}{1 - \Phi(m^*, P_j, FS, Edu_k, C, Time_k)}
\]  

Then, the calculated IMR for each dairy item is included in the second step of HW estimation procedure. In this step, the hypothesis testing of the model selection between AIDS and QUADS is also done, the quadratic dairy expenditure terms are not statistically significant. Thus, the AIDS model presented by Deaton and Muellbauer (1980), which does not include the quadratic term, is more preferable as shown in below:

\[
w_i = \alpha_i + \sum_{j=1}^{k} \gamma_{ij} \ln p_j + \beta_i \ln \left( \frac{m^*}{P(p)} \right) + \Gamma_j FS + \sum_{j=1}^{2} \delta_{ij} Edu_j + \delta_i C + \sum_{j=1}^{2} dt_i Time_j + \lambda_i IMR_i + \zeta_i
\]  

where \( w_i \) is the household’s share of expenditure on different dairy items, satisfied with: \( \Sigma w_i = 1; \ \zeta_i \) is the stochastic disturbance term; \( \alpha_i, \gamma_{ij}, \beta_i, \Gamma_j, \delta_{ij}, \delta_i, dt_i \) and \( \lambda_i \) are the parameters to be estimated; \( p_j \) the price of fresh milk, powdered milk, and yoghurt \((j=1,2,3)\), respectively; \( P(p) \) is the general price index, computed as:

\[
\ln P(p) = a_0 + \sum_{i=1}^{k} \alpha_i \ln p_i + \frac{1}{2} \sum_{i=1}^{k} \sum_{j=1}^{k} \gamma_{ij} \ln p_i \ln p_j
\]  

To comply with the economic theory, the following restrictions are imposed on the AIDS model:

Adding-up:

\[
\sum_{i=1}^{k} \alpha_i = 1, \ \sum_{i=1}^{k} \gamma_{ij} = 0, \ \sum_{i=1}^{k} \beta_i = 0, \ \sum_{j=1}^{k} \Gamma_j = 0,
\]

\[
\sum_{i=1}^{k} \delta_{ij} = 0, \ \sum_{i=1}^{k} \delta_i = 0, \ \sum_{i=1}^{k} dt_i = 0
\]  

and the IMRs would require that (Pollak and Wales, 1978):

\[
\sum_{i=1}^{k} d\lambda_i IMR_i = 0
\]  

Homogeneity:

\[
\sum_{j=1}^{k} \gamma_{ij} = 0
\]  

And symmetry:

\[
\gamma_{ij} = \gamma_{ji}, \ i \neq j
\]
To preserve the adding-up property, we specify the third (deleted) relation estimated using the seemingly unrelated regression (SUR) as follows:

\[
\begin{align*}
    w_i &= z_i + \sum_{j=1}^{k} \gamma_{ij} \ln P_j + \beta_i \ln \left[ \frac{m^*}{P^*(p)} \right] + \Gamma_jF + \sum_{j=1}^{2} d_{ij} \ln E_{dj} + \delta_iC + \sum_{j=1}^{2} d_{ij} \ln Time_j \\
    &= \sum_{j=1}^{k-1} d_{ij} \ln IMR_j + \zeta_i
\end{align*}
\]

(25)

where the corresponding parameters can be computed using the restrictions shown in Equations (21-24).

When calculating the elasticities for different dairy items, one should note that the IMR is the function of \( x \) (denoted \( IMR = f(x) \)). Therefore, we should not neglect to take the derivative of IMR as \( x \), otherwise we will get a biased result. This point is particularly important and often neglected in many studies (Dey et al., 2011). The revised elasticities are provided as follows:

1. Conditional expenditure elasticity for each dairy item (\( e_i \)):

\[
    e_i = \frac{\partial (w_i m^*)}{\partial m^*} \frac{m^*}{w_i m^*} = \left[ \frac{\partial w_i}{\partial (\ln m^*)} + w_i \right] \times \frac{1}{w_i} = 1 + \frac{\beta_i + \psi_i}{w_i} \tag{26}
\]

where \( \psi_i \) is derived as:

\[
    \psi_i = \frac{\partial w_i}{\partial IMR_i} \frac{\partial IMR_i}{\partial (\ln m^*)} = d_{i} \times (-IMR_i) \times \left( H_i^* + IMR_i \right) \times \tau_1 \quad \text{for } H_i = 1 \tag{27}
\]

\[
    \psi_i = \frac{\partial w_i}{\partial IMR_i} \frac{\partial IMR_i}{\partial (\ln m^*)} = d_{i} \times (-IMR_i) \times \left( H_i^* - IMR_i \right) \times \tau_1 \quad \text{for } H_i = 0 \tag{28}
\]

where \( d_{i} \) is the parameter of IMR in AIDS model; \( \tau_1 \) is the parameter of \( \ln m^* \) in the Probit model (the first-step of HW estimation procedure); \( H_i^* \) is the predicted value of \( H_i \).

2. Uncompensated Marshallian price elasticities for each dairy item (\( e_{ij} \)):

\[
    e_{ij} = \frac{\partial (\ln q_j)}{\partial (\ln p_j)} = \frac{\partial (\ln w_i)}{\partial (\ln p_i)} \times \frac{\partial w_i}{\partial (\ln p_i)} - \delta_{ij} \tag{29}
\]

where \( \delta_{ij} \) is computed as:

\[
    \delta_{ij} = \frac{\partial (\ln q_j)}{\partial (\ln p_j)} = \frac{\partial (\ln w_i)}{\partial (\ln p_i)} \times \frac{\partial q_j}{\partial (\ln p_j)} \tag{30}
\]

\[
    \delta_{ij} = \frac{\partial w_i}{\partial IMR_i} \frac{\partial IMR_i}{\partial (\ln p_i)} = d_{i} \times (-IMR_i) \times \left( H_i^* + IMR_i \right) \times \tau_j \quad \text{for } H_i = 1 \tag{31}
\]

\[
    \delta_{ij} = \frac{\partial w_i}{\partial IMR_i} \frac{\partial IMR_i}{\partial (\ln p_i)} = d_{i} \times (-IMR_i) \times \left( H_i^* - IMR_i \right) \times \tau_j \quad \text{for } H_i = 0 \tag{32}
\]

where \( \tau_j \) is the parameter of \( \ln p_j \) in the Probit model; \( \delta_{ij} \) the Kronecker’s \( \delta \), for \( i \neq j \), \( \delta_{ij} = 1 \); for \( i = j \), \( \delta_{ij} = 0 \).
Compensated Hicksian price elasticities for each dairy item ($e_{ij}^c$):

$$e_{ij}^c = e_{ij}^d + e_{ij} w_j \tag{32}$$

The expenditure and own-price elasticities for the last dairy item can be computed using the three restrictions in Equation (13).

(4) Unconditional income elasticity for each dairy item ($\Pi_i$).

The income elasticity for each dairy item can be derived from Equations (2), (8) and (26) as shown in below:

$$\Pi_i = \Omega_i m e_i \tag{33}$$

4. Empirical results

4.1 Estimates of the three-stage budgeting estimation approach

We applied the three-stage budgeting estimation approach to estimate the food expenditure share in the first stage by using the Engel model. The food expenditure share was considered as a function including household income (also including its quadratic term), household characteristics (such as family size, householder’s education level, household structure), and the time and zone dummy variables. This function had been estimated according to the ordinary least square method. Based on the empirical results (Table I), all of the parameters were statistically significant at the 1 per cent level.

The second stage used in this study was the QUAIDS model, which allowed to determine whether the goods are necessities or luxuries, compared to the AIDS model (Garcia et al., 2005). In the final two stages, we use the Wald test to conduct a model selection between the QUAIDS form in Equation (3) and the AIDS form in Equation (19). The Wald test indicates that the model specification of QUAIDS is preferable in the second stage (Table II), because the coefficients of the square terms of food expenditure are jointly statistically significantly different from zero, supporting the non-linear nature of a specific type of food expenditure. This demand system could be estimated by NSUR with the 6th (deleted) equation of “vegetable and fruit”. The parameter estimates for the deleted equation can be constructed by the restrictions shown in the Methodology. In this stage,

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnY</td>
<td>0.183***</td>
<td>(0.023)</td>
</tr>
<tr>
<td>(lnY)^2</td>
<td>-0.012***</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Edu1</td>
<td>0.034***</td>
<td>(0.002)</td>
</tr>
<tr>
<td>Edu2</td>
<td>0.018***</td>
<td>(0.002)</td>
</tr>
<tr>
<td>FS</td>
<td>0.012***</td>
<td>(0.001)</td>
</tr>
<tr>
<td>C</td>
<td>0.007***</td>
<td>(0.002)</td>
</tr>
<tr>
<td>Zone2</td>
<td>0.033***</td>
<td>(0.003)</td>
</tr>
<tr>
<td>Zone3</td>
<td>0.022***</td>
<td>(0.003)</td>
</tr>
<tr>
<td>Zone4</td>
<td>0.054***</td>
<td>(0.003)</td>
</tr>
<tr>
<td>Time2</td>
<td>0.025***</td>
<td>(0.002)</td>
</tr>
<tr>
<td>Time3</td>
<td>0.018***</td>
<td>(0.002)</td>
</tr>
</tbody>
</table>

Obs 7,426
F-value 532.84
Prob > F 0.00

Notes: SE means robust standard errors shown in parentheses; similarly hereinafter. *,**,***Significant at the 10, 5 and 1 per cent levels, respectively; similarly hereinafter
we considered that each household allocated a proportion of their food expenditure to dairy. The dependent variables, as the expenditure shares for the six food items, were positive for each household. From Table III, we can see that most of the parameters are statistically significant at the 1 per cent level.

We considered the HW two-step procedure to analyze the shares of expenditure on different dairy items in the third stage. This stage had two steps due to the problem of zero consumption, where the first step involved making estimates using the Probit model, and the second step involved making estimated using the AIDS model inserted into the IMR. The IMRs were all significant in the three equations, implying that the insertion of this variable into the AIDS model to correct for sampling bias was effective (Poi, 2002). Moreover, from the Wald test of model specification (Table II), a null hypothesis that the coefficients of the square terms of dairy expenditure are not jointly statistically significant was found. The linear AIDS model was estimated by SUR with the deleted equation of “yoghourt”. The dependent variables included the binary variable of consuming or not consuming the three dairy products and the corresponding consumption per year. From the estimates of the two steps (Tables IV-V), our hypothesis on the independent variables' influence on shares of dairy expenditure was empirically demonstrated.

4.2 Elasticities calculated in the three stages

Stage 1: food expenditure elasticity with respect to total household income. Food expenditure elasticity with respect to total household income ($\Omega$) was calculated using Equation (2).

<table>
<thead>
<tr>
<th>Test</th>
<th>Null hypothesis</th>
<th>$\chi^2$ value</th>
<th>p-value</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wald test of QUAIDS model in the second stage</td>
<td>The coefficients of the square terms of food expenditure are not jointly statistically significant</td>
<td>19.94</td>
<td>0.001</td>
<td>Reject</td>
</tr>
<tr>
<td>Wald test of AIDS model in the third stage</td>
<td>The coefficients of the square terms of dairy expenditure are not jointly statistically significant</td>
<td>4.94</td>
<td>0.085</td>
<td>Accept</td>
</tr>
</tbody>
</table>

### Table II.

Wald test of model specification between QUAIDS and AIDS

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cereal</th>
<th>Oil and fat</th>
<th>Meat</th>
<th>Egg</th>
<th>Dairy</th>
<th>Vegetable and fruit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Edu_1$</td>
<td>0.035***</td>
<td>0.011*</td>
<td>0.140***</td>
<td>0.002</td>
<td>-0.170***</td>
<td>-0.018</td>
</tr>
<tr>
<td>$Edu_2$</td>
<td>0.025***</td>
<td>0.010</td>
<td>0.114***</td>
<td>-0.005</td>
<td>-0.126***</td>
<td>-0.018</td>
</tr>
<tr>
<td>$FS$</td>
<td>0.007</td>
<td>0.001</td>
<td>0.042***</td>
<td>0.001</td>
<td>-0.002***</td>
<td>-0.022***</td>
</tr>
<tr>
<td>$C$</td>
<td>-0.023***</td>
<td>0.016***</td>
<td>-0.014</td>
<td>0.001</td>
<td>0.081***</td>
<td>-0.062***</td>
</tr>
<tr>
<td>$Zone_2$</td>
<td>0.125***</td>
<td>0.094***</td>
<td>0.738***</td>
<td>0.040***</td>
<td>-0.402***</td>
<td>-0.595***</td>
</tr>
<tr>
<td>$Zone_3$</td>
<td>0.287***</td>
<td>-0.100***</td>
<td>0.617***</td>
<td>-0.023</td>
<td>-0.314***</td>
<td>-0.466***</td>
</tr>
<tr>
<td>$Zone_4$</td>
<td>0.133***</td>
<td>0.262***</td>
<td>0.391***</td>
<td>0.006</td>
<td>-0.267***</td>
<td>-0.529***</td>
</tr>
<tr>
<td>$Time_2$</td>
<td>-0.089***</td>
<td>0.046***</td>
<td>0.021</td>
<td>0.003</td>
<td>-0.003</td>
<td>0.022</td>
</tr>
<tr>
<td>$Time_3$</td>
<td>0.046***</td>
<td>-0.083***</td>
<td>0.138***</td>
<td>-0.002</td>
<td>0.005</td>
<td>-0.104***</td>
</tr>
<tr>
<td>$lnP_{1k}$</td>
<td>0.587***</td>
<td>0.102***</td>
<td>1.255***</td>
<td>0.112***</td>
<td>0.054***</td>
<td>-0.017*</td>
</tr>
<tr>
<td>$lnP_{2k}$</td>
<td>-0.242***</td>
<td>0.112***</td>
<td>-0.088***</td>
<td>0.112***</td>
<td>-0.039</td>
<td>0.335***</td>
</tr>
<tr>
<td>$lnP_{3k}$</td>
<td>0.039</td>
<td>-0.026***</td>
<td>0.258***</td>
<td>-0.010***</td>
<td>-0.272***</td>
<td>-0.005</td>
</tr>
<tr>
<td>$lnP_{4k}$</td>
<td>-0.008</td>
<td>-0.001</td>
<td>0.044***</td>
<td>-0.001</td>
<td>0.040*</td>
<td>0.022</td>
</tr>
<tr>
<td>$lnP_{5k}$</td>
<td>0.112***</td>
<td>-0.001</td>
<td>0.044***</td>
<td>-0.001**</td>
<td>0.044***</td>
<td>0.022</td>
</tr>
<tr>
<td>$lnP_{6k}$</td>
<td>0.046***</td>
<td>-0.001</td>
<td>1.255***</td>
<td>-0.001</td>
<td>0.008</td>
<td>-0.001</td>
</tr>
</tbody>
</table>

### Table III.

Estimates for different food consumption using the QUAIDS model (stage 2)

Notes: $lnP_{1k}-lnP_{6k}$ denotes the log prices of cereal, oil and fat, meat, egg, dairy, vegetable and fruit; $lnx$ denotes $ln(m/P)$; $(lnx)^2$ denotes $(ln(m/P))^2$. The parameters were expanded by about ten times only in this table.
This food expenditure elasticity indicates that an increase in household income results in an increase in food expenditure. As shown in Table VI, food expenditure elasticity was positive at a 1 per cent significance level, indicating that a 1 per cent increase in income caused a 0.686 per cent increase in food expenditure.

Analysis of dairy demand in urban China

<table>
<thead>
<tr>
<th>Variable</th>
<th>Fresh milk</th>
<th>SE</th>
<th>Powdered milk</th>
<th>SE</th>
<th>Yoghourt</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnP_{1k}</td>
<td>-0.593***</td>
<td>(0.115)</td>
<td>0.617***</td>
<td>(0.098)</td>
<td>0.349***</td>
<td>(0.108)</td>
</tr>
<tr>
<td>lnP_{2k}</td>
<td>0.480***</td>
<td>(0.064)</td>
<td>-0.352***</td>
<td>(0.035)</td>
<td>0.372***</td>
<td>(0.047)</td>
</tr>
<tr>
<td>lnP_{3k}</td>
<td>0.119</td>
<td>(0.119)</td>
<td>0.028</td>
<td>(0.069)</td>
<td>0.374***</td>
<td>(0.063)</td>
</tr>
<tr>
<td>Imr*</td>
<td>0.388***</td>
<td>(0.048)</td>
<td>-0.142***</td>
<td>(0.029)</td>
<td>0.325***</td>
<td>(0.033)</td>
</tr>
<tr>
<td>Edu1</td>
<td>0.049</td>
<td>(0.085)</td>
<td>0.034</td>
<td>(0.047)</td>
<td>-0.094*</td>
<td>(0.052)</td>
</tr>
<tr>
<td>Edu2</td>
<td>-0.019</td>
<td>(0.078)</td>
<td>-0.074*</td>
<td>(0.041)</td>
<td>-0.072</td>
<td>(0.047)</td>
</tr>
<tr>
<td>FS</td>
<td>-0.088***</td>
<td>(0.032)</td>
<td>0.033*</td>
<td>(0.019)</td>
<td>-0.085***</td>
<td>(0.021)</td>
</tr>
<tr>
<td>C</td>
<td>-0.025</td>
<td>(0.067)</td>
<td>0.213***</td>
<td>(0.037)</td>
<td>-0.076*</td>
<td>(0.042)</td>
</tr>
<tr>
<td>Time2</td>
<td>-0.169*</td>
<td>(0.092)</td>
<td>0.322***</td>
<td>(0.048)</td>
<td>-0.379***</td>
<td>(0.057)</td>
</tr>
<tr>
<td>Time3</td>
<td>-0.365***</td>
<td>(0.088)</td>
<td>0.254***</td>
<td>(0.047)</td>
<td>-0.280***</td>
<td>(0.057)</td>
</tr>
<tr>
<td>Wald (\chi^2)</td>
<td>150.23</td>
<td>205.68</td>
<td>227.32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prob &gt; (\chi^2)</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: \(lnP_{1k} - lnP_{3k}\) denote the log prices of fresh milk, powdered milk, and yoghourt; \(lnx\) denotes \(ln[m/P(p)]\). The SE of IMR regard to yoghourt (the deleted equation) in AIDS model could not be only confirmed, thus, the SE here indicated the standard deviation calculated by the definition.

Table V.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Fresh milk</th>
<th>SE</th>
<th>Powdered milk</th>
<th>SE</th>
<th>Yoghourt</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edu1</td>
<td>0.007</td>
<td>(0.008)</td>
<td>-0.009</td>
<td>(0.006)</td>
<td>0.002</td>
<td>(0.007)</td>
</tr>
<tr>
<td>Edu2</td>
<td>0.028***</td>
<td>(0.007)</td>
<td>-0.015***</td>
<td>(0.005)</td>
<td>-0.012**</td>
<td>(0.006)</td>
</tr>
<tr>
<td>FS</td>
<td>-0.013***</td>
<td>(0.003)</td>
<td>0.012***</td>
<td>(0.003)</td>
<td>0.001</td>
<td>(0.003)</td>
</tr>
<tr>
<td>C</td>
<td>-0.012*</td>
<td>(0.007)</td>
<td>-0.001</td>
<td>(0.005)</td>
<td>0.013*</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Time2</td>
<td>-0.037***</td>
<td>(0.008)</td>
<td>0.072***</td>
<td>(0.006)</td>
<td>-0.037***</td>
<td>(0.007)</td>
</tr>
<tr>
<td>Time3</td>
<td>-0.046***</td>
<td>(0.008)</td>
<td>0.082***</td>
<td>(0.006)</td>
<td>-0.036***</td>
<td>(0.007)</td>
</tr>
<tr>
<td>lnP_{1k}</td>
<td>0.015</td>
<td>(0.015)</td>
<td>0.127***</td>
<td>(0.007)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>lnP_{2k}</td>
<td>-0.069***</td>
<td>(0.007)</td>
<td>0.054***</td>
<td>(0.012)</td>
<td>0.003</td>
<td>(0.011)</td>
</tr>
<tr>
<td>lnP_{3k}</td>
<td>0.064***</td>
<td>(0.012)</td>
<td>-0.053***</td>
<td>(0.006)</td>
<td>0.008*</td>
<td>(0.004)</td>
</tr>
<tr>
<td>lnx</td>
<td>0.028***</td>
<td>(0.005)</td>
<td>-0.036***</td>
<td>(0.004)</td>
<td>0.067***</td>
<td>(0.050)</td>
</tr>
<tr>
<td>IMR</td>
<td>-0.235***</td>
<td>(0.004)</td>
<td>-0.453***</td>
<td>(0.004)</td>
<td>0.008*</td>
<td>(0.004)</td>
</tr>
</tbody>
</table>

Table IV.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Conditional expenditure</td>
<td>1.008***</td>
<td>0.960***</td>
<td>0.982***</td>
<td>0.978***</td>
<td>1.057***</td>
<td>1.017***</td>
</tr>
<tr>
<td>elasticity</td>
<td>(0.006)</td>
<td>(0.009)</td>
<td>(0.004)</td>
<td>(0.008)</td>
<td>(0.015)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>Marshallian own-price elasticity</td>
<td>-0.614***</td>
<td>-0.831***</td>
<td>-0.673***</td>
<td>-0.616***</td>
<td>-0.498***</td>
<td>-0.665***</td>
</tr>
<tr>
<td>Hicksian own-price elasticity</td>
<td>(0.021)</td>
<td>(0.031)</td>
<td>(0.018)</td>
<td>(0.048)</td>
<td>(0.030)</td>
<td>(0.016)</td>
</tr>
<tr>
<td>Unconditional expenditure elasticity</td>
<td>0.691***</td>
<td>0.658***</td>
<td>0.673***</td>
<td>0.670***</td>
<td>0.725***</td>
<td>0.697***</td>
</tr>
<tr>
<td>Food expenditure elasticity with respect to total household income (Ω)</td>
<td>0.686***</td>
<td>(0.008)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Stage 2: expenditure elasticity and price elasticities of demand for dairy. The conditional and unconditional expenditure elasticities as well as Marshallian and Hicksian elasticities for different food items (including dairy products) were presented in Table VI, calculated using Equations (8), (14), (9) and (12), respectively.

The conditional expenditure elasticities show that an increase in food expenditure will cause an increase in expenditure on different food items. From comparing the expenditure elasticities in Table VII with those that also used the NBS urban household survey data (Gould, 2002; Liu and Chern, 2003; Zhang and Wang, 2003; Yen et al., 2004; Zheng and Henneberry, 2010), the estimates for oil and fat, meat in this study were a little lower than those reported by previous studies, ranging between 0.98 and 1.37 (Liu and Chern, 2003; Zhang and Wang, 2003; Yen et al., 2004; Gould and Villarreal, 2006) and 1.04 (Zheng and Henneberry, 2010), respectively. The expenditure elasticities for the remaining food categories from this study were in the range of estimates reported by past studies (listed above). The differences between the expenditure elasticities given by our study and those reported in others might be mainly attributable to the differences in model selection, the make-up of food categories in the demand system, and date selection. Particularly, our study captures the non-linear version of the AIDS model and considers the possibility of expenditure endogeneity.

The relatively large positive and statistically significant expenditure elasticities for the six food categories in our study indicate that income is a notable driving force in urban Guangdong province (Table VII). If the current price structure remains constant, expenditure on the studied food products is expected to grow as urban household incomes continue to rise. However, the increase in demand in response to an increase in food expenditure varies across products. The demand for dairy product is expected to grow by a greater magnitude than the other food categories included in our study, as the conditional expenditure elasticity for dairy was the highest among the six food items with an estimate of 1.057. Our result was very similar to the estimate of 1.055 reported by Liu and Chern (2003) and Gould and Villarreal (2006).

The Marshallian own-price elasticity indicates that a change in the price of specified food items will result in a change in the demand. As shown in Table VI, the Marshallian own-price elasticities of demand for different food items were all price-inelastic with estimates between 0.498 and 0.831. Compared to those reported by past studies, own-price elasticities for cereal, meat and eggs from our study were slightly smaller in absolute value. Furthermore, the own-price elasticity of dairy products, at −0.498 on average, was lower than that in most of the previous studies (Table VII). Our estimate denoted that the effect of changes in dairy prices on consumption was small, which may be a reflection of the food preferences of consumers in Guangdong. One possible reason may be that demand for dairy among urban households is rigid due to consumption inertia. Moreover, special groups such as seniors, children, patients, and pregnant women have gradually become major consumers of dairy products. Thus, the price of dairy might not play an important role in consumer purchasing decisions. The unconditional expenditure elasticities of different food items with respect to total household income were also presented in Table VI, indicating that changes in household income will result in corresponding changes in consumption of different food items. These values were statistically positive but inelastic at the 1 per cent significance level, which ranged from 0.658 to 0.725. In addition, the unconditional expenditure elasticity of dairy was the highest with an estimate of 0.725, denoting that urban households would spend more on dairy products accompanied by rising household incomes.

Stage 3: expenditure elasticity and price elasticities of demand for each dairy item.

The conditional expenditure elasticity, Marshallian and Hicksian elasticities as well as unconditional elasticity of income for each dairy item are presented in Table VIII, calculated using Equations (26), (29), (32) and (33), respectively.
### Table VII

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Liu and Chern</th>
<th>Zhang and Wang</th>
<th>Yen et al.</th>
<th>Gould and Villarreal</th>
<th>Zheng and Henneberry</th>
<th>This study</th>
<th>Liu and Chern</th>
<th>Zhang and Wang</th>
<th>Yen et al.</th>
<th>Gould and Villarreal</th>
<th>Zheng and Henneberry</th>
<th>This study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereal</td>
<td>1.18</td>
<td>0.82</td>
<td>0.79</td>
<td>1.008</td>
<td>-0.75</td>
<td>-0.90</td>
<td>-1.22</td>
<td>-0.62</td>
<td>-0.83</td>
<td>-1.31</td>
<td>-0.85</td>
<td>-0.67</td>
</tr>
<tr>
<td>Rice</td>
<td>1.14</td>
<td>1.13</td>
<td>0.72</td>
<td>0.960</td>
<td>-0.97</td>
<td>-0.53</td>
<td>-0.72</td>
<td>-0.21</td>
<td>-0.67</td>
<td>-1.31</td>
<td>-0.85</td>
<td>-0.67</td>
</tr>
<tr>
<td>Wheat</td>
<td>1.09</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-1.00</td>
<td>-0.96</td>
<td>-0.97</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other grains</td>
<td>1.03</td>
<td>0.99</td>
<td>1.37</td>
<td>1.04</td>
<td>0.982</td>
<td>-0.92</td>
<td>-0.72</td>
<td>-0.21</td>
<td>-0.67</td>
<td>-1.31</td>
<td>-0.85</td>
<td>-0.67</td>
</tr>
<tr>
<td>Oil and fat</td>
<td>1.17</td>
<td>1.14</td>
<td>1.18</td>
<td>-1.00</td>
<td>-0.28</td>
<td>-0.96</td>
<td>-0.97</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meat</td>
<td>1.09</td>
<td>0.97</td>
<td>1.17</td>
<td>1.04</td>
<td>0.982</td>
<td>-0.92</td>
<td>-0.72</td>
<td>-0.21</td>
<td>-0.67</td>
<td>-1.31</td>
<td>-0.85</td>
<td>-0.67</td>
</tr>
<tr>
<td>Pork</td>
<td>1.09</td>
<td>0.97</td>
<td>1.17</td>
<td>1.04</td>
<td>0.982</td>
<td>-0.92</td>
<td>-0.72</td>
<td>-0.21</td>
<td>-0.67</td>
<td>-1.31</td>
<td>-0.85</td>
<td>-0.67</td>
</tr>
<tr>
<td>Beef</td>
<td>0.89</td>
<td>1.04</td>
<td>0.90</td>
<td>0.82</td>
<td>0.978</td>
<td>-0.91</td>
<td>-0.85</td>
<td>-0.70</td>
<td>-0.68</td>
<td>-0.85</td>
<td>-0.616</td>
<td></td>
</tr>
<tr>
<td>Egg</td>
<td>1.05</td>
<td>1.19</td>
<td>1.40</td>
<td>1.37</td>
<td>1.057</td>
<td>-1.07</td>
<td>-1.07</td>
<td>-1.40</td>
<td>-0.44</td>
<td>-1.21</td>
<td>-0.498</td>
<td></td>
</tr>
<tr>
<td>Dairy</td>
<td>1.05</td>
<td>1.19</td>
<td>1.40</td>
<td>1.37</td>
<td>1.057</td>
<td>-1.07</td>
<td>-1.07</td>
<td>-1.40</td>
<td>-0.44</td>
<td>-1.21</td>
<td>-0.498</td>
<td></td>
</tr>
<tr>
<td>Vegetable and fruit</td>
<td>0.87</td>
<td>1.11</td>
<td>0.83</td>
<td>0.96</td>
<td>0.81</td>
<td>-0.64</td>
<td>-0.73</td>
<td>-0.72</td>
<td>-0.64</td>
<td>-0.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vegetable</td>
<td>0.92</td>
<td>0.96</td>
<td>0.80</td>
<td>0.79</td>
<td>0.98</td>
<td>-0.60</td>
<td>-0.85</td>
<td>-0.76</td>
<td>-0.60</td>
<td>-0.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Elasticity comparisons of different food items between this study and other studies.
The results in Table VIII show that the estimated elasticities of each dairy item were all statistically positive at the 1 per cent significance level. Furthermore, the expenditure on fresh milk and yoghurt was found to be elastic with estimates of 1.075 and 1.080, respectively. The expenditure on powdered milk was less elastic with a value of 0.881. Our estimates indicated that yoghurt was the most popular dairy product among urban households in Guangdong province, whereby household expenditure on dairy products has risen.

Among the Marshallian own-price elasticities for each dairy item in Table VIII, there exist differences in own-price elasticities among various dairy products. The own-price elasticity for fresh milk gave a value of −1.043, which is higher than the estimates for powdered milk (−0.724) and yoghurt (−0.855). To stimulate dairy consumption, the government should implement measures to reduce the high prices of fresh milk to keep the dairy market stable. As for dairy enterprises, some price-cutting programs could be carried out to promote the fluid dairy consumption. In contrast to the other two dairy products, the effect of price changes on the demand for powdered milk was relatively low. The reason may be that, first, employed women with infant children in China often face a dilemma when they go to work not being able to breastfeed their babies. Thus, they have to choose powdered milk as an effective substitute (Wu et al., 2014). To some extent, price changes in powdered milk have little impact on its consumption. Second, in contrast to fluid milk (such as fresh milk and yoghurt), the majority of households can purchase powdered milk for longer-term storage. Therefore, changes in the price of powder milk have little effect on its consumption.

Compared to previous studies, the own-price elasticity of powdered milk in our study was small, whereas Zhang and Wang (2003) used 1998 NBS survey data for 30 major cities and arrived at an estimate of −0.897. We consider that this difference is due to data being collected in different time periods and the use of different models. In particular, our study employed the HW two-step procedure to resolve the problem of zero expenditure.

The income elasticities of demand for each dairy item were also given in Table VIII. These calculated figures were all statistically positive but less elastic in the range of 0.639-0.783. The income elasticity of demand for yoghurt was the highest with an estimate of 0.783, followed by an estimate of 0.780 for powdered milk. For these income elasticities, the empirical results indicated that the consumption of fluid milk would continue to increase due to the rising household incomes in urban areas of Guangdong province. When considering China’s future dairy industry, it appears clear that demand is going to continue to grow and may accelerate over time. It is important to note, however, that a major milk safety scandal broke out in China in 2008. Powdered milk consumption in Guangdong has not been significantly affected by the 2008 Chinese melamine-tainted milk scandal. Consumption in 2008 and 2009 was approximately 0.879 and 1.122 kg higher than in 2007, respectively. The reason for this may be that consumers in Guangdong, which is adjacent to Hong Kong, were more easily able to purchase imported powdered milk (Wu et al., 2014). However, some other cities in China, such as Fuyang in Anhui province and Minxian in Gansu province, were greatly influenced by this event. Policies should be made to strengthen production and marketing of both domestic and imported dairy products. Furthermore, dairy enterprises should guarantee the provision of high-quality and safe milk.

<table>
<thead>
<tr>
<th>Item $i$</th>
<th>Fresh milk</th>
<th>Powdered milk</th>
<th>Yoghourt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conditional expenditure elasticity</td>
<td>1.075*** (0.011)</td>
<td>0.881*** (0.010)</td>
<td>1.080*** (0.034)</td>
</tr>
<tr>
<td>Marshallian own-price elasticity</td>
<td>−1.043*** (0.033)</td>
<td>−0.724*** (0.017)</td>
<td>−0.855*** (0.086)</td>
</tr>
<tr>
<td>Hicksian own-price elasticity</td>
<td>−0.528*** (0.032)</td>
<td>−0.380*** (0.017)</td>
<td>−0.715*** (0.085)</td>
</tr>
<tr>
<td>Unconditional income elasticity</td>
<td>0.780*** (0.008)</td>
<td>0.639*** (0.007)</td>
<td>0.783*** (0.024)</td>
</tr>
</tbody>
</table>

Table VIII. Elasticities of demand for each dairy item
5. Results and discussions

The objective of this study is to estimate the elasticities of demand for different dairy items (such as fresh milk, powdered milk and yoghourt) by using a three-stage budgeting approach. The sample data, including 7,426 urban households in Guangdong province, China, were collected by NBS in 2007-2009. The major findings appear to have several important implications.

Regarding model selection as one significant component of our research, we adopted the AIDS model inserted into IMR in the third stage to resolve the problem of zero consumption, and revised the elasticities in Equations (26) and (29), which is particularly important but often neglected in many previous studies. Another important point is that the QUAIDS model was found to be applicable in the second stage to capture the nonlinear relationship between share of expenditure on food items and total food expenditure, also classifying goods as necessities or luxuries.

Analysis of household demand for each dairy item is important for the policy development. As China is gradually becoming an aging society, which will raise the level of awareness of food nutrition, the dairy product is an important indicator of individual welfare and wellbeing (Jabarlin, 2005). From the estimated results, the conditional expenditure elasticity for dairy was found to be the highest among the food products. This estimated elasticity of 1.057 suggests that as food expenditure among urban households rises, the demand for dairy will grow by a greater magnitude than the other food products in this study. As for the Marshallian own-price elasticity of each dairy item, price changes in powdered milk had little impact on consumption. Demand for fresh milk is price elastic with the highest value being $-1.043$, followed by yoghurt with an own-price elasticity of $-0.855$. These elasticities indicate that price plays an important role in the fluid dairy consumption, and a reduction in the corresponding price may result in an increase in dairy consumption. Therefore, to meet the rising demand for fluid milk and ensure the stability of these product markets, the major tasks for policy makers are introducing regulatory measures to promote the stable development of the dairy industry and paying more attention to the price volatility of fluid dairy products. As for dairy enterprises, some price-cutting promotion programs could be carried out to increase fluid dairy consumption.

Our results also indicate that the unconditional expenditure elasticity of dairy products is the highest with an estimate of 0.725, implying that, if household incomes increase, urban households would spend more on dairy products rather than other food items. With improvements in living standards in recent years, households have tended to increase their dairy consumption to maintain a balanced diet. Such consumption will lead to an expansion of the size of the dairy market and will simultaneously open up new development opportunities for dairy enterprises.

However, it is important to note that, in order to prevent further safety incidents occurring, policies should be implemented to strengthen production and marketing of both domestic and imported dairy products. Furthermore, dairy enterprises should guarantee the quality and safety of their products.

References


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Allocation of responsibility among pork supply chain players

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College of Economic and Management, Hunan Agricultural University, Changsha, China

Abstract
Purpose – The purpose of this paper is to investigate the responsibility that should be taken by different pork supply chain participants to ensure pork quality and safety, with the aim of providing some guidance for strengthening the supervision of pork quality and safety.

Design/methodology/approach – The pig farmer survey and the pork consumer survey were conducted in Funing County, Jiangsu Province, using the best-worst scaling (BWS) and a mixed logit model.

Findings – The results showed that the designation of responsibility for ensuring pork quality and safety was of, in descending order, feed producers and suppliers, backyard farmers and farms of designated size, pork processing workshops and companies of and above designated size, slaughterhouses, supermarkets, farmer’s markets, pig transporters, and consumers. Both pig farmers and pork consumers believed that those involved in the initial pork supply chain should take greater responsibility for pork quality and safety.

Originality/value – Allocation of responsibilities across the entire pork industry chain was investigated from the perspective of pig farmers and pork consumers using the BWS and a mixed logit model. The results of this study might explain the unique problems that occur in pork supply chain management in large developing countries like China.

Keywords Quality and safety, Allocation of responsibility, Best-worst scaling, Player, Pork supply chain

Paper type Research paper

Introduction
Pork quality and safety incidents are a frequent occurrence in China, with 22,436 such incidents occurring between 2006 and 2015 (Chen et al., 2016), and approximately 90 percent of incidents have resulted from human factors, i.e., violations by supply chain participants. The study by Yin et al. (2016) revealed that out of all the pork quality and safety incidents referred to, the most common ones were related to illegal additions to pig feed or the use of forbidden objects, which accounted for 22.83 percent of the total. Other causes included fraud or deception, the sale or use of pigs that had died from diseases, and the distribution of gel-injected or water-injected pork, accounting for 13.01, 11.07, and 8.37 percent of total incidents, respectively. In China, pork supply chain providers can fail to adhere to the “origin of responsibility” concept in the pursuit of economic interests, thus resulting in frequent quality and safety incidents. The “origin of responsibility”, as defined by Roman (2012), states that those involved in a supply chain system are not only fully aware of their own

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responsibilities for ensuring quality and safety, but clearly know the responsibilities of others. Although the ability to fulfill their obligations differs among participants, pork quality and safety can be best guaranteed when players do their utmost to fulfill their responsibilities and supervise others, and when government strengthens supervision as per the law (Zhu, 2009; Li and Zheng, 2012). However, pork quality and safety is the concern of all participants also, including the government and consumers. It requires all those involved to communicate with each other and accept their own responsibilities (FAO/WHO, 2003). Moreover, independent consumers must take responsibility to protect themselves (Houghton et al., 2008), rather than simply consuming food in the traditional sense. However, consumers generally pay little attention to the responsibilities of those at the other end of the supply chain, and merely play a role in food consumption, neither supervising other contributors nor fulfilling their own responsibilities (Bala and Mathew, 2009; Han et al., 2015). Therefore, an effective path to successful management of pork quality and safety in China needs all players, including producers, consumers, and government, to understand the “origin of responsibility”, clearly recognize and fulfill their own obligations, and effectively supervise the fulfillment of the responsibility of others.

China can learn from the experience of the European Union (EU) in regards to meat production and safety. For example, since the outbreak of the bovine spongiform encephalopathy crisis in 1996, certain regulations have been enacted that specify the responsibilities of those involved in the beef supply chain to ensure safety at all stages, including farming, transporting, receiving, slaughtering, delivery, and marketing (Bergeaud-Blackler and Ferretti, 2006; Halkier and Holm, 2006). Moreover, the EU requires that independent consumers be fully aware of the food they consume to safeguard their own interests (Holm and Halkier, 2009), understand the responsibilities of other players, and establish a community with government and producers to clarify responsibilities (Lenzen et al., 2007; Al-Busaidi and David, 2015), effectively improving both food quality and safety assurance.

Thus, whether substantial progress can be made in pork quality and safety risk in China depends on the clear definition of responsibilities for those involved in the entire supply chain. Accordingly, we surveyed 211 pig farmers and 209 pork consumers in Funing County, Jiangsu Province, China. We investigated the allocation of responsibilities among the pork supply chain participants from the perspective of pig farmers and pork consumers using the best-worst scaling (BWS) and a mixed logit model. The results of this study will provide some guidance on policy-making for pork safety risk management.

Literature review
Responsibility perception refers to the judgment and analysis of responsibilities that should be taken by each participant for pork quality and safety based on the behaviors and consequent results of other players (Schlenker et al., 1994). Research on the responsibilities that should be taken by all involved players to ensure food safety in a supply chain is relatively well-established in EU countries, but is still in its infancy in China.

Consumers are often not aware of the seriousness of food safety until their health is endangered. Therefore, as the final participant in the food supply chain, consumers should not passively rely on the correct behavior of other players or only focus on food consumption. They should take greater responsibility for preventing food safety risks and ensuring self-protection (Quan and Zeng, 2014). For example, as many foodborne diseases occur in the family kitchen, consumers must understand daily hygiene (Carbas et al., 2013). Nevertheless, few studies have attempted to investigate how consumers perceive their own responsibilities in food safety except for EU. Redmond and Griffith (2004) and Van Kleef et al. (2006) found that consumers believe they should take a greater responsibility for food safety. A survey conducted by Kjaernes et al. (2007) revealed consumer “fully agreed”
that they have a greater responsibility than government, and considerable differences in different countries. In contrast, Van Wezemael et al. (2010) found that consumers in Germany, Spain, France, and UK believe they bear little responsibility. Cultural differences and individual family and social characteristics of consumers are the main reasons for these differences (Siegrist, 1999; Renn, 2005). Krystallis et al. (2007) reported that European consumers are clearly aware of their own responsibility in food safety, whereas experts believe it is more the responsibility of government and producers. Leikas et al. (2009) determined that consumers in Finland perceive and allocate their own responsibility per the food risk type, but also believe that producers and retailers should bear more responsibility than consumers, as many food safety issues are caused by human factors. Van Wezemael et al. (2010) investigated beef quality and safety responsibilities in Germany, Spain, France, and UK, and found that consumers believe that those involved in the initial stages of the supply chain, such as farmers, slaughterhouses, and inspectors, should assume more responsibility. Erdem et al. (2012) investigated how UK consumers and farmers allocate responsibility in the chicken and beef supply chains using BWS. They found that the greatest responsibility for quality and safety was given to processors and supermarkets, and the least responsibility assigned to transporters; moreover, consumers and farmers allocated more responsibility for meat quality and safety to each other, while allocating less responsibility to themselves.

Based on the reality of China, Chen et al. (2011) suggested that food quality and safety incidents are most likely to occur in production. Wu et al. (2013) indicated that, in China, food producers often improperly use additives due to economic self-interest, thus triggering food safety risks. Wen and Liu (2012) found that 68.2 percent of incidents were caused by violations of supply chain participants from 2002 to 2011. Most food safety incidents in other countries have also occurred during production and processing. Although Krystallis et al. (2007), Leikas et al. (2009), and Van Wezemael et al. (2010) did not reach the same conclusions for EU countries, they all stated that producers should bear more responsibility for food safety. Henderson et al. (2010) indicated that producers in Australia had a weak sense of responsibility due to economic self-interest and lack of effective government management, and that they must assume more responsibility for food safety.

Although some Chinese researchers have investigated certain stages of the pork supply chain, and declared that different players should assume different duties, the allocation of responsibilities across the entire pork industry chain remains poorly studied. Furthermore, while most previous studies have investigated the food supply chain within developed countries, due to differences in cultural practices and economic development, the conclusions of such studies might not adequately explain the unique problems that occur in food supply chain management in large developing countries like China. For example, the availability of pork that is safe to eat and of high quality is dependent on the related production processes, meaning that producers are mainly responsible for pork safety. Although the Chinese government works hard to improve the standard of the supervision of pork quality and safety, it is important to ascertain the factors that cause pork safety incidents to occur frequently in China. Thus, the applicability of foreign conclusions to China needs to be further examined.

**Research methodology**

**Methods**

In recent years, BWS has received considerable attention in the field of food consumption behavior and health (Louviere and Flynn, 2010; Marley and Flynn, 2015). Also known as maximum difference scaling (MaxDiff), BWS requires respondents to choose the “best” and “worst” item from a series of product properties based on their own knowledge to show the maximum difference in their preferences for product properties. Ultimately, sets of
consumption preferences can be obtained through group choices of different respondents. It is a specialized method for assessing product consumption preferences of respondents, and is an extension of the paired comparison method (Finn and Louviere, 1992). In general, if preferences are assessed using other methods, such as the Likert scale, ambiguity can arise when respondents face options like "strongly agree" and "agree" due to differences in interpretation. However, relative to the study of multi-level preferences, it is easier for respondents to make accurate choices between the best and worst using BWS (Marley and Louviere, 2005). The scale-free nature of BWS (Cohen and Orme, 2004) can effectively eliminate measurement errors among different preference levels (Baumgartner and Steenkamp, 2001).

Experimental design
The pork supply chain in this study involved following players throughout the supply chain system, from production to consumption.

Feed producers and suppliers. Feed is the material basis of pig growth, and its quality is directly related to the needs of pigs, pork quality, and economic benefit. In China, feed costs account for about 70 percent of the total cost of pig production (Zhang, 2016). In recent years, some of China’s feed producers and suppliers have illegally included forbidden objects in order to meet the pig farmers’ demand for lower production costs, or to simply satisfy their own economic interests; this has led to a decrease in feed quality, and caused a spate of pork quality and safety incidents to occur. Therefore, feed producers and suppliers are responsible for providing standards-compliant feed to farmers (Feng et al., 2015).

Pig farmers. In China, there are a variety of pig farms and these can be categorized into two major types, namely, small-scale household-based farms and large-scale farms, such as farmer professional cooperatives, family farms and intensive farms. The criteria for being categorized as a large-scale farm is met when the total amount of pigs sold each year goes beyond 50, whereas small-scale farms are those where the total amount of pigs sold each year is less than 50. In 2014, some relevant statistics revealed that the percentage of small-scale and large-scale pig farms in China was around 42 and 58 percent, respectively. The dominant risks in pig farming are frequent disease due to environmental degradation and poor prevention and control technology, as well as excessive veterinary drug residue because of illegal veterinary drug use by farmers (Wang and Wang, 2012; Garforth et al., 2013).

Pig transporters. The environment, density, and crowdedness during transport can lead to nutrient loss, weight loss, and reduced immunity in pigs, which can cause disease and endanger pork quality (Yuan and Song, 2013). Pig transporters are therefore responsible for ensuring transport vehicle sanitation and reasonable transport density in accordance with technical specifications.

Slaughterhouses and processors. In China, large-scale enterprises refer to those with an annual revenue of over RMB20 million. According to this criterion, China’s large-scale pig slaughtering and meat processing enterprises accounted for about 68 percent of the total number of pigs slaughtered and pork produced in 2014. China’s pig slaughtering and meat processing market currently demonstrates a coexisting pattern between small-scale businesses and large-scale enterprises. Slaughterhouses and processors are responsible for establishing scientifically based quality and health quarantine systems in line with appropriate technical specifications and processes (Hinrichsen, 2010; Zhou et al., 2013).

Distributors and retailers. Improper temperature control, unsanitary conditions, and improper use of packaging materials during distribution and retailing can lead to microbial growth and decomposition of pork, thus endangering pork safety (Sha and Sun, 2011; Hu et al., 2013). In China, pork is mainly sold in farmers’ markets in rural areas, and in supermarkets and farmers’ markets in urban areas. In all markets, however, it is the...
responsibility of retailers to ensure environmental sanitation, safety of packaging materials, and standards-compliant temperature control. We investigated ten types of participants over the entire pork supply chain system (initial, middle, and final stages), which included feed producers and suppliers, backyard farmers, farms of designated size, pig transporters, slaughterhouses, meat processing workshops, pork processing companies, supermarkets, farmers’ markets, and consumers (Figure 1), who each hold different responsibilities for ensuring pork quality and safety.

Pig farmers are involved in the initial stage of the pork supply chain. They play a decisive role in ensuring pork quality and safety, and are closely related to other producers and operators in the supply chain system. Consumers are at the end of the pork supply chain, and can objectively evaluate the responsibilities that should be taken by each player in the system. Therefore, pig farmers and pork consumers (hereinafter referred to as respondents) were surveyed in this study and questionnaires were designed, respectively. The two types of questionnaires were divided into two parts. The first part covered demographics, and differed between the two questionnaires (Tables I and II). The second part was designed as per the requirements of BWS, and was the same for both questionnaires. It asked respondents to choose the participants that should take the greatest and least responsibility, respectively, for ensuring pork quality and safety from the ten players in the pork supply chain system. Based on the conclusions of Louviere et al. (2013), respondents can become fatigued if there are more than five items to select from in a questionnaire, which can lead to a possible bias in their preferences. Therefore, the

![Figure 1. Position of major participants in the entire pork supply chain system](image)
questionnaires were designed using SSIWeb7.0. The ten players were randomly combined into ten choice groups. A balanced incomplete block design was also used to ensure that the options in each choice group meet orthogonality conditions. Each choice group included five players. The number of occurrences of each player in the questionnaire was the same (five times). The players that should take the greatest and least responsibility appeared at the same time. Respondents were asked to choose the players that should take the greatest and least responsibility from five players. Figure 2 is a sample of the questionnaire designed based on BWS.

**Experimental area**

The pig farmer survey was conducted in Funing County, Jiangsu Province. Funing County is a famous pig farming area and a national model county for standardized pig farming. The two basic forms of pig farming include small-scale household farming and large-scale

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Category index</th>
<th>Sample size (person)</th>
<th>Proportion (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Male</td>
<td>116</td>
<td>54.98</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>95</td>
<td>45.02</td>
</tr>
<tr>
<td>Education</td>
<td>Primary school or below</td>
<td>115</td>
<td>54.50</td>
</tr>
<tr>
<td></td>
<td>Junior high school</td>
<td>73</td>
<td>34.60</td>
</tr>
<tr>
<td></td>
<td>Senior high school (including secondary vocational education)</td>
<td>20</td>
<td>9.48</td>
</tr>
<tr>
<td></td>
<td>Junior college (including higher vocational and technical education)</td>
<td>2</td>
<td>0.95</td>
</tr>
<tr>
<td></td>
<td>Undergraduate and above</td>
<td>1</td>
<td>0.47</td>
</tr>
<tr>
<td>Family size</td>
<td>1</td>
<td>1</td>
<td>0.47</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>24</td>
<td>11.37</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>30</td>
<td>14.23</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>39</td>
<td>18.48</td>
</tr>
<tr>
<td></td>
<td>5 or more</td>
<td>117</td>
<td>55.45</td>
</tr>
<tr>
<td>Proportion of pig farming income in total household income (in %)</td>
<td>30 or less</td>
<td>92</td>
<td>43.60</td>
</tr>
<tr>
<td></td>
<td>31-50</td>
<td>53</td>
<td>25.12</td>
</tr>
<tr>
<td></td>
<td>51-80</td>
<td>30</td>
<td>14.22</td>
</tr>
<tr>
<td></td>
<td>81-90</td>
<td>16</td>
<td>7.58</td>
</tr>
<tr>
<td></td>
<td>90 or more</td>
<td>20</td>
<td>9.48</td>
</tr>
<tr>
<td>Proportion of pig farming labor force in family population (in %)</td>
<td>30 or less</td>
<td>109</td>
<td>51.66</td>
</tr>
<tr>
<td></td>
<td>31-50</td>
<td>52</td>
<td>24.64</td>
</tr>
<tr>
<td></td>
<td>51-80</td>
<td>27</td>
<td>12.80</td>
</tr>
<tr>
<td></td>
<td>81-90</td>
<td>8</td>
<td>3.79</td>
</tr>
<tr>
<td></td>
<td>90 or more</td>
<td>15</td>
<td>7.11</td>
</tr>
<tr>
<td>Pig production in 2015</td>
<td>0-30 pigs</td>
<td>109</td>
<td>51.66</td>
</tr>
<tr>
<td></td>
<td>31-100 pigs</td>
<td>63</td>
<td>29.86</td>
</tr>
<tr>
<td></td>
<td>More than 100 pigs</td>
<td>39</td>
<td>18.48</td>
</tr>
<tr>
<td>Pig inventory in 2015</td>
<td>0-30 pigs</td>
<td>155</td>
<td>73.46</td>
</tr>
<tr>
<td></td>
<td>31-100 pigs</td>
<td>38</td>
<td>18.01</td>
</tr>
<tr>
<td></td>
<td>More than 100 pigs</td>
<td>18</td>
<td>8.53</td>
</tr>
<tr>
<td>Pig farming experience (in years)</td>
<td>0-5</td>
<td>22</td>
<td>10.43</td>
</tr>
<tr>
<td></td>
<td>6-10</td>
<td>42</td>
<td>19.90</td>
</tr>
<tr>
<td></td>
<td>More than 10</td>
<td>147</td>
<td>69.67</td>
</tr>
<tr>
<td>Part-time or full-time pig farming</td>
<td>Part-time</td>
<td>149</td>
<td>70.62</td>
</tr>
<tr>
<td></td>
<td>Full-time</td>
<td>62</td>
<td>29.38</td>
</tr>
<tr>
<td>Children under 12 years of age in the family</td>
<td>Yes</td>
<td>98</td>
<td>46.45</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>113</td>
<td>53.55</td>
</tr>
</tbody>
</table>

Table I. Demographics of the surveyed pig farmers
farming represented by specialized cooperatives, family farms, and large-scale farms. The study survey was conducted as per Erdem et al. (2012). All 13 townships within the jurisdiction of Funing were covered. One village with a middle household income level was randomly selected from each township. A villager group of approximately 15-20 pig

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Category index</th>
<th>Sample size</th>
<th>Proportion (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Male</td>
<td>85</td>
<td>40.67</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>124</td>
<td>59.33</td>
</tr>
<tr>
<td>Marital status</td>
<td>Unmarried</td>
<td>56</td>
<td>26.79</td>
</tr>
<tr>
<td></td>
<td>Married</td>
<td>153</td>
<td>73.21</td>
</tr>
<tr>
<td>Education</td>
<td>Primary school or below</td>
<td>31</td>
<td>14.83</td>
</tr>
<tr>
<td></td>
<td>Junior high school</td>
<td>47</td>
<td>22.49</td>
</tr>
<tr>
<td></td>
<td>Senior high school (including secondary vocational education)</td>
<td>42</td>
<td>20.10</td>
</tr>
<tr>
<td></td>
<td>Junior college (including higher vocational and technical education)</td>
<td>49</td>
<td>23.44</td>
</tr>
<tr>
<td></td>
<td>Undergraduate and above</td>
<td>40</td>
<td>19.14</td>
</tr>
<tr>
<td>Family size</td>
<td>1</td>
<td>4</td>
<td>1.92</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>17</td>
<td>8.13</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>85</td>
<td>40.67</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>43</td>
<td>20.57</td>
</tr>
<tr>
<td></td>
<td>5 or more</td>
<td>60</td>
<td>28.71</td>
</tr>
<tr>
<td>Annual household income (in yuan)</td>
<td>10,000 or less</td>
<td>16</td>
<td>7.65</td>
</tr>
<tr>
<td></td>
<td>10,000-30,000</td>
<td>27</td>
<td>12.92</td>
</tr>
<tr>
<td></td>
<td>30,000-50,000</td>
<td>39</td>
<td>18.66</td>
</tr>
<tr>
<td></td>
<td>50,000-100,000</td>
<td>46</td>
<td>22.01</td>
</tr>
<tr>
<td></td>
<td>More than 100,000</td>
<td>81</td>
<td>38.76</td>
</tr>
<tr>
<td>Occupation</td>
<td>Civil servant</td>
<td>5</td>
<td>2.39</td>
</tr>
<tr>
<td></td>
<td>Company employee</td>
<td>62</td>
<td>29.66</td>
</tr>
<tr>
<td></td>
<td>Farmer</td>
<td>16</td>
<td>7.66</td>
</tr>
<tr>
<td></td>
<td>Public institution employee</td>
<td>22</td>
<td>10.53</td>
</tr>
<tr>
<td></td>
<td>Self-employed</td>
<td>36</td>
<td>17.22</td>
</tr>
<tr>
<td></td>
<td>Retired</td>
<td>15</td>
<td>7.18</td>
</tr>
<tr>
<td></td>
<td>Unemployed</td>
<td>8</td>
<td>3.83</td>
</tr>
<tr>
<td></td>
<td>Student</td>
<td>20</td>
<td>9.57</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>25</td>
<td>11.96</td>
</tr>
<tr>
<td>Presence of children under 12 years of age in the family</td>
<td>Yes</td>
<td>73</td>
<td>34.93</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>136</td>
<td>65.07</td>
</tr>
</tbody>
</table>

Table II. Demographics of the surveyed pig consumers

Please compare the players involved in the pork supply chain and choose the players that should take the greatest and least responsibility for pork safety, respectively.

<table>
<thead>
<tr>
<th>Player that should take the greatest responsibility</th>
<th>Player that should take the least responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumers</td>
<td></td>
</tr>
<tr>
<td>Farms of designated size</td>
<td></td>
</tr>
<tr>
<td>Pig transport</td>
<td></td>
</tr>
<tr>
<td>Farmer’s markets</td>
<td></td>
</tr>
<tr>
<td>Pork processing workshops</td>
<td></td>
</tr>
</tbody>
</table>

Figure 2. BWS sample from questionnaire
farming households of different sizes (i.e., including backyard farmers and farms of designated size) was randomly selected and surveyed for each village. Ultimately, 211 valid samples were collected.

The pork consumer survey was conducted in supermarkets and farmers’ markets with a large flow of customers, which are major places for pork purchase within Funing County. To ensure the randomness of the survey, the third person that came into view was selected as the respondent (Wu et al., 2012), which resulted in 209 valid samples. The surveys among pig farmers and pork consumers were both conducted via one-on-one direct interview by trained investigators. All surveys were completed in January 2016.

Demographics of the samples
Table I shows the demographics of the surveyed pig farmers. Men accounted for 54.98 percent of respondents, mean age was 56.72 years. The level of education of most respondents was primary school (54.50 percent) or below and junior high school (34.60 percent). Most had a family size of five or more (55.45 percent), a pig farming income accounting for 30 percent or less of total household income (43.60 percent), and a pig farming labor force accounting for 30 percent or less of the family population (51.66 percent). In addition, most respondents had an annual production and inventory of 30 pigs (51.66 percent) or less (73.46 percent) in 2015. Most farmers (69.67 percent) had pig farming experience of more than ten years, and 70.62 percent worked as part-time pig farmers[1]. In addition, 53.55 percent of respondents did not have children under 12 years of age in their family.

Table II shows the demographics of the surveyed pork consumers. Women accounted for 59.33 percent of respondents, which coincides with women being the major food buyer in most Chinese families (Zhang and Han, 2009). The average age of respondents was 39.85 years. Most respondents were married (73.21 percent) and junior college educated (23.44 percent), with a family size of three (40.67 percent) and an annual household income of RMB100,000 (38.76 percent). Company employees accounted for 29.66 percent. In addition, 65.07 percent of the respondents did not have children under 12 years of age in their family.

Model construction and estimation
Construction of mixed logit model
Random utility theory is suitable for simulating decision-making behaviors. In the present study, it was assumed that respondents’ individual behaviors were rational. Pig farmers and pork consumers would choose the players that should take the greatest and least responsibility for pork quality and safety based on utility maximization. The general form of random utility theory can be written as:

\[ U_{ijt} = V_{ijt} + \varepsilon_{ijt} \]  

where \( U_{ijt} \) is the utility obtained by pig farmer or pork consumer \( i \) choosing player \( j \) \((j = 1, 2, \ldots, J)\) under situation \( t \) \((t = 1, 2, \ldots, T)\). \( U_{ijt} \) consists of two parts, the deterministic term \( V_{ijt} \) and the stochastic term \( \varepsilon_{ijt} \). \( V_{ijt} \) is the deterministic component of the model, and can be expressed as:

\[ V_{ijt} = \beta_i X_{ijt} \]  

where \( \beta_i \) is the utility parameter vector of pig farmer or pork consumer \( i \), representing a respondent’s individual preferences; \( X_{ijt} \) is the observable explanatory vector, which includes the choice variable of player \( j \) (1 when the player is chosen to take the greatest responsibility; −1 when the player is chosen to take the least responsibility; and 0 when the player is not chosen); and \( \varepsilon_{ijt} \) is the stochastic term, and can be used to make probability
statements about the behaviors of pig farmers and pork consumers (Adamowicz et al., 1998; Lusk et al., 2003).

In the present study, pig farmers chose the mode of production by comparing farming costs and benefits. As they gained more information about the pork supply chain, they perceived the responsibilities of the different players in a different way to that of pork consumers. Because pig farmers are also consumers, the same utility function was used to investigate how pig farmers and pork consumers chose the players that should take the greatest and least responsibility in ensuring pork safety and quality.

In the BWS study, pig farmers and pork consumers were asked to choose a pair of participants with the largest utility difference, i.e., greatest and least responsibility. For example, assuming that pig farmers and pork consumers chose players $j$ and $k$ to take the greatest and least responsibility, respectively, the utility difference between $U_{ijt}$ and $U_{ikt}$ is then greater than that of all other choice sets $M$, where $M = J(J - 1) - 1$. By assuming $\varepsilon_{ijt}$ follows an independent and identically distributed (I.I.D) type I extreme-value distribution, the following choice probability of the conditional logit model can be derived:

$$P = \frac{\exp(V_{ijt} - V_{ikt})}{\sum_{j=1}^{J} \sum_{m=1}^{J} \exp(V_{ilt} - V_{imt}) - J}$$

where $j$ is the player chosen to take the greatest responsibility and $k$ is the player chosen to take the least responsibility. When pig farmers and pork consumers choose a range of player combinations that should take the greatest and least responsibility under situation $t$, the choice probability of Equation (3) can be expressed as:

$$P = L_i(\beta_i) = \prod_{t=1}^{T} \frac{\exp(V_{ijt} - V_{ikt})}{\sum_{j=1}^{J} \sum_{m=1}^{J} \exp(V_{ilt} - V_{imt}) - J}$$

The conditional logit model assumes that respondents’ preferences are homogeneous. Its stochastic term is I.I.D. However, errors may arise due to independence of irrelevant alternatives. Related research states that the assumption that respondents’ preferences are homogeneous does not coincide with empirical fact (Chang et al., 1999; Bell and Lattin, 2000). In other words, respondents’ preferences are heterogeneous. The mixed logit model is considered appropriate for investigating the decision-making behaviors of respondents with heterogeneous preferences. It is a random utility model that can simulate any form (McFadden and Train, 2000). Moreover, it is particularly effective when the same respondent is requested to make repeated choices (Brownstone and Train, 1999), as is the case for BWS.

Mixed logit probability is a weighted average of each logit variable in the estimation of different $\beta$ values. The weights are given by the density function $\varphi(\beta_i)$. It is assumed that $\beta$ has normal distribution with mean $b$ and covariance $w$. The choice probability in Equation (4) can be expressed as:

$$P_i = \int L_i(\beta_i) \varphi(\beta_i|b,w) d\beta_i$$

The parameters of the density function $\varphi(\beta_i)$ were estimated using a hierarchical Bayesian approach.

**Estimation results of the mixed logit model**

The assignment of responsibilities of each pork supply chain player for ensuring pork quality and safety was performed by dummy coding (Table III).
In this study, mixed logit estimation was performed using SMRT software. Results are shown in Table IV. The mean indicates changes in individual perception of responsibility, and the standard deviation indicates dispersion of responsibility perception. The greater the standard deviation, the greater the heterogeneity of the respondents’ perception.

**Results and analysis**

Analysis of data in Table IV led to the following results:

1. Feed producers and suppliers were allocated the greatest responsibility for pork quality and safety, with pig farmers and pork consumers assigning 18.7 and 16.5 percent of the responsibility, respectively. This is likely due to the use of banned drugs in livestock feed and excessive use of antibiotics and trace elements in China, which have seriously endangered the quality and safety of pork (Feng et al., 2015). Pig farmers have a direct interest relationship with feed producers and suppliers, and have a more comprehensive understanding of livestock feed quality than consumers. It is therefore reasonable that pig farmers allocated a higher proportion of responsibility to feed producers and suppliers than did consumers.

2. Backyard farmers and farms of designated size were allocated relatively large responsibilities for pork quality and safety, with pig farmers and pork consumers assigning 11.0 and 11.6 percent of responsibility to backyard farmers, and 14.8 and 13.7 percent of responsibility to farms of designated size, respectively. Both allocated a higher proportion of responsibility to farms of designated size.

<table>
<thead>
<tr>
<th>Players</th>
<th>Consumers Responsibility share</th>
<th>Players</th>
<th>Farmers Responsibility share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed producers and suppliers</td>
<td>0.81 (16.5 [13.5, 19.5])</td>
<td>Feed producers and suppliers</td>
<td>0.90 (18.7 [17.1, 20.3])</td>
</tr>
<tr>
<td>Farms of designated size</td>
<td>0.89 (13.7 [11.2, 16.2])</td>
<td>Farms of designated size</td>
<td>0.77 (14.8 [12.5, 17.1])</td>
</tr>
<tr>
<td>Pork processing workshops</td>
<td>0.56 (9.9 [8.8, 15.4])</td>
<td>Slaughterhouses</td>
<td>0.68 (13.7 [11.8, 15.6])</td>
</tr>
<tr>
<td>Backyard farmers</td>
<td>0.64 (11.6 [9.7, 13.5])</td>
<td>Pork processing workshops</td>
<td>0.45 (11.7 [9.7, 12.7])</td>
</tr>
<tr>
<td>Farmer’s markets</td>
<td>0.54 (10.7 [8.4, 13.0])</td>
<td>Pork companies</td>
<td>0.45 (11.6 [9.9, 13.3])</td>
</tr>
<tr>
<td>Pork companies</td>
<td>0.53 (10.5 [7.7, 13.3])</td>
<td>Backyard farmers</td>
<td>0.21 (11.0 [9.1, 12.9])</td>
</tr>
<tr>
<td>Supermarkets</td>
<td>0.28 (9.3 [8.2, 10.4])</td>
<td>Farmer’s markets</td>
<td>0.14 (6.4 [5.2, 7.6])</td>
</tr>
<tr>
<td>Slaughterhouses</td>
<td>0.05 (6.0 [3.7, 8.3])</td>
<td>Supermarkets</td>
<td>–0.33 (4.4 [2.6, 6.2])</td>
</tr>
<tr>
<td>Pig transporters</td>
<td>0.01 (5.9 [4.6, 7.2])</td>
<td>Pig transporters</td>
<td>–0.45 (4.2 [2.9, 5.5])</td>
</tr>
<tr>
<td>Consumers</td>
<td>–0.93 (3.2 [2.1, 4.3])</td>
<td>Consumers</td>
<td>–0.97 (3.6 [2.3, 4.9])</td>
</tr>
</tbody>
</table>

**Note:** *Denotes 95 percent confidence interval
than to backyard farmers. This conclusion is inconsistent with the findings of Erdem et al. (2012), but has an objectively realistic basis in China. Animal diseases can result in higher safety risks in pig farming, and the higher animal densities of large-scale farms likely increases disease transmission and safety risks (Shreve et al., 1995; Guo, 2010; Kilbride et al., 2012). Therefore, farms of designated size should take a greater responsibility than backyard farmers.

(3) Similar proportions of responsibility were allocated to pork processing workshops and companies of and above designated size. Pig farmers and pork consumers apportioned 11.7 and 12.6 percent of responsibility to pork processing workshops, and 11.6 and 10.5 percent to companies of and above designated size, respectively. Both allocated a higher proportion of responsibility to pork processing workshops, which is important as many safety incidents have occurred in this stage over the years (Liu et al., 2016). Although both pork processing workshops and companies of and above designated size should assume their respective responsibilities, poor equipment and inadequate implementation of required practices are often present in pork processing workshops (Sun and Huang, 2015), and thus they should take greater responsibility than companies of and above designated size.

(4) Pig transporters and consumers were assigned the least responsibility for pork quality and safety. It is not difficult to understand why consumers were allocated the least responsibility. Under the current regulatory system of China, information on producers is opaque to the public. Moreover, consumers have almost no chance to participate in the development of pork production and consumption policies, and therefore cannot bear much of the responsibility. In addition, currently in China, consumers simply engage in the purchase and consumption of pork, with poor awareness of or interest in active participation in protecting pork quality and safety. Pig farmers and pork consumers also allocated the least responsibility to pig transporters (4.2 percent and 5.9 percent, respectively), which is in accordance with the findings of Seda et al. (2012).

(5) Different proportions of responsibility were allocated to slaughterhouses, supermarkets, and farmers’ markets. Only 6.0 percent of responsibility was allocated to slaughterhouses by pork consumers, whereas 13.7 percent was allocated by pig farmers. The allocation of responsibility to slaughterhouses by pig farmers was similar to the conclusion of the study by Van Wezemael et al. (2010). The possible reason for the difference in allocation might be because consumers rarely understand the entire process of pig slaughter, whereas pig farmers are much more knowledgeable about the operation and management of slaughterhouses. The allocation of responsibility to supermarkets and farmers’ markets also differed between the pig farmers and pork consumers, with a significantly higher proportion of responsibility allocated by consumers. The possible reason for this is that consumers know more about markets than do pig farmers. Although farmers are also consumers, they have a different perspective than common consumers in regards to the allocation of responsibility for ensuring pork quality and safety. Therefore, the different perceptions of responsibility between pig farmers and pork consumers are the main reason for the different allocation of responsibility to slaughterhouses, supermarkets, and farmers’ markets.

Main conclusions and implications
In this study, pig farmers and pork consumers opinion showed that the descending order of responsibility for ensuring pork quality and safety was feed producers and suppliers,
backyard farmers and farms of designated size, pork processing workshops and companies of and above designated size, slaughterhouses, supermarkets, farmer’s markets, pig transporters, and consumers.

The responsibilities of the government, pork producers, and consumers should be clearly defined based on current realities to regulate production, operation, and consumption activities through legislation. Given that China’s legal system with regard to pig farming and pork production, processing, transportation and consumption is not yet fully developed, the government should expedite the legislative process and clarify the separate legal responsibilities of the government, pork producers and consumers in order to ensure pork quality and safety. Feed producers and suppliers, backyard farmers and farms of designated size, and pork processing workshops and companies must be strictly regulated according to the law. Furthermore, the government should encourage participants to regulate their respective responsibilities by contractual agreements, together establishing a system of accountability. Moreover, consumer awareness and self-protection should be encouraged and enhanced. Appropriate mechanisms should also be established to ensure that consumers can participate in the supervision of all those involved in the pork supply chain, so as to achieve successful co-management by the government, market, social organizations, and the public. It should be pointed out that although the conclusions of the current study are mainly drawn from the survey of pig farmers and pork consumers in Funing County, Jiangsu Province, and a large number of pig farmers live in different geographical regions of China, where there are likely to be regional differences, many pig farmers behave similarly in the pursuit of economic benefits, such as making illegal additions to pig feed or the use of forbidden objects. Therefore, the findings of the present study should be more generalizable.

Note

1. In China, farmers can engage in various agricultural production activities and also work in manufacturing and services. Farmers with pig farming as the main occupation are called full-time farmers, and those that engage in pig farming as well as other production activities are called part-time farmers.

References


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Differences in quality governance: the case of the Brazilian pork chain

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Abstract

Purpose – The purpose of this paper is to analyze the relationships between coordination mechanisms (CMs) and quality requirements used to support transactions in the Brazilian pork chain.

Design/methodology/approach – Based on the transaction cost economics theory, the paper focuses on the alignment between CMs and quality requirements. The results were obtained by means of interviews (n = 41) with public and private actors, including the main companies and other stakeholders in the Brazilian pork sector. The research addresses regulations, requirements of customers and supporting CMs used in different transaction contexts.

Findings – In the Brazilian pork sector, five transaction contexts can be distinguished: spot market, mini integration, singular cooperative, central cooperative and investor-owned firm. The chain actors apply different CMs to support a set of quality requirements which presents little diversity. The main quality requirements are driven by baseline public regulations. Besides, there are, in particular international, customers with more specific requirements. To support transactions, chain actors use different contracts in terms of resource allocation and price incentives.

Originality/value – Literature assumes alignment between governance structures (GSs) and quality standards. This paper further investigates this assumption by analyzing the relationships between CMs (underlying GSs) and quality requirements (underlying quality standards). The research findings show that similar quality requirements may well be supported by different CMs. It further gives indications on why different CMs are used to support a homogeneous set of requirements.

Keywords Brazil, Contracts, Coordination mechanisms, Pork chain, Quality requirements

Paper type Research paper

1. Introduction

Literature on food chains has shown how developments such as food crises (i.e. in food safety) and changes in consumer preferences have affected a fast development of regulations, quality standards and certification schemes. These have increasingly challenged food chains to implement quality management systems (QMSs) in order to deliver high-quality food and comply with new information requirements on their production processes. (Theuvesn et al., 2007; Heyder et al., 2010; Trienekens et al., 2012). Especially from the early 2000s, a rapid growth of food quality standards and changes in food regulations has occurred. New quality demands also imply new coordination arrangements between buyers and suppliers in these chains. Food companies (slaughterhouses, processors) in the Brazilian pork chain (BPC) have developed a wide range of coordination mechanisms (CMs) with their suppliers in order to comply with the quality requirements set by public and private parties.

Different types of quality standards are used in food chains. Public standards normally address international agreements such as the sanitary and phytosanitary measures and technical barriers to trade mediated by the World Trade Organization (Henson and Reardon, 2005; Henson and Humphrey, 2010). Retailing schemes, such as Global Gap and BRC, set
requirements on good agricultural practices to be met by suppliers worldwide (Theuvsen et al., 2007; Trienekens and Zuurbier, 2008; Heyder et al., 2010). Moreover, industries develop schemes that are sector specific. For example, IKB, Certus and QS are schemes used in meat production, respectively, in the Netherlands, Belgium and Germany (Trienekens and Zuurbier, 2008; Bahlmann and Spiller, 2009). Moreover, there are differentiated standards, such as those on sustainable production, fair trade and business-to-business schemes that are used in narrower scopes (Theuvsen et al., 2007). Retailing, industry and special certification schemes are not used in the BPC. The main quality drivers in the sector are public regulations. Besides, some companies meet stricter quality requirements (e.g. residues, meat quality, biosecurity) demanded by importer countries and specific customers. To address these demands, companies set specific requirements in their contracts with pig farmers.

Food processors and retailers use different types of governance structures (GSs) to support quality addressing food regulations and consumer preferences. Market, contracts, alliances, cooperatives and vertical integration are examples of GSs actors use to support transactions (Ménard, 2004; Raynaud et al., 2005). According to the transaction costs economics theory (TCE), each GS has inherent costs – e.g. selecting and monitoring partners – which are affected by the transaction attributes – i.e. uncertainty, measurement difficulties and assets specificity – and the institutional environment where transactions are embedded. Therefore, this theory assumes that, to support a transaction, an actor selects the GS that most efficiently match these aspects (Williamson, 2000, 2010). In this regard, food quality plays a central role by affecting the attributes of the exchange and demanding institutional mechanisms (e.g. private standards, regulations, contracts) to support its enforcement (Ménard and Valceschini, 2005; Raynaud et al., 2005; Schulze et al., 2007). In this paper, we will analyze how CMs underlying GSs (e.g. pricing, resource allocation) support quality requirements of buyers in the BPC.

Brazil is the fourth largest global producer and exporter of pork. Between 2011 and 2015, Brazil had an average share of 3.1 percent of world production and 8.5 percent of the exports (United States Department of Agriculture). In 2015, Brazil exported 542,000 tons of pork and the main importers were Russia (45 percent), Hong Kong (23 percent), Angola (6.5 percent), Singapore (5.2 percent) and Uruguay (4.2 percent) (MAPA a). The production herd accounts 1,600,000 sows and 39,000,000 pigs. The main regions of production are the South, the Southeast and the Middle West, which maintain, respectively, 61, 21 and 16.5 percent of housed sows. The number of pig farmers in Brazil is estimated at about 42,000 (ABCS, 2015). The per capita consumption is 15.1 kg per year. In 2014, processed pork accounted for 89 percent of production (ABPA, 2015).

The BPC presents little diversity of quality standards and meets, predominantly, public regulations, which are sufficient to supply the internal market and to export. Companies use mostly contracts to support transactions. However, the contracts used in the sector differ in terms of CMs used to support similar transactions in distinct transaction contexts. Previous literature has demonstrated how characteristics of standards (e.g. ownership, scope) affect the choice of GSs (Raynaud et al., 2005; Wever et al., 2010; Schulze et al., 2007). This study goes a step further by analyzing how specific quality requirements (underlying quality standards) affect CMs making up contracts.

Therefore, this paper aims to analyze the relationship between quality requirements and CMs embedded in contracts between buyers and pig farmers in the BPC. The next section presents a theoretical discussion on quality standards and governance. In Section 3, the research methods are described. Section 4 depicts main setters and quality requirements used in the BPC. In Section 5, interactions between CMs and quality requirements are analyzed. Section 6 presents the results. Discussions and conclusions are drawn in Section 7.
2. Governance and quality

TCE theory predicts that the most efficient GSs are those that minimize production and transaction costs taking into account the institutional environment wherein (Williamson, 2000; Menard and Valceschini, 2005). The institutional environment is where formal and informal rules are set in order to reduce uncertainties and transaction costs. When it comes to food quality, regulations, public and private certification schemes (i.e. standards) and buyers’ specific requirements are examples of institutional rules affecting chain organization (i.e. GSs).

In his pioneer paper, Coase (1937) compared markets and hierarchies as alternative GSs and explained that hierarchy (i.e. internal organization) is a response to the limitation of the price mechanism (i.e. market) in coordinating adaptations in transactions. Accordingly, a firm would only exist if it were able to produce at costs lower than market prices. Overtime, scholars demonstrated that intermediary GSs, such as contracts, franchising, cooperatives and alliances, in which parties are mutually dependent, exist between the polar GSs market and hierarchy. These GSs are called hybrids (Williamson, 1991; Ménard, 2004). Contracts, a type of hybrid GS used to support production of pigs in the BPC, are of special interest in this paper.

According to the TCE’s efficient alignment principle, the choice of a GS depends on the magnitude of transaction attributes – asset specificity, uncertainty, and measurement difficulties (Ghosh and John, 1999; Williamson, 2010). In market-like relationships, these attributes present low intensity. Therefore, these exchanges do not demand much control on quality and market prices are seen as a suitable CM. In transactions with increased uncertainty or asset specificity, for instance, more hierarchical GSs are applicable. In such GSs stricter CMs such as control on processes and inputs used by suppliers and prices associated with quality compliance prevail (Hobbs and Young, 2000; Martinez and Zering, 2004; Wever et al., 2010).

Aligning governance and quality

The increasing diversity of quality standards used in food chains has triggered interest on how efficiently GSs support quality. Examining food chains in Europe, Raynaud et al. (2005) found that more hierarchical GSs are used to support strict standards enforced by private actors. Inversely, market-like GSs apply to little differentiated standards supported by public certification. Sector certification, certification supported by a sector organization, also minimizes uncertainties regarding quality and, like with public certification, pushes governance toward market-like arrangements (Bahlmann and Spiller, 2009; Schulze et al., 2007). In line with these contributions, Wever et al. (2010) examined how scope, ownership and scale of QMSs affect governance choices. Scope regards the number of chain stages a QMS covers. Ownership distinguishes the setters of standards – e.g. public, private actor or a third party. Finally, scale regards the number of suppliers (e.g. farmers) in the QMS. In this study, the authors found that hierarchical GSs apply to QMS used in narrow scopes (e.g. business to business), small scale and set by private actors. Market-like GSs, in turn, are more suitable to chain wide QMS, set by public actors and used on large scale. Overall, this literature has provided interesting insights into how GSs align with quality assurance standards.

In the BPC, however, chain actors do not use industry or retailing certification schemes led by third parties. In this sector, the main quality drivers are public regulations – addressing issues on animal health, food safety, animal welfare and environment – and some stricter and specific requirements of importer countries and customers on issues such as meat quality, residues and biosecurity. Nevertheless, there is a wide range of CMs supporting these quality requirements. Therefore, rather than analyzing how types of standards affect chain organization (GSs), this paper goes one step deeper to examine the relationship between quality requirements and CMs.
3. Methodology
This research is exploratory. Open interviews \((n = 41)\) were carried out between September 2014 and April 2015, with public and private actors, in the main regions that produce pork in Brazil (see Table I). The sample includes small companies as well as cooperatives and investor-owned firms (IOFs) which maintain about 75 percent of the Brazilian production. The set of interviewees also includes a retailer and an information technology company which are leaders in their respective sectors and feed companies with important participation in the BPC.

Questions addressed issues on quality and coordination. Regarding quality, the main topics were current and upcoming requirements, strengths and bottlenecks regarding public and private enforcement. In coordination, the main topics were types of mechanisms such as resource allocation (e.g. technical support, inputs) and price incentives used in transactions. Companies’ annual reports, legislation and sector data were used as complementary sources of information. The average time of the interviews was 86 minutes. The interviews were recorded and transcribed. When it was necessary to validate interpretations, additional meetings, by telephone or Skype™, were arranged.

4. Transaction contexts
This research identified five different transaction contexts in which pigs are delivered: spot market (SM), mini integrations (MIs), singular cooperatives (SCs), central cooperatives (CCs) and IOFs. This study focuses on transactions between buyers and pig farmers within these contexts.

In the BPC, production stages are normally assigned to specialized farmers. The predominant scheme used in contractual relationships sets, in sequence, weaning – nursery – and finishing farms. In weaning farms, piglets are born and raised until they reach a weight between 7 and 8 kg. These piglets are transferred to nurseries where they reach a weight between 22 and 25 kg. From nurseries or farrowing farms, piglets go to fattening farms where they reach the slaughtering weight (100-125 kg). In some cases, piglets are born and raised until they are 22-25 kg before being transferred to finishing farms. Some companies use the wean to finish model to cover part of their production. In these farms, piglets enter at

<table>
<thead>
<tr>
<th>Type of organizations</th>
<th>( n )</th>
<th>Interviewees’ functions</th>
<th>States</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buyers: investor-owned firms, cooperatives and mini integrators</td>
<td>21</td>
<td>Owners (5), directors (4), managers on production (10), quality (1) and exports (1)</td>
<td>Rio Grande do Sul, Santa Catarina, Paraná, Goiás, Brasília, Mato Grosso</td>
</tr>
<tr>
<td>Farmers associations (1 national, 5 state, 1 local)</td>
<td>7</td>
<td>Presidents (5), directors (1), and technical manager (1)</td>
<td>Rio Grande do Sul, Santa Catarina, Paraná, Goiás, Minas Gerais and Brasília</td>
</tr>
<tr>
<td>Slaughterhouses associations (1 national 2 state)</td>
<td>3</td>
<td>Vice president (1) and directors (2)</td>
<td>Rio Grande do Sul, Santa Catarina and São Paulo</td>
</tr>
<tr>
<td>Information technology</td>
<td>1</td>
<td>Director</td>
<td>Santa Catarina</td>
</tr>
<tr>
<td>Retailer</td>
<td>1</td>
<td>Staff member of development of meat supply department</td>
<td>São Paulo</td>
</tr>
<tr>
<td>Feed suppliers</td>
<td>2</td>
<td>Owner, technical adviser</td>
<td>Rio Grande do Sul, Santa Catarina</td>
</tr>
<tr>
<td>Government</td>
<td>6</td>
<td>Agricultural ministry areas: animal health (1), livestock production (2), foreign affairs (1), inspection service (1), Brazilian Agricultural Research Corporation (EMBRAPA): researcher on animal health (1)</td>
<td>Santa Catarina, Brasília</td>
</tr>
</tbody>
</table>

Table I. Interviewees
7-8 kg and are raised until the slaughter weight. The farrowing to finish system gathers the three stages in one farm. Although the use of this system is decreasing, it is still adopted by independent farmers and some cooperatives. In what follows, the contexts wherein transactions between buyers and pig farmers take place are described.

Transactions driven purely by markets are not often used in BPC. Thus, in this research, we include in SM arrangements in which a farmer maintains informal long-term relationships with a selected number of buyers. In Brazil, these farmers are known as independent producers. SM farmers supply local slaughterhouses, other farmers or middlemen and meet public baseline standards. In this research, owners of two local slaughterhouses purchasing pigs exclusively from independent farmers were interviewed.

MIs are organizations led by big pig producers that coordinate production by means of contracts or informal relationships. MIs supply local slaughterhouses or big pork processors in the national market and meeting public baseline standards. In this study, three MIs were interviewed – two in Santa Catarina and one in Rio Grande do Sul. The number of farmers that supply each of these MIs ranges between 35 and 210. Deliveries vary between 60,000 and 140,000 pigs annually.

SCs normally arrange production by means of contracts with member farmers. Some SCs are specialized in pork and others diversify their activities (e.g. poultry, dairy). In this research, five SCs were interviewed: two in Rio Grande do Sul, two in Paraná and one in Mato Grosso. The annual slaughters of these SCs range between 140,000 and 290,000 pigs and the number of farmers range between 46 and 290. Smaller SCs meet predominantly public baseline standards and supply local, regional or national markets. There are SCs that arrange part of their supply to meet strict requirements of importers (e.g. substances used in the feed). Data on slaughters of individual processors allow estimating that SCs perform about 7 percent of slaughters in Brazil (SIPS, 2014).

CCs are big organizations that hold affiliated cooperatives. In this research, two CCs that produce pork in Brazil were interviewed. One is based in Santa Catarina and maintains 12 affiliated cooperatives (nine in Santa Catarina, one in Rio Grande do Sul, one in Mato Grosso do Sul and one in Paraná). In total, these cooperatives maintain about 63,000 farmers involved, mainly, in dairy, poultry and pig production (3,500 pig farmers). The CC slaughters about 4,000,000 pigs annually in four slaughterhouses. The other CC produces in Paraná, gathers six affiliated cooperatives and maintain a single slaughterhouse. Although the affiliated cooperatives diversity production, the CC processes only dairy and pork products. In 2013, the affiliated cooperatives accounted 4,664 members (881 pig farmers). The slaughters totalized at about 1,540,000 pigs in 2014. Both CCs supply the domestic market and export. The one in Santa Catarina supplies the more demanding importers such as Russia and Japan. Together, these CCs perform 17 percent of slaughters in Brazil (SIPS, 2014).

IOFs use contracts with farmers to organize production. IOFs lead production of pork in Brazil. The four biggest firms perform about 52 percent of slaughters (SIPS, 2014). We conducted interviews with the two biggest IOFs which, together, maintain 42 percent. The biggest firm maintains contracts with about 3,600 pig farmers and slaughters in nine plants in Rio Grande do Sul (two), Santa Catarina (three), Paraná (one), Minas Gerais (one), Goiás (one) and Mato Grosso (one). The slaughters reached about 9,000,000 pigs in 2014. The other firm is supplied by about 2,600 farmers and slaughters in five different plants (Rio Grande do Sul (two), Santa Catarina (two) Paraná (one)). The firm slaughtered about 4,500,000 pigs in 2014. Both companies export part of their production to more demanding importers (e.g. Russia).

Table II depicts the main characteristics of the transaction contexts. Information on slaughters in IOFs and cooperatives (SIPS, 2014) allows us to estimate that SMs and MIs produce about 24 percent of the pigs slaughtered in Brazil.
5. Quality requirements

Setters

The Ministry of Agriculture, Livestock and Food Supply (MAPA) is the main setter of requirements in the BPC. However, to continuously address food developments and to update requirements, MAPA maintains close interaction with the pork sector. For instance, MAPA maintains the Swine and Poultry Council that brings together organizations which represent farmers (e.g. Brazilian Association of Pig Farmers), processors (e.g. Brazilian Association of Animal Protein), feedstuff sector, retailers and other stakeholders. Sector institutions also perform actions to support compliance in the supply chain. This includes elaboration of manuals on good agricultural practices and allocation of resources such as technicians, vehicles, software and capacitation to implement biosecurity measures (ABCS, 2015; FUNDESA, 2016; ICASA, 2016). Next, as described before, companies adopt specific requirements to address additional demands of customers, emerging issues and gaps in public regulations. This will be further explained in the next sections.

Public regulations

The Federal Inspection System is the MAPA’s scheme which accredits processors to supply the national market and to export meeting international standards. At farming stages, MAPA sets regulations on animal health, food safety and animal welfare. The Environment Ministry sets general policies for the management of water and soil resources. Table III depicts the main regulations used in the BPC.

Regulations on animal health address issues on the use of medicines and control of diseases. Requirements on the use of medicines include issues such as banning, withdrawing periods, quality control and marketing. To control diseases (e.g. classical swine fever (CSF)), MAPA maintains programs to monitor risks, to provide chain actors with capacitation and to establish actions to handle outbreaks. The main instrument used to support the sanitary control throughout the supply chain is the Animal Transportation Guide (GTA). The GTA is a mandatory document used by owners of pigs and transporters including data on the origin and destination, finality (e.g. farming, slaughter) and sanitary information (e.g. use of vaccines). At slaughterhouses, for instance, officials perform systematic control on GTAs accompanying batches of pigs to be slaughtered.

Regulations in food safety include good practices in production of feed, control of residues and banning of certain substances. With respect to animal welfare, MAPA establishes general recommendations on handling, facilities and equipment used in
transportation and production. Based on environment national policies, state agencies set requirements on the licensing of pig farms. These requirements address issues such as the use of water, storage and disposal of manure.

Specific requirements
In the BPC, companies may comply with specific requirements, which are stricter than those set in public regulations for different reasons. For example, sanitary authorities of countries that import pork are normally concerned with residues and sanitary status of regions wherein pigs are produced. Moreover, some customers (e.g. processors, restaurants chains) look at specific aspects regarding meat quality. Finally, companies set requirements to fill gaps in regulations or to address emerging issues such as EU standards on animal welfare. All of these examples, affect, somehow, the requirements companies set in their contracts with pig farmers.

Regarding residues, Russia and China, for example, require evidences that pigs are fed with feed that is ractopamine free[1]. Japan, which is still an emerging market for Brazil, is concerned with residues of medicines. To address issues on residues, companies select specific farms wherein strict requirements on nutrition management, control on the use of medicines and traceability are required. With respect to sanitary status, some countries only accept pork from pigs produced in areas free of herd diseases. For example, Japan only accepts pork produced in areas that are free of foot and mouth disease without vaccination. Santa Catarina is the only state that meets this condition in Brazil. Until 2016, 15 Brazilian states were accredited by OIE as areas free of CSF. It makes BPC a potential supplier of markets such as the USA, Mexico and South Korea.

With respect to biosecurity, MAPA sets requirements on practices and facilities for breeding farms but doe not set measures for production farms. Therefore, companies (e.g. slaughterhouses, processors) define their own requirements farmers need to comply with. MAPA’s requirements on animal welfare are currently accepted in the international markets. However, recent efforts led by MAPA, NGOs and the pork sector have raised awareness on this issue. As a consequence, the two biggest companies in the pork sector are committed to have their whole supply meeting European standards until 2026. These firms are setting specific requirements on facilities and equipment (e.g. collective housing) to be met by piglet farmers.
Different types of customers demand specific issues regarding meat quality. For example, Japanese packers are strict with size of cuts, coloration, fat thickness and marbling. Fast food networks demand specific characteristics in the pork fat used in their products. To address these issues, companies set to farmers, specific requirements on genetics and nutrition. Table IV presents an overview of enforcers and drivers of quality requirements in the BPC.

6. Different CMs to support quality
As explained above, the BPC is basically driven by public standards and some stricter requirements set by countries and customers. However, our research shows that chain actors use a diverse set of CMs (GSs) to handle this quite homogeneous set of standards. In the following, the main settings of these mechanisms, used in the different transaction contexts, are presented (Table V).

**CMs**

Independent farmers use their own animals and feed to produce pigs. These farmers purchase premixes from feed companies. Many farmers receive support, provided by feed companies, in nutritional management aimed to increase feed conversion. Normally, this support is extended to issues such as sanity and handling. Farmers meet public baseline quality standards. There are buyers that maintain exchange relationships with a selected set of independent farmers. Some of these buyers specify genetics, provide vaccines and occasional technical support. However, all transactions are driven by market prices.

In MIs, buyers use different contractual settings with farmers producing in different stages. The ownership of the critical inputs differs across the different chain stages. Farmers use their own feed and sows to produce piglets. At nurseries and finishing farms, the integrator provides farmers with feed and piglets. The integrator provides technical support, which is also used to monitor quality, with focus on sanitary issues. This support is performed in on demand basis at the piglet production and is more systematic at the nursery and finishing stages. The prices used in the payment of piglets follow regional markets. For piglets raised in nurseries and pigs grown in finishing farmers MIs use internal prices and criteria based on productivity of inputs provided to farmers (e.g. mortality, feed conversion). Normally, MIs use formal contracts with piglet farmers and finishers. However, in many cases, the relationship with piglet farmers is informal. The contracts with piglet farmers are known as Buying and Selling. With nursery and finishing farmers, MIs use input providing contracts known as Partnership contracts.

To arrange their supply and control quality, SCs use formal contracts. However, these contracts are arranged with farmers that are also members of the cooperative. Piglet farmers normally use their own sows and feed meeting, for both inputs, standards recommended by the cooperative. Many cooperatives produce feed and recommend that

<table>
<thead>
<tr>
<th>Enforcers</th>
<th>Drivers</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government</td>
<td>International agreements and food developments</td>
<td>Baseline regulations on animal health, food safety, animal welfare and environment</td>
</tr>
<tr>
<td>Government and companies</td>
<td>Specific requirements of countries</td>
<td>Stricter control on residues (nutritional management; traceability) and diseases</td>
</tr>
<tr>
<td>Companies</td>
<td>Emerging issues</td>
<td>Stricter standards on biosecurity, genetics, animal welfare</td>
</tr>
<tr>
<td></td>
<td>Regulatory gaps</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Specific customer’s requirements</td>
<td></td>
</tr>
</tbody>
</table>

Table IV. Enforcers and drivers of quality requirements in the Brazilian pork chain
<table>
<thead>
<tr>
<th>Coordination mechanisms</th>
<th>Production stages</th>
<th>Spot market</th>
<th>Mini integration</th>
<th>Cooperatives</th>
<th>Investor-owned firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provision of feed</td>
<td>Piglet production</td>
<td>The farmer provides the feed to be used in all production stages</td>
<td>The farmer provides the feed</td>
<td>Farmer provides (meeting coops’ standards) or purchases from the coop</td>
<td>The firm provides the feed in all production stages</td>
</tr>
<tr>
<td></td>
<td>Nursery and fattening</td>
<td></td>
<td>The integrator (buyer) provides the feed</td>
<td>The coop provides the feed</td>
<td></td>
</tr>
<tr>
<td>Provision of animals</td>
<td>Piglet production</td>
<td>The farmer provides the animals in all production stages</td>
<td>The farmer provides the sows</td>
<td>The farmer provides the sows (meeting coop’s standards in genetics)</td>
<td>The firm provides the animals in all production stages</td>
</tr>
<tr>
<td></td>
<td>Nursery and fattening</td>
<td></td>
<td>The integrator provides the piglets</td>
<td>The coop provides the feed</td>
<td></td>
</tr>
<tr>
<td>Technical support (and monitoring)</td>
<td>Piglet production</td>
<td>Farmers account with support from their feedstuff suppliers</td>
<td>The integrator provides technical support in an on demand basis</td>
<td>The cooperative provides systematic technical support</td>
<td>The firm provides systematic technical support</td>
</tr>
<tr>
<td></td>
<td>Nursery and fattening</td>
<td></td>
<td>The integrator provides technical support</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pricing (criteria)</td>
<td>Piglet production</td>
<td>Market</td>
<td>The integrator provides technical support and managerial support using software to exchange information</td>
<td>The firm provides technical and managerial support using software to exchange information</td>
<td>Internal price and productivity</td>
</tr>
<tr>
<td></td>
<td>Nursery and fattening</td>
<td>Internal price and productivity</td>
<td>Market and weight of the piglets</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table V. Main coordination mechanisms addressing quality requirements in the Brazilian pork chain
farmers purchase and use it to produce piglets. However, the ownership of the critical inputs is always exerted by the farmers. SCs provide piglets farmers with technical support in production. In many cases, weaning farmers use software to monitor production within a supply chain information exchange scheme which the SC uses to give farmers feedback to improve efficiency (e.g. feed conversion, number of weaned piglets per sow) and quality (e.g. uniformity, welfare, sanity). At the fattening stage, SCs provide farmers with feed, piglets and veterinary inputs and technical support. To support the provision of piglets, SCs maintain contracts with farmers (also cooperative members) who raise weaned piglets in nurseries, as explained before. SCs provide systematic technical support and perform monitoring in production in all production stages. The price mechanisms used to pay piglets include a base price following regional markets and bonus/penalty based on the fit/deviation from a defined weight. For finished pigs SCs use internal prices, criteria based on productivity (e.g. mortality, feed conversion) and a bonus based on a checklist on maintenance (e.g. cleanness, status of equipment and facilities) and administration (e.g. documentation) of the farm. Some cooperatives set specific models of facilities addressing biosecurity measures and include compliance with these measures in their checklists. Similar mechanisms are used to establish the payment for piglets raised in nurseries.

In CCs, the supply is arranged by the affiliated cooperatives which use, in their relationship with farmers, the same CMs used by SCs. Because CCs centralize the slaughtering, processing and delivering of pork products, these organizations set the standards to be met by their affiliated coops. Therefore, the technical support provided to pig farmers is carried out by the affiliated cooperatives with supervision and support of the CC.

IOFs also use contracts to support production and quality. However, these firms focus on maintaining the ownership of critical inputs and providing all types of farmers with feed and animals. IOFs provide technical support and monitor production, systematically, in all production stages. At the weaning stage, it normally includes the use of software to support information exchange on productivity. The mechanisms used in the payment for piglets include an internal base price, bonus based on productivity (e.g. feed conversion, mortality, number of piglets weaned per sow) and bonuses based on checklists on maintenance, administration of the farm and facilities meeting the firms’ standards on biosecurity. More recently, IOFs have also centered efforts in the implementation of weaning farms meeting EU standards on animal welfare. The firms are implementing price incentives to ensure that farmers have margins which overweight the interest rate of the loans the farmer needs to make the investments to meet the requirements specified by the firms. At the finishing stage, IOFs use internal base prices, bonus based on productivity and checklists. In addition, firms establish grids assigning farmers to groups of performance associated with differentiated price levels.

CMs and quality requirements
The previous sections identified for the BPC, the main quality requirements and CMs chain actors use to support the supply of pigs. The results show that baseline public regulations are dominant in this supply chain. However, companies also comply with stricter requirements to address demands of specific countries and customers.

On the level of the GS overall, the results demonstrate alignment between transaction attributes and governance modes, as expected in the TCE theory (Williamson, 1991, 2010; Hobbs and Young, 2000), where transaction attributes are to a large extend dependent on quality requirements constrained by institutional developments (regulations, international markets) (Williamson, 2000; Ménard and Valeschini, 2005; Raynaud et al., 2005; Gellynck and Molnar, 2009). For instance, market prices prevail in all SM transactions and in the supply of piglets in MIs. In these cases, the quality requirements present a low influence on transaction attributes: delivery of standard quality products, which need little
company-to-company monitoring and low specific investments. However, in transaction contexts wherein concerns with quality increase, like in companies delivering to higher demanding customers, it was found that buyers increase control on farming processes and inputs used by farmers. These buyers (i.e., coops, IOFs) use routines of technical support and specific incentive mechanisms, associated with checklists, to decrease uncertainty in quality and protect their investments in genetic and nutrition programs and in feed mills which are made to provide farmers with the right inputs.

However, looking at the CMs included in contracts used in different transaction contexts, our study finds that there are more differences in coordination than in quality requirements. In other words, chain actors use a diverse set of CMs to coordinate a non-diverse set of quality requirements. Chain actors use different types of contracts – i.e., partnership, buying and selling – in different contexts (MIs, Coops, IOFs) to produce piglets complying with public baseline regulations. These contracts present differences in CMs such as resource allocation (e.g., ownership of inputs, technical support) and price incentives (checklists, e.g., productivity). Furthermore, the study demonstrated that individual buyers (e.g., MIs and Coops) maintain different types of contracts to support production at different stages (i.e., buying and selling contract to purchase piglets; partnership contract at finishing farms). IOFs, in turn, focus on using partnership contracts in all stages. However, even contracts that fit a general type of GS (i.e., partnership) might present company-specific differences in underlying CMs. For example, at the fattening stage, IOFs normally use grids comparing performance of farmers to differentiate payment prices. This device is not used in cooperatives.

7. Conclusion, policy implications and further research

Literature on the alignment between GSs and generic types of standards or QMSs (Raynaud et al., 2005; Schulze et al., 2007; Gellynck and Molnar, 2009; Wever et al., 2010) has helped to identify general types of solutions (e.g., markets, contracts, vertical integration) that most efficiently support transactions. However, rather than looking at generic types of standards and GSs, the present study focused on quality requirements and CMs embedded in contracts. This approach helped to explain why in BPC, where public standards prevail, chain actors applied a diverse set of CMs to support transactions. The study also showed that specific quality requirements must be taken into account to understand modes of organization that prevail in a food sector.

The above-explained diverse CMs used to handle a homogeneous set of quality requirements indicate that quality is not the only driver that explains the forms of coordination used to support transactions of pig farmers in the BPC. First, at the processing stage the BPC is highly concentrated. We recall that at the time of this research, four main firms and two CCs that deliver pork maintain, respectively, 52 and 17 percent of the slaughters (SIPS, 2014). On the one hand, it gives buyers (bargain) power to enforce their CMs. On the other hand, processors pursue, constantly, cost advantages in the obtainment of inputs (i.e., live pigs) to maintain their competitive position. This enables them to use input providing contracts in all production stages (i.e., weaning, nursery, finishing). Therefore, considerations regarding the power of the buyer and its specific competitive strategy should be taken into account in analyzing the relationships between quality and governance (Zylbersztajn and Farina, 1999; Silva and Saes, 2007; Menard and Valceschini, 2005).

Second, findings regarding the cooperatives suggest that the context in which the buyer-supplier relationship is embedded matters for governance choices. Cooperatives face specific constraints to align quality and governance. First, besides the supply relationships, relationships between cooperatives and farmers regard membership and control (Cechin et al., 2013). Although supplying contracts of cooperatives specify sanctions in cases of non-compliance,
their enforcement is also affected by these relationships. For example, cooperatives provide technical support to piglet farmers preserving farmer autonomy (i.e. ownership of inputs). Moreover, cooperatives use the contractual relationship with pig farmers as a means to commercialize feed (i.e. grains). Because the relationship with farmer presents these specific characteristics, it is not surprising that (more often than IOFs) cooperatives use devices which go beyond contractual mechanisms such as technical support and price incentives. Many cooperatives use manuals, quality programs, technical meetings and capacitation directed at farmers to improve communication on requirements and production practices.

**Policy implications**
This research provides insights in public and sector policies. The current model of organization is, in part, a response to institutional gaps. The public framework lacks specific standards on various aspects of quality management, such as biosecurity and systematic monitoring for farming. Therefore, companies use their own mechanisms, technical support and monitoring schemes. Thus, it can be of interest to analyze whether the further setting of public regulations on quality management, including facilities, would reduce, through more standardization of processes, the necessity for private coordination. Apart from the impact this would have on IOF and cooperative arrangements, such support could be of special interest for farmers that currently do not receive support (e.g. in practices, provisioning of inputs) from companies. Regarding this, the interviews identified opinions in favor of the use of sector certification to support quality at farming stages (Bahlmann and Spiller, 2009; Trienekens and Zuurbier, 2008). Looking at the GSs described in this paper, it can be assumed that this innovation would challenge the current pattern of organization and competition within the sector. Research into consequences of sector certification could be of great interest from both academic as well as practical perspectives.

**Further research**
The different GSs identified in this study present differences in costs (e.g. of technical support, monitoring, documentation). Comparing these costs can provide interesting insights in the organization of the chain. Moreover, analyzing the effectiveness of the GSs in ensuring quality compliance will enhance our knowledge on the alignment between GSs and quality standards. These analyses could be refined with other aspects that affect the choice of CMs, such as organizational complexity (e.g. CCs), power relationships and competition.

In CCs, the constraints explained above sum up with the challenge to align standards throughout affiliated cooperatives. This is not without frictions regarding, for example, power relationships among these cooperatives and differences in their organization. Therefore, analyzing in more detail how (whether) CMs differ throughout affiliated cooperatives supplying a CC and how these CMs support performance (i.e. in quality and costs) would be an interesting topic for further research.

This paper focused on the main CMs used to support quality (and production) in different contexts of exchange. However, it is known that chain actors combine different CMs to support similar transactions (Heide, 2003; Ménard, 2013). On the one hand, a processor may use markets to purchase part of the supply in order to handle fluctuations in demand. On the other hand, a buyer may deploy stricter mechanisms to address competition with other buyers or to develop knowledge (e.g. practices, technology) to be applied throughout the whole supply chain (Martins et al., 2017; Parmigiani, 2007). Examining the reasons why chain actors combine different CMs to support similar exchange relationships is also an interesting field for further research.
Note
1. Ractopamine is an additive that improves the feed conversion, reduces fat content, and increases the daily weight gain of a pig. World pork producers and exporters such as the USA and Canada use ractopamine in pig production. In Brazil, its effects in terms of cost-efficiency are estimated at about 12-15 percent. Although there are no evidences of risks of this substance to human health, Russia and China, following EU, banned its use.

References


Further reading


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Insights into food system exposure, coping capacity and adaptive capacity

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Abstract

Purpose – The purpose of this paper is to consider the concepts of exposure, coping capacity and adaptive capacity as a multiple structure of vulnerability in order to distinguish and interpret short-term coping responses and long-term strategic responses to food system vulnerability.

Design/methodology/approach – This paper applies an abductive approach for qualitative analysis of data, which were collected through 18 semi-structured interviews among Finnish food system actors.

Findings – The findings suggest that coping capacity and adaptive capacity are indeed two different concepts, which both need to be addressed in the examination of food system vulnerability. Public and private food system governance and related decision-making processes seem to focus on building short-term coping capacity rather than strategic adaptive capacity. In fact, conservative and protective policies can be counterproductive in terms of building genuine adaptive capacity in the food system, highlighting institutional and policy failures as limiting adaptive capacity and affecting future vulnerability.

Originality/value – This paper is the first to provide evidence on the multiple structure of food system vulnerability. It simultaneously considers the external aspect (vulnerability drivers) and internal factors, including short term coping capacity and more strategic adaptive capacity, as key determinants of vulnerability.

Keywords Adaptive capacity, Vulnerability, Food system, Coping capacity

Paper type Research paper

Introduction

Understanding food system vulnerability has become increasingly important in the face of accelerating food demand, competition for depleting resources, the failing ability of the environment to buffer increasing anthropogenic impacts, failing confidence of consumers and civil society in the food system, and the lack of democratic distribution of power and open governance across food supply chains (Vermeulen et al., 2012; Lang and Heasman, 2015). Basically, vulnerability is a measure of possible future harm, which refers to the forward-looking aspect of vulnerability (Hinkel, 2011), such as the vulnerability of food systems to future shocks (Fraser et al., 2005). The characterisation of vulnerability requires a simultaneous consideration of external exposure as well as coping and adaptive capacity of the affected system, and underlines the multiple structure of vulnerability (Birkmann, 2013). Dealing with unexpected changes calls for understanding on natural and social vulnerability drivers but also on vulnerable (natural, social or technical) systems (Khazai et al., 2014; Paloviita et al., 2016). An “outside-in” look can reveal a new array of opportunities and threats (Porter and Reinhardt, 2007), but the actual exploitation of an opportunity requires adaptive capacity.

Vulnerability is a highly theoretical, contextual and place-specific concept (Cutter et al., 2003) that does not denote an observable phenomenon (Hinkel, 2011). For example, vulnerability to climate change is not evenly distributed, because there are major heterogeneities in wealth, adaptive capacity and food access (Vermeulen et al., 2012). Food systems and food supply chains, in turn, are broad systems with complex interdependencies, including economic, environmental and social dimensions. The increasing interconnectivity and complexity that characterise the present food system makes farms, organisations, supply chains and consumers vulnerable to any kind of disturbance generated around the world. The global food supply chain is a paradigmatic example of networks on which disruption spreads rapidly through the food system.
system (Andreoni and Miola, 2015). For example, the rapid rise of food commodity prices in 2007 and 2008 represented a crisis for the global food system (Rosin, 2013).

The purpose of this paper is to consider the concepts of exposure, coping capacity and adaptive capacity as a multiple structure of vulnerability in order to distinguish and interpret short-term coping responses and long-term strategic responses to food system vulnerability. Multiple structure of vulnerability refers to the consideration of susceptibility, coping capacity, exposure and adaptive capacity, instead of narrower conceptualisations of vulnerability, which refer to vulnerability as an internal risk factor or a dualistic approach of susceptibility and coping capacity (Birkmann, 2013, p. 39). We approach the food system as a set of four food system activities related to producing, processing and manufacturing, retailing and distributing, and consuming, following the grouping by Ericksen (2008). We focus on the multiple structure of vulnerability (Birkmann, 2013), by analysing perceived exposure, coping capacity and adaptive capacity across the food system activities. Based on 18 semi-structured interviews conducted among the key actors of the Finnish food system, we provide evidence on the multiple structure of vulnerability, by simultaneously considering the external side (exposure) and internal side of vulnerability (coping capacity and adaptive capacity) in the context of food system vulnerability. The results illustrate the complex interlinkages between the vulnerability of different food system activities.

The outline of the paper is as follows. The next section describes the theoretical background and provides a literature review on vulnerability, coping capacity and adaptive capacity in the framework of the food system vulnerability. The research design, data collection and analysis are described after the literature review. This is followed by the presentation of exposure, coping capacity and adaptive capacity across food system activities in relation to particular vulnerability drivers, which are based on the empirical data and analysis. Finally, the discussion and conclusion are presented.

Theoretical background

Interdependencies and interconnectivity in the food system

Operationally there is no global food system but rather, a set of partially linked food supply chains, varying from local to global supply chains (Vermeulen et al., 2012). Food supply chains, in turn, are interconnected inter-organisational networks embedded within an environment characterised by many uncontrollable vulnerability drivers (Peck, 2005). Moreover, there can be cascading interaction between vulnerability drivers with different spatial and/or temporal scopes (Khazai et al., 2014). In case of hybrid events where there is more than one vulnerability driver or there is a set of interconnected risks facing food systems, there may be interdependency between, for example, poor governance and climate change impact. Interactions also occur between (inter-system interaction) and within (intra-system interaction) systems. For example, the food system as a social functional system (comprised of food system activities) or as an organisational system (comprised of inter-organisational networks) is highly dependent on natural systems, which provide water, ecosystem services and other crucial inputs. Within the social food system, the food supply chain as an inter-organisational network is crucially dependent on functional system activities, such as agriculture, food industry, food distribution and consumption. One outcome of multiple connections between food system actors and activities, and associated feedback loops, is that interventions to decrease one type of vulnerability can increase a different vulnerability (Sundkvist et al., 2005).

Food system vulnerability

To answer the question “Vulnerability of what?” Khazai et al. (2014) make a distinction between natural systems, social systems and technical systems. In fact, the food system
depends on all these subsystems, as demonstrated in the food system vulnerability matrix by Paloviita et al. (2016). Analytically, however, it makes sense to analyse the vulnerability of different subsystems, such as a food supply chain, a sector or an organisation by simultaneously addressing the interdependencies with other subsystems. The food system as a whole is affected both by global environmental change and societal change in institutions, resource accessibility, economic conditions and other multiple stressors (Ericksen et al., 2010, p. 72). Eakin (2010) argues that food system vulnerability research has dominantly focused on vulnerable agriculture, the single functional sub-system, instead of a broader functional system that includes activities such as food processing and manufacturing, distribution and consumption. Fraser et al. (2005) propose an alternative framework for assessing food system vulnerability based on landscape ecology’s “panarchy framework”. Their framework emphasises the available social wealth in the system (how poverty affects food security), connectedness in the system (pathways through the food system and the spread of disturbances) and existing diversity in the system (diverse means of access to food). They argue that increasing the number of food entitlements, reducing connectedness in the food system and diversifying the sources of food reduce food system vulnerability. This view is supported by Vermeulen et al. (2012, p. 211), who argue that “policy incentives for diversification of types of farms across the region could enhance the society’s adaptive capacity in much the same way as on-farm diversification strengthens a farmer’s adaptive capacity”. Bohle et al. (2009) suggest reframing vulnerability from a systems-oriented perspective to more actor-centred and agency-based perspectives. In addition, Ericksen (2008) highlights the role of human agency and interventions in understanding social and ecological vulnerability. Dealing with vulnerability is a process that must be managed by actors with different goals, power and priorities (Lebel et al., 2006). Ultimately, society has to struggle with the competing objectives of food system actors, especially with the growing influence of private sector actors in all food system activities (Ericksen et al., 2010, p. 74).

**Coping capacity and adaptive capacity**

Coping capacity and adaptive capacity are integral characteristics of vulnerability, as “vulnerability is related both to the differential exposure and sensitivity of communities to stimuli such as climate change and also to the particular adaptive capacities of those communities to deal with the effects or risks associated with the exposures” (Smit and Wandel, 2006). This definition of vulnerability can naturally be applied to other vulnerabilities as well. Adaptive capacity and coping capacity are different concepts, although some authors have used them interchangeably (see Gallopín, 2006, on this), and a clear-cut differentiation between coping and adaptation is difficult, if not impossible, to achieve (Birkmann, 2013, p. 22). From a conceptual point of view, however, it is useful to distinguish the differing nature of coping and adaptation processes (Birkmann, 2013, p. 32). While coping capacity is defined as the ability to use available skills and resources to manage adverse effects, adaptive capacity – in contrast – is seen as a function of the strength, attributes and resources available to a system (IPCC, 2012). Hence, coping can be viewed as a short-term approach dealing with capacities and survival in the light of extreme events (Vogel and O’Brien, 2004) as well as the protection and conservation of the current system and institutional settings (Birkmann, 2013, p. 23), e.g. protection of short-term food security or income. In contrast, adaptive capacity as a constantly unfolding, progressive and long-term process of learning, experimentation and change (Kelly and Adger, 2000) requires planned and strategic actions (Vogel and O’Brien, 2004) and modifications in behaviour (Ericksen et al., 2010, p. 117). Hence, adaptive capacity calls for changes in the rules, norms and structures that lead to crises, which emphasise the institutional dimension of vulnerability.
Different modes and constraints in governance and the capacity or incapacity of formal organisations, such as governments and corporations, to deal with risks can lead to policy mismatches (Birkmann, 2013, p. 30). In turn, institutional and policy failures can limit adaptive capacity and at the same time coping strategies and adaptive responses affect future vulnerability by changing the context and outcomes of vulnerability (Leichenko and O’Brien, 2008). Hence, Eakin (2010, p. 80) distinguishes between the manifestation of harm and innate characteristics of the system itself that predispose it to vulnerability. Ultimately, the inner conditions of a society, community, business entity or an individual related to their capacity to anticipate, resist, cope with, and recover from outside-in impacts are crucial (Birkmann, 2013, p. 63; Bohle, 2001). Consequently, high adaptive capacity does not guarantee successful management of change or reduction of vulnerability, because higher level institutional and policy reforms are also needed (Adger et al., 2007). Overall, in vulnerability research, it is important to address different factors of vulnerability and their interplay, such as linkages between exposure, coping capacity and adaptive capacity (Smit and Wandel, 2006; Birkmann, 2013, p. 26).

Vulnerability drivers
Khazai et al. (2014) use the term “driver” as an abstract term to answer the basic question: Vulnerability to what? In their ontology, driver can refer both to instantaneous events and long-term processes with external and internal causes. For example, Misselhorn et al. (2010, p. 88) make a distinction between drivers that act quickly and those that act more steadily over a longer period of time. Moreover, Khazai et al. (2014) make a distinction between “natural” and “social” drivers, where natural drivers refer to geophysical, hydrometeorological (such as climate change) and biological/ecological drivers, whereas social drivers refer to anthropogenic impacts, social inequality, governance and war or conflict (Khazai et al., 2014).

In this study, we selected three different types of vulnerability drivers for empirical examination in order to demonstrate the multifaceted nature of vulnerability. First, hydrometeorological changes were selected as an example of both instantaneous events (e.g. extreme weather events) and long term processes (climate change), which are clearly associated with external causes due to exogenous “natural” vulnerability drivers. Climate change and weather extremes have received significant academic attention recently (e.g. Linnenluecke and Griffiths, 2010; Linnenluecke et al., 2012; Paloviita and Järvelä, 2015; Beermann, 2011) due to their impacts on organisations, supply chains and food systems, and they are probably the most studied vulnerability driver in the food system context. However, as there has been a shift in focus from “natural” drivers to chronic or underlying socioeconomic drivers related to politics and economics, such as institutional and policy failures (Ericksen et al., 2010, p. 71), we also selected two vulnerability drivers as examples of internal “social” causes: policy and consumption patterns. Policies are associated with the dual system of food system governance, private and public, which can increase or decrease the coping capacity and/or adaptive capacity of the system.

Consumption patterns, in turn, reflect decision-making processes among consumers. For example, a shift in consumption patterns to vegetarian diets can make meat and dairy supply chains extremely vulnerable. On the other hand, energy and resource-intensive and high waste-producing consumption patterns can make natural systems vulnerable. Nevertheless, Misselhorn et al. (2010, p. 107) argue that understanding the vulnerability drivers is not enough, because understanding their dynamic interactions and synergies over time and through space is also needed. The following sections investigate this multiple structure of vulnerability in the context of the Finnish food system, referring to both external vulnerability features to various food system activities (exposure) and those vulnerability factors that are related to internal coping capacity and adaptive capacity.
Research design, data collection, and analysis

Research design
Food system vulnerability is an abstract concept and measuring it in the whole food system level is extremely arduous. Hence, the research topic was approached by first selecting three concrete vulnerability drivers, which refer to external and/or internal causes of vulnerability, as explained in the previous section. First, hydrometeorological changes, including climate change, heavy rain, drought, floods, heat waves and snow storms, together represent an exogenous “natural” vulnerability driver (Khazai et al., 2014). Second, the aim was to analyse vulnerability from a societal perspective, focusing on endogenous processes of “social” drivers (Khazai et al., 2014), which refer, for example, to decision-making processes in corporations, governments and among consumers. Hence, two vulnerability drivers, namely private and public policies and consumption patterns, were selected as potential internal contributors to creating vulnerability in different parts of the food system.

In the case of the first driver, hydrometeorological changes, the food system as a whole was researched as a vulnerable system because hydrometeorological impacts typically affect (directly or indirectly) all activities of the food system. In terms of two other vulnerability drivers, focus was deliberately narrowed down to their impact on particular food system activities: the vulnerability of agriculture to public and private policies, and the vulnerability of food industry to changing consumption patterns. The purpose of this delimitation was to achieve deeper understanding about the vulnerability factors of given activities, which would not have been possible if the chosen vulnerability drivers were examined only in relation to the food system as a whole. However, thematic broadening from these predetermined drivers and activities was allowed during the interviews as far as the discussion remained within the scope of food system vulnerability.

Data collection
The researchers conducted face-to-face semi-structured thematic interviews in Finnish, with 19 interviewees in 18 different Finnish organisations (in one organisation we conducted a group interview of two interviewees). In all, 18 interviewees were from private sector organisations, six from public sector organisations, three from interest groups and two represented expert organisations. Among interviewees from private sector organisations, there were five interviewees from the retail sector and three interviewees from food industry companies. Public sector organisations included a ministry, a national agency, a regional agency and three research organisations. There were three interviewees from two interest groups representing agricultural producers and the food industry. Half of the organisations visited were located in Helsinki, while the other half resided in various regions of Finland. All the interviewees were in a leading position within their organisation or had special expertise related to the topic. Interviews were mostly conducted in August 2015, but four interviews related to hydrometeorological changes were conducted in 2013 related to a previous research project on climate change adaptation in food supply chains. The interviews were recorded and transcribed. We presented a loose definition of vulnerability to the respondents, defining it as a potential future harm to a specific organisation/ sector/ food system. During the interviews, however, we extended the definition of vulnerability beyond the likelihood of experience harm towards coping capacity and adaptive capacity.

Analysis
We applied an abductive data analysis, referring to dialogue between data and theory, with emphasis on “theory matching” or “systematic combining”, which focus on refining existing theories (Dubois and Gadde, 2002). Our data analysis was guided by Birkmann’s (2013) conceptualisation of vulnerability as a multiple structure and the grouping of food system exposure insights into food system exposure.
activities by Ericksen (2008). After reading the transcriptions of all the interviews repeatedly and thoroughly, we successively matched the conceptual framework of the multiple structure of vulnerability, the groups of food system activities and the collected empirical data. Given the desire to produce abductive research, our literature review, empirical analysis and the theory matching were conducted in an intertwined manner. When formulating the final results, we tried to respect parsimony (Eisenhardt, 1989) in a sense that the number of empirically derived themes and factors was radically decreased during the analytical process. In the analysis, we focused on three different layers of vulnerability: exposure, coping capacity and adaptive capacity. Susceptibility (or sensitivity), which is commonly referred as a factor of vulnerability, was not separately addressed in the analysis, because it was initially assumed that the selected systems are more or less susceptible/ sensitive to studied exposures. As Smit and Wandel (2006, p. 286) argue, “exposure and sensitivity are almost inseparable properties of a system”.

Perceived food system vulnerability

Exposure

Food system exposure to climate change and extreme weather events was clearly acknowledged by the interviewees. However, due to the long-term process of climate change, respondents had difficulties to explicitly address the character, magnitude or rate of exposure faced by different food system activities in the future. Agriculture’s exposure to hydrometeorological changes was perceived higher compared to other food system activities.

Food system exposure to policies, regulations and overall governance was highlighted by the majority of the respondents. Finnish regulative policies were largely criticised by many interviewees due to the complexity they create in the business environment. It was generally understood that the directives and the legislation stem from European Union (EU) level decisions, but interviewees recognised a tendency in Finland to further complicate and tighten the legislation at the national level. Heavy bureaucracy stemming from excessive authoritative control was criticised and associated with increased costs and loss of time, as well as unfairness in the allocation of costs between authorities and enterprises. Finnish regulative policies were also associated with the unawareness of the decision makers about the impacts of their decisions. Respondents representing the agriculture and food industries argued that they are adversely affected by both public policies at the EU/national level and private policies defined by a powerful retail sector. In terms of private sector policies, interviewees agreed that the retail sector has a strong negotiation position towards suppliers due to its leadership and gatekeeper position in the food system. Representatives of the agricultural sector perceived the retail sector’s negotiation behaviour as a dictation policy and increased profits and margins of retailers were judged as unearned by some interviewees.

Moreover, the growing importance of private labels, which are promoted by retail sector policies, was considered problematic for food producers and the food industry by some respondents. Respondents from the retail sector, in turn, perceived the Finnish legislative and administrative environment as more stringent compared to other EU countries and hence, unfair. Informants strongly requested for fairness in national legislation and awareness among decision makers about the actual impacts of their decisions. The embargo on Russian was mentioned as an example of exposure to international policy. As the negotiations between Russia and the EU failed, Russia slapped a ban on a range of food imports from the EU, including Finnish dairy products. As a consequence, the Finnish dairy supply chain was adversely affected, since Russia was formerly a very important export market.

Compared to hydrometeorological changes and policies, food system exposure to consumption patterns received less concern. Respondents from the food industry perceived changes in consumption patterns as a window of opportunity, rather than vulnerability. For instance, the low carbohydrate diet trend (that thrived in the 2010s) was experienced as an
opportunity to try new products that matched consumer preferences, even if many of these innovations were available for only a relatively short period. It needs to be acknowledged, though, that the data did not include interviews from small bakeries that were hit hardest by the low carbohydrate trend; interviewing them could have raised different views in this matter. Some concerns were expressed about the cheap food culture that has dominated Finland over the past decades. On the other hand, cheap food culture was strongly associated with the policies implemented by large retail corporations through their price drop policies. A price drop campaign launched by the largest Finnish retailer group in 2015 was mentioned in many interviews, mainly with negative connotations. Interviewees in both the agricultural and the food sectors perceived that the price drop campaigns had harmful impacts on primary producers, domestic manufacturers and food culture. Hence, policies that push food prices down to decrease consumer vulnerability might increase the vulnerability of agricultural or food industry activities: they just “shift” the vulnerability impact from one food system activity to another. Also, a shift from hypermarket culture to diverse multi-channel culture was associated with changing consumption patterns. Hence, large retailers may be exposed to a shift from centralisation to decentralisation. While majority of the food is purchased through super- and hypermarkets, an emerging trend in the popularity of smaller food stores, alternative distribution channels and shorter food supply chains was recognised.

Coping capacity
Our results indicate that the Finnish food system actors were more concerned about short-term coping capacity than long-term adaptive capacity. The main strengths, attributes or resources identified within the Finnish food system that can reduce food system vulnerability are national emergency supply, agricultural subsidy system, global food supply chain networks, and food aid for low-income citizens. All these resources deal with the protection or conservation of the current food system and institutional settings. First, the work of The National Emergency Supply Agency, an organisation working under the Ministry of Economic Affairs and Employment and which is tasked with planning and measures related to developing and maintaining food supply security was generally associated with reduced vulnerability to short-term crises and weather extremes. Second, some respondents suggested that the most important task of agricultural policy is to provide an economic safety net for farms, which struggle with many outside-in impacts, such as weather and market changes. Hence, the safety net created by the subsidy policy of the EU and national administration can decrease uncertainty in farms to a certain degree. This point of view was augmented with a general perception that traditional agricultural policy is replaced little by little with environmental policy. However, subsidy mechanism built in the agricultural/environmental policy to cope with vulnerabilities cannot be considered to promote the long term adaptive capacity, since farmers will be given planning security up to five years only due to limits of the Common Agricultural Policy. Third, global food supply chain networks were generally considered as a resource to cope with food system vulnerability. Essentially, imported food was associated with the process of globalisation and free markets and in some interviews, Finland was described as an island, which should not forget international procurement channels. However, global food supply chain networks are a useful resource only as long as the national purchasing power is sufficient. When the global food prices rise and the national gross domestic product falls, a national food system may face increased vulnerability. Hence, due to perceptions on future food scarcity, reliance on global food markets alone can be considered as a short-term coping capacity rather than adaptive capacity. Fourth, respondents from the retail sector identified their cooperation with charity organisations as a resource to cope with food waste and food insecurity. They donate edible yet unsalable food to low-income consumers through charity organisations, which was generally viewed to advance climate change.
mitigation and save costs. Charity policies appear as an attempt to integrate the three dimensions of sustainability: social (helping low-income households), environmental and economic. The interpretation here is that charity policies can be associated with coping capacity rather than adaptive capacity, since they may discourage to make more fundamental changes in the “wasteful” and inefficient food supply chain.

Adaptive capacity
This paper notes that while majority of the food system is mainly concerned with coping capacity, the retail sector can be clearly associated with planned and strategic actions required by adaptive capacity. For example, the largest retailer organisation in the Finnish food system was complimented by the representatives of the agriculture sector in terms of its perseverance and commitment to its goals. Large retailing organisations have built their dominant position over 20-25 years by systematically following their long-term strategy. Retailer organisations were also credited for introducing the culture of efficiency in the Finnish food system. Food retailers were commonly considered leaders of the food system and the gatekeepers between production and consumption. It was admitted that this leadership position results from a long term, target-oriented policy. As a consequence, the retail sector is able to take a larger share of the final consumer price, which, in turn, leads to a lower share of the price along the upstream supply chain. Consequently, long-term planned and strategic actions implemented by retail organisations can be associated with high adaptive capacity. At the same time, however, vulnerability of the upstream suppliers and dependency of downstream customers has increased.

A flexible hybrid of global and local procurement strategy, requiring procurement channels at the international, national and local level, was an emergent theme in interviews. Designing a hybrid procurement strategy can be interpreted as a resource for adaptive capacity within the retail sector in order to increase diversity of supply. Interviewees in the retail sector were the main informants of this theme, but it was supported by many other interviewees. The availability of domestic food was associated with self-sufficiency and domestic food supply chains were clearly perceived as a critical in reducing food system vulnerability at the national level. However, 100 per cent self-sufficiency was not considered necessary due to existing global supplier networks. Relations with local producers comprised a part of risk management among retailers. Local retailer entrepreneurs and regional co-ops of the large retailer groups emphasised their willingness to procure locally produced food and their headquarters also encouraged procuring local food. The flexibility of local suppliers was seen as the main advantage of local supplier networks.

In contrast to food retailers, adaptive capacity was less characteristic of other food system actors. Some factors related to farmers’ adaptive capacity surfaced. For example, new entrepreneurial culture, learning contractual practices and juridical issues as well as business and marketing skills of farmers were emphasised as crucial resources in order to decrease vulnerability. On the other hand, one interviewee argued that farmers apply too much congenital thoughts from father to son, which leads to traditional and learned operating models in farms. The interviewee emphasised adjustments of existing structures and need for changes in agricultural practices, especially in the context of climate change. In terms of adaptive capacity in the food industry, factors such as employee commitment, flexibility, organisational culture and proactive product development were raised. Consumers’ adaptive capacity, in turn, was associated with personal responsibility, increased awareness and food skills.

Institutional and policy reforms
High coping or adaptive capacity is insufficient to ensure reduction of food system vulnerability, since at a broader level enabling institutions and policies are also needed. From a food system vulnerability perspective, our data shows that institutional and policy
reforms to decrease food system vulnerability include complex questions due to interdependencies in the food system. First, different policy segments are increasingly intertwined, such as agricultural policy and environmental policy. One interviewee suggested a shift from animal-based food production towards more plant-based production, based on climatic impacts. This will eventually lead to increased vulnerability of dairy and livestock farmers as well as of meat and dairy supply chains, not to mention potential biodiversity impacts. In addition, another interviewee suggested the integration of food policy and defence policy, demanding that issues related to food supply should be discussed along with NATO, defence budgets and vulnerability to war. Second, food supply chain activities are interconnected, which means that private policies implemented by powerful food industries and the retail sector have potential vulnerability implications. In our data, primary producers, food manufacturers and consumers were perceived vulnerable to the policies of the retail sector. For example, consumers were perceived to be dependent on retailers and thus vulnerable to private food policies (like price fluctuations and grocery store siting decisions), mainly due to the lack of consumer control in the food system. One interviewee suggested a more balanced policy approach in terms of efficiency and food system vulnerability. The maximisation of efficiency in the food system can increase food system vulnerability, whereas policies integrating moderate efficiency goals and sufficient adaptive capacities for dealing with future crises and harms represent a more long-term approach.

The data presented here reveal that it may be difficult to define common food policy due to a conflicts of interest, which were frequently reported by the respondents. According to some respondents, vulnerabilities of other actors in the food system were neglected or even exploited by the most powerful actors. There are trade-offs between rural livelihood and environmental goals, between primary producers, food manufacturers and food retailers, between efficiency and vulnerability, between cheap food and affordability, between private and public goals, between economic, environmental and social goals and between centralisation and decentralisation. However, perceived exposures in different parts of the food system are real, which require short-term coping responses and preferably, long term adaptive capacity. The general finding is, however, that current policies, both public and private, related to the food system have failed to encourage long-term strategic planning and improvement of adaptive capacity. Only actors with significant financial resources, such as large retail organisations, have been truly able to increase their adaptive capacity.

**Discussion and conclusion**

While there has been extensive research on food system vulnerability, the overall understanding of the multiple structure of vulnerability in the food system has remained underexplored. Food system vulnerability was investigated in this paper through three separate vulnerability drivers, namely hydrometeorological changes, policies and consumption patterns. While each vulnerability driver introduces a different and specific type of exposure in the food system, the data found that the responses to exposure, associated with coping capacity and adaptive capacity, are relatively general in nature. It is thus argued that improving general adaptive capacity through learning, experimentation and change can decrease vulnerability to multiple vulnerability drivers. The advantage of this research is that we deal with all major food system activities: producing, processing, retailing and consuming; the interviewees represented primary production, food manufacturing, the retail sector as well as expert and research organisations and government agencies.

The major contribution of this paper relates to the methodology of food system vulnerability research and to making the concept of vulnerability more operational. It shows that applying multiple structure of vulnerability and distinguishing between exposure, coping capacity and adaptive capacity can be analytically fruitful. Exposure is typically directly associated with a specific vulnerability driver, whereas coping capacity (and especially adaptive capacity) refers to
more generic strengths, attributes and resources of the food system or its subsystems. In addition, distinguishing between coping capacity and adaptive capacity is important, because the former represents short-term protection and conservation of the current system and institutional settings, and the latter long term strategic actions and change. Finally, as high adaptive capacity is not sufficient to decrease vulnerability, institutional and policy reforms should be addressed. With the multiple structure of vulnerability applied in this study, the multifaceted nature of vulnerability is highlighted, including internal chronic factors such as institutional and policy failures as well as other structural and deep-rooted issues of contemporary food supply chains.

The findings have implications to both public and private food policy. First, the concept of vulnerability as a multiple structure shifts the focus of vulnerability away from a single vulnerability driver to the characteristics of the food system itself. This emphasises vulnerability explicitly as a social phenomenon related to a system of different goals, power and priorities. Second, vulnerability shifts within the food system and between the subsystems should be addressed by both public and private policies. Public policies need to consider vulnerability shifts between economic, environmental and social dimensions of vulnerability, while private policies need to address vulnerability shifts within the food supply chains, since actors in the food supply chains are in very different positions in terms of their adaptive capacity. This is also related to the strategic management of internal and external supply chain risks, which involves conflicts of interests (Manning and Soon, 2016).

Furthermore, the results presented here come with several caveats. First, the study investigated perceived food system vulnerability instead of actual measured vulnerability. However, when approaching vulnerability as a social phenomenon, perceptions are important. Hinkel (2011), for example, argues that vulnerability cannot be measured because it does not denote an observable phenomenon. Second, it remains unclear to what extent the evidence would generalise beyond the Finnish context. There are obviously remarkable national differences in terms of exposure to climate change, policies and consumption patterns. However, it is likely that national food systems dominated by only a few very powerful retail companies experience similar vulnerability issues. Methodologically, nevertheless, the findings can encourage the application of the vulnerability concept as a multiple structure. Although differentiation between coping capacity and adaptive capacity in this study is strongly interpretative, it was based on the dialogue between data and theory. Finally, the data is limited to 18 interviews only and three vulnerability drivers. That is why the respondents of the study were carefully selected from different levels of food system governance and from different food system activities. The three vulnerability drivers provide snapshots of perceived vulnerability in a specific point of time but do not represent the whole gamut of factors that influence food system vulnerability. For example, the study was made before the massive vegetarian food trend began in Finland and thus at least meat and dairy companies might now have different perceptions on vulnerability to consumption patterns.

Future work could extend this analysis along several lines. One area is food system resilience research, which is closely related to the concept of adaptive capacity, remembering that resilient food systems are characterised by the ability to build capacity for learning and adaptation (Berkes et al., 2003; see also Gallopín, 2006). This could be related, for example, to exploring windows of opportunity provided by vulnerability drivers for change and innovation across the food system. Furthermore, from a food security research perspective, it might be useful to investigate adaptive capacities needed within the food system to feed everyone sustainably, equitably and healthily (Sustainable Development Commission, 2009). The ability of agro-food supply chains to effectively cope with and adapt to vulnerabilities considerably affects people’s access to food and food security (Falkowski, 2015). Finally, food supply chain management research could extend its reach towards vulnerability shifts along the food supply chain and their consequences to supply chain resilience.
References


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The governance of geographical indications
Experiences of practical implementation of selected case studies in Austria, Italy, Greece and Japan

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Abstract
Purpose – Place-based foodstuffs have gained salience in markets worldwide and geographical indication (GI) products are prominent examples. The purpose of this paper is to focus on the governance (formal and informal institutions) of the European and Japanese GI schemes, discuss the variety of procedures of implementing the features of the governance system (inclusion and exclusion of actors) for six GI cases and reflect on future GI governance.

Design/methodology/approach – The criteria for assessing the six cases were descriptive and analytical and the information and data come from official documents, literature (scientific and "grey"), interviews, observations and personal communications with key-informants of the GI systems. Three of the cases are categorized as “failures” and are included to provide more insights on the diverse dynamics of GI systems.

Findings – Registration of GIs seems to be a process rather than a single step, requesting coordination and consensus and an interplay between internal and external actors. “Success” and “failure” are relative and related to self-governance processes and the openness of the social system of the GI to establish transparency on inclusion and exclusion. GI systems require constant management and re-definition of production quality or geographical boundaries to adapt to market, climate or technological change.

Originality/value – The paper introduces GI systems categorized as “failures” (either products that did not register as GIs in the end or did register but failed to keep the registration) which provides more insights on how to design and manage complex GI systems.

Keywords Japan, Governance, European Union, Inclusion, Geographical indications, Food production systems

Paper type Viewpoint

1. Introduction
In an increasingly globalized food market, place-based foodstuffs have gained salience in markets worldwide. Prominent examples of such products are geographical indication (GI) products that aim to link foodstuff with particular areas (Vandecandelaere et al., 2010).
Producers or other actors create these links to address consumer demands for place-based foodstuffs, with support from policy makers in food and agriculture as well as market forces. For producers, GIs present an opportunity to differentiate their products from the competition with third parties such as producers from other areas and from global players. Consumers often perceive GIs as “better” and of higher quality than no-name, place-less products, which fill the shelves of retailers. GIs also provide symbolic associations with places and notions of “locality,” “authenticity” and “tradition” (Tregear et al., 2007). GIs allow retailers to build niche markets where these foodstuffs can be sold at higher prices and reach consumers, who are willing to pay extra for the foodstuffs’ origin-based reputation (Allaire et al., 2011; Agostino and Trivieri, 2014). There is much debate on the merits and risks of GI systems and how to meet both consumer expectations as well as fair competition in global food markets. Perception of quality and taste are central, along with claims of “authenticity” or “traditionality.” But, legal protection is also sought, due to the possibility of GIs to generate added value (Gangjee, 2012; West, 2013).

For a long time, GIs have been understood mostly as a European concern (Flandrin and Montanari, 1997). A brief account of international regulations on the protection of GIs starts with the Paris Convention for the Protection of Industrial Property in 1883, the Madrid Agreement (registration of marks, 1891) and the Lisbon Agreement for the protection of apppellations of origin in 1958, which was signed by 26 countries (Sylvander and Barham, 2011). With the creation of the World Trade Organization (WTO) in 1994, GIs were included in the Trade-Related Aspects of Intellectual Property Rights (TRIPS) Agreement, which protects GI identified wines (Art. 23) and provides a minimum standard for protecting other food products in national legislations of WTO members (Thevenod-Mottet and Marie-Vivien, 2011). Article 22 defines GIs as “indications which identify a good as originating in the territory of a Member, or a region or locality in that territory, where a given quality, reputation or other characteristic of the good is essentially attributable to its geographical origin. In respect of GIs, members shall provide the legal means for interested parties to prevent: the use of any means in the designation or presentation of a good that indicates or suggests that the good in question originates in a geographical area other than the true place of origin in a manner which misleads the public as to the geographical origin of the good; any use which constitutes an act of unfair competition within the meaning of Article 10bis of the Paris Convention (1967).” Europe (and especially the EU) has been charged (Firth, 2015) in this context of using GIs to defend some sort of rentier power over its agri-food products (Coombe and Aylwin, 2011) with the core of this complaints lying in the (alleged) claims of some proprietary of its territory and know-how (in other words, the highly contested and poorly understood concept of terroir).

Today, GIs have been adopted by both developed and developing countries in different ways, raising discussions on the exact nature of GIs and their power beyond pure market-related issues, including issues related to cultures or local identity (Kohsaka, 2015; Mancini, 2013). Although a common global GI legal system does not exist yet, individual countries (e.g. Japan, Switzerland) or economic regions (European Union, Andean Community) implement specific GI regulatory schemes and acknowledge GI products based on bilateral agreements. On the other hand, countries like the USA, Australia or Sri Lanka, do not see a need to complement their well-introduced trademark schemes with GIs.

Depending on the formal institutions available in the country of origin and/or target market, producers have different options to protect GIs: through specific GI regulations (e.g. sui generis GI law, such as the Japanese or EU regulatory GI framework) and trademark laws in the absence of a specific GI law. Whereas trademarks are usually characterized by the “first in time – first in right” principle and the right to transfer and/or sell the right to anyone, wherever located, GIs are not tradable and are only accessible for producers located in the origin region (Giovannucci et al., 2010; Barham, 2003).
GIs, similar to trademarks, are based on the idea of excluding illegitimate users of a product name (Rangnekar, 2011), not only producers from outside the designated area, but also less powerful players or marginal producers within the area, who may not be able to meet quality standards or to access the certification system. As Chen (1996, p. 39) proposes, “the power to exclude is the power of property” and all GIs follow some specific path that leads to inclusion or exclusion of people, places and outcomes well before reaching the final stage of legal protection. One might ask whether producers know: what lies before them when deciding to join their forces and create a GI within a certain production area and product quality; and who will likely have the ability and social network to get to the final stage of recognition to obtain GI benefits.

The way that consensus on the geographical delimitation and the quality standards of GIs is reached, calls upon issues of governance. Governance in its wider form deals with governing and all the matters that such a process involves. The widely cited Stoker (1998, p. 17) proposed that “governance refers to the development of governing styles in which the boundaries between and within the public and private sectors have become blurred. The essence of governance is its focus on governing mechanisms which do not rest on recourse to the authority and sanctions of government.” The term has been aptly used to signify a shift from processes of governing based on the role of the state as the central body of regulation, to a more decentralized set of operations where multiple actors (Jessop, 1995, p. 310) talks of the “conceptual trinity of market-state-civil society” can shape the process. While in the past governing was a pure matter of political economy and analysis of the mechanisms of government within the state, now attention comes from other research fields and is paid to actors and mechanisms beyond the state (Higgins and Lawrence, 2005, p. 2).

In this paper, we follow this last strand and adopt a wide perspective on the mechanisms and relationships that characterize GI governance. We avoid the ambiguous public-private dichotomy (since public is often equated with the state but also with collective action, whereas private can be linked to markets but also to civil society or to activities taking place in private homes) and refer instead to “internal” (here referring to self-governance, (self-) regulation, interactions, etc. within producer groups) and “external” actors of governance on diverse spatial levels (local, regional, national, international). We are inspired by Young (1997), who talks about governance as a matter of public concern, where members of a social group realize that they are interdependent in the attempt to reach a specific goal – which in our case is an agreement over a GI designation. We consider governance as a complex process, involving informal negotiations and collective choice procedures at a local level, which will impinge upon a global and formal institutional level.

This paper focuses on governance and issues of exclusion comparing selected case studies with different historical perspectives and approaches to GI protection. Although exclusion has been acknowledged as a key issue in GI literature (for instance: Anders and Caswell, 2008; Coombe and Aylwin, 2011; Galtier et al., 2013; Mancini, 2013; Rangnekar, 2011), we lack comparative, cross-continental empirical insights across different cases and GI schemes on the governance behind these products and its practical consequences. Consequently, the objectives of this paper are to:

(1) compare the European and Japanese GI schemes with focus on their governance (formal and informal institutions);
(2) discuss the variety of procedures of implementing the features of the governance system for six cases with focus on inclusion and exclusion of actors (geographical boundaries and exclusion of producers outside of the designated area, social boundaries and exclusion within the area); and
(3) reflect on insights for future GI governance in Europe and Japan and derive lessons for GI systems designed or implemented elsewhere.
2. Methods and data

This paper is based on a comparative case study design, a well-established qualitative research method (Simons, 2014). Cases are studied when they are of special interest either by themselves or for their interactions with other cases (Stake, 1995). Case study approaches have been questioned for their use for generating hypotheses and theory building and for a bias toward verification, as well as for the level of knowledge required to summarize a case study (Flyvbjerg, 2006). But, they are the preferred strategy when “how” and “why” questions are posed to address explanatory interrogations with the purpose of producing a first-hand understanding of contemporary phenomena within complex and diverse real-life contexts (Yin, 2009). In food studies, the case study approach has been particularly useful to present real examples of both people (Macbeth and MacClancy, 2004) and businesses (Lyons, 2005). In our approach, we use some cases that can be considered as “typical” in the sense that they represent many similar real-life examples in the field of GIs (the so-called “successful” cases) and “special” cases, as they present some features that make them particularly suitable for studying and reporting. These three cases are considered as “failures” in the sense that the GI in question was either not registered in the end, or registered but not utilized by local producers. These cases provide more insight on the diverse dynamics of GI systems and the practical issues that may support or undermine their “success” than just the presentation of “best practice cases”.

The selected case studies represent: a diverse institutional context (EU countries with long GI traditions such as Italy and Greece, EU countries with a comparative short GI history, such as Austria, and a totally new system such as Japan); registered GIs with shorter and longer durations of the registration process; foodstuffs with varying target markets (local vs international); what we consider as “failed” cases (including one non-registered and two registered but not used GIs) “Failure” here refers to the inability of the internal and external parties to apply the indication effectively: either failure to register from the start or failure to use the acquired registration. It does not reflect market failure for the products. The cases from the EU include two protected designations of origin (PDOs), i.e. products “the production steps of which all take place in the defined geographical area” Reg (EU) No 1151/2012, Art. 5) and two protected geographical indications (PGIs) (where “at least one of the production steps [including processing or preparation] of which take place in the defined geographical area”: Reg (EU) No 1151/2012, Art. 5). From Japan, two cases are included, one successfully registered and one that did not register (the Japanese system refers to GIs only, without distinguishing if all or some steps of production, processing or preparation take place inside the designated area).

The case studies selected are: Mostviertler Birnmost PGI (Mostviertel Perry; a kind of cider made from pears), Parma Ham PDO, Aceto Balsamico Tradizionale di Modena, PDO, Yubari Melon, Tea A (the real name of the product is not used after the request of the parties involved) and Mytilini – Lesvos PGI Olive oil (Table I, Figures 1 and 2).

Our criteria for assessing these cases were:

- Descriptive: the product, the area (size, location, population, agriculture, and socioeconomic development), the actors involved and their roles (producers /processors and other individuals, farmers, cooperatives, associations, etc.), and the volume of production, along with recent changes (not available for Japanese cases).

- Analytical: the history of governance (who initiated, supported, or opposed the registration process); the producers’ motivation for GI registration; conflicts and challenges along the registration process; inclusion strategy (who is in the GI system and who is out and the relevant procedures); implementation and monitoring of the quality criteria (including ecological/social standards).
<table>
<thead>
<tr>
<th>GI product</th>
<th>Country</th>
<th>Relationship with the area</th>
<th>Designated area (in km$^2$)</th>
<th>Number of producers</th>
<th>Volume of production (per year)</th>
<th>Governance bodies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mostviertler Birnmost PGI (Mostviertel Perry)</td>
<td>Austria</td>
<td>Quality and taste considered to be linked to climate, soil, pear variety and expertise of predominantly small farmers. Historical evidence of production since 1240, has contributed to regional identity (“Mostviertel” is translated as “Perry-Quarter”)</td>
<td>5,500 km$^2$ (Perry quarter)</td>
<td>250</td>
<td>2 Million l</td>
<td>Association of Fruit Producers (150 members)</td>
</tr>
<tr>
<td>Yubari Melon</td>
<td>Japan</td>
<td>Known in Japan for juicy orange flesh, rich aroma, high sugar content and shape; characteristics attributed to topography, climate, soil and local cultivation techniques. History dates back to 1950, when Yubari Melon Association launched (Kinoshita, 2012)</td>
<td>1.8 km$^2$</td>
<td>116</td>
<td>3,400 t</td>
<td>Agricultural cooperative of Yubari</td>
</tr>
<tr>
<td>Prosciutto di Parma (Parma Ham) PDO</td>
<td>Italy</td>
<td>Dry-cured raw ham, produced in one-year curing process (for some, three years). Quality considered to be linked to the pig-bred used, fed only with grains, cereals and whey. Production techniques date back to the fourteenth century</td>
<td>Meat from several northern and central Italian regions; processing only in limited area of the province of Parma</td>
<td>160</td>
<td>8,000,000 branded pieces of ham</td>
<td>Consorzio del Prosciutto di Parma</td>
</tr>
<tr>
<td>Aceto Balsamico Tradizionale di Modena PDO</td>
<td>Italy</td>
<td>Balsamic vinegar, has been produced since the Middle ages from cooked grape-must and obtained through a complex process of production and aging (12 or 25 years)</td>
<td>2,689 km$^2$ (district of Modena in Emilia Romagna region)</td>
<td>250</td>
<td>80,000 trademark bottles (ca. = 20 t)</td>
<td>Consorzio Tutela Aceto Balsamico Tradizionale di Modena</td>
</tr>
<tr>
<td>Mytilini – Lesvos PGI Olive oil (previously Lesbos PGI olive oil)</td>
<td>Greece</td>
<td>Produced on the island of Lesvos (also known through the island's capital Mytilene). Olive cultivation characterized Lesvos' landscape, economy and culture from antiquity (Kios and Vakoufaris, 2011)</td>
<td>1,460 km$^2$</td>
<td>Unknown (max 16,000)</td>
<td>Unknown (max 16,000)</td>
<td>None</td>
</tr>
<tr>
<td>Tea A</td>
<td>Japan</td>
<td>Tea A indicates tea produced in Minami-Kyusyu Town (Kyusyu island). Goal for GI process to Unify existing brands and establish quality standards (Minami-Kyusyu 2014).</td>
<td>34.5 km$^2$</td>
<td>787 farmers (114 factories)</td>
<td>11,755 t</td>
<td>Agricultural cooperative of Minami-Satsuma, and Minami-Kyusyu city tea promotion organization</td>
</tr>
</tbody>
</table>
Figure 1. Case study locations in Europe

Figure 2. Case study locations in Japan
The information and data needed for our analysis come from: the European Council’s database of origin & registration (DOOR: http://ec.europa.eu/agriculture/quality/door/), which includes the official documents of all product names for foodstuffs registered in the European Union; available literature for some of these cases (Kizos and Vakoufaris, 2011; Pircher, 2015; Quiñones-Ruiz et al., 2016; Quiñones-Ruiz et al., 2017); “grey” literature for all cases, typically in the language of each country (studies, internal documents from the producer associations, press clippings, websites, etc.); interviews, observations and personal communications with key-informants of the GI systems (for Yubari Melon interview with a key actor in the local agricultural cooperative in Yubari; for Tea A an interview with a key actor in local municipality (employee/staff member) in Minami-Kyushu; for Mytilini – Lesvos PGI Olive oil six interviews with local actors and two with external ones; and for Mostviertel Perry PGI seven interviews with key-actors, four follow up communications and participatory observations); our personal experience and knowledge of the systems and their actors. The data and the information are diverse and not homogenous, since the cases represent a wide variety of food systems with fewer or more actors and longer or shorter histories. The data certainly is not exhaustive, but rich enough for our research objectives (see above). Before presenting the case studies, we provide a brief outline of the implementation of the GI systems in the EU and in Japan, which is vital for contextualizing the cases and the processes discussed.

3. THE GI schemes in the EU and Japan

The GI regulatory framework in the European Union was established in 1992 (EU Council (EC) Regulation No. 2081/92 (1992), replaced by Regulation No. 510/06 (2006), replaced by the current Regulation No. 1151/2012 that incorporated wine in the system) in an effort to harmonize different national GI frameworks, with two categories of GIs: PDO and PGIs. Differences between adopting a PDO or a PGI designation are not always trivial: although geographical limitations in all production and processing steps involved in PDOs may be more difficult to manage, valorization differences between PDOs and PGIs have not been reported (ARETE, 2013). For some PDO products, research indicates that consumers may be willing to pay more for a PDO rather than a non GI product (e.g. Mesías et al., 2010; Garavaglia and Mariani, 2017 for dry-cured ham; De Magistris and Gracia, 2016 for cheese; but not always for olive oil; Krystallis and Ness, 2005; Aprile et al., 2012), although insufficient knowledge of the scheme in general is reported as a constraining factor, especially in Northern Countries of the EU where consumers are less familiar with the scheme (e.g. ARETE, 2013; Vecchio and Annunziata, 2011 for Italy; Krystallis and Ness, 2005 for Greece; Fandos and Flavián, 2006 for a Spanish product). Some of the most “successful” in terms of prices PDO examples are well-established global brands (e.g. Roquefort PDO cheese). Since its introduction in 1992, 679 PDOs and 796 PGIs have been protected (DOOR database, 6 November 2016, excluding wines), making the European schemes the most widespread application of the GI approach (with the exception of wines that are globally regulated in the TRIPS agreement).

Applications for PDOs or PGIs “may only be submitted by groups who work with the products with the name to be registered,” although in exceptional cases “a single natural or legal person may be treated as a group” (Article 49). The group is entitled (Article 45) to: ensure that the quality, reputation and authenticity of their products are guaranteed on the market; take action to ensure adequate legal protection; develop information and promotion activities; develop activities related to ensuring compliance of a product with its specification; take action to improve the performance of the scheme; take measures to enhance the value of products and, where necessary, take steps to prevent or counter any measures which are, or risk being, detrimental to the image of those products. Different national food safety legislation and inspection or certification frameworks involve a varying number of actors in each Member State in the production, safety and marketing of PDOs and PGIs.

Governance of geographical indications
In comparison, the history of GIs in Japan is relatively young. The GI regulatory framework in Japan was established in June 2014 and entered into force in June 2015. The law formed mainly through the process coordinated by the Japanese Ministry of Agriculture, Forestry and Fisheries and focuses on agricultural, forest and fishery related products. Alcoholic beverages such as wine and spirits have a separate legal framework, regulated under the TRIPs treaty. Within the framework for the agricultural, forest and fishery related products, the scheme equivalent to the European PGI was adopted (the applicants de facto registered papers that are equivalent to the PDO but there is no independent category for the stricter standard). In December 2015, six months after the enforcement of the law, seven products were registered. To date (December 2016), 21 items are registered (food, but also tatami mats and raw silk). The most important agri-food product of Japan – rice – is still missing and there are regional imbalances as well that favor more peripheral and/or mountain areas.

4. Comparison of the GI cases
The findings are presented comparatively in Table I (descriptive variables) (analytical for “success”) and (analytical for “failure”). The three cases that were considered to be successfully implemented (Table II) have all been motivated by the protection against fraud and are self-governed by producers’ organizations. Two of the three remaining cases were successfully registered (Lesvos Olive Oil PGI, Mostviertel Perry PGI), but not, or only partly, implemented (Table III). For the other case, Tea A, the process started, but the producers (particularly some big processors who were not involved from the beginning into the GI discussion) finally decided against a GI application (Table III).

5. Discussion
5.1 “Success” and “failure” of GIs
In this paper, we have not only explored “success,” but also “failure” in the establishment and operation of GI food systems. “Success” in a GI system – as defined in this paper – entails the registration of the product as a GI and the use of the GI label by the local producers. Although there may be many drivers for “success,” we have focused on the governance of the respective GI food systems and on issues of inclusion/exclusion inside and outside the designated area.

We compared case studies from an older and developed GI system in the EU with the Japanese ones, where a similar GI system was set up in 2015. The approach is not exhaustive and might be affected by selection bias, but we believe that the comparison of “successful” and “failed” cases within each system and between the systems provides insights on the process and practice of GI food systems and can guide existing and future GI processes. Our cases demonstrate that the categorization of the cases as “successful” and “failure” is relative and related to the creation and establishment of a GI. Registration is not a simple task and does not guarantee that the GI will then be actually used by local producers as demonstrated by the Mostviertler Birnmost PGI or the Lesvos PGI olive oil cases. Nor does the use of the GI label by local producers guarantee market success and rewards.

5.2 The initiation of the GI system – registration
The initial decision to start the process to obtain a GI was guided by “internal” and “external” actors in the different case studies. The clearest of these cases for which external actors were prominent is that of Lesvos PGI olive oil, which demonstrates how political choices at the national level (the Ministry of Agriculture and Food pushed for the registration of the PGI) can dictate the process at the local level. For the “successful” cases of the Italian products and the Yubari melon, the process involved a complex internal (local) negotiation of multiple parties with a “stake” in the GI. In the Tea A case, the producers and
<table>
<thead>
<tr>
<th>GI</th>
<th>Motivation for GI protection</th>
<th>Actors</th>
<th>Self-governance</th>
<th>Quality standards</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yubari Melon – GI</td>
<td>To ensure compliance control and protection by government (high costs of taking legal action against fraud)</td>
<td>Farmers from the agricultural cooperative of Yubari that were organized in the Yubari Melon association</td>
<td>Only members of the cooperative are allowed to cultivate the Yubari king variety and use the GI</td>
<td>Only “Yubari King” variety quality standards based on existing market regulations for melons and trademark rules Monitoring by the Ministry of Agriculture, Forestry and Fisheries of Japan</td>
<td>Collective trademark in 1993 One of the first Japanese GIs in Japan in 2015 Increasing number of orders</td>
</tr>
<tr>
<td></td>
<td>To benefit from overseas trade</td>
<td></td>
<td></td>
<td></td>
<td>In the first season-opening auction after registration record high price</td>
</tr>
<tr>
<td>Prosciutto di Parma – PDO</td>
<td>To acquire closer control over fraud (many cases of fraud)</td>
<td>Association of producers (called consortium) including producers, pig farms and abattoirs</td>
<td>Although consortium membership is no longer compulsory to produce the PDO, the consortium is still responsible for several tasks (e.g. producer support, promotion, initiation of change or cancellation of GI)</td>
<td>Quality standards established by consortium based on historical practices Organoleptic analyses for certification Debate on the length of the aging period resolved within the consortium Monitoring in the past by the consortium, now by private certification body</td>
<td>National protection (Denominazione di Origine Controllata, D.O.C.) from 1970 EU protection (PDO) 1992 Various GI amendments Recognition in 50 countries worldwide Producers affiliated to the consortium are increasingly also selling ham without PDO label</td>
</tr>
<tr>
<td>Aceto Balsamico Tradizionale di Modena – PDO</td>
<td>To protect and control the product (in 1967 foundation of the “ Consorteria dell’ Aceto Balsamico Tradizionale di Modena”) To differentiate the production process on the basis of traditional methods and GI recognition by the association of producers (due to commercial boom, industrial production and reputation loss)</td>
<td>Association of producers (called consortium) of mainly small family businesses Due to conflicts in 2002, most bigger producers established a second consortium 250 producers certified for PDO, most are also (voluntary) members of one of two consortia</td>
<td>Consortium still responsible for several tasks (e.g. producer support, promotion, initiation of change or cancellation of GI)</td>
<td>The quality standards have been defined by the 1st consortium based on historical practices Organoleptic analysis for certification Monitoring first by consortium, now by private certification body</td>
<td>National protection (D.O.C.) 1977 for the ‘Aceto balsamico di Modena’ National protection of ‘Aceto Balsamico Tradizionale di Modena’ 1983 EU protection (PDO) 2000 Some producers lamented bureaucratic pressure and restrictions due to the 100-ml-bottle</td>
</tr>
</tbody>
</table>

Table II. Comparison of three successfully implemented GIs
processors are organized in two different organizations and could not come up with a common GI strategy. In fact, the re-negotiation with actors that did not support the registration made the whole process collapse. External actors may also be an important part of the registration process: such as in Austria, where the Regional Management Organization Austria and the regional Chambers of Agriculture played an important role in the GI registration process; in Greece and Japan the Ministries for Agriculture are pivotal (in Japan regional branches are also important); and in Italy the regional governments and research organizations have played an important role in facilitating GI registration and implementation.

### Table III.
Comparison of three “failed” GIs

<table>
<thead>
<tr>
<th>GI</th>
<th>Motivation for GI protection</th>
<th>Actors</th>
<th>Self-governance</th>
<th>Quality standards</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mostviertel Perry – PGI</td>
<td>To acquire protection against misuse of geographical name</td>
<td>Fruit producers’ association and some processors</td>
<td>Board members of the fruit producers’ association drove the GI process with limited direct participation from farmers</td>
<td>No new quality standards for perry were set, those defined by national and provincial law remained in place Monitoring poorly implemented (in the application the authority indicated was the Governor of Lower Austria, but after registration a private certification body was required)</td>
<td>GI protection in 2011 GI never used (unwillingness of majority of producers to pay for certification) Majority decision to cancel GI Quality seal for fruit wine introduced based on Austrian wine law in 2016 (cheaper for producers, wine quality seal better known to Austrian consumers than GI label)</td>
</tr>
<tr>
<td>Lesvos – Mytilini Olive oil – PGI</td>
<td>Greek government’s strategy to register as many products as possible when the EU GI scheme was introduced</td>
<td>PGI registration implemented in the name of the Island’s Union of Agricultural Cooperatives (its members are 1st degree cooperatives) Limited direct participation of local producers (members of 1st degree cooperatives) No self-governance body of the GI (GI is not governed in practice)</td>
<td>Quality standards below extra virgin olive oil (collection and milling practices, acidity, mixing of oils) Practically everyone can produce it, no monitoring of quality</td>
<td>Top-down government driven PGI registration in 1993 Low demand for the PGI less than 1% of the island’s olive oil sold as PGI in 2007</td>
<td></td>
</tr>
<tr>
<td>Tea A – GI</td>
<td>To revalorize the product (low price of tea leaves and increasing production costs in recent years) To unify existing brands To protect the geographical name</td>
<td>Farmers and processors</td>
<td>Stricter GI quality standards would have excluded lower-quality tea producers</td>
<td>No consensus on quality standards Trademark in 2007 No application for a GI Processors and farmers organized in two different organizations had different expectations regarding quality standards (processors were afraid of shrinking their supply)</td>
<td></td>
</tr>
</tbody>
</table>
Our cases confirm that registration seems to be a process rather than a single step, requesting coordination and consensus (Young, 1997). It requires the definition of the product (in theory at least a slightly different product from that of the competitors), the definition of the producers and the rest of the actors, the area, the quality standards and the self-governance context (formal and informal rules on decision making). This process is dynamic, in the sense that definitions and agreements are constantly re-negotiated, as the two Italian cases show, where producers had to adapt governance and monitoring mechanisms and to “defend” their registered product from ones made with “modern” techniques.

5.3 The construction of “quality”
The definition of the product and its “quality” (how it is different from the competition) is critical for GI systems. The literature suggests that this is a process (Bingen and Busch, 2006; Busch, 2011), as it can change due to “internal” (i.e. from the producers and/or other actors involved in self-governance) and “external” pressures, but also from international markets. Setting standards is probably the “core” of any GI, as the standardization process defines the peculiarity of a product with which it gets legal protection against counterfeiting. As our case studies show, setting a standard, on which all interested parties agree seems to be the central element for “success”. The examples of the two Italian PDOs is telling: producers of Prosciutto di Parma PDO based “quality” on historical practices, but a critical aspect (the aging period) was later again discussed and resolved through the consortium; similarly, producers of Aceto Balsamico Tradizionale di Modena PDO “defended” their product by setting quality standards based on historical rather than modern methods. Lesvos PGI olive oil serves as the other opposite example: the original process yields products that the market does not consider of value anymore. The lack of internal negotiation processes, as part of self-governance, for the adaptation of quality standards to consumer needs has rendered the GI label as almost useless on the market. The case of Mostviertel Perry PGI is also revealing in the sense that it seemed to be difficult to make quality of the fruit and the final product of different producers uniform and closer to a set of guidelines.

5.4 Inclusion – exclusion
GIs are collective rights with established entry barriers (inclusion/exclusion) defined along social and geographical boundaries (Quiñones-Ruiz et al., 2015). GIs have to be accessible by all producers located within the area meeting the quality standards defined in the product specification and thus the definition of these standards (and also of the producers and those with “a stake” in the product) is a process and subject to negotiations (Sonnino, 2013). At the same time, it has been argued (Kizos and Vakoufaris, 2011) that GIs are a “common resource” of the area, which means that they “belong” to the area and not to individual producers. However, individual producers make and sell GI products. This constant interplay between area and producers (as well as between internal and external actors) is what makes the process of inclusion so dynamic. Here again our case studies range from socially very “open” systems, where basically any producer located in the designated area can produce the GI due to loose quality specifications (e.g. Lesvos PGI olive oil or the Japanese tea case), to the more “closed” and strict system of Aceto Balsamico Tradizionale di Modena PDO. The role of self-governance structures and processes is key to establish transparency on inclusion and exclusion (who can enter and how, who has to leave and why). The example of Tea A illustrates this as internal and external actors involved (farmers and processors) decided to abandon the idea of a GI application due to the fear of shrinking supply of tea leaves if quality standards were set; further they could also not agree if and how processors outside of the geographical area would be included in the
GI system. On the contrary, in the case of Yabari mellon, the interplay between internal and external actors was more effective and has so far managed to overcome friction. In the case of Mostviertel Perry PGI, the heterogeneity of Perry producers in terms of quality (some produce very high and others low quality of pears and perry) and the lack of direct involvement of many farmers in the GI registration process, made the majority of farmers to waive what they considered as a costly certification system and continued to market their products via direct on-farm sales. Here, the low quality standards and socially open GI system, has disadvantaged the few high quality producers that will not be able to benefit from the GI on (inter-)national markets.

The geographical boundaries, characterizing each GI system, express the power of place by territorial exclusion. Territorial inclusion or exclusion can make a vital difference, such as higher price margins for producers located within the area compared to producers of equivalent products located outside (Dentoni et al., 2012; Bowen and de Master, 2011). Changes of the geographical delimitation, however, need consensus among the local (internal) producers and formal approval of an application for amendment in the European system (external actors). The case studies show that a sense of belonging to a specific place is fundamental. The acknowledgment of common spatial origin and production cultures, which translate also in context-specific knowledge and skills for local quality food products, emerges as a central element for “success,” which is the ability to recognize whether the area and the final GI goals are in the best interest of the stakeholders (e.g. the Italian cases). The case of Tea A on the contrary marks a “failure” related to the (non) definition of clear geographical boundaries. Sometimes however, the definition of geographical boundaries follows administrative and legal necessities (Vakoufaris and Kizos, 2011).

5.5 Governance

Finally, self-governance of a GI system is probably the most important aspect of its operation and refers to all of its dimensions (in our case studies these bodies can be “consortia” in Italy, “producer organizations – associations” in Japan and Austria or “unions of cooperatives” in Greece) that regulate GI implementation (Torre and Traversac, 2013). The examples of “success” and “failure” indicate that self-governing bodies are pivotal for successful GI registration and implementation. Dentoni et al. (2012) highlighted that European GIs are regulated by EU laws whereas in the rest of the world there is a mixed structure of internal and external institutions; therefore, we cannot ascribe differences in the outcomes only to different geolocalization (Lio and Liu, 2008). The Italian cases are particularly revealing, where collaboration between different internal and external (public and private) actors has been highly rewarding for both. This does not mean that there are no internal conflicts, but these seem to be managed in established negotiation arenas that help to overcome friction. Quiñones-Ruiz et al. (2016) showed that self-governance of GI systems and associated negotiations and discussions imply considerable time and efforts, which however pay off for effective protection, which is exactly what was not done in the case of Tea A. This effectiveness in governing the GI system involves all the aspects already discussed (participation, negotiations, adaptation, inspection and certification of quality standards, transparency on inclusion/exclusion) and is striking compared to the “failed” cases. In failed cases, when difficulties arose, mechanisms or institutions that could handle these difficulties were not present.

Self-governing bodies can be formal or informal (Fuchs and Glaab, 2011), evident in the democratically ran consortia of our Italian cases, where diverse actors can openly express opinions and negotiate changes. External institutions are of great importance as well (Devaney, 2016), also in terms of encouraging and acknowledging self-governance among producers (Dentoni et al., 2012). The Lesvos-Mytilini PGI olive oil case shows that managing the registration was made particularly difficult due to the absence of supporting
local governance structures. In the same vein, the Austrian case tells how an old and very traditional beverage did not succeed in GI implementation, due to a registration process that did not acknowledge the asymmetries and heterogeneous needs among high and low quality producers. However, the case of Mostviertel Bärnmost PGI is ambiguous. Although the majority of producers decided not to implement the PGI in the end, the registration process resulted in a re-definition of goals and an alternative certification strategy. An extreme example of policy related assistance is that of Yubari melon, where the agricultural cooperative farmers’ association (the JA) of Yubari collaborated with the local government to support the branding of the product as an official gift which can be given in return for paying a specific donation in the area (Furosato Nozei in Japanese).

5.6 Similarities and differences of European Union – Japan GI systems

Differences between Europe and Japan in the GI systems are mainly on the formal level: the Japanese GI system includes handicraft products and does not differentiate between stricter PDOs and less restrictive PGIs. Another difference reflects the longer traditions of protection in many southern EU countries that were transferred in a common legislative framework, whereas in Japan the system is still in its infancy and struggles to gain recognition in markets and producers. But, even after more than 20 years of PDOs and PGIs in the European Union, Kizos (2013) reports that the degree of knowledge of the scheme is not very high among European consumers and most appear to not know PDO and PGI designations, nor informed of what these labels refer to, with major differences among Southern and Northern countries, reflecting the existing differences in the adoption of the scheme. A more striking difference refers to the role of the state and the interplay between “bottom up” and “top down” approaches in implementing GIs as rural development strategy. Even though there is a long tradition of extended state intervention in agriculture and rural development in Europe, the GI system is widely run by internal and privately organized bodies. Our European cases are a mix of bottom-up and top-down practices, with the bottom-up being stronger with the notable exception of the Lesvos PGI olive oil, a fact directly related to its “failure”. In Japan, with an equally long tradition of state intervention in farming, the ministry of agriculture monitors the GI standards and the mix seems to be toward “top-down” rather than “bottom-up,” at least to date, and comparative to the European cases analyzed in this article.

6. Conclusion

How should GIs be implemented and governed? What can we learn from successful and failed examples in Europe and Japan, i.e. two different GI systems implemented in two different political and cultural contexts in the Global North? The first finding that emerges is related to the evolving nature of GI systems. What our cases make clear is that these systems do not “end” with the registration, but in order to ensure “success”, GIs require constant management, possibly involving re-definition of production quality or geographical boundaries to adapt to market, climate or technological change. This collective management is shaped by the blend of internal and external actors involved and it is important to realize the complex dynamics of this heterogeneous social network.

Another critical issue is the interplay between external vs internal processes of decision making. The external policy frameworks, all parts of international trade deals that provide legal protection, and governance support are important. Ultimately, however, successful GI registration and implementation does depend on internal collaboration of heterogeneous producers and processors in the GI area, who have to agree on exclusion and quality criteria and how to implement them, which cannot be effectively enforced top-down. Whereas countries with a long GI tradition, such as Italy, have elaborated mechanisms and democratic principles of self-governance in their consortia over several decades already,
other countries, such as Austria, Japan or Greece have less rich traditions of GI related self-governance for horizontal and vertical collaboration among local farmers, processors, traders and other stakeholders. Compared to Europe, the Japanese cases seem to display a stronger role of the state in GI implementation and monitoring. We conclude with inclusion/exclusion. Our cases show that a feeling of “belonging” is very important and actors have to feel welcome inside the GI system from the start, but at the same time be able to exclude and claim collective ownership of the product and its reputation. This may be the difference between “success” and “failure” in setting up and managing a GI system.

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**Further reading**


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Abstract

Purpose – The purpose of this paper is to determine whether there is a difference in the development of shopping lists and use of advertisements as pre-store food-buying practices in terms of planned shopping by South African consumers who dwell in different socio-economic status (SES) areas. The paper also considers the influence of shopper and socio-demographic characteristics on pre-store food-buying practices in a developing country.

Design/methodology/approach – A self-administered questionnaire was used to survey 1,200 consumers in retail stores in low, middle and high SES areas in South Africa. A generalised linear model was employed for the statistical analysis of pre-store food-buying practices within the SES area groups in a developing country.

Findings – South African consumers that reside in high SES area displayed the largest of shopping list development, while consumers who dwell in low SES areas showed the highest incidence of advertisement usage. Several shopper and socio-demographic characteristics were also found to have an influence on pre-store food-buying practices in different SES areas in South Africa.

Research limitations/implications – A qualitative approach would offer a deeper understanding of consumers’ pre-store food shopping predispositions as opposed to the quantitative approach, which was adopted for this study. A longitudinal design would also provide a more extensive representation of pre-store food shopping practices over a longer time frame than cross-sectional research. The survey was conducted on Saturdays, whereas consumers who shop during the week may have different shopping and socio-demographic characteristics.

Practical implications – Astute food brands, marketers and grocery stores could use the findings of this study to assist with their marketing efforts that they direct at consumers in different SES areas in South Africa and other developing countries.

Social implications – The findings of this study may assist consumers in developing countries, especially those who reside in low SES areas, with food-buying strategies to reduce food costs, make wiser purchase decisions and reduce shopping.
Originality/value – No study (to the best of the researchers’ knowledge) has considered shopping list development and use of advertisements’ pre-store food-buying practices in different SES areas in a developing country. Furthermore, there is a dearth of research analysing shopper and socio-demographic characteristics in relation to pre-store food-buying practices among different SES areas in developing and developed countries.

Keywords South Africa, Developing country, Pre-store food-buying practices, Shopping list development, Socio-economic status (SES) areas, Use of advertisements

Paper type Research paper

Background

South African consumers have experienced increasing debt levels over the past decade as a result of an enduring recession. One of the many consequences of this economic downturn has been a major increase in energy and transport, which, coupled with the current drought experienced Africa, means that food prices have markedly increased in South Africa (South African Reserve Bank, 2016). The Community Survey 2016 reported that one in five households did not have sufficient money to buy food in the past 12 months (Statistics South Africa, 2016a). Hence, consumers generally agree that their economic situation has an important effect on their shopping behaviour (Darko et al., 2013; Petzer and De Meyer 2013). Food-buying practices can be used by consumers to help to reduce the amount of money, which is spent on food, and increase funds that are available for other household expenses.

Despite the high rate of unemployment and household indebtedness, consumer confidence and subsequently household expenditure on consumer goods and services has been on the increase (South African Reserve Bank, 2016). However, consumers should consistently employ effective purchasing strategies to protect themselves against uncertain economic times, especially since consumer credit facilities are less freely available owing to the National Credit Act (Hampson and McGoldrick, 2013; O’Haughey, 2016). The National Agricultural Marketing Council (2016) reports that South Africa has one of the highest inflation rates for food in comparison to other countries, with the cost of an urban food basket increasing by 16.3 per cent over a period of one year (July 2015-July 2016).

It is generally accepted that there is an inverse relationship between income level and the amount of money, which is allocated to food purchasing. Hence, low-income households usually devote a larger percentage of their total expenditure to food, while in each successively high-income group the amount that is spent on food declines as a percentage of total expenditure (Frazao et al., 2007; Darmon and Drewnowski, 2015; KPMG, 2016). South African consumers, particularly from low-income households, are impacted the most by rising food costs and currently spend 57.1 per cent (compared to 49.1 per cent of July the previous year) of their disposable income on food compared to the 2.3 per cent of high-income consumers (National Agricultural Marketing Council, 2016). Therefore, consumers from low socio-economic groups often have to cut back on food spending to make room for other essentials such as housing and utilities (Ward et al., 2012). Socio-economic status (SES) differences in household food purchasing behaviour were investigated by Turrell et al. (2004), who found that residents of socio-economically disadvantaged areas have purchasing patterns that are different compared to those in more advantaged areas. Ellaway and Macintyre (2000) agree that shopping practices differ by neighbourhood and income group.

The use of consumers’ money-saving techniques, particularly during difficult economic times, has not been extensively researched in South Africa or other developing countries. Additionally, research concerning the influence of SES characteristics such as income, education and occupation, which reflect socio-economic determinants of consumers’ use of food-buying practices, is also limited. Dinkins (1997) mentions that additional behavioural
research is required to determine, which factors influence consumers’ use of various money-saving methods. Harper and Crafford (2011) assert that shopping lists and use of advertisements (to plan shopping) are the two most popular pre-store food-buying practices, which is also suggested by Friedman and Rees (1988). The aforementioned pre-store food-buying practices were also identified by The Food Marketing Institute (2014) as commonly used cost-cutting methods. A majority of studies that considered the aforementioned pre-store food-buying practices were conducted in developed countries (Wilkinson and Mason, 1976 (USA); Shipchandler, 1982 (USA); Spiggle, 1987 (USA); Zaichkowsky and Sadlowsky, 1991 (USA); Thomas and Garland, 1993 (New Zealand); Polegato and Zaichkowsky, 1994 (USA); Thomas and Garland, 1996 (New Zealand); Dinkins, 1997 (USA); Putrevu and Ratchford, 1997 (USA); Block and Morwitz, 1999 (USA); Thomas and Garland, 2004 (New Zealand); Govindasamy et al., 2007 (USA); Herbst and Lloyd, 2007 (USA); Bassett et al., 2008 (Canada); Heinrichs et al., 2011 (Germany); Mortimer and Clarke, 2011 (Australia); DeNoon, 2012 (USA); Schmidt, 2012 (Denmark); Hampton and McGoldrick’s, 2013 (UK); Mikolajczak-Degrauwe and Brengman, 2014 (Belgium); Flagg et al., 2014 (USA); Zimmerman and Shimoga, 2014 (USA); Tariq et al., 2016 (USA)). Furthermore, few of these inquiries considered the association of shopper and socio-demographic characteristics regarding shopping list development and/or use of advertisements among different SES groups.

Hence, an understanding of factors that account for variations in food shopping behaviour across households and SES groups in a developing country is required. The primary aims of this research are as follows: To ascertain whether there is a difference in the development of shopping lists and advertisements’ pre-store food-buying practices for planned shopping by consumers who shop in different SES areas in South Africa; to determine whether shopper characteristics have an influence on the development of shopping lists and use of advertisements as pre-store food-buying practices among consumers shopping in different SES areas in South Africa; and to establish whether socio-demographic characteristics have an impact on the development of shopping lists and use advertisements as pre-store food-buying practices among consumers shopping in different SES areas in South Africa.

Literature

SES
The American Psychological Association describes SES as an intersecting measurement of education, occupation, and income, which determines the social standing or class of an individual or group (American Psychological Association, 2007). Consumers’ level of income is vastly affected by their employment status. The severe recessionary conditions in the first half of 2016 were reflected in massive job losses in South Africa, and a subsequent high level of unemployment in 2016 (South African Reserve Bank, 2016). The Quarterly Labour Force Survey 2016’s results show that the unemployment rate among Black and Coloured population groups is higher than other population groups, with the White population group displaying the lowest unemployment rate (Statistics South Africa, 2016b). The major differences, which are apparent among South Africans in respect of their educational levels, abilities, occupations and wealth, have resulted in one of the most unequal distributions of personal income in the world, which is clearly evident in the population groups (Petzer and De Meyer, 2013; Statistics South Africa, 2016a). Although the abolishment of Apartheid a quarter of a century ago resulted in an increase in household incomes across all population groups, there remains an unequal distribution of income. Household income directly affects a family’s ability to afford and procure food (Turrell et al., 2004), and is subsequently associated with budget constraints on grocery shopping behaviours (Kim and Park, 1997).
Pre-store food-buying practices
The primary objective of food-buying practices is to provide food shopping guidelines, which are aimed at reducing food costs, but there are also other aims, namely: to increase satisfaction with food choices; improve dietary quality; reduce shopping; obtain the best quantity and value for money spent; and make wise purchase decisions (Friedman and Rees, 1988; Herrmann and Warland, 1990). The use of food-buying practices essentially revolves around planned buying (Friedman and Rees, 1988). As consumers become more experienced, their shopping habits begin to generate a specific decision-making style (Alagöz and Ekici, 2011). When faced with multiple decisions and numerous distractions, consumers may rely on aids (such as food-buying practices) to help simplify the decision-making process (Block and Morwitz, 1999). Pre-store planning activities are completed before the shopper enters the store, which include the following food-buying practices when planning shopping: development of a shopping list; use of advertisements; planning of menus; use of coupons; avoidance of shopping when hungry; and planning of menus around “specials” (Friedman and Rees, 1988).

It is generally only during pre-purchase and post-purchase activities that consumers experience the worth of time and money given to an activity. Consumers will decide whether or not the amount of time spent on an activity is worth its perceived monetary cost (Robinson and Nicosia, 1991). Herrington and Capella (1995) further add that, in general, shoppers tend to spend less time making a purchase, and more money in the time that is available to them. Grocery shopping is typically perceived as a time-consuming activity. Van Kenhove and De Wulf (2000) examined income and time pressure, which were applied to grocery retail shopping, to establish four grocery shopping segments: Money-poor and time-rich consumers (retired/pensioners and low education); money-poor and time-poor consumers (females, live alone or with children, employed full-time and low education levels); money-rich and time-rich consumers (older, married, retired, children left home or were about to leave, and good education); and money-rich and time-poor consumers (middle-age, live with a partner; two to three children, well-educated and full-time employed). Hence, time-pressed consumers, especially among high-income households, are generally in a hurry and are constantly looking for ways to save time. They tend to adopt time-saving strategies, which include: the purchasing of convenience food, bulk buying; shopping at less busy times; and shopping in less busy locations. They also tend to purchase fewer products than intended; make fewer unplanned purchases; and spend less time comparing product brands, prices and attributes (Davies and Madran, 1997; Chetthamrongchai and Davies, 2000; Popkowski Leszczyc et al., 2004). Bawa and Ghosh (1999) shows that the higher an individual’s or household’s income, the busier they are, thus increasing the value of their time. As a result, the amount of time that the consumer is willing to spend on shopping activities often decreases. Blaylock and Smallwood (1987) suggest that consumers develop shopping lists and use advertisements as cost- and time-saving techniques. As mentioned in prior text, shopping list development and use of advertisements were identified as the two most popular pre-store food-buying practices in South Africa (Harper and Crafford, 2011) and, hence, were the primary focus of this study.

Development of shopping lists
Bassett et al. (2008) defines a shopping list as “[…] itemised products to be purchased to re-stock the household […].” Shopping lists represent the purchase intentions of consumers and are an indicator of pre-shopping planning (Spiggle, 1987). The presence of a list is associated with enhancing shopping efficiency, as it enables the shopper to remember items that are needed, avoid overbuying, organise shopping activities and control expenditure (Putrevu and Ratchford, 1997; Thomas and Garland, 2004). Gollwitzer (1993) found that specifying one’s intentions (e.g. stating or writing them down)
increased the probability that the objective was achieved. This can be explained by Intons-Petersen and Fournier (1986), who suggest that the process of creating a memory aid or writing the shopping list reinforces the likelihood of remembering to purchase those specific items, regardless of whether the memory aid (shopping list) is available at the time of action, or when the person is in the grocery store. Block and Morwitz (1999) and Bassett et al. (2008) revealed that shoppers who used a written list perceived that it guided the shopping process. It gave them the sense of a shopping strategy, and encouraged them to shop isle by isle, thereby avoiding buying unlisted or unplanned items. Furthermore, shoppers who use a grocery list are thought to have engaged in more planning than shoppers without a list (Bassett et al., 2008, p. 207). However, Thomas and Garland (1996) found that 93 per cent of consumers who used a list during a major trip purchased 2.6 times more items than those specified. They suggest that the in-store environment contributed to this additional buying. This led them to believe that the role that the written shopping list plays in grocery shopping behaviour is that of a guiding action rather than a governing action.

Thomas and Garland (2004) suggest four main list-user categories: Consumers who use a list to ensure that their shopping requirements are met; shoppers who feel that using a list simplifies the shopping experience and saves time in the shopping process; those who like to control their expenditure, stick to a budget, save and prevent overspending; and shoppers who use a list to remember “specials” and promotions, which also ensures that they obtain bargains and ultimately save money. However, Herbst and Lloyd (2007) reveal that when a shopping list is based on advertised “specials”, the use thereof leads to less spending, because consumers are less inclined to deviate from a list, which mostly comprise of items on promotion. Block and Morwitz (1999) confirm that items are more likely to be purchased upon the development of a shopping list, which increases in larger households, but is lower for products that are advertised more frequently. Schmidt (2012, p. 37) asserts that heavy advertising within a product category may lead to a higher propensity among consumers to write down brand names on shopping lists. Shipchandler (1982) disclose that consumers are more likely to use shopping lists and stock up on promoted products during recessionary periods. Thomas and Garland (1996) indicate that shopping list users spend less time shopping than non-list users, regardless of whether shopping alone or with company.

Hersey et al. (2001) found that low-income households are less likely to use a list when grocery shopping. Conversely, Bassett et al. (2008) confirm that consumers with lower household incomes are more likely to use shopping lists. Dinkins (1997) agrees that consumers who adhered to strict food budgets are less likely to use shopping lists, but more likely to have a lower education, lower household income and a larger household size, whereas population groups and gender did not have an influence. However Spiggle (1987) reports that Black consumers are more likely to write down shopping lists than White consumers, but no significant difference was found for occupation, household income, age or size of household. Thomas and Garland (1993) assert that consumers with higher education are more likely to use shopping lists, whereas part- or full-time employed consumers who are less likely to use shopping lists. Gender, age, household income and marital status were found to not have an influence. DeNoon (2012) reports that men have a tendency to get lost in the supermarket without a list, so the female in the household will provide them with a list of items to purchase. Men, however, tend to only purchase specific items on the shopping list while, women are more inclined to browse. However, Polegato and Zaichkowsky (1994) determine that women used shopping list as frequently as men, whereas Blaylock and Smallwood (1987) and Bassett et al. (2008) confirm that women are more likely to use shopping lists. Polegato and Zaichkowsky (1994) reveal that women attach greater importance to store “specials” since they are more likely to develop the shopping list and tend to carry out household tasks that are associated with food-buying practices.
Therefore, this study aims to address the following research questions due to the dearth of research on shopping list development (dependant variable) among different SES groups (none of the aforementioned inquiries consider different SES areas) in developing countries (not one of the abovementioned studies originate from a developing country), and the divergent results in terms of shopper (independent variables) and socio-demographic (independent variables) characteristics’ association with shopping list development:

**RQ1.** Is there a difference in shopping list development by consumers who shop within different SES areas in South Africa?

**RQ2.** Do shopping characteristics have an influence on the development of shopping lists among South African consumers within different SES areas?

**RQ3.** Do socio-demographic factors have an impact on shopping list development among consumers within different SES areas in South Africa?

**Use of advertisements to plan shopping**

Weekly newspaper advertising “specials” by grocery store chains are a major source of consumer information about food prices (Zaichkowsky and Sadlowsky, 1991; Darko et al., 2013). Bassler and Newell (1982), Smith and Carsky (1996), Yoo et al. (2006) and East et al. (2008) confirm that one weekly main trip and one or more secondary ‘quick’ trips were the most common food shopping patterns among consumers. Advertising of food “specials” offers an economic incentive to make a purchase (in the form of price reductions and store coupons). Consumers may, therefore, place these advertised items on their shopping list to remember to purchase them (Block and Morwitz, 1999). According to Smith and Carsky (1996), consumers who frequently use advertisements to plan their shopping believe that this practice is highly relevant and useful in terms of saving money. Furthermore, studies have shown that there is a general lack of customer loyalty towards any specific store chains (especially during or after a recession), and that a significant number of consumers switch stores to take advantage of price discounts (Hampson and McGoldrick, 2013; Food Marketing Institute, 2014). Mikolajczak-Degrauwe and Brengman (2014) reveal that favourable attitudes towards advertising could result in impulse buying. Govindasamy et al. (2007) found that a majority of consumers used food advertising to plan their shopping, hence, it can be assumed that the use of this pre-store food-buying practice is quite popular and reflects a common concern for price, as is evident among South African consumers during these tough economic circumstances (National Agricultural Marketing Council, 2016).

Shipchandler (1982) and Hampson and McGoldrick’s (2013) also found consumers, especially during or after a recession, are more susceptible to advertised price discounts and made fewer shopping trips. Dinkins (1997) and Darko et al. (2013) established that low-income consumers are more likely and stock up on food on promotion. Zimmerman and Shimoga (2014) confirm that low-income consumers are more likely to use food advertisements than high-income consumers. Tariq et al. (2016) agree that consumers with higher incomes may be less price-sensitive and, hence, have less incentive to use food advertisements. However, Wilkinson and Mason (1976, p. 220) found high response rates to advertised food “specials” among low-income Black consumers and high-income White consumers. Zimmerman and Shimoga (2014) also found that food advertising had a disparate influence on different population groups. Govindasamy et al. (2007, p. 9) reports that consumers with higher levels of education tend to read or use food advertisements. Mortimer and Clarke (2011) reveal that female consumers consider grocery stores advertised promotional specials more important than men. Furthermore, advertised promotional specials of grocery stores were found to be more important among lower educated, older and
blue collar consumers. Govindasamy et al. (2007) agree that older consumers are more likely to use advertisements. Zaichkowsky and Sadlowsky (1991), Thomas and Garland (2004) and Govindasamy et al. (2007) assert that women use advertisements more frequently than men, whereas there was no difference in terms of household income and education level. Flagg et al. (2014), Mittal (2016) and Tariq et al. (2016) agree that women use advertisements more often than men.

Hence, this research intends to address the following research questions owing to the lack of enquiry on the use of advertisements (dependent variables) among different SES groups (only one of the abovementioned studies consider different SES areas) in developing countries (none of the aforementioned inquiries originate from developing countries), and the diverse results regarding shopper (independent variables) and socio-demographic (independent variables) characteristics’ association with the use of advertisements:

**RQ4.** Is there a difference in the use of advertisements by consumers who shop within different SES areas in a developing country (South Africa)?

**RQ5.** Do consumer shopping characteristics have an impact on the use of advertisements within different SES areas in a developing country?

**RQ6.** Do socio-demographic factors have an influence on the use of advertisements among consumers within different SES areas in a developing country?

### Methods

#### Sampling

The sample included consumers who reside in Delft, Maitland and Meadowridge in South Africa. These areas were selected for participation based on their socio-demographic and SES profiles, as provided by Statistics South Africa’s census data (Statistics South Africa, 2013a, b, c). Shoprite Usave, Shoprite, and Checkers belong to the Shoprite Holdings group and are the group’s three leading grocery store chains. Checkers offer a wide range of food and household goods for upper-income consumers and targets living standards measure (LSM) segments eight to ten (Shoprite Holdings, 2017a). Shoprite is the leading South African food retailer, which promises consumers low prices and committed customer service for a wide range of food products. Shoprite’s main customers are low-income to middle-income from the LSM segments four to seven (Shoprite Holdings, 2017b). Usave is a no-frills, small-format grocery store, which focusses on the low-income consumers from LSM segments one to five (Shoprite Holdings, 2017c). Shoprite Holdings uses similar promotional strategies for Usave, Shoprite, and Chequers, which include some television advertising, but predominantly promotional catalogues that feature “special” offers. The promotional catalogues are generally inserted in local community (free-sheets) newspapers and/or distributed directly to homes in the close proximity to the grocery stores’ geographic locations on weekly basis (Furlonger, 2015). A total of 1,200 consumers (400 in each area) who were older than 18 years anonymously and voluntarily participated in the study, which was conducted at pre-selected stores in the suburban areas, namely Usave to represent the low SES area (Delft), Shoprite to represent the middle SES area (Maitland) and Checkers to represent the high SES area (Meadowridge). A systematic sampling method was utilised with every second or third person that entered the grocery store, and who was approached to participate, according to the pace at which consumers entered the supermarket. Respondents comprised solely of volunteers who responded to an open invitation at the entrance of the supermarket and anonymity was assured.
Design of questionnaire
Since the residents of Delft were predominantly Afrikaans speaking (Statistics South Africa, 2013a), the questionnaire was available in both English and Afrikaans to avoid any comprehension difficulties, which may have been experienced by respondents who answered questions in a second language. Possible respondents were first verified by means of pre-screening questions to establish eligibility to participate in the study. Only respondents who were primary food product buyers and decision-makers in a household and who lived in one of the SES areas (Delft, Maitland or Meadowridge) were eligible to participate in the study. The first section consisted of four questions, which provided information regarding consumers’ shopper characteristics (independent variables), namely how often consumers usually shopped for food, how long they usually took to shop for food, who usually accompanied them to the shop, as well as their means/method of payment. The second section focussed on consumers’ shopping list development and use of advertisements (dependent variables) to plan shopping as pre-store food-buying practices scales, as identified by Friedman and Rees (1988). These two scales were represented by five and six structured questions, respectively, with each question providing for four response options (1 = Frequently, 2 = Sometimes, 3 = Seldom, and 4 = Never). These options were used by Herrmann and Warland (1990) who evaluated frequencies of the use of nine food-buying practices. The third section involved the socio-demographic characteristics (independent variables) of the respondent, namely the gender, age, marital status, household size, level of education, employment status, population group and household monthly income, which were borrowed from those used in the census household questionnaire (Statistics South Africa, 2012). Written permission to conduct the research at Usave, Shoprite, and Checkers stores was sought from Shoprite Holdings. A concise consent form, incorporating the minimum essential elements, was attached to the cover page of the questionnaire, and each respondent was required to read and sign it before completing the questionnaire. Ethical approval was received from the Faculty of Applied Sciences’ Research Ethics Committee at the Cape Peninsula University of Technology.

Data collection and analysis
The survey was conducted over five consecutive Saturdays; this day was chosen to include consumers who did not have sufficient time during the week to complete their grocery shopping. Consumers who shop on week days may have divergent shopping and socio-demographic characteristics compared to those who shop over weekends, which has been identified as a possible limitation of the study. However, Kahn and Schmittlein (1989) found that a majority of respondents indicated that they preferred to shop on a Saturday, as they had more time and could stock up for the week ahead. Two fieldworkers were employed, trained and remunerated to assist with distributing and collecting the consent forms and questionnaires, and to aid respondents, on request, to complete the questionnaire. A majority (87 per cent) of the respondents opted for the self-administered questionnaire as their chosen method to provide the requested information. A generalised linear model (GLM), using the Wald’s \( \chi^2 \) distribution and Bonferroni correction pairwise comparisons, was utilised to ascertain the significant differences between the consumers’ use of the two pre-store food-buying practices (dependent variables) and SES area groups, as well as the shopper and socio-demographic characteristics (independent factors).

Confirmatory factor analysis was performed to empirically test the pre-store food-buying practice scales in terms of reliability and validity. The reliability (internal consistency) of the scales were assessed using Cronbach’s \( \alpha \) and composite reliability (CR) scores, which both have recommended minimum thresholds of 0.70 (Bagozzi and Yi, 2012). The Cronbach’s \( \alpha \) and CR values for the shopping list development and use of advertisement scales displayed robust
internal consistencies, with all of the scores exceeding 0.9 (refer to Table I). Convergent validity was evaluated by examining the average variance extracted (AVE). The AVE of the shopping list development and use of advertisement scales were both greater than 0.7 (refer to Table I), which exceeded the proposed minimum level of 0.5, and is suggestive of good convergent validity (Hair et al., 2011). Discriminant validity was examined by using the square root of AVE for each scale, which should be greater than the correlation between the scales (Fornell and Larcker, 1981). The square root of AVE for the shopping list development and use of advertisements scales were 0.865 and 0.871, respectively, which was larger than the correlation score of 0.047, thereby confirming discriminant validity. Furthermore, Pearson’s correlation coefficient analysis was used to ascertain the strength of the association between variables, which revealed a predominantly positive strong ($r > 0.5$) correlation for the shopping list development and use of advertisements scales, thereby indicating an overall convergence of responses (refer to Table I).

Results and discussion
The descriptive statistics pertaining to education level, employment status and household monthly income provide a satisfactory representation of the different SES areas. A majority of the respondents in the low SES area (81.2 per cent) indicated that they had acquired a Grade 11 level of education or lower, whereas three-quarters of the middle SES area respondents specified that they had acquired a Grade 12 or lower. More than half (54 per cent) of the respondents in the high SES area indicated that they had acquired a post-matric diploma or certificate, degree or post-graduate degree. The larger part of respondents within the low (37.7 per cent), middle (55.2 per cent) and high (47.7 per cent) SES areas indicated that they were employed on a full-time basis. There was nonetheless a noticeable difference between the percentage of respondents in each area who indicated that they were unemployed (looking for work or not looking for work). The lower SES area had more (22.8 per cent) respondents compared to the middle (6.2 per cent) and high (2.0 per cent) SES areas. Furthermore, only 2 and 6.2 per cent of respondents in the low and middle SES areas specified that they were self-employed vs 14.3 per cent of respondents in the high SES area. The average monthly household in the low SES area was R800 to R3 200 for a majority (57 per cent) of respondents, whereas 77.5 per cent of the middle SES area respondents’ monthly household income was R801 to R12 800. The household monthly income for a majority (65 per cent) of respondents in the high SES area was R12 801 and above.

Effect of SES areas on pre-store food-buying practices
The GLM showed that there were significant differences at $p < 0.001$ for both the development of shopping lists ($M = 2.23, SD = 1.055$) and use of advertisements ($M = 1.91, SD = 0.864$) (dependent variables) as a result of the different SES areas (independent variable). Respondents within the low SES area ($M = 2.59, SE = 0.56$) displayed a lower propensity to develop shopping lists compared to the high ($M = 1.89, SE = 0.51$) and middle ($M = 2.22, SE = 0.24$) SES area respondents. The middle SES area ($M = 2.22, SE = 0.24$) respondents also exhibited less of an inclination to develop shopping lists in comparison to the high SES area ($M = 1.89, SE = 0.51$) respondents. Hence, there is a difference in shopping list development by consumers who shop within different SES areas in South Africa (RQ1), which exhibited a declining trend among the three SES areas. It is plausible that high SES area consumers generally have higher incomes, thereby facilitating the purchase of a larger quantity and variety of food products, which necessitates shopping lists as a memory aid (Intons-Petersen and Fournier, 1986). Dinkins (1997), Hersey et al. (2001) and Bassett et al. (2008) concur that low-income households are less likely to use a list when grocery shopping.
### Table I. Pre-store food-buying practices (shopping list development and use of advertisements) descriptive statistics, confirmatory factor analysis (factor loadings), Cronbach’s α, CR, AVE and Pearson’s correlation

<table>
<thead>
<tr>
<th>Pre-store food-buying practices</th>
<th>M</th>
<th>SD</th>
<th>Factor loadings</th>
<th>AVE</th>
<th>CR</th>
<th>Cron. α</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shopping list development</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Write down a list (1)</td>
<td>2.40</td>
<td>1.347</td>
<td>0.952</td>
<td>0.748</td>
<td>0.936</td>
<td>0.915</td>
<td>1.000</td>
<td></td>
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</tr>
<tr>
<td>Having a list while shopping (2)</td>
<td>2.39</td>
<td>1.328</td>
<td>0.946</td>
<td>0.748</td>
<td>0.936</td>
<td>0.915</td>
<td>1.000</td>
<td>0.948*</td>
<td>1.000</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Purchase according to a list (3)</td>
<td>2.43</td>
<td>1.312</td>
<td>0.935</td>
<td>0.748</td>
<td>0.936</td>
<td>0.915</td>
<td>1.000</td>
<td>0.941*</td>
<td>0.923*</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check at home first (4)</td>
<td>2.04</td>
<td>1.009</td>
<td>0.794</td>
<td>0.748</td>
<td>0.936</td>
<td>0.915</td>
<td>1.000</td>
<td>0.647*</td>
<td>0.639*</td>
<td>0.613*</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>Know exactly what to buy (5)</td>
<td>1.90</td>
<td>1.072</td>
<td>0.657</td>
<td>0.748</td>
<td>0.936</td>
<td>0.915</td>
<td>1.000</td>
<td>0.483*</td>
<td>0.480*</td>
<td>0.450*</td>
<td>0.598*</td>
<td>1.000</td>
</tr>
<tr>
<td><strong>Use of advertisements</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Look for advertisements (1)</td>
<td>1.63</td>
<td>1.005</td>
<td>0.947</td>
<td>0.758</td>
<td>0.949</td>
<td>0.935</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plan to shop for advertised “specials” (2)</td>
<td>1.72</td>
<td>1.011</td>
<td>0.925</td>
<td>0.758</td>
<td>0.949</td>
<td>0.935</td>
<td>1.000</td>
<td>0.906*</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pay attention to advertisements (3)</td>
<td>1.70</td>
<td>0.990</td>
<td>0.925</td>
<td>0.758</td>
<td>0.949</td>
<td>0.935</td>
<td>1.000</td>
<td>0.888*</td>
<td>0.886*</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shop knowing about “specials” (4)</td>
<td>1.95</td>
<td>0.948</td>
<td>0.846</td>
<td>0.758</td>
<td>0.949</td>
<td>0.935</td>
<td>1.000</td>
<td>0.768*</td>
<td>0.722*</td>
<td>0.748*</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>Use advertisements to plan shopping (5)</td>
<td>2.15</td>
<td>0.972</td>
<td>0.802</td>
<td>0.758</td>
<td>0.949</td>
<td>0.935</td>
<td>1.000</td>
<td>0.680*</td>
<td>0.653*</td>
<td>0.637*</td>
<td>0.617*</td>
<td>1.000</td>
</tr>
<tr>
<td>Immediately plan to shop once aware of a “special” (6)</td>
<td>2.30</td>
<td>1.041</td>
<td>0.762</td>
<td>0.758</td>
<td>0.949</td>
<td>0.935</td>
<td>1.000</td>
<td>0.646*</td>
<td>0.606*</td>
<td>0.602*</td>
<td>0.554*</td>
<td>0.654*</td>
</tr>
</tbody>
</table>

**Note:** *Correlation is significant at the 0.01 level (two-tailed)
The opposite result was true for the use of advertisements. Respondents within the low SES area (\(M = 1.57, SE = 0.39\)) showed a higher tendency to utilise advertisements than the middle (\(M = 1.83, SE = 0.36\)) and high (\(M = 2.32, SE = 0.51\)) SES area respondents. The middle SES area (\(M = 1.83, SE = 0.36\)) respondents also displayed a higher propensity to use advertisements compared to the high SES area (\(M = 2.32, SE = 0.51\)) respondents. Consequently, there is a difference in the use of advertisements by consumers who shop within different SES areas in a developing country (RQ4), since the use of advertisements displayed an increasing tendency among the different SES areas. It is probable that low SES area consumers have lower incomes and, hence use advertisements to stock up on the best deals by purchasing food products that are on “special” (Dinkins, 1997; Darko et al., 2013). Zimmerman and Shimoga (2014) agree that low-income consumers are more likely to use food advertisements. Tariq et al. (2016) confirm that consumers with higher incomes may be less price-sensitive and, therefore have less incentive to use advertisements. Furthermore, consumers in the high SES area are typically time-poor and do not have the time to consult advertisements (Van Kenhove and De Wulf, 2000).

Influence of shopping characteristics on pre-store food-buying practices

The Bonferroni correction pairwise comparisons of estimated marginal means ascertained significant differences between shopping frequency, shopping length, co-shopping payment method (independent variables) in terms of shopping list development and/or use of advertisements (dependent variables). Therefore, consumer shopping characteristics do have an influence on pre-store food-buying practices, namely, the development of shopping lists (RQ2) and the use of advertisements (RQ5), within different SES areas in a developing country (refer to Table II).

Shopping frequency. Respondents in the low SES area who shopped once a week (\(M = 2.62, SE = 0.31\)) exhibited a significantly \((p < 0.05)\) higher predisposition to use advertisements than those who shopped for food two to three times a month (\(M = 3.09, SE = 0.33\)). A majority of the leading food retailers distribute advertisements on a weekly basis, which may have caused the higher use of advertisements by consumers who shopped once a week in the low SES area in comparison to the high SES area (Zaichkowsky and Sadlowsky, 1991; Bassler and Newell, 1982; Smith and Carsky, 1996; Yoo et al., 2006; East et al., 2008; Darko et al., 2013). Weekly local community newspapers (free-sheets) are distributed at no cost to a majority of neighbourhoods in South Africa (Furlonger, 2015). Hence, these retail advertisements facilitate a means for consumers in the low SES area to save money by finding the best prices of food products that are on “special”. However, consumers in the high SES area displayed a much higher frequency of shopping (2-4 times a week) than the consumers in the low SES area. This result is most likely due to the lower dependence of advertised “special” offers by consumers residing in the high SES area, as they are less price sensitivity owing to their larger discretionary incomes (Tariq et al., 2016). Furthermore, a majority the high SES consumers are typically time-poor and more likely to frequent the grocery stores several times a week (refer to Table II) for short shopping trips (most likely during lunchtime and/or after work to make the most of the available time) without using advertisements due to time constraints (Van Kenhove and De Wulf, 2000).

Shopping length. Respondents in the low SES area who indicated that they took less than half an hour to shop (\(M = 3.42, SE = 0.59\)) displayed a significantly \((p < 0.05)\) lower propensity to use a shopping list compared to those who indicated that they took one to two hours (\(M = 2.88, SE = 0.62\)) to shop for food. The higher development of shopping lists by consumers who spend longer periods of time shopping for groceries may be caused by longer lists of items to buy, which may be difficult to memorise, but facilitates improved budget control and a reduction of impulse purchases (Intons-Petersen and
<table>
<thead>
<tr>
<th>Shopper characteristics</th>
<th>High SES area (n = 400)</th>
<th>Middle SES area (n = 400)</th>
<th>Low SES area (n = 400)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>p</td>
</tr>
<tr>
<td><strong>Shopping frequency</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Every day (1)</td>
<td>87</td>
<td>21.7</td>
<td>0.990 (SL)</td>
</tr>
<tr>
<td>2-4 times a week (2)</td>
<td>137</td>
<td>34.2</td>
<td>0.949 (SL)</td>
</tr>
<tr>
<td>Once a week (3)</td>
<td>132</td>
<td>33.0</td>
<td>0.915 (Ad)</td>
</tr>
<tr>
<td>2-3 times a month (4)</td>
<td>21</td>
<td>5.3</td>
<td>0.004** (Ad)</td>
</tr>
<tr>
<td>Once a month (5)</td>
<td>23</td>
<td>5.8</td>
<td></td>
</tr>
<tr>
<td><strong>Shopping length</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than half an hour (1)</td>
<td>169</td>
<td>42.2</td>
<td>0.931 (SL)</td>
</tr>
<tr>
<td>.5-1 hour (2)</td>
<td>165</td>
<td>41.3</td>
<td>0.0949 (SL)</td>
</tr>
<tr>
<td>1-2 hours (3)</td>
<td>56</td>
<td>14.0</td>
<td></td>
</tr>
<tr>
<td>More than 2 hours (4)</td>
<td>10</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td><strong>Co-shopping</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shop alone (1)</td>
<td>282</td>
<td>70.5</td>
<td>0.004** (Ad)</td>
</tr>
<tr>
<td>Husband (2)</td>
<td>29</td>
<td>7.2</td>
<td></td>
</tr>
<tr>
<td>Wife (3)</td>
<td>31</td>
<td>7.7</td>
<td></td>
</tr>
<tr>
<td>Partner (4)</td>
<td>3</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>Children/grandchildren (5)</td>
<td>25</td>
<td>6.2</td>
<td>0.004** (Ad)</td>
</tr>
<tr>
<td>Relative(s) (6)</td>
<td>10</td>
<td>2.5</td>
<td></td>
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<tr>
<td>Friends (7)</td>
<td>6</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>Colleagues (8)</td>
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<td>0.3</td>
<td></td>
</tr>
<tr>
<td>Family (9)</td>
<td>13</td>
<td>3.3</td>
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(continued)
<table>
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<tr>
<th>Shopper characteristics</th>
<th>High SES area (n = 400)</th>
<th>Middle SES area (n = 400)</th>
<th>Low SES area (n = 400)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>p (%)</td>
<td>n (%)</td>
</tr>
<tr>
<td><strong>Payment method</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cash (1)</td>
<td>147 (36.8)</td>
<td>0.513 (SL) 0.586 (Ad)</td>
<td>282 (70.5)</td>
</tr>
<tr>
<td>Cash (1)</td>
<td>147 (36.8)</td>
<td>0.513 (SL) 0.586 (Ad)</td>
<td>282 (70.5)</td>
</tr>
<tr>
<td>Debit card (2)</td>
<td>173 (43.2)</td>
<td>0.513 (SL) 0.586 (Ad)</td>
<td>112 (28.0)</td>
</tr>
<tr>
<td>Credit card (3)</td>
<td>68 (17.0)</td>
<td>0.513 (SL) 0.586 (Ad)</td>
<td>3 (0.7)</td>
</tr>
<tr>
<td>Cheque (4)</td>
<td>6 (1.5)</td>
<td>0.513 (SL) 0.586 (Ad)</td>
<td>1 (0.3)</td>
</tr>
<tr>
<td>Cape consumers (buy aid) (5)</td>
<td>6 (1.5)</td>
<td>0.513 (SL) 0.586 (Ad)</td>
<td>2 (0.5)</td>
</tr>
</tbody>
</table>

Notes: *Wald $\chi^2$ test showed a significant difference at $p < 0.001$; **Wald $\chi^2$ test showed a significant difference at $p < 0.05$. *Bonferroni correction pairwise comparisons mean difference is significant at the 0.001 level; ^Bonferroni correction pairwise comparisons mean difference is significant at the 0.05 level.
Fournier, 1986; Thomas and Garland, 2004). Furthermore, a majority of respondents in the low SES area who took less than half an hour to shop were less likely to develop a shopping list (refer to Table II), probably owing to financial constraints, which restricts them to only purchase a few essential items at a time (Frazao et al., 2007). This may also cause them to buy the same types of food products or brands, which is easier to remember and requires less time in the grocery stores (Bassett et al., 2008).

**Co-shopping.** Respondents in the high SES area who shopped alone \( (M = 2.48, SE = 0.26) \) or with their children/grandchildren \( (M = 2.73, SE = 0.29) \) had a significantly \( (p < 0.05) \) lower tendency to use advertisements to plan their food shopping compared to those who shopped with their wives \( (M = 1.76, SE = 0.31) \). Co-shopping is a well-known consumer phenomenon, where shopping in groups has an influence on shopping patterns (Mangleburg et al., 2004). Furthermore, the notion of pester power is another recognised consumer behaviour concept, which purports that children have an influence on parents’ and grandparents’ (adults) purchase decisions (James, 2015). Hence, consumers who shopped alone or with children/grandchildren were less likely found to be influenced by advertisements, especially in high SES areas (Tariq et al., 2016). Women use advertisements more than men as confirmed in abovementioned literature (Flagg et al., 2014; Mittal, 2016; Tariq et al., 2016); therefore, men who shop with their wives may be influenced or guided to use advertisements to plan their shopping.

**Payment method.** Respondents in the low SES area who paid via debit card \( (M = 2.52, SE = 0.58) \) had a significantly \( (p < 0.05) \) higher inclination to use a shopping list in comparison to those who paid by means of cash \( (M = 3.19, SE = 0.54) \). Furthermore, respondents in the low SES area who paid by means of a debit card \( (M = 1.94, SE = 0.30) \) were also found to have a significantly \( (p < 0.001) \) higher tendency in their use of advertisements compared to those who paid via credit card \( (M = 3.16, SE = 0.49) \) or cheque \( (M = 3.94, SE = 0.51) \). However, few respondents in the low SES area used credit cards and cheques as payment methods. The growing use of debit cards as a payment method frequently results in larger purchases, as consumers are not limited to the amount of cash that they have in their possession. Borzekowski and Kiser (2008) and Klee (2008) assert that the probability of consumers using a debit card increases as their income increases. Furthermore, carrying large sums of cash in low SES areas poses an increased security risk (Arango and Taylor, 2009). Hence, debit cards enable consumers in the low SES area to purchase food in bulk and a larger variety of items, which may increase their use of advertisements and shopping list development.

**Influence of socio-demographic characteristics on pre-store food-buying practices**

No significant differences were determined for age, marital status and education level for both pre-store food-buying practices in any of the SES areas. However, the Bonferroni correction pairwise comparisons of estimated marginal means determined significant differences between gender, household numbers, employment status, population group and household monthly income (independent variables) regarding the development of shopping lists and/or use of advertisements (dependent variables). Therefore, consumer socio-demographic characteristics do have an impact on pre-store food-buying practices, namely the development of shopping \( (RQ3) \) and the use of advertisements \( (RQ6) \), within different SES areas in South Africa (refer to Table III).

**Gender.** Female respondents \( (M = 1.88, SE = 0.28) \) in the high SES area displayed a significantly \( (p < 0.05) \) larger propensity to use a shopping list compared to male respondents \( (M = 2.17, SE = 0.30) \). Furthermore, female respondents \( (M = 1.43, SE = 0.25) \) in the middle SES area also showed a significantly \( (p < 0.001) \) larger inclination to use advertisements as a pre-store food-buying practice than male respondents \( (M = 1.85, \)
Table III. Influence socio-demographic characteristics on pre-store food-buying practices – development of shopping lists (SL) and use of advertisements (Ad).

<table>
<thead>
<tr>
<th>Socio-demographic characteristics</th>
<th>High SES area (n = 400)</th>
<th>Middle SES area (n = 400)</th>
<th>Low SES area (n = 400)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>p</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male (1)</td>
<td>124</td>
<td>31.0</td>
<td>0.017** (SL)</td>
</tr>
<tr>
<td>Female (2)</td>
<td>276</td>
<td>69.0</td>
<td>0.368 (Ad)</td>
</tr>
<tr>
<td><strong>Age (years)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-25 (1)</td>
<td>22</td>
<td>5.5</td>
<td>0.144 (SL)</td>
</tr>
<tr>
<td>26-35 (2)</td>
<td>52</td>
<td>13.0</td>
<td>0.900 (SL)</td>
</tr>
<tr>
<td>36-45 (3)</td>
<td>72</td>
<td>18.0</td>
<td>0.900 (SL)</td>
</tr>
<tr>
<td>46-55 (4)</td>
<td>90</td>
<td>22.5</td>
<td>0.900 (SL)</td>
</tr>
<tr>
<td>56-65 (5)</td>
<td>83</td>
<td>20.7</td>
<td>0.900 (SL)</td>
</tr>
<tr>
<td>&gt; 66 (6)</td>
<td>81</td>
<td>20.3</td>
<td>0.900 (SL)</td>
</tr>
<tr>
<td><strong>Marital status</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Married (1)</td>
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<td>Living together (2)</td>
<td>23</td>
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<tr>
<td>Single (3)</td>
<td>73</td>
<td>18.3</td>
<td>0.900 (SL)</td>
</tr>
<tr>
<td>Widower/widow (4)</td>
<td>31</td>
<td>7.7</td>
<td>0.900 (SL)</td>
</tr>
<tr>
<td>Separated (5)</td>
<td>3</td>
<td>0.8</td>
<td>0.900 (SL)</td>
</tr>
<tr>
<td>Divorced (6)</td>
<td>45</td>
<td>11.3</td>
<td>0.900 (SL)</td>
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<td><strong>Household (HH) numbers</strong></td>
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<td></td>
</tr>
<tr>
<td>1 (1)</td>
<td>57</td>
<td>14.2</td>
<td>0.511 (SL)</td>
</tr>
<tr>
<td>2 (2)</td>
<td>121</td>
<td>30.3</td>
<td>0.018** (Ad)</td>
</tr>
<tr>
<td>3 (3)</td>
<td>92</td>
<td>23.0</td>
<td>0.018** (Ad)</td>
</tr>
<tr>
<td>4 (4)</td>
<td>73</td>
<td>18.2</td>
<td>0.018** (Ad)</td>
</tr>
<tr>
<td>5 (5)</td>
<td>41</td>
<td>10.3</td>
<td>0.018** (Ad)</td>
</tr>
<tr>
<td>6+(6)</td>
<td>16</td>
<td>4.0</td>
<td>0.018** (Ad)</td>
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(continued)
### Table III.

<table>
<thead>
<tr>
<th>Socio-demographic characteristics</th>
<th>High SES area ( (n = 400) )</th>
<th>Middle SES area ( (n = 400) )</th>
<th>Low SES area ( (n = 400) )</th>
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<tr>
<td></td>
<td>( n )</td>
<td>%</td>
<td>( p )</td>
</tr>
<tr>
<td><strong>Education level</strong></td>
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<td>Grade 1-7 (1)</td>
<td>7</td>
<td>1.7</td>
<td>0.579 (SL)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.861 (Ad)</td>
</tr>
<tr>
<td>Grade 8-11 (2)</td>
<td>56</td>
<td>14.0</td>
<td>0.087 (SL)</td>
</tr>
<tr>
<td>Grade 12 (3)</td>
<td>121</td>
<td>30.3</td>
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<tr>
<td>Post-matric diploma or certificate (4)</td>
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<td>25.5</td>
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<tr>
<td>Degree (5)</td>
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<td>Post-graduate degree (6)</td>
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<td><strong>Employment status</strong></td>
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<td></td>
</tr>
<tr>
<td>Employed (full-time) (1)</td>
<td>191</td>
<td>47.7</td>
<td>0.001* (SL)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(7-3)*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.087 (Ad)</td>
</tr>
<tr>
<td>Employed (part-time) (2)</td>
<td>27</td>
<td>6.7</td>
<td></td>
</tr>
<tr>
<td>Self-employed (3)</td>
<td>57</td>
<td>14.3</td>
<td></td>
</tr>
<tr>
<td>Unemployed (looking for work) (4)</td>
<td>5</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>Unemployed (not looking for work) (5)</td>
<td>3</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>Housewife/homemaker (6)</td>
<td>24</td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>Pensioner/retired (7)</td>
<td>86</td>
<td>21.5</td>
<td></td>
</tr>
<tr>
<td>Student (8)</td>
<td>7</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>Not working – other (9)</td>
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</tr>
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<td><strong>Population group</strong></td>
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<tr>
<td>Black African (1)</td>
<td>24</td>
<td>6.0</td>
<td>0.150 (SL)</td>
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<td></td>
<td></td>
<td></td>
<td>0.112 (Ad)</td>
</tr>
<tr>
<td>Coloured (2)</td>
<td>134</td>
<td>33.5</td>
<td></td>
</tr>
<tr>
<td>Indian/Asian (3)</td>
<td>11</td>
<td>2.8</td>
<td></td>
</tr>
<tr>
<td>White (4)</td>
<td>227</td>
<td>56.7</td>
<td></td>
</tr>
<tr>
<td>Other (5)</td>
<td>4</td>
<td>1.0</td>
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(continued)
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<tr>
<th>Socio-demographic characteristics</th>
<th>High SES area (n = 400)</th>
<th>Middle SES area (n = 400)</th>
<th>Low SES area (n = 400)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>p</td>
</tr>
<tr>
<td>Household monthly income (R1 = $1)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Less than R800 ($67) (1)</td>
<td>2</td>
<td>0.5</td>
<td>0.853 (SL)</td>
</tr>
<tr>
<td>R801 ($87)-R3 200 ($246) (2)</td>
<td>28</td>
<td>7.0</td>
<td>0.044** (Ad)</td>
</tr>
<tr>
<td>R3 201 ($247)-R6 400 ($492) (3)</td>
<td>43</td>
<td>10.7</td>
<td>0.033** (Ad)</td>
</tr>
<tr>
<td>R6 401 ($493)-R12 800 ($985) (4)</td>
<td>67</td>
<td>16.8</td>
<td>0.266 (Ad)</td>
</tr>
<tr>
<td>R12 801 ($986)-R25 600 ($1,969) (5)</td>
<td>115</td>
<td>28.7</td>
<td>0.0</td>
</tr>
<tr>
<td>R25 601 ($1,970)-R51 200 ($3,938) (6)</td>
<td>86</td>
<td>21.5</td>
<td>0.0</td>
</tr>
<tr>
<td>R51 201+ ($3,938+) (7)</td>
<td>59</td>
<td>14.8</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Notes: *Wald $\chi^2$ test showed a significant difference at $p < 0.001$; **Wald $\chi^2$ test showed a significant difference at $p < 0.05$. *Bonferroni correction pairwise comparisons mean difference is significant at the 0.001 level; *Bonferroni correction pairwise comparisons mean difference is significant at the 0.05 level.
Females typically have the primary responsibility of shopping for food products in a developing country, hence they frequently utilise a variety of pre-store food-buying practices (such as the use of advertisements and shopping list development) more frequently than males (Flagg et al., 2014; Mittal, 2016; Tariq et al., 2016), irrespective of the SES area, as confirmed by the results of this study.

**Household numbers.** Households with two members ($M = 2.35$, $SE = 0.28$) in the high SES area exhibited a significantly ($p < 0.05$) lower propensity to use advertisements in comparison to households with five members ($M = 1.80$, $SE = 0.30$). Larger households generally have a larger need to employ a variety of pre-store food-buying practices to save money than smaller households, which were found to use advertisements less frequently. Dinkins (1997) ascertained that consumers who adhered to strict food budgets were more likely to have larger household sizes. This can be attributed to the fact that household grocery expenditure increases with family size (Tariq et al., 2016). Murthi and Rao (2012) agree that large families tended to evaluate prices, for example, via advertisements, as a means to save money more often than small families.

**Employment status.** Self-employed respondents ($M = 2.28$, $SE = 0.30$) in the high SES area showed a significantly ($p < 0.001$) lower tendency to use a shopping list in comparison to pensioner/retired ($M = 1.46$, $SE = 0.32$) respondents. Generally, senior citizens in South Africa have lower incomes, more time to plan, and their memories may not be as good compared to their younger self-employed counterparts. Putrevu and Ratchford (1997) and Thomas and Garland (2004) confirm that shopping lists enable shoppers to remember items and avoid overbuying.

**Population group.** White respondents ($M = 4.00$, $SE = 0.64$) in the low SES area showed a significantly ($p < 0.05$) lower predisposition to use advertisements compared to Black ($M = 2.17$, $SE = 0.23$) and Coloured ($M = 2.20$, $SE = 0.22$) respondents. The higher lower use of advertisements by White consumers may be as a result of higher disposable incomes, thereby enabling the purchase of a larger variety and quantity of food products owing to lower levels of price sensitivity and greater time constraints (Govindasamy et al., 2007; Tariq et al., 2016). Hence, households in low SES areas (mainly Black and Coloured consumers in South Africa) use advertisements more, mainly in a bid to save money by buying food products that are on “special” (Hersey et al., 2001; Govindasamy et al., 2007; Tariq et al., 2016).

**Household monthly income.** Respondents in the high SES area with a household monthly income of R25 601 ($1,970)-R51 200 ($3,938) ($M = 2.41$, $SE = 0.29$) displayed a significantly ($p < 0.05$) lower inclination to make use of advertisements compared to those with a monthly income of R801 ($67)-R 3 200 ($246) ($M = 1.77$, $SE = 0.31$) and R3 201 ($247)-R6 400 ($492) ($M = 1.87$, $SE = 0.30$). Respondents in the middle SES area with a household monthly income of R25 601 ($1,970)-R51 200 ($3,938) ($M = 1.94$, $SE = 0.29$) also exhibited a significantly ($p < 0.05$) lower tendency to make use of advertisements compared to those with a monthly income of R801 ($67)-R 3 200 ($246) ($M = 1.38$, $SE = 0.26$) and R3 201 ($247)-R6 400 ($492) ($M = 1.45$, $SE = 0.26$). The low usage of advertisements by respondents with high incomes in the high and middle SES areas could be explained by the fact that these consumers do not need to save money, but probably have time constraints. These consumers are characteristically money-rich and time-poor (Van Kenhove and De Wulf, 2000) and, therefore do not have the time or the need to use advertisements. Mittal (2016) and Tariq et al. (2016) concur that consumers with high levels of education and income may be less price-sensitive and, therefore less likely to use advertisements than their lower income counterparts.

**Implications and conclusions**

Shopping list development and the use of advertisements have been broadly researched over several decades in developed countries. However, little academic research has been
conducted in terms of the pre-store food-buying practices in developing countries. Furthermore, few studies consider pre-store food-buying practices in different SES areas from a developed and developing country perspective. Additionally, there is a dearth of research on the association of shopping and socio-economic characteristics with the development of shopping lists and use of advertisements in different SES areas in emerging and developed nations. Several of the independent variables have not previously been investigated in relation to the abovementioned pre-store food-buying practices. Therefore, this study makes a valuable contribution to theory development and food-buying practice research in a developing country. The results of this research could also help consumers in developing countries with food-buying practices to reduce shopping and food costs, as well as make more prudent shopping decisions. This study also provides international supermarket chains with insight into the food-buying practices, shopping and socio-demographic characteristics of South African consumers, which provides them with valuable information to diversify their operations into developing country markets.

Grocery stores should continue to disseminate weekly advertisements, which conspicuously display their food products to attract consumers into their stores, but also encourage children to accompany their parents/grandparents by creating a child friendly shopping atmosphere and environment, which may have a favourable effect on turnover. Furthermore, consumers could be enticed to stay in the supermarkets for longer periods of time via promotional offers, which will have a positive effect on sales. Grocery stores should create a senior citizen friendly shopping atmosphere and environment (e.g. a day where pensioners receive a special promotional discount) that will entice these lucrative shoppers to frequent their outlets. Furthermore, the higher usage of advertisements by Black and Coloured consumers provides discerning grocery stores with the prospect of conspicuously featuring their food products in the promotional catalogues that are directed at these consumer groups. Larger households should be targeted with bulk food and other sales promotions that are featured in promotional catalogues, which should also be distributed to consumers in low-income areas due to their high incidence of advertisement usage.

It can be concluded that high SES area consumers have the highest propensity of shopping list development, and low SES area consumers show the highest incidence of advertisement usage in a developing country, which is analogous to the findings in developed countries. Grocery stores could place emphasis on their marketing communications by highlighting the need to add certain food products to shopping lists. For example, grocery stores could create a mobile app to facilitate shopping list development when targeting these consumers due to the rapid growth and adoption of mobile devices by South Africans residing in all SES areas. Mobile connections exceed the South African population since many consumers use multiple mobile devices (Goosen, 2017). Grocery stores should persist with promotional catalogues, which are distributed to consumers in low SES areas. Furthermore, the mobile app could be used to disseminate promotional offers directly to these consumers, which enables consumers to add advertised food products directly to their shopping list, thereby increasing their use of advertisements and shopping list development in a developing country.

References


Further reading

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Does switching-intention result in a change in behaviour? Exploring the actual behavioural shopping patterns of switching-intended customers

Hayiel Hino
Ariel University, Ariel, Israel

Abstract

Purpose – The purpose of this paper is to investigate the relationship between switching intention and actual behaviour in the grocery shopping context. In particular, the study examines how switching intention drives customers to either replace the current store or cross to others. In addition, the study examines the role of cross-shopping in total-switching behaviour.

Design/methodology/approach – The study employs data collected from a sample consisting of 247 food grocery shoppers. The conceptual framework and hypothesis were analysed using the partial least squares approach.

Findings – The empirical results support the author’s claim that the research approach applied in this study better explains the switching intention–actual behaviour relationship. Specifically, the analysis provides strong support for the effect of switching intention and various moderating barriers on both cross-shopping and total-switching behaviour. Additionally, the study results point to the positive relationship between cross-shopping and total-switching, indicating that crossing to competing stores is the first step towards utilising the total-switching behaviour.

Practical implications – Implications for food retail providers are identified, together with a discussion of the study’s limitations and avenues for future research.

Originality/value – The study extends previous research in that it proposed and tested a conceptual framework for investigating the relationship between switching-intention and actual behaviour, claiming that switching intention drives customers to either replace their current store or cross to others, whereas the crossing pattern is a predictor of the total-switching behaviour.

Keywords Cross-shopping, Switching barriers, Switching intention, Actual behaviour, Partial least squares approach (PLS), Partial switching

Paper type Research paper

1. Introduction

Over the last few decades, numerous studies have investigated the factors influencing grocery shopping behaviour. A review of many of these studies points to them primarily researching store choice, customer patronage, and, to a lesser extent, store-switching behaviour in the context of grocery shopping. In this regard, however, empirical studies on customer-switching have mostly concentrated on the impact of perceived satisfaction on consumer intention to replace grocery stores. Hence, little is known about switching behaviour, particularly whether switching intention ends in the actual replacement of the current store. Moreover, there is growing evidence that many dissatisfied consumers continue to shop at their current stores, or at most adopt the cross-shopping behaviour, thereby decreasing their shopping intensity at these stores in parallel to directing a large proportion of their shopping trips to competing stores. Clearly, this buying pattern is most common in shopping for food products where consumers use various food store-formats for supplying different food categories (Hino, 2014, 2015; Jayasankaraprasad and Kathyayani, 2014). Under these circumstances, switching behaviour is not easy to control or predict. The reason for such unpredictability of consumer behaviour is that the basis of consumer choice and continued purchasing behaviour is significantly less
obvious in the food shopping context. In contrast to other industries, such as insurance and mobile communications, in which consumers subscribe to a particular service provider for a relatively long period of time, subscription or a long-term commitment is almost non-existent in the food shopping context.

The goal of the current study is twofold: to investigate the shopping behaviour patterns of customers who have a clear intention to switch where they shop for food products. Our research framework suggests that even though dissatisfied customers may replace their current grocery store entirely, they are also more likely to cross-shop to competing stores, in addition to replacing the current ones; to examine the role of consumer cross-shopping in total-switching behaviour. Thus, the study expands on previous research in that it investigates factors affecting two different buying patterns: switch-shopping and cross-shopping. In addition, the study highlights the role played by cross-shopping and various switching barriers (e.g. relationship length and switching costs) and explains how they affect customers’ shopping decisions.

The study of factors driving customers to either cross-shopping or total-switching is being seen as increasingly important for scholars and retail executives, especially as the competitive environment intensifies (Bansal and Taylor, 2005; Ganesh et al., 2007). Customer total-switching and cross-shopping have critical effects on retailers’ market share, profitability, viability, and future revenue stream in today’s competitive marketplace (Keaveney, 1995). With increasing competition and rising costs, securing significant market share and profitability will necessitate both decreasing cross-shopping and total-switching as well as increasing store patronage by attracting new consumers (Cho and Song, 2012; Garace and O’Cass, 2005; Hino, 2015). Moreover, both shopping behaviours indicate a strategic or executive failure. Thus, better understanding of consumer shopping patterns, in particular the reasons for switching or crossing to competing providers, is the first step towards rectifying the problem.

2. Conceptual framework and research hypotheses

2.1 Store-switching vs cross-shopping

Store-switching behaviour is defined as the process by which a consumer abandons his or her shopping relationship with a current retail provider and replaces it either partially or entirely with another for a given time period (Nimako, 2012). Switch-shopping is total when consumers terminate an existing relationship with a provider and substitute it for a competitor. Partial switching, on the other hand, is determined as a shopping pattern that incorporates the crossing between different stores (Hino, 2015). Hence, a cross-shopping pattern is defined as the process by which consumers conduct their shopping activities at two or more food stores thereby, dividing their shopping basket between different stores (Hino, 2014; Jayasankaraprasad and Kathyayani, 2014). This suggests that cross-shopping allows customers to preserve their relationship with current stores as they continue directing a proportion of their shopping trips to those stores, while crossing between various store formats.

2.2 Relationship between switching intention, switching behaviour, and cross shopping

Research on store-switching behaviour distinguishes between switching intention and behaviour. Switching intention has been defined as the possibility of transferring existing purchasing activities with a particular retailer to competitors whereas switching behaviour means customers actually replace one provider with another (Nimako, 2012). In the context of our study, switching behaviour involves a decision regarding complete switching from the current store or crossing to others thereby continuing purchasing some of their food needs at the existing groceries, and the predictors that affect this decision.
The Theory of Planned Behaviour (TPB) provides a useful framework for understanding the switching intention – switching behaviour relationship. According to the TPB, “the intention to perform a specific behaviour is believed to predict actual behaviour” (Ajzen, 1991, p. 181). Moreover, the TPB suggests that the immediate antecedent of behaviour is the behavioural intention to perform this behaviour (Madden et al., 1992). Empirical studies applying the TPB reported a strong relationship between switching intention and actual behaviour (Bansal and Taylor, 2005; Cho and Song, 2012). Thus, the more the intention an individual has to perform the specific behaviour (e.g. to replace a retail provider), the more likely that he or she will actually perform the behaviour:

H1. Switching intention has a positive impact on consumer total-switching.

However, although actions are controlled by intention, “not all intentions are eventually executed; some are abandoned altogether while others are revised to fit changing circumstances” (Ajzen, 1985, p. 11). In the context of the current study that discusses grocery store-switching, this suggests that customer intention to replace a retail store does not necessarily lead to total switching. It may end in crossing to other stores, depending on the importance and significance of the switching motivations. Previous research on the “multiple-store shopping” approach (e.g. Jayasankaraprasad and Kathyayani, 2014) reported a significant relationship between store-switching motivations and actual crossing:

H2. Switching intention has a positive impact on consumer cross-shopping behaviour.

Prior studies discussing additional reasons that may directly influence store-switching attribute significant importance to the alternative attractiveness factor (Bansal and Taylor, 2005; Han et al., 2009; Keaveney, 1995; Valenzuela 2010; Zhang et al. 2012). Attractive alternatives in the market place are situations in which customers believe the alternatives to the current retailer are superior. According to Jones et al. (2000), attraction by competitors refers to customer perceptions regarding the extent to which viable competing alternatives are available in the market place. Customers tend to switch if a competitor provides differentiated offers that are difficult for the existing provider to match (Valenzuela, 2010). This is especially prominent as the competitive environment intensifies. Thus, when there is a great deal of competition or few perceived differences among the available alternatives, the customer may possibly choose to replace the current provider despite being satisfied (Capraro et al., 2003).

Availability of superior alternatives has also been discussed in studies discussing food shopping behaviour. Findings from these studies point to a significant relationship between the availability of superior alternative stores and consumer tendency to cross to others (Findlay and Sparks, 2008; Han et al., 2009):

H3. High availability of superior alternative stores has a positive impact on total-switching.

H4. High availability of superior alternative stores has a positive impact on cross-switching.

2.3 Moderating effects of switching barriers: the influence of switching costs

Switching barriers are factors that make it difficult or costly for customers to replace retail providers (Baltas et al., 2010; Jones et al., 2000; Rhee and Bell, 2002). Numerous studies have investigated the moderating effects of switching barriers on customers’ repurchase behaviour (Klein and Schmitz, 2016; Lee et al., 2001; Valenzuela, 2010; Zhang et al., 2012). According to Jones et al. (2002), switching barriers are defined as the perceived economic and psychological switching costs associated with replacing one retail provider with another. Prior research has classified switching costs into three different categories: relational switching costs, financial switching costs, and procedural switching costs (Burnham et al., 2003; Han et al., 2009; Jones et al., 2002; Nagengast et al., 2014).
2.4 Store familiarity as a measure of relational switching costs
Most of the research that discusses the effects of switching barriers includes studies that focus on the positive scope of relational switching costs, suggesting that factors such as relational benefits associated with shopping at familiar stores often decrease store-switching (Han et al., 2009; Findlay and Sparks, 2008; Harrison et al., 2012; Jones et al., 2000; Vázquez-Carrasco and Foxall, 2006). The concept of relational benefits includes social benefits, favourable treatment, and special offers that store sales personnel grant to customers (Colgate et al., 2007; Valenzuela 2010). These benefits are of major significance when shopping for food product categories (Huang et al., 2015). According to Goldman et al. (2002), consumers who highly value the use of fresh ingredients are more inclined to shop for these items at familiar stores, and are more loyal to food retailers with whom they perceive they have close relationships. In traditional markets in China, for example, consumers are able to contact sellers directly. When consumers require exact quantities, sizes, parts, and quality levels, it is convenient for them to communicate with the retailer (Maruyama and Wu, 2014). Furthermore, many consumers view interpersonal relationships with known retailers as providing better outputs in these product lines (Hino and Levy, 2016). Store familiarity was also seen as important by Hino (2014, 2015), and Popkowski-Leszczyc and Timmermans (1997). Drawing on this previous work, it can be argued that “familiarity” with a store that employs friendly salespeople appears to be a store-switching barrier as it decreases consumer tendency to replace the current familiar store:

H5. The influence of switching intention on total-switching is negatively moderated by perceived store familiarity.

From yet another angle, the current study suggests that consumers who use fresh products and traditional food ingredients are more likely to shop for these items at specialized stores, to ensure the desired quality and freshness. Further, studies that examine the effect of store familiarity on store patronage show that consumers cross-shop in various food stores for purchasing high quality perishable products (Hino, 2014; Hino and Levy, 2016). Since this is the case, shopping for perishables at stores that provide these items at the desired quality and freshness motivates consumers to cross to familiar alternative stores, thereby continuing shopping for non-perishables at the current groceries (Findlay and Sparks, 2008; Hino, 2014, 2015):

H6. The influence of switching intention on cross-shopping behaviour is moderated by perceived store familiarity.

2.5 Price and promotions as a measure of financial switching costs
Financial switching costs, too, are classified as “positive switching costs” as they derive from positive sources of constraints, particularly, shopping at stores that offer lower priced products, sales promotions, loss of privileges, and forfeited loyalty card points (Jones et al., 2007). A large number of empirical studies highlighted the important role financial costs play in customer-switching behaviour, in particular when financial switching costs outweigh switching benefits (Chen and Hitt, 2002; Harrison et al., 2012; Klein and Schmitz, 2016; Wirtz et al., 2014; Zhang et al., 2012). Thus, the higher the level of perceived switching costs, the higher the tendency to stay with the current retailer (Burnham et al., 2003; Jones et al., 2002; Wirtz et al., 2014). This also suggests that consumers would be reluctant to cross to competitors due to the high switching costs associated with cross-shopping behaviour (Hino, 2014):

H7. The influence of switching intention on total-switching is moderated by perceived financial switching costs.

H8. The influence of switching intention on cross-switching is moderated by perceived financial switching costs.
2.6 Cost of time and searching effort as a measure of procedural switching costs

Consumer perceived cost of time and effort is yet another important dimension of switching costs. Contrary to the former two categories, procedural switching costs result from “negative sources” of constraints (e.g. search time), and hence represent “negative switching costs” (Jones et al., 2007; Nagengast et al., 2014). Studies (e.g. Han et al., 2009; Lee et al., 2001; Wirtz et al., 2014), indicate that variables relating to perceived switching costs, such as the investment of time, money and effort, associated with the search for alternative stores, affect consumer switching behaviour. The most relevant perspective here is the household production approach (Goldman et al., 2002; Messinger and Narasimhan, 1997). This framework suggests that a household’s opportunity cost of time, that is, consumer predisposition to consider time a scarce resource and therefore plan its use carefully, has significant impact on consumer behaviour (Kleijnen et al., 2007; Konus et al., 2008). Thus, high opportunity costs of time drive shoppers to economise on search costs (Popkowski-Leszczyc and Timmermans, 1997). Consequently, time-pressured shoppers would rather stay with their current retail store in order to spend less time and effort searching for alternatives:

\[ H9. \] The influence of switching intention on total-switching is moderated by perceived switching costs.

In the context of the current research which also discusses consumer crossing behaviour, switching costs refer to costs incurred when customers shop at multiple-store formats as they cross between different stores (Chen and Hitt, 2002). This shopping pattern involves procedural switching costs resulting from searching for comparable retailers in the marketplace, specifically efforts associated with search time and travel costs. As such, it represents negative switching costs (Nagengast et al., 2014; Stan, 2015), which in turn provide a passive reason for staying (Vazquez-Carrasco and Foxall, 2006):

\[ H10. \] The influence of switching intention on cross-shopping is moderated by perceived switching costs.

2.7 The moderating role of relationship length

Relationship length refers to the duration of the relationship between a customer and retail provider, arguing the longer the relationship has a customer with a store, the smaller the tendency to switch to another. According to Lopez et al. (2006), relationship length is a key predictor of switching behaviour. Customers who remain in longer relationships with current retail providers are also less likely to switch to a new one. Moreover, as customers remain longer in relationships with providers, they are able to utilise the store more, develop attachment, and increase commitment to the current retailer (Harrison et al., 2012; Lopez et al., 2006):

\[ H11. \] The influence of switching intention on total-switching is moderated by relationship length.

In the context of food shopping, a few studies (see, e.g. Huang et al., 2015), have examined the influence of relational length on cross-shopping, suggesting that as customer relationships with retailers grow longer they gain more expertise, and hence become more experienced shoppers (Dagger and O’Brien, 2010). Consequently, those customers may change their evaluative criteria regarding key store factors, such as product and services quality, which are all hypothesised to impact customer attitude towards the current store (Hino 2014; Hino and Levy, 2016). In other words, experienced customers with longer relationships become experts, and are hence able to assess the core attributes of the...
addressed store more accurately. Thus, length of relationship experienced with a store can influence dissatisfied consumers to cross to more attractive stores:

\[ H12. \text{The influence of switching intention on cross-shopping is moderated by relationship length.} \]

2.8 Cross-shopping as a predictor of total-switching

While there has been some research interest in customer switching patterns, little attention, if any, has been devoted to studying the relationship between cross-shopping and total-switching.

As noted, cross-shopping refers to consumers who divide their shopping basket between different stores when shopping for groceries. This multiple-store shopping pattern is associated with more shopping effort as compared with benefits derived from maintaining affinity with a main store, including economic gains and reduced cognitive effort concerning store-specific knowledge of assortment, layout and prices (Putrevu and Ratchford, 1997; Rhee and Bell, 2002). Thus, the natural condition of the consumer is one of shopping at one store. Indeed, large food formats which attract consumers through one-stop shopping have become prevalent over the last three decades. Many consumers, especially in Western developed economies, do all their shopping in large supermarkets and hypermarkets thereby utilising the one-stop shopping model. Consequently, it could be argued that consumers who use several competing stores will end up shopping at a primary store thereby terminating their shopping relationships with other retailers and replacing them entirely. If this is the case, then it could be claimed that cross-shopping comprises an intermediate step in the total-switching behaviour:

\[ H13. \text{There will be a positive relationship between cross-shopping and total-switching behaviour.} \]

3. Research methodology

A two-part questionnaire was developed to solicit the necessary data for this study. The first part investigated the respondents’ socioeconomic and demographic profile. The second part dealt with the investigation of four constructs and four moderating variables that comprise the conceptual framework of this study. The constructs were presented to the subjects in question form, which they answered using a five-point Likert scale. The data for this study were collected by phone during September 2014. The phone interviews were conducted by a professional research company specializing in collecting data from household samples. A sample of 247 respondents was obtained from across the Israeli population. The person in each household responsible for most food and grocery shopping was interviewed using a structured questionnaire. Data were collected about consumers’ shopping behaviour for food products. In particular, respondents were asked about their intention to switch to another store, based on five items that had been shown in earlier studies to be the top important reasons for switching intention (see Table I). In addition, respondents were asked about their cross-shopping behaviour and actual switching. Following Hino (2014) and Jayasankaraprasad and Kathyayani (2014), data were collected about store type (e.g. neighbourhood groceries, supermarkets, hypermarkets), in which consumers shopped for food products, and the number of stores they had replaced over the past three years. Finally, there were questions regarding switching barriers. These questions were based on past studies that discussed the impact of four switching barriers (perceived switching costs, availability of attractive stores, store familiarity, and financial switching costs) on cross-shopping and store-switching (see Table I).
To ensure that the items used to operationalise the constructs of interest were internally consistent and free of measurement errors, reliability analysis was carried out using Cronbach’s α. Since the internal consistency reliability coefficients for research constructs

<table>
<thead>
<tr>
<th>Construct (Cronbach’s α)</th>
<th>Item</th>
<th>Factor loading</th>
<th>Eigen value</th>
<th>% of variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switching intention (SI) (0.71) (adapted: Kim et al., 2006)</td>
<td>1. I am considering switching from my current store</td>
<td>0.705</td>
<td>3.347</td>
<td>17.617</td>
</tr>
<tr>
<td></td>
<td>2. The likelihood of me switching to another food store is high</td>
<td>0.730</td>
<td>3.347</td>
<td>17.617</td>
</tr>
<tr>
<td></td>
<td>3. I intend to stop purchasing products from the current store in the future</td>
<td>0.793</td>
<td>3.347</td>
<td>17.617</td>
</tr>
<tr>
<td></td>
<td>4. I am determined to switch to another store</td>
<td>0.662</td>
<td>3.347</td>
<td>17.617</td>
</tr>
<tr>
<td></td>
<td>5. I would not continue shopping at the current store</td>
<td>0.624</td>
<td>3.347</td>
<td>17.617</td>
</tr>
<tr>
<td>Switching costs (0.86) (adapted: Awwad and Neimat, 2010; Jones et al., 2000).</td>
<td>1. It would take a lot of time to switch to another retailer</td>
<td>0.805</td>
<td>3.080</td>
<td>16.213</td>
</tr>
<tr>
<td></td>
<td>2. I will spend a lot of money if I switched current retailer</td>
<td>0.790</td>
<td>3.080</td>
<td>16.213</td>
</tr>
<tr>
<td></td>
<td>3. I will spend many efforts if I switched current retailer</td>
<td>0.616</td>
<td>3.080</td>
<td>16.213</td>
</tr>
<tr>
<td></td>
<td>4. In general it would be a hassle switching to another retailer</td>
<td>0.774</td>
<td>3.080</td>
<td>16.213</td>
</tr>
<tr>
<td>Alternative stores attractiveness (0.76) (adapted: Kim et al., 2006; Ranaweera and Prabhu, 2003)</td>
<td>1. I know that there are alternative stores I can switch to</td>
<td>0.789</td>
<td>2.046</td>
<td>10.766</td>
</tr>
<tr>
<td></td>
<td>2. There are grocery stores I find more attractive than the one I am shopping at</td>
<td>0.739</td>
<td>2.046</td>
<td>10.766</td>
</tr>
<tr>
<td></td>
<td>3. There are competing stores that meet my expectations</td>
<td>0.733</td>
<td>2.046</td>
<td>10.766</td>
</tr>
<tr>
<td>Store familiarity (0.86) (Nagengast et al., 2014; Jayasankaraprasad and Kumar, 2012)</td>
<td>1. At least one employee is familiar with me personally</td>
<td>0.886</td>
<td>1.945</td>
<td>10.237</td>
</tr>
<tr>
<td></td>
<td>2. The layout of this store makes me easy to get around</td>
<td>0.875</td>
<td>1.945</td>
<td>10.237</td>
</tr>
<tr>
<td></td>
<td>3. This store has good merchandise display</td>
<td>0.655</td>
<td>1.945</td>
<td>10.237</td>
</tr>
<tr>
<td>Financial switching costs (0.72) (adapted: Awwad and Neimat 2010; Jayasankaraprasad and Kumar, 2012)</td>
<td>1. This store has attractive in store price – promotion</td>
<td>0.543</td>
<td>1.541</td>
<td>8.111</td>
</tr>
<tr>
<td></td>
<td>2. I will lose benefits of being a long-term customer if I leave current store</td>
<td>0.600</td>
<td>1.541</td>
<td>8.111</td>
</tr>
<tr>
<td></td>
<td>3. Switching the current store is costly</td>
<td>0.593</td>
<td>1.541</td>
<td>8.111</td>
</tr>
</tbody>
</table>

Table 1. Exploratory factor analysis of items

3.1 Reliability and validity
were higher than the recommended levels of 0.70 (range from 0.71 for perceived switching intention, to 0.86 for store familiarity; see Table I), the test for construct reliability was satisfied. Prior to the reliability analysis, an exploratory factor analysis using Varimax rotation was conducted to test construct validity and determine whether multiple items for each construct comprised one factor dimension. No items were dropped. Hence, the results indicate that each of the constructs can be considered sufficiently reliable.

3.2 Data analysis and hypotheses test

This study employs the partial least squares (PLS) regression to examine the presented research structure. A structural model was built including all the antecedents and relevant relationships, enabling us to examine the hypothesised causal paths among the constructs by performing a simultaneous test. Structural equation modelling using the WarpPLS 5.0 software was used for the analysis. To assess the model fit with the data, it is recommended that the $p$-values for both the average path coefficient ($\text{APC} = 0.179$, $p = 0.001$) and the average $R^2$ ($\text{ARS} = 0.502$, $p < 0.001$) both be lower than 0.05. In addition, it is recommended that the average variance inflation factor (AVIF = 1.523) be lower than 5 (Kock, 2009).

Convergent validity was evaluated to validate the measurement model through investigation composite reliability (CR) and average variance extracted (AVE). Table II illustrates that all CR and AVE values meet the recommended threshold values. On behalf of CR values are recommended to exceed 0.70 and AVE values should be greater than 0.50 (Chin et al., 2003).

Discriminant validity was evaluated by obtaining the AVE values for each variable (see Table II). The square root of AVE for each variable is greater than the correlations between the variables and all other variables in the model, signifying that these variables have discriminant validity. VIFs were evaluated to check for the existence of collinearity. VIF values of less than 5 indicate no collinearity. Furthermore, all VIF values meet the recommended threshold values. Based on the current findings, this study demonstrates that the proposed model exhibits adequate reliability, construct validity, and collinearity (Hair et al., 2003).

4. Findings

Figure 1 graphically displays the path coefficients and squared multiple correlations ($R^2$) for the endogenous constructs. The proposed conceptual model allowed a moderate amount of variance in the switching behaviour dependent variable ($R^2 = 0.46$), whereas $R^2$ for the other dependent variable (cross-shopping) was relatively high ($R^2 = 0.53$).

<table>
<thead>
<tr>
<th>Construct</th>
<th>CR</th>
<th>Mean</th>
<th>SD</th>
<th>VIFs</th>
<th>AVE</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. SI</td>
<td>0.882</td>
<td></td>
<td></td>
<td></td>
<td>0.775</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>2. ASA</td>
<td>0.820</td>
<td></td>
<td></td>
<td></td>
<td>0.777</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>3. S_FAM</td>
<td>0.770</td>
<td></td>
<td></td>
<td></td>
<td>0.767</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>4. FSC</td>
<td>0.750</td>
<td></td>
<td></td>
<td></td>
<td>0.728</td>
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<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>5. S_COSTS</td>
<td>0.906</td>
<td></td>
<td></td>
<td></td>
<td>0.842</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>6. REL_L</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>0.158</td>
<td>0.069</td>
<td>0.326</td>
<td>0.283</td>
<td>0.030</td>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>7. S_BHV</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>0.326</td>
<td>0.283</td>
<td>0.030</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>8. CROS_S</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>0.326</td>
<td>0.283</td>
<td>0.030</td>
<td>1</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Notes: CR, composite reliability; SI, switching intention; ASA, alternative stores attractiveness; S_FAM, store familiarity; FSC, financial switching costs; REL_L, relationship length; S_COSTS, perceived switching costs; S_BHV, switching behavior; CROS_S, cross shopping
$H1$ and $H2$ proposed that switching intention predicts actual switching and cross-shopping. The results revealed that the proposed relationships received statistical support ($H1$: $\beta = 0.65$, $p < 0.01$; $H2$: $\beta = 0.69$, $p < 0.01$). $H3$ and $H4$ suggested that competition reflected in the availability of attractive competing stores positively affects both customer behaviours: actual switching and crossing. The results revealed that while the proposed relationships received statistical support for $H4$, the results did not support the prediction described in $H3$ ($H3$: $\beta = 0.09$, $p = 0.08$; $H4$: $\beta = 0.12$, $p = 0.03$).

As for the moderating effects of switching costs, store familiarity, financial switching costs, and relationship length, the PLS results with moderators are displayed in Figure 1. Figure 1 indicates that store familiarity moderates the positive influence of switching intention on both switching behaviour and cross-shopping. The study results demonstrated statistical support for the proposed relationship in $H5$ and $H6$ ($H5$: $\beta = −0.09$, $p > 0.05$; $H6$: $\beta = −0.14$, $p = 0.02$).

$H7$ and $H8$ suggested that financial switching costs moderate the influence of switching intention on, respectively, switching behaviour and cross-shopping. However, the study results did not provide statistical support for the proposed relationships ($H7$: $\beta = −0.02$, $p > 0.05$; $H8$: $\beta = −0.01$, $p > 0.05$). $H9$ and $H10$ predict the moderating effect of switching costs on both customer switching and cross shopping behaviour. As hypothesised, perceived switching costs exhibited significant moderating impacts ($H9$: $\beta = 0.17$, $p < 0.01$; $H10$: $\beta = 0.13$, $p = 0.02$).

$H11$ and $H12$ suggested that relationship length moderates the influence of switching intention on, respectively, actual switching and cross-shopping. The results demonstrated statistical support for the proposed relationships ($H11$: $\beta = −0.1$, $p = 0.06$; $H12$: $\beta = −0.13$, $p = 0.02$). Finally, $H13$ proposed that cross-shopping predicts total-switching. The results revealed that the proposed relationships received statistical support ($H13$: $\beta = 0.17$, $p < 0.01$).
Almost all the hypothetical relationships were supported by the empirical model results, thus providing strong evidence for most of the hypotheses drawn from the theoretical framework. This means that our conceptual model was able to capture most of the factors impacting shopping behaviour of switching-intention customers. However, the study results point to noticeable differences with regard to the degree of impact of the predicting variables on actual behaviour. First, switching intention and competition intensity were found to be the most influential factors affecting customer shopping behaviour, especially in predicting cross-shopping behaviour: the incremental contribution of both factors to the explanatory power ($R^2$) of the cross-shopping and total switching was, respectively, 47 and 42 per cent. This is consistent with findings reported previous studies. For example, the strong influence of competition intensity on switching behaviour has been demonstrated in context of various contractual services (see, e.g. Capraro et al., 2003; Keaveney, 1995; Valenzuela, 2010; Wirtz et al., 2014).

As for the moderating variables, the study results show that most of the variables’ coefficients are significant with the expected negative signs, indicating these factors appear to be significant barriers of customer behaviour as they decrease consumer tendency to both replacing the current store or crossing to others. In particular, the study found switching costs significantly moderate the influence of switching intention on actual behaviour (total-switching and cross-shopping). This finding, too, is congruent with other research studies on the impact of switching costs on behaviour in various services industries (Pick and Eisend, 2014). An additional variable that moderates the influence of switching intention on actual behaviour is length of relationship with the current retailer, indicating that experienced customers with longer relationships with a retailer are less interested in replacing their grocery store or crossing to others. This is consistent with previous research that found relationship length motivates customers to stay with the current retailers (Harrison et al., 2012; Lopez et al., 2006). In addition, the study found store familiarity to significantly moderate the influence of switching intention on cross-shopping, indicating that “familiarity” with the current retailer appears to be a significant barrier as it decreases consumer tendency to cross to competitors. This conclusion corresponds with findings of previous studies that examined the effect of store-familiarity on consumers’ tendency to shop at multiple stores (Goldman et al., 2002; Hino, 2014). In contrast, no significant evidence was obtained regarding the influence of store-familiarity on switch-shopping. Consequently, it emerges that consumers may consider the total-switching behaviour despite the expected loss of privileges and benefits associated with replacing the current familiar store.

The PLS results too found financial switching costs to have no bearing on customer shopping behaviour, as this variable did not moderate the influence of switching intention on both switch-shopping and cross-shopping. This conclusion corresponds with results of previous studies (e.g. Wirtz et al., 2014) found monetary switching costs insignificant in explaining actual behaviour. This means that dissatisfied consumers who enjoy a relatively high economic status are more likely to stay with their current providers, as the actual behaviour (switching or crossing) is associated with the time, money, and effort necessary to invest in searching for superior alternative groceries. In other words, consumers who want to replace a store or to cross-shop to others are restricted by the cost of time and effort variable captured by the economic measures.

Finally, the study found consumer-crossing to significantly affect total-switching behaviour ($\beta = 0.17, p < 0.01; R^2$ rose to 50 per cent, see Figure 1). This indicates that crossing to two or more stores drives consumers to adopt the total-switching behaviour. That is, when shopping at multiple-store formats is of major importance to consumers, this study showed the strengthening of the relationship between cross shopping and total-switching. If this is the case, then it appears that cross-shopping is an intermediate step of the total-switching, in that consumers who cross to other stores would end up adopting the total-switching behaviour.
6. Conclusion
A number of earlier studies documented the tendency of many consumers to switch where they shop for food products (e.g., Baltas et al., 2010; Findlay and Sparks, 2008; Hino, 2014; Hino and Levy, 2016). The researchers conducting these studies were mostly interested in identifying factors affecting consumers’ store-switching intention. Our interest in this paper is different. We focus on the relationship between switching intention and actual behaviour. We have attempted here to deepen our understanding of an important phenomenon in shopping for food products – actual store-switching – through focusing on two distinct but related behaviours: cross-shopping and total-switching. Consequently, the current study extends previous literature in that it proposed and tested a conceptual framework for investigating the relationship between switching intention and actual behaviour, claiming that switching intention drives customers to either replace the current store or cross to others. In addition, to better understand the relationship between switching intention and actual behaviour, additional insights into the link were provided by examining the moderating effects of switching barriers.

The study results indicate that switching intention has a direct and significant influence on both switch-shopping and cross-shopping. Our study results shed light on the influence of competition in the market era on consumer shopping behaviour, indicating significant impact on customer behaviour. In particular, the study results of a positive relationship between switching intention and actual behaviour accords with previous research, as customers who have a clear intention to switch are more likely to replace their providers or cross to others than those with satisfactory experiences (Lu et al., 2012). In addition, the study results in which most of the moderating factors have significant influence demonstrate the major role switching barriers play in keeping customers tied to their current stores. A possible conclusion is that consumer willingness to replace a retail provider is largely affected by perceived intention to replace the current marketers. However, the findings reveal that despite evidence that customer intention is positively related to switching behaviour, in general, consumers may not consider the actual behaviour. This, too, is consistent with previous studies that found the relationship between customer intention and actual behaviour often demonstrates considerable variability and complexity (Cho and Song, 2012; Jones et al., 2000; Lu et al., 2012), indicating that customer-switching is contingent on additional factors such as switching barriers, which moderate the influence of perceived switching intention on store-switching. Furthermore, the study results provide empirical evidence of the impact of switching barriers on cross-shopping, suggesting that factors such as relational benefits associated with shopping at familiar stores, switching costs, and length of relationship experienced with a store, act as inhibiting factors for cross-shopping. This is consistent with previous studies that found customers are affected by different moderating factors when making switching decisions (Jones et al., 2000; Vazquez-Carrasco and Foxall, 2006).

Combining all the above, a possible additional conclusion is that switching intention exerts significant influence on customer shopping behaviour. As mentioned earlier, however, the study results point to noticeable differences regarding the degree of impact of switching intention on the actual behaviour pattern, with switching intention playing a relatively large role in explaining cross-shopping behaviour. Consequently, this leads to the conclusion that customers are more likely to cross-shop rather than switch entirely. However, given that the study results provide evidence for the switching pattern, an additional conclusion is that customers may utilise both shopping patterns concurrently. That is, they apply the cross-shopping behaviour to alternative stores. In other words, while cross-shopping, customers continue to direct some proportion of their shopping trips to the existing store. Finally, the study results indicate that cross-shopping behaviour has a direct and significant influence on actual switching. Consequently, this leads to the conclusion that crossing to competing stores is the first step towards utilising the total switching behaviour.
7. Theoretical and managerial implications

From a theoretical perspective, this study contributes to the marketing literature in several ways. First, it serves as a pioneering effort to incorporate a conceptual framework to include consumer behaviour in empirical studies of store-switching in food retailing. Second, the study provides new insights into the growing body of literature on consumer-switching behaviour and related theories, especially consumer dissatisfaction and cross-shopping. Our proposed conceptual framework identifies determinants of consumer behaviour and describes how these determinants affect each of the addressed shopping patterns: total switching or crossing. Finally, the model introduced in the study evaluates the links between switching intention and both store-switching and cross-shopping, whereas the testable hypotheses derived from the model show how these may be used to draw up a systematic assessment of the affecting factors in additional consumer shopping settings.

From a practical perspective, the study findings pose major strategic challenges for retail executives. To start with, the present framework and measurement approach can be implemented as a diagnostic and monitoring device to help identify key factors driving consumers towards actual behaviour. An understanding of the affecting factors provides useful implications for retail managers interested in securing significant market share and profitability, thereby decreasing actual switching (store-switching and cross-shopping), and increasing store patronage by attracting new customers. Additionally, retail executives who have experienced actual switching may gain better understanding of the limitations of store retention and loyalty programs in the context of grocery shopping. Thus, a major managerial implication deriving from our results—that found store familiarity moderates the impact of switching intention on actual behaviour—is that rather than trying to compete merely through price and other financial switching costs, managers need to focus on improving personal benefits (i.e. social benefits, favourable treatment, and special offers) that store sales personnel can grant to customers. Second, based on findings from the present study, managers can also reduce switching by increasing nonmonetary switching costs to retain existing customers. Such barriers play a very important role in preventing competitors from successfully attracting prospective switching consumers. However, retailers should be cautious about utilising negative switching barriers; doing so can intensify negative emotions since such barriers provide passive reasons to remain (Han et al., 2009; Jones et al., 2000, 2007). Another important implication derives from positive effects of alternative store attractiveness on switching behaviour. Since customer perceptions of the current stores’ performance and attractiveness, compared with those of competitors, are important for reducing cross-shopping and total-switching, retail managers should strive to achieve supremacy through differentiated values in most store attributes. Finally, studying the store-switching phenomenon is of major importance for food retailers who want to attract prospective switchers and cross-shoppers. Understanding why consumers choose to switch is of major importance when creating marketing strategies to overcome barriers that prevent customers from actual behaviour. This is particularly relevant to the cross-shopping pattern, which allows consumers to preserve their relationship with current stores, directing a proportion of their shopping activities to those stores, while crossing between various store formats. Thus, understanding the driving forces behind the crossing pattern is critical to retail managers interested in reducing the crossing phenomenon. Such understanding is also highly significant, given that the study results show cross-shopping behaviour ends in total replacement of the current stores.

8. Limitations and directions for future research

The current study is not free of certain limitations which offer avenues for further research. First, the empirical findings from the relationships reported in this paper are based on cross-sectional data. Previous research suggests that longitudinal data is appropriate for better
understanding the exact causal nature of the link between the constructs. Second, the present study deals with consumer switching and crossing related to grocery products shopping. It is neither inter-type shopping specific nor intra-type specific in nature. Future research could investigate shopping pattern-specific within store-format types as well as between format types. Finally, we suggest that future researchers compare the switching behaviour between customers who shop at one store to those that shop at two or more stores. Such a comparison would highlight different customers in one common term; switching behaviour.

References


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A new coffee culture amongst Costa Rican university students

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Abstract

Purpose – The purpose of this paper is to identify what type of changes, if any, have taken place, in the factors influencing coffee consumption among Costa Rican university students.

Design/methodology/approach – The study consisted of quantitative and qualitative phases. The quantitative data were collected through a written questionnaire distributed to a random sample of 370 students at a private university. The data were analyzed using Cronbach’s \( \alpha \), principal component/exploratory factor analysis and standardized ordinal logistic regression. Qualitative in-depth interviews with ten students were undertaken to verify the quantitative results.

Findings – Of the sample, 70 percent were females and 30 percent males. Of those interviewed, 70 percent drank coffee and 30 percent did not. In 64 percent of those who did not drink coffee, juice was the main substitute. The predictors of the coffee culture are: the country tradition, parents, general socialization with friends, home, workplace and restaurants. Tradition, parents and home were found to be the predictors of coffee culture for women; for men the predictors were the workplace and restaurants.

Originality/value – Coffee culture amongst university students is experiencing a transition, and the changes identified seem to be affected by the gender of the student and the change in the economic base of the country. The information will be valuable in marketing coffee to young people.

Keywords Gender, Culture, Costa Rica, University students, Coffee, Logistic regression

Paper type Research paper

1. Introduction

For over two centuries, coffee and bananas have been the major foreign exchange earners of Costa Rica. Over this time, the importance of coffee and its ubiquity has led to the development of a coffee culture which is part of the national lifestyle and of family behavior, with coffee drinking being a central part of family activities. In the late 1960s and early 1970s, Costa Rica was “discovered” by tourism and service industries; what was a solid agricultural export economy, based on coffee and bananas started a transformation into a service economy.

This economic transition is bringing about a transformation in the coffee-drinking culture. The “traditional drink” is slowly becoming a social drink, and the younger generations appear to be at the center of that transformation as the home-based “coffee culture” is being challenged by coffee shops, restaurants and the marketplace.

When the cultivation of coffee was introduced into Costa Rica in the nineteenth century, it was evident that there were beneficial climatic and soil conditions for its production and development. Local production has facilitated and consolidated coffee consumption by families and communities across the country, making coffee the modeler of national culture, part of the country’s history, a national symbol and the facilitator of social relations (Jimenez, 2013; Peters and Samper, 2001; Tucker, 2011).

In 2006, it was reported that 85 percent of Costa Ricans drank at least one cup per day, and socializing was cited as the main engine of such consumption, followed by tradition, family, culture and food (Vega Jimenez, 2006). In 2011, coffee consumption was estimated at 1.88 cups and in 2015, at 1.21 cups per capita/per day – an overall reduction of 0.67 cups per day (Instituto de Cafe de Costa Rica, 2015; Instituto Nacional de Estadistica y Censo, 2011). A further study conducted in 2015 showed that people between the ages of 18 and 30, representing one-fourth of the country’s population and 33 percent of those with university education, consumed between one and two cups and in some cases up to three cups a day (Aguirre, 2016).
This important group, representing the future of both consumption and prospects for the coffee industry, deserves to be understood in relation to the factors, if any, that may be affecting their traditions, socializing, places of consumption and patterns of coffee-related behavior. The change in consumption is taking place in a changing country, where agriculture represents only 5.6 percent of gross domestic product, women make up 41 percent of the labor force and 60 percent of households have internet access (Instituto Nacional de Estadística y Censos, 2015; SEPSA, 2016).

Therefore, the purpose of the study was to identify what type of changes, if any, have taken place in the culture of coffee consumption in terms of its traditions, where coffee is consumed and its role in socializing and to use these changes as indicators of future consumption patterns.

2. Coffee culture

Conceptual framework

Coffee culture in the country is a social atmosphere or a series of associated social behaviors that depend heavily upon coffee as a social facilitator and as a tradition inherited from forebears and transmitted to descendants (adapted from UNESCO, 2016).

Coffee culture is in the case of Costa Rica part of the cultural heritage and social atmosphere of the country, which has been transmitted from one generation to the next. However, what is important to understand is that: “Food choices tell us about family histories, migration, assimilation, resistance to change and the influence of institutions and individuals, as well as the identity of groups […]” (Almerico Gina, 2014). In the case of Costa Rica, the choice of coffee as a drink reflects a century and half of socially related behavior.

In the USA, studies have shown that four cups a day do not appear to have negative effects on the individual (Gardener et al., 2013). Adults between the ages of 20 and 39 consume only one cup of coffee a day, while adults over 40 consume almost two cups (LaComb et al., 2011).

In China, drinking coffee is a status symbol of the emerging middle class which reflects the new opulence of certain segments of society (Zhang, 2014). In Brazil, it is closely related to the social habits of the country (Sousa Gaspar et al., 2016). In Mexico City, “Let’s have a coffee,” is synonymous with “We have to talk about serious things”; one does not invite anyone to have a cup of coffee (Manual de Mexico. DF, 2016). In Ethiopia, coffee drinking in the home is at the discretion of the wife and depends on her work (Sagawa, 2006). In Serbia, studies suggest that coffee consumption occurs in circumstances where people want to spend time with friends or stay alert – for women in 37 percent of cases and for men in 38 percent of cases (Adamovic et al., 2014). In Israel, evidence suggests that men are more concerned about coffee than women; apparently, this stems from a need to indicate status through the choice of gourmet products when socializing with friends (Tifferet et al., 2013). In Finland, coffee is consumed all day, and coffee breaks are required by the trades unions. Usually, special occasions like post-church luncheons are celebrated with a coffee table – a buffet of cold sandwiches, bread, cookies, cakes and, of course, endless “khavi” (World Atlas, 2013). Ethiopia, Brazil, Israel, Serbia, Mexico, China and Finland are just some of the places where culture and coffee are closely interrelated.

One of the best examples of the world of coffee culture is to be found in the coffee region of Quindio in Colombia (Jurado, 2012), home to Juan Valdez, the icon of Colombian coffee. The equivalent area in Costa Rica is Los Santos, where many believe that the best coffee in the country is produced (Instituto de Cafe de Costa Rica, 2015). In Costa Rica, the ritual of coffee of consumption is over 175 years old and has resulted in a social relationship that has developed its own utensil, the “coffee dripper.” This is usually a cloth bag, which functions as a filter, suspended from a wooden frame. The ground coffee is placed in cloth bag and the boiling water is then poured into it. The infusion drips into a container placed below the bag (Espiritu Santo Coffee Tour, 2016).
The social relationships around coffee consumption are traditions that have been transmitted from one generation to the next. Giddens (2000) is clear when he writes that sociologically the consumption of coffee is based on its symbolic value, the “extra push” (caffeine), previous social and economic development and extensive social and economic relations.

First, the morning cup of coffee, which for many is the extra push, is a ritual that has a central socializing effect when repeated within the family. In an agricultural economy, such as that of Costa Rica until the 1970s, where the father works on the farm and the mother takes care of the household chores, the daily ritual, by which children develop the competence to consume and appreciate good coffee, consolidates the youngster in the coffee culture (Bandura, 1989; Bussey and Bandura, 1999; Reckwitz, 2002; Warde, 2005; Whittington, 2006).

Second, Giddens argues that social and economic development came about gradually and may change in the future. The relationships around coffee began when the crop was first brought into the country, and these evolved over 175 years within an agriculture-based economy and a land-holding structure that facilitated small coffee production on family farms. However, people looking for better living conditions and employment opportunities began moving from the farm to urban areas. For an urban resident employed in the service industries, coffee as the preferred drink at home during breakfast, lunch and dinner is no longer guaranteed because of the distance between home, workplace and school or university. This has begun to alter the process of consumption, which can now take place at home or outside the home. The mother’s social role in an urban service-based economy begins to change; she still forms family eating habits but begins to depend on other products, reasonably priced and convenient, that eventually become coffee substitutes. This affects traditional coffee consumption, which in turn affects the culture of the country.

Third, coffee does not remain on the farm. Giddens refers to extensive social and economic relationships because the cultivation, packaging, distribution and marketing of coffee are national activities. Costa Rica exports around 80 percent of its coffee, given its high quality, and what cannot be exported for lack of export demand, lower quality or a combination of these reasons, is left for local consumption. However, the young rural consumer, now in an urban setting, was taught by his or her parents, relatives and community to drink and appreciate the pure, high-quality coffee available on the farm, and s/he objects to the low quality of the coffee consumed in urban cafeterias. This is fertile ground for the media to create, modify or influence demand through advertising campaigns in favor of substitutes, and this is becoming increasingly easier with new technologies available (Thompson and Craig, 2005).

The former rural resident, now a young urban consumer, buys and drinks what he or she can afford, which may not be the quality that they were used to when they were on the farm. The difference between coffee drinking in an agricultural context and in an urban context becomes evident and contrasting. Table I is an attempt to point out the difference under both conditions, and this is reflected in the consumption behavior of the young urban coffee consumer.

Hypotheses

The following hypothesis is the result of the “traditional idea” of the local people:

\[ H1 \] The frequency of consumption predicts and supports the coffee culture.

The coffee culture concept is being measure by the response to following statement: Costa Rica has a culture of coffee consumption. The frequency of consumption concept is represented by the number of cups of coffee consumed per day.
H2-H4 refer to the concept of tradition as an expression of the combined actions of parents, relatives and country, a combination that facilitates the coffee culture and is represented by these three statements, each of which represents a hypothesis:

H2. The country’s tradition of drinking coffee to socialize with other people.
H3. The tradition of parents drinking coffee to socialize with other people.
H4. The family tradition of drinking coffee to socialize with relatives and other people.

H5-H7 refer to the concept of socializing with friends and university colleagues as reasons for coffee drinking and the idea of energy is that it facilitates the socializing process, by giving the extra push and a sense of alertness that facilitates conversations with others. The concept is represented by the three statements, each of which represents a hypothesis:

H5. Coffee drinking with friends in general as a way of socializing.
H6. Coffee drinking with university friends as a way of socializing.
H7. The energizing effect of coffee improves my ability to socialize.

H8-H10 refer to the concept of the place of consumption and make an attempt to acknowledge that coffee is consumed everywhere, but the emblematic sites are the house, workplace and restaurants. The coffee take-away is a fairly recent development and has been adopted as a service by many restaurants. Coffee drinking in the workplace is facilitated by many public and private organizations who supply their staff with electric coffee machines and in some cases the coffee. This is represented by the three statements, each of which represents a hypothesis:

H8. Home is the best place to drink coffee.
H9. The workplace is the best place to drink coffee.
H10. The restaurant is the best place to drink coffee.

Operational models

\[ Y_{cdc} = \text{Culture of Drinking Coffee.} \]
\[ Y_{cdc} = a + Y_f \text{ Frequency} + Y_t \text{ Tradition} + Y_s \text{ Socialization} + Y_p \text{ Place} + e \]

where \( Y_f = a + \beta \text{ Frequency} + e \), \( Y_t = a + \beta_1 \text{ Tradition} + \beta_2 \text{ Parents} + \beta_3 \text{ Relatives} + e \);
\( Y_s = a + \beta_1 \text{ General Friendship} + \beta_2 \text{ Friendship in the U} + \beta_3 \text{ Energy} + e \), \( Y_p = a + \beta_1 \text{ House} + \beta_2 \text{ Workplace} + \beta_3 \text{ Restaurant} + e \).

<table>
<thead>
<tr>
<th>Considerations</th>
<th>Agro-base</th>
<th>Service-base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>As needed</td>
<td>When time is available</td>
</tr>
<tr>
<td>Mother</td>
<td>Caring for house</td>
<td>Working and may study</td>
</tr>
<tr>
<td>Learning</td>
<td>From mother</td>
<td>Mother and streets</td>
</tr>
<tr>
<td>Father</td>
<td>Farmer or farm laborer</td>
<td>Employee outside home</td>
</tr>
<tr>
<td>Tradition</td>
<td>Strong</td>
<td>Normal</td>
</tr>
<tr>
<td>Availability</td>
<td>In the patio</td>
<td>In the store</td>
</tr>
<tr>
<td>Friends general</td>
<td>In the vicinity</td>
<td>From anywhere</td>
</tr>
<tr>
<td>Preferred place</td>
<td>Home/farm</td>
<td>Home/outside</td>
</tr>
<tr>
<td>Quality</td>
<td>Not in question</td>
<td>Challenge</td>
</tr>
<tr>
<td>Price</td>
<td>Farm available</td>
<td>Doubts, purchase</td>
</tr>
</tbody>
</table>

**Source:** Framework

**Table I.** Difference between agriculture and services economic activities and coffee culture
Each gender was treated with the same models and hypotheses detailed above. In order to avoid being repetitive the models for each gender are not included, only the general model.

**Socioeconomic data**
Socioeconomic data were collected for age, gender, study conditions, nationality, the range of possible cups per day and the most common occasion for consumption in the day. A seven-level Likert scale was used in the ten perception statements where 1 indicated that what was stated was not important and 7 that it was important.

**Site**
The site was the main campus of a private university with a population of 10,000 students.

**Unit of study**
The units of the study were students between the ages of 18 and 30. The interest in this group is due to the fact that this age group was the first whose parents experienced the transition from agriculture to a service economy, making them a segment that combines economic transition and education with future income.

**Research phases**
The methodological approach was a combination of quantitative and qualitative methods.

**Quantitative phase**
The estimated sample size was 370 students, with 95 percent confidence, 5 percent error and 50 percent response distribution. The interviews started at 9:30 and were completed around four o’clock in the afternoon. Interviews were conducted in the dining area.

In order to guarantee a random sample, each of the 40 tables (all seating four) in the dining area was given a number. Every day for ten days, ten tables were selected by lot. The people seated at the chosen tables were interviewed until 37 surveys had been conducted.

The dining area was chosen to avoid interfering with classes and so as to be able to talk to students and answer any questions they might have. The dining hall is the only location on the site where one can find students of every faculty at any given time who are enjoying a conversation and are ready to talk and share their thoughts.

The instrument was pre-validated using the Cronbach $\alpha$ with the surveys on the first day, thus allowing time to make any adjustment that may have been needed. The Cronbach $\alpha$ result was a value of 0.7985, superior to the 0.70 required, indicating that the instrument could be used without adjustment (Carmines and Zeller, 1979). The first stage of the quantitative phase consisted of a combined principal component exploratory factorial analysis to confirm the existence of latent variables, with the Kaiser selection criteria in relation to factors to be retained and, with a 50 percent restriction on the eigenvalues, logic link with a varimax rotation (Kachigan, 1991). The second stage consisted of a semi-standardized ordinal logistic regression (OLR) to test the different hypotheses to identify the variables that were significant and those that were not.

**Qualitative phase**
The selection of students was not random but based on convenience since they were approached in the dining area. They were asked to provide more in-depth explanation and to verify the results of the quantitative study. If they agreed to participate the interview was conducted, if they refused they were thanked and another student approached. Two refused and ten agreed and gave permission for written notes to be taken. A slip of paper to guide
the conversation was given to each student, asking them to explain in detail why they drank coffee, and if they did not to explain why not. They were also asked what the roles were of the country’s traditions, socializing with friends and the home in coffee culture. The notes taken were analyzed for content, and general categories were developed in line with the conceptual framework.

3. Results and discussion

The results of the \( \alpha \) test were: for all questions 0.81, for the traditions (F1) 0.86, for socialization (F2) 0.77, and for place (F3) 0.71, indicating that the instrument is valid for the purpose in question.

Construct verification

The exploratory principal component/exploratory factorial analysis verified the existence of the latent variables (Table II).

The latent variable tradition, factor 1, represented 2.464 variance and a 0.274 percent of total variance, the latent variable socializing, factor 2, represented 2.001 variance and 0.223 percent of the total variance and the latent variable place of consumption, factor 3, represented 1.768 variance for 0.196 percent of variance and a total variance of 0.693.

The latent variables tradition, socializing and place presented a correlation between factor 1 and factor 2 of \(-0.337, p = 0.375\); between f1 and f3 it was \(-0.494, p = 0.179\); and between f2 and f3 \(-0.587, p = 0.097\); in addition coffee culture was aligned with the latent variables associated with tradition validating to the idea of the initial importance of tradition and the existence of the theoretical proposal.

General student profile

Table III presents the general profile of students. The students’ profiles indicated that 70 percent drank and 30 percent did not drink coffee. The preferred substitute for coffee was juice. The usual time to drink coffee was breakfast. A total of 29 percent studied and worked; 70 percent were females; 95 percent were Costa Ricans and 5 percent foreigners; the average age was 21.

Of those who did not drink coffee, most (88 percent) gave their reason for not drinking as that they not like it. This is important because it is a question of taste, and with alternative drinks readily available, reasonably priced and convenient, this is an issue for marketing strategies.

The characteristics described suggest that new young consumers are predominantly female, in further education, and may well be working to help pay for that education.

<table>
<thead>
<tr>
<th>Variable</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>Communality</th>
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<td>Family</td>
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<td>0.845</td>
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<tr>
<td>Relatives</td>
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<td>Energy</td>
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<td></td>
<td></td>
<td>0.743</td>
<td>0.655</td>
</tr>
<tr>
<td>Home</td>
<td></td>
<td></td>
<td>0.683</td>
<td>0.732</td>
</tr>
<tr>
<td>Restaurants</td>
<td></td>
<td></td>
<td>0.665</td>
<td>0.506</td>
</tr>
<tr>
<td>Variance</td>
<td>2.464</td>
<td>2.001</td>
<td>1.768</td>
<td>6.233</td>
</tr>
<tr>
<td>% Variance</td>
<td>0.274</td>
<td>0.223</td>
<td>0.196</td>
<td>0.683</td>
</tr>
</tbody>
</table>

Source: Survey

Table II. Latent variables verification
Hypotheses testing – general results

Frequency and culture. The hypothesis \( H_1 \) was rejected since frequency of consumption was \(-0.334\) with a \( Z \) value of \(-1.55 \) and a \( p \) value of 0.122. Frequency is not significant for predicting the coffee culture.

Table IV results suggest that \( H_2, H_3, H_5, H_8, H_9 \) and \( H_{10} \) can be accepted and the others rejected. The results also suggest that the absolute values of tradition (\(-0.754\)), parents (0.698) and home (0.777) identify those variables as the most important of the group in a ratio of 2 to 1 above all others. This is interesting because it suggests that the group is still influenced by parents and the home, and tradition seems to be maintained by the family. However, the fact that all the three locations for consumption are significant suggests that the young student is open to consuming coffee in a variety of places and that this is part of a developing new culture.

Genders. The gender analysis of frequency – male with a coefficient of \(-0.189\), \( Z \) value \(-0.78 \) and \( p \) at 0.433, and female \(-0.1921\), \( Z \) value \(-0.77 \) and \( p \) at 0.456 – indicates that frequency does not influence coffee culture in men or women (Table V).

\( H_1 \), the frequency of consumption influences the coffee culture, i.e., the belief that frequency is associated with coffee culture, may have been the correct hypothesis in earlier times, but in 2016 among young university students this may or may not be the case.

For women, the accepted hypotheses were: \( H_2 \): the country’s tradition of drinking coffee to socialize with other people is accepted for women and not for men; \( H_3 \): the tradition of parents for drinking coffee to socialize with other people is accepted for women and not for men; and \( H_8 \): home is the best place to have coffee is accepted for women and not for men.

For men, the accepted hypotheses were: \( H_9 \): the workplace is the best place to drink coffee; and \( H_{10} \): the restaurant is the best place for coffee.

---

**Table III.**

| Student consumer profile for coffee drinkers (2016) |  |

<table>
<thead>
<tr>
<th>Coffee drinkers</th>
<th>Most common range</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average age</td>
<td>21 years</td>
<td>Males 30% Females 70%</td>
</tr>
<tr>
<td>Locals 97%</td>
<td>Foreigners 3%</td>
<td>29% study and work; 71% study only</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Perception variables</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The tradition of the country to drink coffee to socialize with other people</td>
<td>4.56</td>
</tr>
<tr>
<td>The tradition of the parents to drink coffee to socialize with other people</td>
<td>4.6</td>
</tr>
<tr>
<td>The tradition of the relatives to drink coffee to socialize with other people</td>
<td>4.84</td>
</tr>
<tr>
<td>The socialization with friends in general as a way to share</td>
<td>4.25</td>
</tr>
<tr>
<td>The socialization with friends at the university as a way to share</td>
<td>3.67</td>
</tr>
<tr>
<td>The energy effect of coffee improves my capacity to socialize</td>
<td>4.09</td>
</tr>
<tr>
<td>The home is the best place to drink coffee</td>
<td>4.96</td>
</tr>
<tr>
<td>The workplace is the best place to drink coffee</td>
<td>4.24</td>
</tr>
<tr>
<td>The restaurant is the best place to drink coffee</td>
<td>4</td>
</tr>
<tr>
<td>Costa Rica has a culture of drinking coffee</td>
<td>5.67</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non-coffee drinkers</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average age</td>
<td>21</td>
</tr>
<tr>
<td>Locals 95%</td>
<td>Foreigners 5%</td>
</tr>
<tr>
<td>Males 27% Females 73%</td>
<td>18% study and work; and 82% study</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reasons for not drinking</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Not like</td>
<td>88%</td>
</tr>
<tr>
<td>Health</td>
<td>11%</td>
</tr>
<tr>
<td>Other</td>
<td>1%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternatives drinks</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tea</td>
<td>43%</td>
</tr>
<tr>
<td>Sodas</td>
<td>36%</td>
</tr>
<tr>
<td>Juices</td>
<td>64%</td>
</tr>
<tr>
<td>Chocolate</td>
<td>20%</td>
</tr>
<tr>
<td>Yogurts</td>
<td>7%</td>
</tr>
<tr>
<td>Energizers</td>
<td>7%</td>
</tr>
</tbody>
</table>

Summary:

Coffee drinkers: 70%
Most common range: 1 to 2 cups
Average age: 21 years
Males: 30%
Females: 70%
Locals: 97%
Foreigners: 3%
29% study and work; 71% study only

Non-coffee drinkers: 30%
Average age: 21
Locals: 95%
Foreigners: 5%
Males: 27%
Females: 73%
18% study and work; and 82% study

Not like: 88%
Health: 11%
Other: 1%

Tea: 43%
Sodas: 36%
Juices: 64%
Chocolate: 20%
Yogurts: 7%
Energizers: 7%

Source: Survey

---
The results identify the importance for females of the tradition, home and parents, which is not the case for men, whose only significant variables are a workplace with 0.679 and restaurant − 1.053 making the restaurant the most important variables.

The five central variables identified by the quantitative analysis are tradition, parent and home for women, and work and restaurants for men. Results serve as indications of what are the interests of each group and the gender differences that need to be considered when planning strategies to promote consumption amongst both genders.
Qualitative results. The answers given were concrete and in a simple, colloquial language that allowed authors to better understand that the results were not far from the reality of the coffee consumption culture of those interviewed in the quantitative phase.

The answers of those drinking coffee are presented below.

Student No. 1 (male).

The reason I drink coffee is that my family drank it, and since I was little they offered it to me and I gradually developed the taste, and today the truth is that it energizes me. The time I spend drinking coffee is an occasion for conversation and sharing with my friends. I only drink it at breakfast at home, and if I can in the afternoon, but many times I do not have time because of the class schedule.

Student No. 2 (male).

My mother taught me. I am not from San José, and at home, the coffee is available at home, and when the harvest is ready, peeled, dried and stored – and my grandmother knows how to process it and taught my mother – that provides the family with free coffee all year. The problem is that now that I’m studying in San Jose, I do not have time to do it, as they do in my house, so I drink less and when I drink it is more as a way to enjoy a moment with friends.

Student No. 3 (female).

I drink coffee because at my house we all drink it and it’s really available. Besides, it smells good, and helps me to wake up in the morning, you know it’s like an energy injection and to me it is a time to enjoy my friends and my parents.

Student No. 4 (female).

My mother when I was a baby gave it to me since I was little and I like it, but now no modern mom will do that, they give babies juices. You know, today everybody is in a hurry and coffee is a drink that you need to have to have time to enjoy, like in the old days, and now my friends and I only have minutes, but is a way to get rid of stress.

Those who do not drink coffee answered.

Student No. 1 (male).

The truth is, I do not like its smell or taste and it’s more expensive than the juices: Besides, we do not drink it at home. My mother works and when she comes home from work, she wants to rest and watch TV.

Student No. 2 (male).

I do not drink coffee because I do not like it. I come from a farming family but in my house my mother suffers from stomach (problems) and cannot drink it. She makes coffee only when my dad asks her and only for him. I do not like it, besides it’s very expensive, for what I pay for a coffee I can have two juices or juice and some cookies.

Student No. 3 (female).

I do not drink it, I quit three years ago. Why quit? It’s very expensive, asking for a watered down coffee, what they ask for is not fair. Besides, it does not taste like coffee, and when they make it in a coffee machine, they inject more water, using steam.

Student No. 4 (female).

I used to, I do not drink anymore. I do not have time to do it the old way, and cafeterias, what they make is awful coffee, and charge the same as gourmet coffee. You know, nobody taught me, I learned on the street, in fact now I only take it when I have an exam or the time to make it the old fashion way.
Student No. 5 (male).

This was an older student, he said “Coffee is a drink to enjoy, today there is no time, but the most serious problem is that they want to charge ridiculous prices. Imagine a medium cappuccino costs between 2 and 3 dollars, and with a little more I can have breakfast, and when I get home I want to rest and at work, what they provide us is the coffee machine but not the coffee.”

Table VI is a brief summary of the in-depth conversations.

The results seem to coincide with the changes about the role of the parents and mother, the price/quality concern and the gender differences that are important because of the marketing implications discussed below.

Factor changes and possible marketing implications

Although the findings are preliminary, what seem to be in the process of change? Given the coincidences in parents, tradition, home, quality and substitutes supported by each of the two approaches and the differences in gender interest, six coincidences and implications for marketing strategic planning have been identified.

The first coincidence and change are in the parents and home roles. The parents’ influence on their daughters is evident in Costa Rica; daughters stay at home longer and parents are an influence on what they eat and drink. The male student is different, he leaves home earlier and coffee drinking is more associated with his needs to socialize with others, at work and in restaurants. For men coffee drinking has become a part of spending time with friends and that can occur anywhere.

The second change in the parent’s role is in the teacher role of the mother. If the family drinks coffee and the mother plays her role in teaching about coffee, then coffee is the family drink. If the mother works, she is still the teacher of eating and drinking habits but her choices about what products to use for food and drinks are influenced by convenience and price.

The third change is in the idea of socializing with friends in general and in the university as very important: In the qualitative analysis, coffee drinking was ratified as an occasion to socialize with friends. Socializing with the parents at home is important but other options are as important as the home, especially for men.

The fourth change is in the place where coffee is enjoyed. The differences in the preferred place of consumption are evident: the females’ preferred place is the home and for men the workplace and restaurants. Coffee drinking today is an occasion for spending time with

Table VI.

Summary of observations made by drinkers and non-drinkers

<table>
<thead>
<tr>
<th>Drinking</th>
<th>Male 1</th>
<th>Male 2</th>
<th>Female 3</th>
<th>Female 4</th>
<th>Female 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family drinks it</td>
<td>Mother taught</td>
<td>Family influence</td>
<td>Mother taught</td>
<td>Family drinks</td>
<td></td>
</tr>
<tr>
<td>Breakfast</td>
<td>Early age</td>
<td>Availability</td>
<td>Time limitation</td>
<td>Quality</td>
<td></td>
</tr>
<tr>
<td>Socialization</td>
<td>Grandmother</td>
<td>Energizing</td>
<td>Juices</td>
<td>Preparation</td>
<td></td>
</tr>
<tr>
<td>Time limitation</td>
<td>Quality preparation</td>
<td>Socialization</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energizing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Not drinking</th>
<th>Male 1</th>
<th>Male 2</th>
<th>Male 5</th>
<th>Female 3</th>
<th>Female 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family does not drink</td>
<td>Mother has no time</td>
<td>Expensive</td>
<td>Female 3</td>
<td>Machine objection</td>
<td></td>
</tr>
<tr>
<td>Mother has no time</td>
<td>Expensive</td>
<td>Time available</td>
<td>Expensive</td>
<td>Price</td>
<td></td>
</tr>
<tr>
<td>Expensive</td>
<td>Juices</td>
<td>Machine objection</td>
<td>Poor quality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Juices</td>
<td>Time available</td>
<td>Quality</td>
<td>Time available</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source: Survey</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Coffee culture amongst Costa Rican university students
friends and to some extent with parents, but it seems to depend on the time available and the place where they may be.

The fifth change is the concern for price and quality. It is evident that those interviewed like to drink high-quality coffee. The traditional way of making coffee is their “baseline,” and electric and espresso machines do not seem, thus far, to be popular.

The sixth change is in the gender difference that needs to be accepted and reconcile with the strategies for promoting coffee culture and consumption. The genders differ in their coffee-drinking habits and that needs to be understood and taken into account when promoting consumption.

The changes outlined previously are creating a different context that is affecting coffee consumption practices of university students. The possible impacts of the changes are in relation to the product, the media used for promotion, the place of consumption and the quality/price relation.

The product impact: instant coffee and sachets are options to the traditional ritual, but in countries accustomed to good coffee, these are not options that compete with “drip” coffee. A new high-quality, “rapid” method that provides quality and speed may be a viable business option.

The media impact: technologically aware university students expect options that are in accordance with their interest in the internet and the flexibility of purchasing options.

The place impact: promoting the consumption of good coffee for use at home, with an emphasis on breakfast, is a promising option. The take-away is a short-term solution, but a longer-term one may imply the integration of a family atmosphere, talks in shopping centers and games for children with coffee as a way to promote coffee consumption among youngsters.

The impact on price and quality: a general comment that coffee drinking outside the home is expensive and of questionable quality is something that needs to be addressed. A new culture is developing and is the result of the changes society is undergoing from an agricultural to a service-based economy. In a service economy, university students have limitations on their time because of work and study obligations, they have income restrictions and there is the availability of less expensive and more convenient substitute. Findings suggest that the social relations around drinking coffee will have to be adjusted to this emerging reality.

4. Conclusions

(1) The instrument and the combination of quantitative and qualitative research techniques prove satisfactory for the purpose.

(2) The students’ profile indicated that 70 percent drink and 30 percent do not drink coffee, 88 percent of the non-drinkers because they do not like it. The preferred substitute is juice. The usual time to drink coffee is breakfast. Of the respondents, 29 percent study and work, 70 percent are females and 95 percent are locals and 5 percent foreigners; the average age was 21.

(3) The derived factors were not correlated with each other and have a total variance of 0.693, with the culture aligned with the latent variables and associated tradition, providing additional validation to the latent variables.

(4) The general OLR, identify, tradition, parents, home, workplace and restaurants, suggests the idea that the service economy and, for present, tradition and parents have a role to play, particularly amongst the females.

(5) The final gender model reflects a situation of change since the preferred location for females to drink coffee is the home and for the males restaurants and workplace.
The females stay longer at home and the males move away sooner for traditional cultural reasons. This has to be considered in the development of marketing strategies for this segment.

(6) Marketing to a young educated consumer with computer knowledge, operating in a service industry-based society, where consumption is based on disposable income, quality consciousness and where coffee has a wide range of substitutes at attractive prices, is not easy and requires sound marketing strategies.

(7) The major changes of the new coffee culture are in parents and home roles, the teacher role of the mother, socializing with friends in general and at the university, the places to enjoy coffee, the concern for price and quality and the gender differences create the need for long-term strategic planning to influence young consumers to drink coffee.

(8) The coffee culture and consumption in a service economy may be a mixture of a “fast” ritual, good-quality coffee at a reasonable price, in a pleasant place, integrated with the new socialization centers and workplaces. The challenge is how to integrate family, work and new places to socialize while having a cup of coffee with the culture of drinking coffee in developing countries as their economies change from agriculture to services and industrialization.

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Instituto Nacional de Estadistica y Censos (2015), Anuario Estadistico, INEC, San Jose.


Further reading

ICAFE (2016), Nuestro Cafe: Regiones Cafetaleras, ICAFE, San Jose.


About the author
Dr Juan Aguirre received PhD, BS and MS Degrees from the University of Florida and a PhD Degree from the Cornell University also. Dr Aguirre is an Academic Doctor at the University of Costa Rica, a Research Professor and the Research Directorate at the Universidad Latina de Costa Rica, a Vice Rectory for Academics and the Former Dean of the Graduate of the Graduate School, CATIE, Costa Rica. Dr Aguirre is the author of the following books: Mercado Organicos de Costa Rica, Evaluación Económica y Financiera de Inversiones Agropecuarias y Emprendeduría Practica para Hacer Negocios. Dr Aguirre has published articles in international and Costa Rica journals; is a Consultant to FAO, IDB, IFAD, OASA, World Bank; has areas of interest: consumption and satisfaction, applied statistics, park management, student satisfaction, marketing of agricultural products and probiotics. Dr Aguirre has received international awards, Outstanding Reviewer British Food Journal in 2010 and 2013 and Zamorano Agricultural University Golden Pin. Dr Juan Aguirre can be contacted at: picoaguirre@gmail.com

Coffee culture amongst Costa Rican university students

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A profile of older green tea consumers in the USA

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Abstract
Purpose – The purpose of this paper is to identify the demographic and psychographic characteristics of older green tea consumers in the USA. By understanding this segment’s background, perceptions, and behaviors, health and marketing professionals can tailor messages to reach clients and consumers.

Design/methodology/approach – An online survey was completed in January 2014 with 1,335 older adult consumers (≥55 years old). Data were analyzed using descriptive statistics and binomial logistic regression.

Findings – More than half (n = 682, 51.2 percent) of respondents drank green tea. Most green tea consumers in this sample are college-educated and employed female home owners. The odds for green tea consumption are greater if a respondent is in good health, was informed about diet and health, or made a health-related dietary change in the past year. There are greater odds of consumption if the respondent is familiar with the relationship between drinking green tea and the reduced risk of cancer however, the importance of health statements on product labels are not predictive of consumption.

Research limitations/implications – This study was conducted in the USA and with older adults. Future research should explore characteristics of younger consumers, i.e. 18-54 years old.

Practical implications – Health educators, regulators, and marketing professionals may use this profile to tailor messages that speak to consumers and client’s values and motivations.

Originality/value – To the authors’ knowledge, this is the first profile of older adult green tea consumers in the USA.

Keywords USA, Consumer profile, Green tea, Older adult

Paper type Research paper

1. Introduction
There is a substantial interest among American consumers in managing their health through “prescriptive eating” – selecting foods based on their health benefits (Crowe and Francis, 2013; Reinhardt Kapsak et al., 2011). When assessing the value of food products, health-conscious American consumers consider more than the macro- and micro-nutrient content (Crowe and Francis, 2013) and believe that some foods offer benefits beyond basic nutrition (International Food Information Council, 2011). Food products that may have a potentially beneficial effect on health, when consumed as part of a healthy diet, are termed functional foods (FF) by the Academy of Nutrition and Dietetics (Crowe and Francis, 2013).

Shoppers consume functional products to achieve a variety of health goals including to maintain and improve their overall physical health and well-being (International Food Information Council, 2011), to lose weight, and to prevent or ameliorate specific health conditions (Reinhardt Kapsak et al., 2011). Most consumers can name a FF and its associated health benefit, unaided, (Reinhardt Kapsak et al., 2011) and are also guided to use them by registered dietitians (Berhaupt-Glickstein and Enrione, 2011).

Numerous studies have explored consumer characteristics associated with the acceptance of FFs including age, sex, education, socioeconomic status, among others (Gilbert, 2000; Pothoulaki and Chryssochooidis, 2009; Cox et al., 2011; Reinhardt Kapsak et al., 2011; Contini et al., 2015; Kraus, 2015; Schnettler, 2016). Research suggests that FF are most appealing to consumers who are healthy (Cox et al., 2011; Reinhardt Kapsak et al., 2011),
educated (Gilbert, 2000; Cox et al., 2011; Pothoulaki and Chryssochoidis, 2009; Evans et al., 2016; Contini et al., 2015), have higher socioeconomic status (Pothoulaki and Chryssochoidis, 2009), and who also take dietary supplements (Reinhardt Kapsak et al., 2011).

Research about the acceptance of FF and age is demonstrably less consistent. While some research has found that FF are accepted by women 35-54 years old (Pothoulaki and Chryssochoidis, 2009) and adults 30-70 years old (Gilbert, 2000), other studies have not found a relationship between age and acceptance (Pothoulaki and Chryssochoidis, 2009; Contini et al., 2015).

Green tea is a well-known FF (Reinhardt Kapsak et al., 2011), with the potential to reduce the risk of cancer (Seeley et al., 2005; Samavat et al., 2015; National Cancer Institute, 2015). Reports indicate there is increasing popularity of green tea in the beverage (Lee et al., 2010; Tea Association of the USA, Inc., 2014) and dietary supplement categories (Council for Responsible Nutrition, 2015). Its rise in popularity may relate to green tea’s potential to reduce the risk of cancer which is a common health concern among American consumers (International Food Information Council, 2011; Nielsen and Natural Marketing Institute, 2014).

In the USA, advancing age is a primary risk factor for two common forms of cancer, breast and prostate cancer. A 30-year old woman in the USA has a one in 227 chance of being diagnosed with breast cancer, while a 70-year-old woman has a one in 26 chance (National Cancer Institute, 2012). Similarly, men have the greatest risk of receiving a prostate cancer diagnosis between the ages of 55 and 74 years old (National Cancer Institute, 2015).

While older adults are not often the focus of educational or marketing campaigns (Sahyoun, 2002; Nielsen and BoomAgers LLC, 2012), they constitute a large portion of the US population (Colby and Ortmann, 2014) and are eager to learn about what they can do to stay healthy as they age (Centers for Disease Control, Strategic and Proactive Communication Branch, 2016). There are nearly 100 million consumers over the age of 49 (Nielsen and BoomAgers LLC, 2012) and by 2030, the US Census Bureau projects that one in five Americans will be 65 years or older (Colby and Ortmann, 2014). Older adults are receptive to new information and are known to adopt disease preventive behaviors (Nocella and Kennedy, 2012), such as reading food labels (Academy of Nutrition and Dietetics, 2011; Govindasamy and Italia, 1999) and taking dietary supplements (Balluz et al., 2000; Gray et al., 1996; Slesinski et al., 1995).

Since age is a risk factor for chronic disease, older American consumers (National Cancer Institute, 2015; National Cancer Institute, 2012) demonstrate interest in innovative strategies, such as prescriptive eating and FFs, to keep their healthcare costs low (Centers for Disease Control, Strategic and Proactive Communication Branch, 2016; Crowe and Francis, 2013). As label readers, one way that older consumers might learn about prescriptive eating for their health is through health claims, which can be found on food and dietary supplement product labels.

Health claims market FFs by describing the relationship between consuming a food or substance and its ability to reduce the risk of a disease or health-related condition (i.e. diet-disease relationship) (Food and Drug Administration, 2011). These claims are regulated by the US Food and Drug Administration and some claims, called qualified health claims (QHCs), also describe how much evidence there is for a diet-disease relationship, such as green tea and cancer (Food and Drug Administration, 2003).

QHCs aim to communicate the level of scientific support for the claim of a diet-disease relationship (Government Accountability Office, 2011) and hold the potential to improve public health. However, research suggests that QHCs confuse consumers, who misinterpret them as an indication of a product’s health, safety and quality (Berhaupt-Glickstein et al., 2014).

The purpose of this study is to identify demographic (e.g. education, marital status) and psychographic characteristics (e.g. values, lifestyles) (Hardcastle and Hagger, 2016) related to diet and health. The objective is to generate a profile of older green tea consumers in the USA, which may inform food and nutrition policy-makers, and marketers about this audience. A consumer profile may help educators, communicators and marketers...
to tailor audience-specific messages for public health and marketing campaigns as well as health claims, that may improve the clarity of messaging and help consumers achieve their health goals (Reinhardt Kapsak et al., 2011; Centers for Disease Control, Strategic and Proactive Communication Branch, 2016). This study hypothesizes that this segment of consumers can be characterized by:

1. the same sociodemographic variables associated with FF acceptance (see above);
2. perceptions of good health and nutrition knowledge; and/or
3. health-related behaviors such as supplement use and dietary change for health.

2. Methods
2.1 Sample
Participants who met the following criteria were included in the study: non-institutionalized adults, aged 55 years or older residing in the USA. Older adults were selected for study because they represent a large portion of the US population in size and purchasing power (Colby and Ortman, 2014; Nielsen and BoomAgers LLC, 2012), and are at increased risk of cancer (National Cancer Institute, 2012, 2015).

2.2 Procedure
An online survey was administered by GfK Custom Research, LLC (GfK) in January 2014. GfK used probability-based recruitment for a representative sample of the USA. The study was approved by the Institutional Review Board at Rutgers, The State University of New Jersey.

2.3 Questionnaire
An introduction screen informed participants of the study’s purpose, “This survey is designed to determine what Americans know and think about the health benefits of certain foods and dietary supplements. We are interested in what you currently know and feel, without using the internet or other resources to learn more about them. We are asking that you finish this survey in one sitting.” The next section asked questions about participants’ perceptions, beliefs and behaviors related to food and health. The participants were asked about their consumption practices of green tea as a beverage, not as a dietary supplement, and their reasons for consuming it in the past year. There were three subsequent survey sections that asked the participants about specific health claims. However, the focus of this study and its analyses are on the participants who consume green tea, and their reasons for doing so, and involves data collected prior to exposing the participants to health claims.

2.4 Demographic measures
Demographic measures were selected based on prior consumer research that identified them as predictive of general appeal and acceptance of FFs (Glanz et al., 2008). Other demographic measures were selected based on a conceptual framework about consumer purchase behavior of FFs with health claims (Wills et al., 2012).

Race/ethnicity, sex, education, age, household income, current employment status, home ownership, and marital status were collected prior to the current study, as part of the GfK panelist database (see Table I). Our sample of adults aged 55 years and older, encompass potential retirees, and therefore it was determined that traditional measures of employment and income might not accurately capture socioeconomic status. To account for this, home ownership was included as a proxy for long-term financial standing (Herbert et al., 2005).
2.5 Psychographic measures

The participants answered questions about their personal health, perceptions, and beliefs hypothesized to predict their odds of drinking green tea in the past year. Questions about personal health inquired about the participants’ health status and whether they had ever received a cancer diagnosis from their doctor. The participants also indicated how much they worry about their overall health and about becoming sick with cancer. Behavioral measures asked about dietary change in response to a health concern and dietary supplement use. The participants reported their self-assessed knowledge of diet and health (i.e. nutrition knowledge), their familiarity with the relationship between green tea and cancer, their reason(s) for drinking green tea, and the importance they placed on health statements found on the labels of food and supplement products (i.e. health claims) (see Table I).

2.6 Statistical analyses

Descriptive statistics were generated for all measures listed in Table I. Data were adjusted for non-response by withholding those case(s) from analyses. Consequently, some results

variable | Type | Scale
---|---|---
**Dependent variable**
Drank green tea | CB | 0 = No, 1 = Yes

**Independent variables**
Demographic
- Sex | CB | 1 = Female, 0 = Male
- Age | CO | 1 = 55-64, 2 = 65-74, 3 = 75+
- Race/Ethnicity | CN | 1 = white, 2 = black, 0 = other, 0 = Hispanic, 2 = 2+ races
- Education | CO | 1 = Less than high school, 2 = High school, 3 = Some college, 4 = Bachelor’s degree +
- Household income | CO | 1 = $0-$49,999, 2 = $50,000-$99,999, 3 = $100,000-$149,999, 4 = $150,000+
- Employment | CN | 1 = Working, 2 = Not working, 3 = Retired
- Marital status | CB | 1 = Married/partnered, 0 = Not married/partnered
- Home ownership | CB | 0 = Not owned, 1 = Owned
Psychographic
- Health status | I | 1 = Poor, 2 = Fair, 3 = Good, 4 = Very good, 5 = Excellent
- Health worry | I | 1 = Not at all, 2 = A little, 3 = Somewhat, 4 = Quite a bit, 5 = All the time
- Cancer diagnosis | CB | 0 = No, 1 = Yes
- Cancer worry | I | 1 = Not at all, 2 = Somewhat, 3 = Moderately, 4 = Very, 5 = Extremely
- Nutrition knowledge | I | 1 = Not informed, 2 = Somewhat, 3 = Fairly, 4 = Very, 5 = Extremely informed
- Familiarity | I | 1 = Not all familiar, 2 = Somewhat, 3 = Fairly, 4 = Very, 5 = Extremely familiar
- Importance of HC on nutrition labels | I | 1 = Not at all important, 2 = Somewhat, 3 = Important, 4 = Very, 5 = Absolutely essential
- Supplement use | O | 1 = Never, 2 = Less than 1 day/month, 3 = 1-3 days/month, 4 = 1-3 days/week, 5 = 4-6 days/week, 6 = Everyday
- Diet Δ for health | I | 1 = Not at all, 2 = A little, 3 = Somewhat, 4 = Quite a bit, 5 = All the time

Notes: “Type: C, Categorical; B, Binary; O, Ordinal; I, Interval; in the past year; white, black, 2+ races = non-Hispanic; other = non-Hispanic Asian/Pacific Islander, Native American; 2+ Races = self-identified as more than two races; familiarity = relationship between green tea and reduced cancer risk; HC, health claim

Table I. Variable description
are presented with an adjusted sample size (n). Reference groups were determined for ordinal variables (see note section in Table VI for reference groups). Binomial logistic regression tested demographic and psychographic variables as single regressors to understand their predictive value of green tea consumption in the past year. Three models were built to create a parsimonious predictive model of the odds that an older adult had consumed green tea in the past year. First, demographic variables were tested as single regressors and then, significant predictors were entered into a logistic regression model using hierarchical entry to understand their predictive contribution to the odds of drinking green tea. Second, psychographic variables were tested using the same procedure as demographic variables. Third, a final hierarchical binomial logistic regression determined the significant demographic and psychographic predictors of green tea consumption. p < 0.05 was considered statistically significant. All analyses were conducted using SPSS, version 22.0 (SPSS Inc., Chicago, IL, USA).

3. Results

3.1 Sample description

A total of 2,219 participants were recruited and 1,335 completed the survey for a response rate of 60 percent. This sample of older adults is predominantly 55-75 years old, white, and married. Most participants are retired home owners with an annual household income of less than $100,000 (Table II). The study sample is nationally representative of the USA. Most participants report they are in good or very good health. Still, over 60 percent worry somewhat or a little about their health and in the past year, their worry led to a health-related dietary change (Tables III and IV). Fewer than 20 percent report they received a cancer diagnosis from their doctor and only 10 percent are very or extremely worried about becoming sick with cancer (Table III).

Most participants report they are fairly or very knowledgeable about diet and health, and are familiar with green tea’s potential to reduce the risk of cancer (Table V). Even so, in the past year just over 50 percent of participants drank green tea (n = 682, 51.2 percent). Approximately half of the green tea consumers indicated their reason for consuming it (n = 342). Of those, two-thirds enjoy its taste (n = 216, 63.3 percent) while fewer drank green tea to reduce their risk of cancer (n = 31, 9.1 percent), for other health reasons (n = 70, 20.5 percent), or other reasons not related to health (n = 87, 25.4 percent).

In the past year, most respondents took a daily dietary supplement. The participants consider health claims on supplement labels as important or very important, and health claims on food labels as important or somewhat important (Tables III and IV).

3.2 Green tea consumers

Overall, nearly three-quarters (70.8 percent) of green tea consumers self-identify as white. However, univariate analyses show that a smaller percentage of white respondents (47.1 percent) consumed green tea in the past year than either Hispanic (65.1 percent) or black (61.6 percent) consumers. White consumers comprise a greater portion of green tea drinkers overall since they represent a larger proportion of the population.

Compared with those who did not consume green tea in the past year, a greater percentage of tea drinkers are employed, female, home owners, with an annual income of more than $100,000 and hold a bachelor’s degree or more (Table II). More green tea consumers take a dietary supplement(s) most days of the week, and made a dietary change in response to a health worry in the past year (Table IV). In addition, a greater proportion of green tea consumers are very or extremely informed about diet and health and consider health claims on food and dietary supplement products very important or absolutely essential when making a purchase decision (Tables III-V).
3.3 Predictors of green tea consumption

Race/ethnicity, sex, education, income, home ownership, and employment are statistically significant predictors of consuming green tea. Marital status and age are not predictive of green tea consumption.

A hierarchical model of significant demographic predictors on the odds of green tea consumption was statistically significant, \( \chi^2 (10) = 101.680, \ p < 0.0001 \). The model explains 9.8 percent (Nagelkerke \( R^2 \)) of the variance and correctly classifies 61.5 percent of cases. Sensitivity is 66.8 percent, specificity is 55.9 percent, positive predictive value is 61.8 percent, and negative predictive value is 61.2 percent. In this model, race/ethnicity, sex, education, and home ownership remain significant.

There are greater odds that home owners and women drank green tea in the past year than non-home owners or men. The odds that participants are green tea consumers are two
to three times greater if they are black, Hispanic, or from another non-Hispanic race/ethnicity than if they are white. Also, the odds of consuming green tea increases with higher education. That is, there are 3.951 times greater odds of drinking green tea in the past year if participants hold a bachelor’s degree or more advanced degree than those with less than a high school education (see Model 1 in Table VI).
Four of the seven psychographic measures are statistically significant. The measures that do not increase the odds of consuming green tea are: a past cancer diagnosis, worry about becoming sick with cancer, or worry about general health.

A hierarchical model of the four psychographic predictors was significant, $\chi^2(7) = 57.003, p < 0.0001$. The model explains 14.4 percent (Nagelkerke $R^2$) of the variance in predicting consumption of green tea and correctly classifies 63.4 percent of cases. Sensitivity is 74.1 percent, specificity is 50.0 percent, positive predictive value is 65.0 percent, and negative predictive value is 60.7 percent. Five of the seven variables significantly contribute to the odds of green tea consumption: health status, nutrition knowledge, having made a dietary change for a health-related concern, importance placed on health claims on food labels, and familiarity with the relationship between green tea and cancer.

The odds of consuming green tea increases by one and half times with each step increase in health status, and with familiarity of the green tea cancer relationship. That is, the greater the self-described health status and the more familiar participants report they are with the green tea cancer relationship, the greater the odds that they drank green tea in the last year. Moreover, the odds are five times greater that participants drank green tea if they are extremely informed about nutrition, or made a health-related dietary change in the past year, than if they are not well-informed or had not made a dietary change (see Model 2 in Table VI).

The final model was generated with a two-step process. Step 1, the four demographic measures were entered into the model, followed by Step 2, the four psychographic variables. The model was statistically significant, $\chi^2(11) = 118.110, p < 0.0001$. The model explains 22.1 percent (Nagelkerke $R^2$) of the variance and correctly classifies 67.6 percent of

| Table V. | Psychographic measures ($n$ (%) ) related to nutrition and health awareness for participants who did and did not consume green tea |
|-----------------|-----------------|-----------------|-----------------|-----------------|
|                | Yes | No | Yes | No |
| N (%) | n (%) | M, SD | n (%) | M, SD |
| Nutrition knowledge | 3.40, 0.781 | 2.97, 0.935 | | |
| Extremely informed | 77 (5.8) | 47 (62.7) | 28 (37.3) | |
| Very | 412 (31.0) | 258 (62.8) | 153 (37.2) | |
| Fairly | 571 (43.1) | 299 (52.5) | 270 (47.5) | |
| Somewhat | 231 (17.4) | 76 (33.0) | 154 (67.0) | |
| Not informed | 36 (2.7) | 1 (2.8) | 35 (97.2) | |
| Familiarity | 2.14, 1.13 | 1.62, 0.83 | | |
| Extremely familiar | 10 (1.6) | 8 (72.7) | 3 (27.3) | |
| Very | 45 (7.0) | 41 (61.1) | 4 (8.9) | |
| Fairly | 112 (17.3) | 72 (54.3) | 40 (45.7) | |
| Somewhat | 174 (27.0) | 86 (50.0) | 86 (50.0) | |
| Not familiar | 303 (47.0) | 131 (43.5) | 170 (56.5) | |
| Importance of health claims on: supplement labels | 3.36, 1.19 | 3.09, 1.18 | | |
| Absolutely essential | 169 (16.8) | 118 (69.4) | 52 (30.6) | |
| Very | 276 (27.3) | 147 (53.5) | 128 (46.5) | |
| Important | 276 (27.4) | 158 (57.7) | 116 (42.3) | |
| Somewhat | 206 (20.4) | 105 (51.0) | 101 (49.0) | |
| Not important | 82 (8.2) | 36 (43.9) | 46 (56.1) | |
| Food labels | 3.08, 1.16 | 2.60, 1.10 | | |
| Absolutely essential | 108 (8.2) | 79 (73.1) | 29 (26.9) | |
| Very | 296 (22.3) | 184 (62.0) | 113 (38.0) | |
| Important | 373 (28.1) | 187 (50.4) | 184 (49.6) | |
| Somewhat | 374 (28.2) | 165 (44.6) | 205 (55.4) | |
| Not important | 175 (13.2) | 61 (35.1) | 113 (64.9) | |

Drank green tea last year? | Yes | No |
<table>
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<tbody>
<tr>
<td>N (%)</td>
<td>n (%)</td>
<td>M, SD</td>
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<tr>
<td>682 (51.2)</td>
<td>649 (48.8)</td>
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</table>

Note: $M$, mean

Older green tea consumers in the USA

2939
cases. Sensitivity is 70.0 percent, specificity is 65.1 percent, positive predictive value is 68.6 percent and negative predictive value is 66.6 percent. Six of the eight predictor variables are statistically significant: race/ethnicity, sex, health status, nutrition knowledge, worry that led to dietary change(s), and familiarity with the green tea cancer relationship (see Model 3 in Table VI).

The odds are nearly three times greater that a participant drank green tea if he or she is of black or Hispanic. There are also a 1.5 greater odds that home owners and women consume green tea than non-owners or men. The more familiar with the green tea cancer relationship and the greater the self-described health, the greater the odds that participants consume green tea, 1.96 and 1.56, respectively (see Model 3 in Table VI).

4. Discussion
To our knowledge, this is the first study to explore the demographic and psychographic characteristics of older green tea consumers in the USA. The odds are greater that a woman...
who identifies as black, Hispanic, or another non-Hispanic race/ethnicity consumes green tea. She believes that she is informed about diet and health, and is familiar with the green tea cancer relationship. She reports good health and has made a dietary change in the past year to address a health-related concern.

These results are similar to other findings that identified predictors of healthy behavior, apart from race/ethnicity. Whereas nutrition-related health behaviors have been associated with Whites (National Research Council (US) Panel on Race, Ethnicity, and Health in Later Life, 2004; Chen et al., 2011), in this study, the odds of green tea consumption are greater if a person is black, Hispanic, or from another non-Hispanic or non-white race/ethnicity.

Interestingly, familiarity with the green tea cancer relationship is a strong predictor of green tea consumption, but the importance that participants place on health claims found on food and supplement labels is not. While half of the tea consumers are familiar with the relationship between green tea and cancer, they likely did not learn about it from a health claim. Previous research surveyed labels of green tea products and found that none included a health claim about the green tea cancer relationship (Hooker, 2008). This suggests consumers learned about this relationship from another information source such as “health-conscious raising” marketing strategies (Walker Naylor et al., 2009) or advertisements (Mazis and Raymond, 1997; Abbatangelo-Gray et al., 2008).

This research provides a profile of older green tea consumers living in the USA and is intended to be useful to a variety of stakeholders. This profile may be useful for marketers who want to craft messages that better resonate with clientele who drink green tea as a way to increase market share, or try to expand their potential clientele by targeting messages to those who are not already drinking green tea. Since “baby boomers” are projected to control 70 percent of disposable income by the end of 2017 (Nielsen and BoomAgers LLC, 2012), this profile may contribute to “fine-grained segmentation” and market success (Lu, 2015).

Educators may also find these results useful. Although the focus of this profile is on green tea consumers, there are similar characteristics with consumer acceptance of FFs and health-related behaviors. Similar to other research findings, green tea consumers in this study are more likely to be female and educated, having attended some college or more (Gilbert, 2000; Cox et al., 2011; Pothoulaki and Chryssochoidis, 2009; Evans et al., 2016; Contini et al., 2015), report good or very good health (Cox et al., 2011; Reinhardt Kapsak et al., 2011) and take dietary supplements on a daily basis (Reinhardt Kapsak et al., 2011). It is likely that older adults will continue to seek ways to manage their healthcare spending, and prescriptive eating and FFs offer tangible opportunities to do so (Crowe and Francis, 2013).

This profile may support nutrition and health educators and provide context for presentation and program design for older adults in settings such as outpatient hospital departments or assisted living facilities. Tailored messages are preferred by older adults because they speak to their values and may inspire action in a motivated audience (Glanz et al., 2008; Centers for Disease Control, Strategic and Proactive Communication Branch, 2016).

Finally, this profile may inform regulators and policy makers about older consumers who are willing to try innovative strategies to manage their health, including reading labels and health claims on food and supplement products. While it is reasonable that few green tea products bear health claims about its relationship to cancer (Hooker, 2008) since they confuse consumers (Berhaupt-Glickstein and Hallman, 2017), the current study indicates that health claims are generally important to older consumers with roughly 30-40 percent who consider them when buying a new product (see Table V). This profile than may provide baseline information to regulators and scientists about the target audience of product claims and green tea cancer QHCs.
5. Conclusions

Understanding the older green tea consumer is important for health educators, regulators, and marketing professionals who tailor messages to help clients and consumers to successfully attain their health goals (Glanz et al., 2008; Reinhardt Kapsak et al., 2011). Our study demonstrates that these consumers in the USA, “baby boomers,” are knowledgeable about nutrition, including the green tea cancer relationship, and are engaged in behaviors to maintain their health as they age.

References


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Food professionals’ opinions of the Food Studies curriculum in Australia

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Abstract

Purpose – The purpose of this paper is to investigate the food system professionals’ opinions of a new senior secondary school food literacy curriculum named Victorian Certificate of Education Food Studies in Victoria, Australia.

Design/methodology/approach – A purposive sample of 34 food system professionals from different sub-sectors within the Australian food system was interviewed individually in late 2015 and early 2016. Interviews were analysed using the template analysis technique.

Findings – Most participants appreciated the extensive coverage of food literacy aspects in this new curriculum. However, many suggested amendments to the curriculum including pay less emphasis on food history-related topics and pay more focus on primary food production, nutrition awareness and promotion, and food security, food sovereignty, social justice, and food politics.

Practical implications – A well-structured, comprehensive secondary school food literacy curriculum could play a crucial role in providing food literacy education for adolescents. This will help them to establish healthy food patterns and become responsible food citizens. The findings of this study can be used to modify the new curriculum to make it a more comprehensive, logical, and feasible curriculum. Moreover, these findings could be used to inform the design of new secondary school food literacy curricula in Australia and other countries.

Originality/value – The exploration of perspectives of professionals from a broad range of food- and nutrition-related areas about school food literacy education makes this study unique. This study highlights the importance of food professionals’ opinions in secondary school food-related curricula development.

Keywords Australia, Food literacy, Secondary school, Food Studies curriculum, Food system professionals

Paper type Research paper

Introduction

Promotion of the public’s interest in food and the food system (i.e. food production, food processing, food distribution and marketing, food consumption, and waste management) is timely (Colatruglio and Slater, 2014; Gallegos and Vidgen, 2010). Recently the concept of “food literacy” has emerged in an attempt to re-define interactions people have with the food system (Colatruglio and Slater, 2014; Gallegos and Vidgen, 2010). In the literature, food literacy has long been considered as a component of health literacy. Recently Vidgen and Gallegos (2014) have defined food literacy as “the scaffolding that empowers individuals, households, communities or nations to protect diet quality through change and strengthen dietary resilience over time. It is composed of a collection of inter-related knowledge, skills and behaviours required to plan, manage, select, prepare and eat food to meet needs and determine intake”. However, some others have acknowledged that the broader aspects such as the environmental, social, cultural, economic, historical, employment aspects of food system should be included in the food literacy and they argue that health is only one among these aspects. For an example, Cullen et al. (2015) suggest, “Food literacy is the ability of an...
individual to understand food in a way that they develop a positive relationship with it, including food skills and practices across the lifespan in order to navigate, engage, and participate within a complex food system. It’s the ability to make decisions to support the achievement of personal health and a sustainable food system considering environmental, social, economic, cultural, and political components. In accordance with this broad approach, the concept of food literacy includes: the food system from production to waste, the effect of food on health and well-being; the wider context of the food system including social, economic, cultural, environmental, and political factors; and the skills and behaviours required to plan, manage, select, prepare, and eat food (Bellotti, 2010; Cullen et al., 2015; Fordyce-Voorham, 2015).

Food literacy is important for adolescents in many ways. During adolescence, habitual food patterns, which have short- and long-term health consequences, are established (Mikkilä et al., 2004; Nelson et al., 2008; Story et al., 2008). Food literacy helps adolescents to establish healthy food consumption patterns (Graham et al., 2013; Larson et al., 2006; Thorpe et al., 2014). Moreover, adolescents need to be assisted to prepare for their future independent lives (Lichtenstein and Ludwig, 2010). The teaching of food literacy is a way of enabling adolescents to become knowledgeable and skillful about what to do with food to maintain their own health and that of others (Colatruglio and Slater, 2014). Furthermore, food literacy deals with broader aspects of the food system including its social, economic, cultural, environmental, and political contexts (Cullen et al., 2015). Potentially, this enables adolescents to be informed citizens who can exert positive influences on the food system.

During the late industrial revolution, home economics was introduced to the school curriculum as a way of improving dietary patterns and living conditions (Pendergast, 2001). Later on the vision of home economics became broader and a health component was incorporated into it (Pendergast, 2008). Certain components of food literacy (i.e. food and nutrition knowledge, food planning, and food preparation skills) have been taught to adolescents in schools through home economics or related subjects for over 100 years (Grundy and Henry, 1995; Lichtenstein and Ludwig, 2010; Pendergast, 2008). More recently, the global increase in the prevalence of obesity and non-communicable diseases, combined with poor dietary patterns and lack of food preparation skills, has rekindled interest in the importance of home economics and broader food and nutrition education in secondary schools (Lichtenstein and Ludwig, 2010; Pendergast et al., 2011). Many curricula, however, are driven by health interests and are focussed mainly on nutrition knowledge and food preparation skills (Engler-Stringer, 2010; Lang and Caraher, 2001; Larson et al., 2006), to the exclusion of the broader aspects of food. Clearly, adolescents should have nutrition knowledge and food preparation skills which are often neglected in the contemporary society (Lichtenstein and Ludwig, 2010; Pendergast and Dewhurst, 2012; Savige et al., 2007). However, incorporation of the broader aspects of the food system in school education will allow students to explore, and question their food system (Robertson and Scheidler-Benns, 2016) and make wise decisions over their food choices (Cullen et al., 2015; Ronto et al., 2016b).

Until now there have been few secondary school food literacy education programs which cover an exposition of the food system. For example, the revised Ontario Family Studies learning area has included some broad food literacy areas (Ontario Ministry of Education, 2013). These innovations deal with multiple aspects of the food system in additional to the more domestic, health focussed areas in traditional home economics. These broad curricula recognise the importance of food not only for individual and family health, and well-being but also economic, social, and environmental sustainability. As such they are applicable to all cultures and countries.

Over the last two decades, secondary school students across Australia have been taught food and nutrition knowledge, and food preparation skills through elective subjects such as “home economics”, “health and physical education”, and “food technology” (Australian
These subjects, however, only cover the health domain of food literacy and focus on individual life skills. Until now, broader aspects of food and food systems have not been integrated into a single Food Studies subject in secondary or senior secondary school education in Australia. From 2017, a new elective curriculum named Victorian Certificate of Education Food Studies (Food Studies) is offered to students in years 11 and 12 in Victorian schools (Victorian Curriculum and Assessment Authority, 2016). This curriculum was designed and approved by the Victorian Curriculum and Assessment Authority (VCAA) in 2015 and it is the first attempt at incorporating broad aspects of food literacy in Australian secondary school education. It has four units and eight study areas (Table I) (Victorian Curriculum and Assessment Authority, 2016).

Food and nutrition education efforts around the world have recognised the influence of various stakeholder groups in food and nutrition curriculum development (Bindler et al., 2012; Cunha et al., 2000; Perry et al., 1996). Previous school food and nutrition education-related studies investigated perspectives of different groups of stakeholders. For example, in England, Rutland and Owen-Jackson (2015) explored the views of stakeholders interested in school food technology education to develop a conceptual framework to modernise the secondary school food technology curriculum. In Australia, in 2011, Pendergast and Dewhurst (2012) investigated home economics professionals’ opinions of the role of home economics in developing food literacy. In another Australian study, home economics teachers’ views of the importance of the food skills they teach in secondary schools were investigated (Fordyce-Voorham, 2016). Recently, in Australia, qualitative and quantitative investigations were carried out by Ronto et al. (2016a, b, 2017) to explore home economics teachers’ and adolescents’ views of secondary school food literacy education.

Food system professionals are one group of stakeholders, who can provide valuable insights into food-related curriculum design and implementation process (Aksoydan and Mizikaci, 2015; Gussow and Contento, 1984; Pan Canadian Joint Consortium for School Health, 2010; Trexler et al., 2000). Most often these professionals have general and often specific expertise in the subject matter and are familiar with various aspects of the food system (Aksoydan and Mizikaci, 2015; Trexler et al., 2000). Moreover, they are highly aware of the career, training, and higher education opportunities available for young people in the food-related areas and could potentially be future employers or tertiary educators of the

<table>
<thead>
<tr>
<th>Units and study areas</th>
<th>Main content</th>
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<tr>
<td><strong>Food origins</strong></td>
<td>Origins and cultural roles of food</td>
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<tr>
<td>Food around the world</td>
<td>History and culture of food in Australia</td>
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<td>Food in Australia</td>
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<td><strong>Food makers</strong></td>
<td>Primary food production, food processing and manufacturing, retail and food service sectors</td>
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<td>Food industries</td>
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<td>Food in the home</td>
<td>Domestic and small-scale food production</td>
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<td><strong>Food in daily life</strong></td>
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<td>The science of food</td>
<td>Patterns of eating in Australia, influences on the food consumption</td>
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<td>Food choice, health and well-being</td>
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<td><strong>Food issues, challenges and futures</strong></td>
<td>Australian and global food systems-related issues</td>
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<td>Environment and ethics</td>
<td>Food information and misinformation</td>
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<td>Navigating food information</td>
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**Table I.** VCE Food Studies curriculum units, study areas, and main content
senior secondary school students (Aksoydan and Mizikaci, 2015). Accordingly, it is important that their views and advice are taken into consideration during the design and implementation of any new food-related curriculum.

So far, the opinions of a wide range of food system professionals have not been solicited in the development of the Food Studies curriculum. Therefore, this qualitative study was undertaken to explore food system professionals’ views of the new curriculum. The VCAA has decided to keep the new curriculum as a living document, which can be continually edited and updated over the next few years. Therefore, the findings of this study could provide curriculum design and implementation bodies with new insights into future revisions of this curriculum. Moreover, these findings could be applied in designing or modifying secondary school food literacy curricula across Australia and in other countries.

Methods

Design
A qualitative research design was adopted to gain a detailed understanding of food system professionals’ views about school food literacy education in general and also specifically about the content of the new “Food Studies” curriculum (Harris et al., 2009; Swift and Tischler, 2010).

Participants
Food system professionals from across the Australian food system were recruited; including food production, food processing and distribution, food marketing, food movements, food service, and education and public service sectors, to elicit a range of perspectives on senior secondary school food literacy education (Harris et al., 2009). Potential participants were identified through discussion with the second and third authors and their colleagues. These people were at managerial level or above with several years of experience in food and nutrition fields (Vidgen and Gallegos, 2014). An invitation letter and a plain language statement were e-mailed to the potential participants. At the end of each interview, the participants were asked to recommend other food system professionals who could be approached to be interviewed (snowball sampling) (Marshall, 1996; Patton, 1990).

Altogether 52 professionals were invited and 34 agreed to participate. No new themes had emerged at the 30th interview (i.e. data saturation was achieved) (Marshall, 1996; Mason, 2010; Trotter, 2012). However, the remaining participants who agreed to participate were also interviewed to confirm the findings and to get a balanced perspective (Draper and Swift, 2011; Harris et al., 2009). These 34 professionals were from different sub-sectors within the Australian food system (food production sector – four, food processing and distribution sector – four, food marketing sector – five, food movements sector – seven, food service sector – four, and education and public service sector – ten) (mainly from Victoria and few participants from other states of Australia).

Interview guide
An interview guide with a series of open-ended questions was developed to generate rich, detailed information (Harris et al., 2009) and to use the allocated interview time efficiently (Bernard, 2006). The interview questions relevant to this paper are shown in Box 1. The face validity of the interview guide was established by pre-testing it with two food system professionals, who were familiar with qualitative research methods.

Data collection
Semi-structured interviews were conducted in this study (Bernard, 2006). In total, 21 individual face-to-face interviews and 13 phone interviews were conducted by the first author. Two weeks before the scheduled interviews, a concise version of the new Food Studies curriculum was sent
to the participants. Again, a few days before the interview, the interview reminder e-mail was sent to the participants along with the curriculum document. At the commencement of each interview, the interviewer confirmed that the participants had read the curriculum and then a printed version of the curriculum was given to refer during the interview. Each participant was given a chance to clarify any questions or doubts they had with regards to curriculum before the interview. Each interviewee was asked to give their written consent and permission to audio-record the interview. The mean interview duration was 21 minutes; they ranged in duration from 7 to 72 minutes. The participants’ responses to the questions about the new Food Studies curriculum are presented in this paper.

Ethics approval
Ethical approval for this study was granted by the Deakin University Health Ethics Advisory Group (HEAG-H 109_2015).

Data analysis
The interviews were transcribed verbatim using a professional transcription service. Transcripts were sent to 23 participants who wished to review their transcripts and any changes made by them were incorporated into the analysis. The qualitative data analysis software QSR NVivo 10 (QSR International Pvt Ltd 2010) along with manual coding was used to establish themes.

The data analysis followed the “template analysis” technique. Adhering to this technique, an initial template was developed (King, 2004, 2014). The template was started with some ‘a priori’ codes: most important units, less important units, modifications for the curriculum, and overall views. After developing the initial template, the full set of transcripts was read, modifications were made to ‘a priori’ codes and new codes were added as required. This technique was used as this can be used to analyse textual data obtained from research, which assumes that there will be various explanations for any given issue depending upon the position of the informants and the research as in the present study (i.e. the contextual constructivist position) (King, 2014). Moreover, the use of ‘a priori’ themes helped to accelerate the initial phases of data coding (King, 2014). The final template comprising themes and subthemes is described in the “Results” section. Verbatim quotes are used below to illustrate the major findings.

To confirm the findings and reduce bias in their interpretation, inter-rater checking (the authors independently coded a sample of transcripts and compared the coding for agreement) (Armstrong et al., 1997) and peer-debriefing (the authors discussed findings with two colleagues outside the research group) were conducted (King, 2004, 2014; Morse et al., 2002).

Results
The themes and the accompanying subthemes are described below.

Box 1. Interview questions related to the new VCE Food Studies curriculum

<table>
<thead>
<tr>
<th>Interview guide – Questions about the new curriculum</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) What are the most important topics/areas in the new VCE Food Studies curriculum?</td>
</tr>
<tr>
<td>Probe: Why do you think they are most important?</td>
</tr>
<tr>
<td>(2) What are the least important topics/areas in the new curriculum?</td>
</tr>
<tr>
<td>Probe: Why do you think they are least important?</td>
</tr>
<tr>
<td>(3) What should be added or deleted or modified in the new curriculum?</td>
</tr>
<tr>
<td>Probe: Why do you think those sections/topics to be added/ deleted or modified?</td>
</tr>
<tr>
<td>(4) Do you have any general comments about this curriculum or school food and nutrition education?</td>
</tr>
<tr>
<td>(5) Who else would you recommend I interview for this research?</td>
</tr>
</tbody>
</table>

Food professionals’ opinions

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Theme 1. Positive evaluation of the curriculum

Comprehensive and exciting curriculum. The new curriculum was viewed favourably by most participants. The majority (24) used terms such as comprehensive, exciting, interesting, positive, timely, important, good, and logical in expressing their views about the overall curriculum. Moreover, 13 participants appreciated the broad food system approach in this curriculum over narrow food and nutrition approach. They believed that students would get a strong understanding of food and food systems through food system approach. Furthermore, they mentioned that this understanding would help students to identify and criticise the influences on, and impacts of, the modern food production, processing, distribution, consumption, and waste, which ultimately help them to take wise decision over food:

I think that’s what the strength of this course is, it’s not just looking at food pyramids and all the rest of it. It’s a very broad, multi-disciplinary approach to food, so I think it’s good (P3: Researcher/Author; Food movement sector).

Importance of units. Many participants (16) believed that all four of the proposed units were important. According to the high frequency of comments, the unit considered to be the most important was “Food issues, challenges and futures” (20 participants) followed by “Food in daily life” (17 participants), “Food makers” (15 participants) and finally “Food origins”.

In total, 13 participants commented on the “Environment and ethics” study area of “Food issues, challenges and futures” unit. In particular, they liked the inclusion of equitable access to food and food security, environmental sustainably, and the environmental effects of food production. The participants gave many reasons for the importance of including these topics in this curriculum. They mentioned that there is a lack of awareness among citizens of the effects of the food system on the environment and they thought this could be used as a perfect opportunity to discuss food system-related issues with students. Moreover, the participants mentioned that these topics would help to make students understand their own role as citizens in society and citizens as to what they can do to make a difference to the food system. For example:

[…] There’s very little public awareness of those issues [environmental sustainability] currently. I personally think that it’s hugely important that, it is a part of this curriculum (P23: Research Fellow; Food movement sector).

“Food in daily life” unit covers the science of food, physiology of eating and digestion, and food choices for healthy living topics and was viewed by nine participants as important:

I think the science of food, that’s the kind of scientific underpinnings of nutrition and health and wellbeing (P7: Nutritionist/Lecturer; Food movement sector).

Nine participants saw the “Food industries” study area of “Food makers” unit as an opportunity to provide information about the food system. The participants mentioned that there is a lack of understanding of where and how food is grown or produced among the general public as well as among students. They thought that this study area could be used as an opportunity to link citizens back to primary food production as well as food distribution. Moreover, ten participants appreciated the recipe development, and food preparation sections of “Food in the home” study area. The participants mentioned that this study area has the potential to increase student interest on home cooking as well as understand, and appreciate biological and cultural differences in dietary requirements. For instance:

Knowing the industry itself, knowing the whole supply chain, where things are grown, how they’re grown, and how they’re transformed into food stuff, how they’re distributed through into the retail environment, and how they’re picked up in the home is absolutely important (P10: Lecturer; Marketing sector).
Five participants appreciated the presence of the global food systems in the “Food around the world” study area. They mentioned that this could help students to understand the development of food systems around the world, the historical origins of foods, and evolution of food over time. Six participants praised the inclusion of indigenous foods and food patterns in the “Food in Australia” study area. They mentioned that there is a lack of understanding of indigenous food ingredients and their dietary patterns in contemporary Australian society. They believed that this study area could be used to enhance students’ interest in Indigenous food practices. Moreover, these participants highlighted that this study area could be a good way to expose students to the migration history of Australia and to discuss how the food culture of Australia has been shaped by migrants’ food cultures:

I think it’s important for students to know where the different cuisines come from, where the different ingredients come from, what the historical origins of some of those foods are, and then I think importantly, what Indigenous food in Australia is […] (P10: Lecturer; Marketing sector).

Theme 2. Concerns about the curriculum

Doubts about the feasibility of delivery. Six participants doubted the feasibility of teaching the curriculum in any depth over a two year period. For example:

[…] is it feasible to cover so much in one course of study? I have no idea how it might be altered to make sure that everything could be looked at in this sort of depth that it needs (P11: Dietitian/Lecturer; Education and public service sector).

Some other concerns were expressed. Four participants stressed the importance of linking the different units and avoiding overlaps between them. The important roles of teachers, teaching guides, and teaching and learning tools in the successful delivery of this curriculum were mentioned by four participants.

Theme 3. Proposed amendments to the curriculum

Modifications to Food origins unit. Eight participants thought this unit would not stimulate the interest of the students. The majority of them suggested placing less emphasis on this unit, reducing the teaching devoted to it, and linking the topics in this unit to those in the other three units:

[…] the history of it [Food origins], perhaps doesn’t need the same level of coverage as the other areas. That’s one area that, I think could perhaps reduce down a little bit (P11: Dietitian/Lecturer; Education and public service).

Three participants suggested more discussion of indigenous food culture in this unit to increase students’ awareness of indigenous foods and give them an opportunity to try these foods in their daily life.

Modifications to Food makers unit. Eleven participants stressed the importance of making students more conscious about primary food production and suggested discussion about growing foods, farmers’ roles and their problems, and different types of food production such as genetically modified crops, community gardens, organic farming, and small-scale domestic food growing. For example:

I would love everybody to understand the link between good farming or regenerative farming, and human health and environmental health (P8: Fruit Farmer; Food production sector).

Furthermore, six participants believed that innovation and marketing related topics should be introduced:

I think the innovation part is interesting and essential (P30: Research Director; Marketing sector).
Other suggestions for this unit included: inclusion of processes, places, guidelines, and standards associated with food processing and distribution (mentioned by five), and giving more weight to domestic cooking, and related practical activities (mentioned by four).

*Modifications to Food in daily life unit.* Seven participants believed that health and nutrition awareness and promotion should be included in “Food choice, health and well-being” study area. They stressed that students should be taught about the public health burden of poor diets and the role of current dietary patterns in non-communicable diseases such as diabetes, cardiovascular diseases and obesity. For example:

> […] learning a bit about the role that food has played, and will continue to play in our public health in terms of the current diseases that we’re experiencing in Australia (P13: Dietitian/Nutrition Programme Manager; Education and public service sector).

Four participants suggested giving more emphasis to the nutritional aspects of food. They mentioned that students need to be given more guidance on which food groups should be eaten to achieve good health and help them differentiate between unprocessed and processed food. Three suggested the inclusion of food trends, fad diets, and their effects on health.

*Modifications to Food issues, challenges, and futures unit.* Seven participants suggested pay more emphasis about food security, food sovereignty, social justice and food politics in “Environment and ethics” study area. They gave many reasons to show the importance of these topics including, wastage of food at various stages of the food chain, pressure for certain countries to grow particular types of crops which are not necessarily relevant to their local cuisines, increasing world population and hunger issues, and the dominance of supermarket chains in food retailing:

> […] It could also be worth exploring ideas of food sovereignty. Because food security often comes down to questions of do we have enough, rather than questions of is this the food that we want? […] (P20: Lecturer; Food service sector).

There were some other suggestions for this study area. Six participants wanted the environmental effects of modern food production and environmentally sustainable food production methods to be included. Four participants suggested discussing issues such as the impacts of intensive agriculture, and, welfare of farm labourers and animals. Three participants suggested the inclusion of the effects of climatic changes on food systems.

Moreover, six participants suggested the inclusion of health star ratings (an Australian food label guidance system), nutrition information panels, and the scientific rationale behind those schemes in the “Navigating food information” study area to facilitate students to make wise decisions in food selection.

*Importance of practical activities.* Seven participants mentioned the need to provide a strong practical basis for the curriculum:

> One suggestion is “make it [curriculum] practical” and “keep it fun” (P18: Marketing Manager; Food processing and distribution sector).

In total, 19 participants proposed the inclusion of specific practical activities. Ten wanted cooking to be an integral part of the curriculum and suggested that cooking activities be used to initiate discussion around complex food issues as well as to develop students’ food skills. For example:

> […] learning about food through cooking and eating, and through the conversations that happen around cooking and eating, […] (P23: Research Fellow; Food movement sector).

Moreover, many of them thought that students would get a chance to understand and appreciate the cultural diversity of modern Australian society through preparation of different ethnic cuisines.
Ten participants suggested site visits as important practical activities. They suggested primary food production sites, food processing sites, food retailing sites, food service sites, and food testing sites. They noted that these visits could be real eye-opening experiences for students helping them to get a sense of what is actually going on in food system. For example:

[...] visit a farm, show the students where the food comes from and how it gets to your plate (P18: Marketing Manager; Food processing and distribution sector).

Five participants suggested experts in the food system should visit schools to make students aware about real-world food problems:

The other thing we could do is to have industry representatives come and present pictures of things behind the scene [...] (P30: Research Director; Food marketing sector).

Other suggestions for practical activities included: the growing of food crops (mentioned by four), volunteering and internships in the food sector (mentioned by four) especially on farms, in kitchens, and food relief and rescue organisations and practicals related to indigenous foods.

Discussion

There has been little research about food system professionals’ opinions of senior secondary school food literacy education in Australia or elsewhere. Moreover, this type of extensive consultation had not been conducted on the new “Food Studies” curriculum. Unlike other studies which have investigated the opinions of experts from a fairly narrow range (e.g. experts from the education sector), we recruited professionals from a much wider range of food- and nutrition-related areas, which allowed us to explore wider perspectives. This inclusion of informants from a broad range of backgrounds across the food system makes our study unique and consequently difficult to compare with the literature.

The study revealed that the new curriculum is an exciting and comprehensive one. However, these professionals identified a number of modifications that could be made to the curriculum including placing less emphasis on food history-related topics and focussing more on primary food production, health and nutrition awareness and promotion, and food sovereignty, social justice and food politics. Furthermore, many participants mentioned the importance of practical activities, especially cooking activities as central components of this curriculum.

Several participants considered the history of food (“Food origins” unit) to be less interesting than other topics and suggested reductions in the teaching time spent on this unit. This may reflect their own lack of interest in the humanities. However, the suggestion needs to be considered carefully as one of the aims of the new curriculum is to include both humanities and sciences related to the food system. The teaching of food history and food practices may be a conduit for understanding socio-cultural characteristics such as race, gender and class (Cargill, 2005). In a previous study, home economics professionals ranked food tradition, culture, history, and festival (values) as the sixth most important element out of 15 elements for inclusion in a school food literacy curriculum (Pendergast and Dewhurst, 2012).

Several professionals suggested greater inclusion of knowledge about the growing of food, and various food production approaches such as organic farming and growing genetically modified food crops, in the “Food makers” unit. The lack of connectedness of modern society with farming and related activities makes this a good suggestion (Dyg et al., 2014). Moreover, several professionals suggested that there should be more emphasis on food security, food sovereignty, social justice, and food politics in the “Food issues, challenges and futures” unit. Some previous studies have also suggested to include similar topics in school food literacy education (Kuurala and Rauma, 2008; Pendergast and Dewhurst, 2012; Rutland and Owen-Jackson, 2015; Slater, 2013). These emerging concepts are related to the relationships between food systems and health and social equity. Exposure of students to these concepts
helps them to recognise multiple driving forces behind these concepts as well as inter-
relationship between those forces. These understanding will enable them to become responsible
food citizens who can take wise decisions on food purchase, consumption and wastage.

It was suggested that there should be more discussion of both the role of current dietary
patterns in non-communicable disease causation and the nutritional aspects of food under the
“Food in daily life” unit. Two previous studies that explored ‘home economics’ professionals’
and education experts’ opinions about food and consumer science (home science) education
revealed nutrition and wellness (Smith et al., 2001) and nutrition-related trends (such as
obesity) (Alexander and Davis, 2011) should be top priorities. Across the world, traditional
plant-based-fibre rich diets have been replaced by high fat-highly refined foods. As a
consequence energy density of diets has increased over the last few decades (Popkin, 2006).
These contemporary diets act as risk factors for many NCDs including cancer, cardiovascular
disease, diabetes, and obesity (World Health Organization, 2011). In this context, increasing
adolescents’ awareness about the adverse health effects of current unhealthy dietary patterns
through school food literacy education is of utmost important.

Many professionals mentioned the importance of the acquisition of practical skills. A previous review of adolescents’ food literacy programmes had recommended “hands-on”
or “experiential-learning” for the successful delivery of food literacy programmes
(Brooks and Begley, 2014). Many of the interviewees wanted cooking to be an integral part
of the new curriculum. Several studies which have explored experts’ or teachers’ opinions
about school food literacy education have also reported food preparation and cooking
activities as an important element (Fordyce-Voorham, 2011; Lichtenstein and Ludwig, 2010;
Pendergast and Dewhurst, 2012; Ronto et al., 2016b; Rutland and Owen-Jackson, 2015). They highlighted students’ engagement and enjoyment in these cooking activities
(Fordyce-Voorham, 2011; Markow et al., 2012). Furthermore, food and cooking can be used
to initiate discussion around various aspects of health, nutrition, environment, economy,
culture, and equity (Höijer et al., 2011). Moreover, the participants suggested visits to
various food-related establishments as practical activities. This may help to make students
more aware of the food system and to increase their motivation and passion about food
(Fordyce-Voorham, 2011; Lichtenstein and Ludwig, 2010; Pendergast and Dewhurst, 2012).

Across the world food system is changing and the relationships citizens have with the
food system are changing (Lang, 2003). These changes are associated with myriad of
problems ranging from adverse environmental impacts of modern agriculture and food
production practices (Tilman et al., 2011), to social equity issues in utilising the food system
resources (Weiler et al., 2015), to increasing rates of obesity and other diet related
non-communicable diseases (Popkin et al., 2012). The design and implementation of a
broader food literacy school curriculum is timely as it strengthens the relationship between
humans and the food system. Since the new “Food Studies” curriculum aims to provide
broad food literacy education, the findings of this study could provide valuable insights for
similar school food literacy curriculum development efforts in Australia and other countries.

Study limitations
We recruited professionals for our study based on their sector, position, and experience in the
food system. However, we did not consider their expertise in education. Therefore, they
differed sometimes in their levels of understanding and interpretation of the new curriculum.
Moreover, each professional is an expert in a particular field and may not be able to comment
on all the areas of the new curriculum. They can still, however, provide valuable insights into
food-related senior secondary school curriculum. As employers or tertiary educators in the
food sector, they are aware of food-related knowledge, skills, and attitudes school leavers
should possess. The present study did not include secondary school food teachers, as we will
be exploring their opinions of the new curriculum in a separate study.
Conclusions and implications

The new curriculum was appreciated for its comprehensiveness and the food system approach taken, but some suggestions for improvement were made. These included placing less emphasis on the history of food, and giving more emphasis to primary food production, health and nutrition awareness, food equity, environmental sustainability, and practical activities related to each of these areas.

The most important practical implication of this study relates to support the development and delivery of new “Food Studies” curriculum. Most often new curricula are reviewed by education experts and teachers based on the pedagogy, educational theories, and their teaching experiences. Besides, food professionals look at school food literacy education through multiple angles based on their expertise in specific food-related areas and experiences in real-world food system issues. The curriculum developers could consider these professionals’ suggestions and make necessary modifications to the living “Food Studies” curriculum document. Adoption of suggested modifications would result in a more comprehensive, feasible, logical curriculum that includes applied and theoretical aspects of food literacy (Slater, 2013). Further exploration of the views of stakeholders in school food literacy education including teachers, school administrators, students, and parents is necessary to fully understand the important features of this new curriculum and make modifications accordingly.

The findings of this study also have implications for development and delivery of other secondary school food literacy curricula in Australia or elsewhere. This study suggests that broad range of professionals’ could provide valuable insights in to new food-related curriculum development and emphasises the need for their inputs in food literacy curriculum development. Therefore, future food literacy related curricula development process should include food professionals representing broad range of food system such as food production, food processing and distribution, food service, food education and research, and food regulation.

References


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Quality parameters of freeze-dried peach snack

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Abstract

Purpose – The causes of food waste or loss are numerous and occur at the stages of production, processing, retailing and consumption. Peaches must be processed quickly to maintain their quality because they are seasonal and their shelf life is short. The purpose of this paper is to evaluate the effect of freeze drying on quality parameters of stored peaches in order to increase shelf life, consumption and to decrease waste of fruit.

Design/methodology/approach – Samples were ripped on maturity time, stored for 16 days and sampled out and freeze-dried at every four-day interval. Microstructure was carried out by applying scanning electron microscopy, texture and colour parameters by image analysis techniques and physicochemical parameters by conventional analysis.

Findings – Statistical differences ($p < 0.05$) were obtained of colour and texture (stored and freeze-dried rehydrated samples) and for water activity and porosity (freeze-dried samples). Results revealed that after 12 days of storage/freeze, dried peach snacks showed lower pore size with higher amounts of pore, which affected rehydration process leading to a harder sample. Colour was also affected leading to a darkener fruit.

Originality/value – This research incorporates a quick approach to quality applying image analysis techniques and it will benefit to increase shelf life and consumption of fat-free snack peach and to decrease waste of fruit.

Keywords Image, Quality, Freeze drying, Image analysis technique

Paper type Research paper

1. Introduction

Peaches are a seasonal fruit, usually harvested when they reach maturity. Fruits picked before physiological maturity will not ripe satisfactorily and will be smaller, very firm in texture, with low sugars, reduced flavour and colour, while those harvested at a more mature stage will be softer, higher in sugar and water content (Gupta and Jawandha, 2010; Fernandez-Trujillo et al., 2000). This will lead to a higher perishability and a rapid softening during shelf life affecting quality parameters and consumers acceptance (Crisosto et al., 2004; Crisosto and Neri, 2006; Ferrer et al., 2005).

To increase shelf life in fruits, drying is the oldest process (Cakmak and Yildiz, 2011). Dried fruits have been considered as an alternative fat-free snack and have recently gained much more attention (Sette et al., 2017; Zhang et al., 2014). Most dehydrated fruits are produced by air drying. A disadvantage of this method is a substantial quality degradation in appearance (shrinkage, drying-up, darkening), nutrients, flavour and the low rate of rehydration (Devahastin and Niamnuy, 2010). Higher quality products can be obtained using freeze-drying methods. Freeze drying involves crystallisation of water in ice crystals, which subsequently sublime, thus leaving a porous dried product with high quality (Mujumdar and Law, 2010). Very limited studies regarding the potential use of peach snacks applying freeze drying have been reported.

On the other hand, quality in peaches has always been measured in terms of the traits of the fruit, mainly through evaluation of the physical and chemical properties that best describe the progress of maturation and ripening (Karimi et al., 2012) because they provide a
common language among researchers, producers and handlers (Echeverría et al., 2015). Among many quality parameters, colour is considered the most important visual attribute in the perception of the product quality; it is critically appraised by consumers and often is the basis for their selection or rejection. Consumers tend to associate colour with texture, flavour, safety, storage time and nutrition because it correlates well with physical, chemical and sensorial properties. Along with colour, texture also plays an important role in the overall acceptance of food quality by consumers (Pieniazek and Messina, 2016a). Texture in food has been defined as “all the rheological and structural (geometric and surface) attributes of the product perceptible by means of mechanical, tactile, visual and auditory receptors” (Lawless and Heymann, 1998).

An interesting alternative for analysing the surface of food products and quantifying appearance characteristics is to use computerised image analysis techniques (Saini et al., 2014; Mendoza et al., 2012). Image analysis can be a useful tool for characterizing food morphology because the highly irregular structures of many food materials elude precise quantification by conventional means. This technique allows obtaining measurements from digitalised images providing objective evaluations of the morpho-colorimetric features of samples, a method that is more quantitative and less biased than the common method of visual perception, which is prone to variation due to the personal opinions of inspectors or trained panels (Kono et al., 2014). When microscopic techniques such as scanning electron microscopy (SEM) and images analysis are used together, they become a powerful tool to evaluate microstructure changes of a product; cell size and number of cells can then be measured and quantified from the projected image. Employing image processing with SEM, some important sensory attributes, such as texture, could be predicted by processing the surface and cross-section images of a product.

The aim of the present research was to evaluate the effect of freeze drying on quality parameters of stored peaches applying conventional and non-conventional techniques. This process will benefit increases in consumption of fat-free snack peach and will decrease the effect of wasting unnecessary fruit.

2. Material and methods
2.1 Sampling and freeze-drying process

Peaches (Prunus Persica cv Snow Giant) (P) were obtained at a local farmer. Preliminary evaluation to set storage conditions, temperatures, etc., was performed in order to improve analysis. Optimised parameters were applied as follows: one fruit sample (n = 20) was used for fresh fruit determinations and the other (n = 100) was stored at 21°C ± 1°C at 90 per cent relative humidity. Peaches were sampled out, unpeeled and sliced as chips with a porcelain knife into 10 mm thick sections and freeze dried every four-day interval (T1, T2, T3, T4) during 16 days of storage.

Freeze drying was carried out using a non continuo's equipment (Rificor, Buenos Aires, Argentina). Parameters applied were the following: freezing temperature: −50°C ± 1°C until 12 h; drying process: 40°C ± 1°C at maximum vacuum (pressure: 0.346 Pa) during 12 h. Samples were vacuum packaged with polyethylene bags (Lumenpol®, Argentina) of 350 × 180 × 150 mm dimension and 90 microns, individually identified and stored in a dark place at room temperature until analysis.

In order to analyse microstructure of freeze-dried rehydrated samples (FDRP), rehydration was performed with tap water at 98°C. The duration of rehydration process was fixed at 3 min, as after that time period there was no more absorption of water by the samples.

2.2 SEM

SEM was used for the observation of the microstructure of P, FDP and FDRP. Samples were cross-sectioned using a scalpel; the cut was always performed in the same direction. P and FDRP samples were gradually dehydrated in an ethanol series
(25, 50, 75, and at 100 per cent, 10 min), once in acetone (100 per cent, 10 min) and then dried at room temperature. All solvents used in these experiments were of high purity and purchased from Sigma-Aldrich®.

Samples were mounted on holders and coated with a gold film. Microscopic evaluation was performed using a scanning electron microscope (SEM 515, Philips, Amsterdam, the Netherland). Observations of the samples at magnification of 250×, 500× and 1,000× were obtained for image analysis (Model Genesis Version 5.21.). Brightness and contrast are the most important variables to be controlled during the acquisition of images; therefore, the values of these parameters were kept constant for each magnification during the process of the specific image acquisition.

2.3 Colour analysis
Samples were illuminated using a lamp (model TL-D Deluxe, Natural Daylight, 18 W/965, Philips, NY, USA) with a colour temperature of 6,500 K (D65, standard light source) and a colour-rendering index (Ra) close to 90 per cent. The four fluorescent tubes (60 cm long) were situated 35 cm above the sample and at an angle of 45° with the sample. Additionally, light diffusers covering each lamp and electronic ballast assured a uniform illumination system.

A colour digital camera (CDC) (Canon Eos Rebel, Japan) was located vertically over the sample at a distance of 12.5 cm. The angle between the camera lens and the lighting source axis was around 45°. Lamps and CDC were inside a wooden box with internal walls that were painted black to avoid the light and reflection from the room (Girolami et al., 2013).

A total of 18 images from one side of each sample and eight regions of interest of each image were taken on the matte black background using the following camera settings: manual mode with the lens aperture at f of 4.5 and speed 1/125, no zoom, no flash, 3,088 × 2,056 pixels resolution of the CDC and storage in the JPEG format. The algorithms for pre-processing of full images, image segmentation and colour quantification were processed by Adobe Photoshop cs6 (v13.0 Adobe Systems Incorporated, 2012). L, a and b values were transformed to CIE L*, a* and b*.

2.4 Grey level co-occurrence matrix and image texture analysis
A total of 18 images (1,024 × 800 pixels) were captured using an SEM (1,000×) and stored as bitmaps in a grey scale with brightness values between 0 and 255 for each pixel constituting the image. The size of each sample (region of interest: 122 × 122 pixels) was the same for all the evaluated magnifications. Textural property was computed from a set of GLCM probability distribution matrices for a given image. The GLCM shows the probability that a pixel of a particular grey level occurs at a specified direction and distance (d = 1) from its neighbouring pixels. Grey level co-occurrence matrix is represented by Pd, θ (i, j) where counts the neighbouring pair pixels with grey values i and j at the distance of d and the direction of θ (16) (Pieniazek and Messina., 2016b; Pieniazek et al., 2015).

Five image texture features (correlation (COR), energy (ASM), homogeneity (HOM), entropy (ENT) and contrast (CON)) were calculated using MATLAB 8.4 (The MathWorks, Inc., MA, USA) (Equations 1-5):

\[
\text{CON} = \sum_{i=0}^{n-1} \sum_{j=0}^{n-1} (i-j)^2 P_d, \theta(i,j)
\]

\[
\text{ENT} = -\sum_{i=0}^{n-1} \sum_{j=0}^{n-1} P_d, \theta(i,j)^2 \log P(i,j)
\]
\[ HOM = \sum_{i=0}^{n-1} \sum_{j=0}^{n-1} \frac{P_d, \theta(i,j)}{1+|i-j|} \]  
\[ ASM = \sum_{i=0}^{n-1} \sum_{j=0}^{n-1} P_d, \theta(i,j)^2 \]  
\[ COR = \frac{\left[ \sum_{i=0}^{n-1} \sum_{j=0}^{n-1} (i,j)P(i,j) \right] - \mu_x \mu_y}{\sigma_x \sigma_y} \]

where \( \mu_x, \mu_y, \sigma_x \) and \( \sigma_y \) are the means and standard deviations of \( p_x \) and \( p_y \).

2.5 Water activity and porosity

Water activity (\( a_w \)) and porosity (\( P \)) were performed in freeze-dried samples. \( a_w \) was performed using a water activity meter (AquaLab 4TE, USA) and \( P \) was analysed using a Stereopycnometer (Quantachrome multipycnometer Model MVP-1, USA) with an accuracy of 0.001 cm³, utilising Helium gas. All experiments were carried out by triplicate.

2.6 Solid soluble content (SSC)

SSC of stored peaches was measured using a hand-held refractometer (Atago Co., PR-1 Brix-Meter, Tokyo, Japan). The exuded juice from the total peach flesh was used as a sample. The value of SSC of each sample was obtained by averaging three evaluations of the sample.

2.7 Statistical analysis

Regression equations and correlation coefficients (\( R^2 \)) were performed. Significant differences between values were determined by Tukey test. A \( p \) value of 0.05 was used to verify the test significance. All statistical tests of this experiment were conducted using SPSS-Advanced Statistics 13 software (SPSS Inc., Chicago, IL).

3. Results and discussion

3.1 SEM

Micrographs taken from cross-sectional cut of P, FDP and FDRP were performed at 250, 500 and 1,000 times magnification. Micrographs of P at \( T_0 \), \( T_3 \) and \( T_4 \) were smooth, flat, uniform and regular, showing an organised structure without gaps (Figure 1). Structures in FDP showed that cell walls were dehydrated, separated and partially fragmented. Fragility of cell walls appeared; especially tearing of cell walls from their base. High pore size structure with larger and irregular cavities was observed until \( T_3 \) (Figure 2). Lower pore size and higher pore amounts were observed at \( T_4 \) (Figure 2). FDP showed that the pores mainly were not uniformly distributed, this can be attributed to its tissue, containing different types of cells having different size, shape and orientation with different cell wall thickness and strength. During freezing the growth of ice crystal ruptures, pushes and compresses cells. This process is influenced by the strength of the cell walls (Mousavi et al., 2007). Pores and cavities are left after sublimating the ice crystals from the matrix. The ice crystals will grow in the cell direction creating elongated pores.

FDRP showed that surfaces were smooth, flat, uniform and regular until \( T_3 \), similar to \( P_3 \); \( T_4 \) showed changes as it was compared to \( P_3 \) (Figure 3). In the freeze-drying process, higher porous size helps to maintain the structure without the deformations that are inevitable in other drying methods, allowing a fast rehydration process due to that water easily reoccupies the empty spaces.
A general view of all micrographs showed that lower porous size was observed at $T_4$; porous size and amount was similar from $T_0$ to $T_3$. Porosity seemed to be gradually dispersed due to a fast and good rehydration process in freeze-dried samples until $T_3$ and similar microstructure was observed in P and FDRP from $T_0$ to $T_3$. 

Figure 1. Scanning micrographs performed at 250x, 500x and 1,000x of pech (P) cv Snow Giant at $T_0$, $T_3$ (12 days) and $T_4$ (16 days).

Figure 2. Scanning micrographs performed at 250x, 500x and 1,000x freeze-dried peach (FDP) at $T_3$ (12 days) and $T_4$ (16 days).
3.2 Water activity and porosity

Significant differences between $a_w$ values ($p < 0.0001$) were obtained for FDP ($a_wT_0 = 0.31$; $a_wT_1 = 0.24$; $a_wT_2 = 0.23$; $a_wT_3 = 0.20$; $a_wT_4 = 0.13$). Lower values of $a_w$ generate secondary reactions that may affect attributes. Significant differences between porosity values ($p < 0.0001$) were observed. Mean values of FDP revealed that porosity increased among storage ($P_{T0} = 79.8$; $P_{T1} = 81.9$; $P_{T2} = 82.1$; $P_{T3} = 82.9$; $P_{T4} = 92.8$). Lower pore size and higher amounts of pores was observed at $T_4$. In freeze drying, the porosity degree has influence on texture and rehydration ability, when the size of the air cells in porous material are larger, it allows a fast rehydration due to the fact that water easily enters and reoccupies the empty spaces (Oikonomopoulou et al., 2011; Leelayuthsoontorn and Thipayarat, 2006).

During subsequent freezing and drying the ice sublimation creates pores; the amount of pores is related to the water uptake and is higher when water uptake is increased. The pore structure is also influenced by the freezing process; a high undercooling procedure leads to smaller ice crystals and a larger inner surface. Due to the high porosity, the freeze-dried cell suspension creates a high specific surface area; influencing this fact the sorption behaviour as well as the rehydration process (Mounir, 2015).

When porosity was related to SEM images, results revealed that $T_0$ to $T_3$ exhibited higher pores size and less amounts of porous; lower porous size and higher amounts of porous were obtained at $T_4$. Therefore, SEM micrographs with porosity confirmed the based microstructure discussion presented above.

3.3 Colour analysis

Significant differences ($p < 0.0001$) (Table I) were obtained for colour parameters in P and FDRP. Data revealed that lightness decreased gradually from $T_0$ to $T_4$ in P and FDRP; decreases in lightness are related to the darkening of the fruit and linked to the browning of the surface due to the enzymatic browning (Rocha and Morais, 2003). On the other hand, $a^*$ and $b^*$ values increased in P and in FDRP, this can be attributed to the various pigments present in the skin and flesh tissue of fruit which, in the case of FDRP differences among colour parameters may be assigned to the drying process.

For consumer acceptance, a ripe or “ready to eat” peach is defined when flesh firmness is approximately 0.9-1.4 kgf and “ready to sale” firmness is below 2.7-3.6 kgf (Crisosto and Neri, 2006). Mitchell et al. (1991) reported that firmness was well correlated with background
Colour; a more mature fruit shows better skin colour, flavour, higher soluble solids concentration and lower titratable acidity than less mature fruit. Byrne et al. (1991) reported that in different genotype of peaches, a* value was also well correlated with firmness. Results mainly revealed that colour values in P were higher than FDRP and that decreases in lightness were linked to darkening of the fruit.

3.4 SSC
Statistical differences (p < 0.0001) were obtained for SSC during storage. Data showed that SSC content increased among storage (T₀ = 11.0, T₁ = 11.2, T₂ = 11.8, T₃ = 12.4, T₄ = 13.9°Brix). Decrease in acidity and increase in sucrose concentration contributes to a peach with better sensory acceptability. Peaches testing below 10°Brix usually are not satisfying to consumers, being optimal peaches those that reach 11.4-14°Brix, for consumer’s acceptance (Meredith et al., 1989).

According to the authors above mentioned and to Perkins Veazie et al. (1999), optimal consumer’s acceptance is produced when SSC is between 11.4 and 14°Brix, and results revealed that stored peaches had optimal SSC for consumers acceptance from T₂ to T₄. Changes in the amount of SCC can be due to changes in constituents of SSC such as ratio of glucose/fructose, organic acids during storage (Javanmardi and Kubota, 2006) and to moisture content (Romano et al., 2011).

3.5 Image texture analysis
Significant differences (p < 0.05) were obtained for image texture analysis, ASM, CON, ENT and COR (Table II). P samples showed that ASM, CON and ENT value increased from T₂ to T₄ which are related to roughness, hardness and uniformity. FDRP showed increases of ASM, CON and COR from T₂ to T₄ related to hardness, linearity and uniformity and increases from T₃ to T₄ for ENT related to roughness.

When P and FDRP were compared, P samples revealed to have higher ASM and lower ENT, CON and COR values than FDRP. A higher ASM value means represents the smoothness of an image; when ASM is high, the image has very similar pixels. ENT values are related to smoothness; the lower the ENT values, the lower the smoothness in the image. COR indicates the linearity of the image; for an image with large areas of similar intensities, a high value of correlation is measured. CON is a measure that shows the difference from one pixel to others close to it representing a measure of local grey variations; the softer the texture the lower the contrast, which is due to lower pixel value difference between two neighbours (Laddi et al., 2013; Koc et al., 2008; Zheng et al., 2006).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>T₀</th>
<th>T₁</th>
<th>T₂</th>
<th>T₃</th>
<th>T₄</th>
<th>p value</th>
<th>RSME</th>
</tr>
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<tbody>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L*</td>
<td>85.03a</td>
<td>84.20b</td>
<td>83.96c</td>
<td>82.34d</td>
<td>82.55d</td>
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<td>1.15b</td>
<td>1.85c</td>
<td>2.70b</td>
<td>5.45a</td>
<td>0.0001</td>
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<tr>
<td>b*</td>
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<td>45.01b</td>
<td>47.50c</td>
<td>48.17b</td>
<td>51.57a</td>
<td>0.0001</td>
<td>0.04</td>
</tr>
<tr>
<td>FDRP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L*</td>
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<td>80.20b</td>
<td>78.96c</td>
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<td>a*</td>
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<td>1.35c</td>
<td>2.51b</td>
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<td>b*</td>
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<td>42.56b</td>
<td>45.09b</td>
<td>46.63b</td>
<td>49.73b</td>
<td>0.0001</td>
<td>0.25</td>
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</table>

Notes: P, peach without treatment; FDR, freeze-dried rehydrated; RSME, root mean square error; L*, lightness; a*, red to green; b*, yellow to blue; T₀, non-stored; T₁, 4 days stored; T₂, 8 days stored; T₃, 12 days stored; T₄, 16 days stored. Small superscripted letters in the same row indicate that means are significantly different (p < 0.0001) related to treatment (Turkey’s test)
According to image texture analysis, FDRP hardness and linearity increased from \( T_2 \) to \( T_4 \) and roughness from \( T_3 \). Increases in hardness and roughness are due to losses in moisture and to a higher porosity. The textural changes in freeze-drying process especially hardness and roughness can be associated with the composition and structure of the cell walls, likely caused by physical and structural modifications of the peaches tissue inducing viscoelastic behaviour; this is due to that moisture content decrease in storage and when freeze drying is applied.

Bai et al. (2003) reported that moisture content decreased in apples when drying methods were applied; at higher drying rates or longer storage, apples turned to be more rigid and harder, roughness appeared and the formation of thick crust on the surface appeared.

Image analysis parameters revealed that texture changes are influenced by storage and drying processes. Optimal quality for texture parameters in peach snacks is \( T_2 \); after this stage when samples are freeze dried and then rehydrated, texture parameters revealed that samples turn to be harder, and roughness and undesirable texture quality appears.

### 4. Conclusions

In order to increase consumption of peach and to decrease wasting fruit, freeze-drying methods are an excellent option to increase shelf life of peach and to maintain its quality. In order to have good quality in peach snacks, it was necessary to reach an initial approach to the effect of freeze drying on the fruit storing. On the other hand, image analysis was a technique that allowed reaching a quick approach on texture parameters on colour and physicochemical parameters to evaluate quality.

Results revealed that after 12 days (\( T_3 \)) of storage and then freeze drying, peach snacks showed lower pores size and higher pores amounts, which affected rehydration process leading to a harder sample. Colour was also affected leading to a darkener fruit.

This approach to quality showed that a way to increase peach consumption and decrease the fruit waste caused by a wrong processing after ripening and a shorter shelf life is to apply freeze-drying process in stored peaches until 12 days, due to the fact that after 12 days of storage, samples get harder, darker and undesirable quality appears. Snacks are good options because they are fat-free snacks and can contribute to a better healthy life. In the future additional studies involving other cultivars, physicochemical analysis, etc., will be considered to assess to improve the research.

### Table II.
Image texture values of peach cv. Snow Giant

<table>
<thead>
<tr>
<th>Sample</th>
<th>Period</th>
<th>ASM</th>
<th>ENT</th>
<th>CON</th>
<th>COR</th>
</tr>
</thead>
<tbody>
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<td>P</td>
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<td>0.623&lt;sup&gt;d&lt;/sup&gt;</td>
<td>3.753&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.024&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.569&lt;sup&gt;g&lt;/sup&gt;</td>
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<tr>
<td>P</td>
<td>( T_1 )</td>
<td>0.783&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.895&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.030&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.638&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>P</td>
<td>( T_2 )</td>
<td>0.795&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.029&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.031&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.666&lt;sup&gt;c&lt;/sup&gt;</td>
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<tr>
<td>P</td>
<td>( T_3 )</td>
<td>0.843&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.031&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.034&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.707&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>P</td>
<td>( T_4 )</td>
<td>0.841&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.473&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.035&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>5.237&lt;sup&gt;d&lt;/sup&gt;</td>
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<td>0.837&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
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<td>FDRP</td>
<td>( T_1 )</td>
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<td>5.632&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.072&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.860&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>FDRP</td>
<td>( T_2 )</td>
<td>0.528&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.633&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.065&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.908&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td>FDRP</td>
<td>( T_3 )</td>
<td>0.539&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.659&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.065&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.911&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td>FDRP</td>
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<td>0.18</td>
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</table>

Notes: \( P \), peach without treatment; FDR, freeze-dried rehydrated; RSME, root mean square error; COR, correlation; ASM, energy; ENT, entropy; CON, contrast; \( T_0 \), non-stored; \( T_1 \), 4 days stored; \( T_2 \), 8 days stored; \( T_3 \), 12 days stored; \( T_4 \), 16 days stored. Small superscripted letters in the same column indicate that means are significantly different \((p < 0.0001)\) related to storage (Tukey’s test).
References


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