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Relationship between intangible assets and productivity: proved fact or wishful thinking?

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Guest editorial

The relationship between intangible assets and firm productivity – still myth or is there new evidence?

We have titled the special issue in a way that partly questions the relationship between intangible assets and firm productivity. What urged us to do so? While it is hard to find clear evidence that developing intangible assets lead to higher productivity, yet, much wishful thinking and even myths still exist in this field. Looking back on existing academic research, the relevance of productivity as a topic has long been acknowledged. Indeed, some evidence does exist supporting a positive relationship between intangible assets and productivity; but the picture remains rather eclectic. On the other hand, there are also many studies that show no causal relationships between the two phenomena. However, the topic is still vital and of interest to scholars.

To illustrate this, we conducted a search in the Scopus database (retrieve "productivity" in the title, subject areas business, management, accounting and economics, econometrics and finance) for the years 2016–2019. As a result of this search, 317, 320 and 336 papers were found in 2016, 2017 and 2018, respectively, and by the first half of 2019, more than 100 articles have been published. In the most recent papers in 2019, productivity is explored with the following intangibles: engagement and involvement, human and intellectual capital, various manifestations of knowledge management, working practices and standards, stress, organizational spirituality and others. The studies rely on data from different regions of the world: the most represented are Asia (47 articles), Europe (28 articles) and North America (8 articles), but very little research has been conducted in this field in South America, Africa, Central America and Oceania (altogether, only eight studies)[1]. The vast majority of these articles (107) employ quantitative analysis; only one paper uses qualitative, and one an experimental, approach. The focal sectors in these studies included manufacturing (25 articles), agriculture, finance and business (18 articles)[2]. This brief overview demonstrates that considerable research has been conducted, but the studies suffer from focusing on a single, albeit interesting, aspect of intangibles and thus generalizing the findings is quite complicated. Another issue is the geographical and sectorial spread of the studies. While country and sector-based studies are valuable, cross-sector research is also to be welcomed, as it facilitates a more profound and reliable picture of the mutual relationships between the phenomena under study.

Nevertheless, a number of papers published in recent years illustrate that the question of the relationship between intangibles and productivity is still topical, both from an academic and a practical, managerial perspective. To open up this agenda, the approach by Syverson (2011) can be mentioned – certain types of capital may themselves be invisible; in other words, intangible capital. He names such elements as a firm's reputation, know-how, or its loyal customer base. This broad approach can be paired with the notion that no common understanding or agreed definition of productivity exists in the academic debate thus far. Bloom and Van Reenen (2010, p. 204) open their seminal article by stating: "Economists have long puzzled over the astounding differences in productivity between firms and countries."

In many business sectors, the quantification of output is not easy, and therefore the classical approach to productivity as a ratio of outputs and inputs does not apply. Complexity in this regard reflects much academic research, where the alternative term

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performance is often used (the latter is true also for some of the papers in this special issue). In such cases, performance is understood as an "umbrella term for all concepts that consider the success of an organization and its activities" (Tangen, 2005, p. 40). Furthermore, intangible assets also lack a common definition. The field of inquiry usually considers human capital (knowledge, skills and abilities) and structural capital (structures, processes, culture and relationships with external stakeholders) as part of intangible assets (Kristandl and Bontis, 2007; Brynjolfsson *et al.*, 2002; Youndt *et al.*, 2004; Coff, 2002). The spectrum of factors illustrating human and organizational capital is wide and the role of each of these factors individually, and all of them together, in terms of organizational performance remains vague and requires further study. Since empirical studies typically analyze the effect of a single element on productivity (e.g. Mathew *et al.*, 2012; FitzRoy and Kraft, 2005; Grafton *et al.*, 2010) thus far, there is no agreement about the relative importance of these elements for productivity.

Technological optimism and hopes for growth have not led to an increase in productivity in all countries and sectors. Although developed and developing countries benefit from landline and cell technologies, there is a productivity dispersion between developing and developed countries; the latter countries gain significantly more from computing power than their counterparts in developing countries (Stanley *et al.*, 2018). One of the issues in considering intangible assets is that traditional management systems have been designed for tangible assets; however, the role of intangible assets has grown significantly. Syverson (2011, p. 360) writes: "If one really could measure intangible capital (which, alas, is inherently difficult given its nature), the productivity differences arising from such sources could be explained." Attempts to boost productivity, and to define and measure intangible assets, is a major concern for different stakeholders in order to improve and make future strategies and operations easier. That said, the questions regarding the relationships between intangible assets and productivity are not only of interest within academia, but are important for world of the business too. Questions such as:

- How is it possible to reach higher productivity, especially in knowledge intensive companies or in creative industries where "production" and "productivity" are sometimes fuzzy concepts and hard to measure?
- What measures should be taken in aging societies and in a situation of a decreasing qualified workforce, in order to sustain acceptable productivity levels? are critical ones for businesses.

With this special issue we aim to open up a re-examination (and if necessary a questioning) of the concepts and relationships between intangible assets and performance, and especially productivity. This special issue aspires to provide a step forward in achieving a better understanding of how intangible assets affect productivity and how to measure these processes. The latter has been seen as an important factor for achieving sustainable growth and competitive advantage in a company. The special issue presents seven papers which approach productivity and intangible assets from different angles, including gossip, CEO characteristics, employee age and wages.

The first paper by Ben-Hador adopts a unique and under-studied perspective on productivity, exploring how gossip is associated with social capital and productivity. The paper analyses how gossip is related to social capital and performance in the aviation and shipping industry in Israel. The author distinguishes between two types of social capital: personal and intra-organizational. Contrary to the hypothesis set, the study shows that gossip does not have a negative impact on individual performance – gossip is not the villain one would expect. Surprisingly, the study demonstrated that gossip reinforced personal social capital, and therefore mediated higher levels of performance via intra-organizational social capital. The findings are more surprising when we consider the cultural context of the study – Israeli culture

traditionally condemns gossip. The author argues that gossip includes many positive aspects including faster data transfers, solidarity and strengthening of social ties among organizational members and that these characteristics facilitate performance.

The second paper, by Kengatharan, takes the reader to banking, insurance, telecom and tourism sectors in Sri Lanka. The author focuses on three types of intellectual capital: human, social and organizational. The study shows that these three types of intellectual capital have a positive impact on productivity and performance. An attempt to analyze both productivity and performance within the scope of one study is quite rare, but it reveals new insights. The study reports a strong connection between productivity and different facets of intellectual capital, but the link between performance and intellectual capital is mediated by productivity. Consequently, the study illustrates the importance of all levels of intellectual capital in organizations. Organizations aiming to increase productivity and performance should focus on developing individuals (knowledge, skills and expertize), work groups (networks, ties and mutual learning in teams) and elements of the organization (culture, processes facilitating learning).

The third paper, by Garcés-Galdeano and García Olaverri, is based on high-tech companies in Spain. While the sample and region differ from Kengatharan's study, the conclusions are somewhat similar. Analyzing data from 1,500 CEO's, the study demonstrated the crucial role of constant learning in organizational performance. The study used both objective and subjective indicators (e.g. market share, employment growth, new knowledge applicability and success) to measure performance, thus making a valuable contribution to the field of inquiry. Another unique aspect of the study is its combination of a set of objectively measured CEO characteristics. Performance increased when the CEO has a good education both general and in the field of business. Concerning tenure, both in the same firm or elsewhere, and experience in the same industry and as an entrepreneur in general, the results are mixed. The study also revealed few significant differences in respect to the profiles of younger and older CEO's and the impact these profiles may have on performance.

While the previous paper showed the importance of the CEO's education, experience and tenure as accumulated knowledge, the fourth paper focuses on the question of whether investments in formal training pay off in terms of the firm's financial performance. Kwon analyses data from 312 manufacturing, banking and other service sector companies in Korea. The study confirms that investments in training and development predict enhanced financial performance of the firm. The paper focuses on the long-term effects of investments on training and provided evidence that the Korean companies studied did not decrease investments in training during the Great Recession or the subsequent recovery period. The study revealed that an increase in the training and development budget over time improved the financial performance of companies.

The fifth paper, by Jaakson, Aljaste and Uusi-Kakkuri, concentrates on different facets of innovativeness and financial performance in Estonian and Finnish biotechnology companies. In total, 26 companies from this innovative business sector were studied, applying both quantitative and qualitative methods. As the majority of studies on social capital and productivity rely on quantitative methods, this paper is of particular interest from the methodological perspective. The study showed that different dimensions of innovativeness are not necessarily related to each other. For example, strategic clarity is often considered a pre-requisite for innovativeness; yet a flexible structure was not necessarily in use in these companies nor a system of personalized rewards for innovative ideas. Interestingly, the strategic dimension of organizational innovativeness did not significantly improve performance indicators; instead, dimensions that were related to human resource policies had more potential to positively affect the company's financial performance. The study also showed that certain combinations of organizational innovativeness are quite effective for improving performance indicators. For example, the study revealed that a higher earnings before interest and taxes) per

employee in biotechnology companies was achieved by implementing either a loose structure and personalized rewards or strategic clarity, but not both. Another interesting conclusion was that high financial performance can also be achieved without being highly innovative; however, an optimal level of organizational innovativeness can be very advantageous in this respect.

The sixth paper aims to answer the question: does a greater complexity of products contributes to the productivity of exporting manufacturing firms. Varblane and Bormann's study related to Estonian companies, over the period 2008–2014. The authors presume that production of complex products requires more capabilities and the development of employees and in that sense the complexity of products is approached as one indication of learning and enhanced intellectual capital. The paper combines three firm-level datasets: first, The Atlas of Economic Complexity; second, Statistics Estonia, which contains the full population of exporting firms in Estonia; and third, Estonia's Commercial Registry, which collects the annual reports of all companies registered in Estonia. This is a unique combined data set and the study includes 3,056 companies. Contrary to expectations, the study showed that the production of more complex products did not lead to greater productivity in the companies studied. This finding resembles the results from the study by Jaakson, Aljaste and Uusi-Kakkuri discussed above. Namely, increasing innovativeness either in the form of organizational structures and processes, or in terms of the development and improvement of products, does not necessarily give better results in terms of productivity.

The final paper in this collection relates employee age to productivity, comparing high-wage and low-wage employees in manufacturing and service sectors in Estonia. Roosaar, Masso and Varblane combine two large datasets – the Estonian Tax and Customs Board and the Estonian Commercial Register resulting in 43,783 firm-level observations. As discussed in the paper by Garcés-Galdeano and García Olaverri (third paper in this issue), older employees have more experience which, under certain circumstances, is a potential source for better performance. The authors showed that the most productive employees are middle-aged, outperforming both younger and older colleagues. No significant difference in the productivity levels of old and young employees was found. The study also indicated that the high-wage employee group showed greater productivity, compared to the low-wage group. The study emphasizes the point the role of older employees in the organization should not be underestimated. While new generations in the workplace have gained significant attention, the current study demonstrates that older employees perform at least at the same level of productivity as young employees and that both age-groups merit opportunities for training and development in order to realize their full potential.

Overall, this special issue opens up several new perspectives on intangible assets and productivity in diverse organizational settings, including biotechnology, aviation and shipping – business sectors that have thus far been under-studied. Asia and Europe are regions where the majority of research on productivity is being conducted; thus the guest editors welcomed papers from these two regions. Also, the manufacturing sector is traditionally a popular object of study; three paper in this study aspects of intangible assets and productivity in manufacturing. From a methodological point of view, the special issue includes papers that employ traditional, quantitative or qualitative research methods; while most of the studies are quantitative, one study combined quantitative with qualitative methods.

Did we find new evidence that productivity benefits from intangible assets? To a certain extent this was the case, but many questions remain unanswered, indicating the need for further studies in the field. The papers in this special issue indicate that several aspects of intangible assets do have a direct or indirect effect on productivity. Learning and training are indicated as key factors leading to higher productivity. While this finding is not surprising, the collection did revealed some important nuances in this respect. For example, not all kinds of education and experience necessarily lead to higher productivity. Interestingly one of the papers found that employee age does not set any limits on the capacity and ability for learning

and productivity – a finding that should encourage organizations to invest in the development of both young and old employees. However, one study indicated that expecting higher productivity through producing more complex products (and, thus, investing in human capital), may not be realistic. This finding, at least partly, resembles the conclusion from another paper – that it is not enough to develop employees and raise their competences; organizations must also focus on forms of learning at the team and organizational level.

A factor mitigating against making generalizations on the issues under scrutiny in this special issue, is that much research focusing on the measurement of intangible assets and employee productivity in new businesses and in new employment and working modes, is currently underway and the results still emerging. We invite scholars to join this research stream. The special issue showed relationships between elements of intangible assets and firm productivity, adding sector and country-specific perspectives to the field of inquiry. But more studies are also required in order to broaden academic knowledge and provide new insights for managers. In designing the special issue, we called for papers presenting detailed case studies both as success stories and failures. Unfortunately, no research analyzing failed attempts by organizations to increase productivity through intangible assets were forthcoming. We still believe that the positive relationship between intangibles and productivity is, to a certain extent, a matter of wishful thinking and myth; in this respect, detailed case studies with a different methodological perspective would be of utmost value in adding new knowledge to the field.

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Notes

1. In total, 34 studies did not specify region.
2. In total, 75 studies did not specify sector.

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Social capital levels, gossip and employee performance in aviation and shipping companies in Israel

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Abstract

Purpose – The purpose of this paper is to understand better the organizational social capital (SC) levels and their impact on organizations by focusing on personal SC and intra-organizational SC as well as their different connections to organizational gossip and employee performance.

Design/methodology/approach – Participants in a field study included 617 employees from five Israeli organizations in the field of aviation and shipping. Levels of personal SC, intra-organizational SC, gossip and self-evaluated performance were measured, and connections between them detected.

Findings – The results indicate that intra-organizational SC is positively connected to employee performance, while personal SC is positively linked to gossip. Personal SC also leads to performance with the mediation of intra-organizational SC, although gossip was not found to be connected to performance.

Originality/value – The contributions of this study are both conceptual and practical. The distinction between organizational SC levels is refined, improving organizational research accuracy and facilitating a better grasp of the connections between SC and other variables. The scant research on organizational gossip has been expanded. From a practical perspective, clarification of the link between organizational SC and performance can be beneficial to employees and organizations.

Keywords Performance, Employee productivity

Paper type Research paper

1. Introduction

Social capital (SC) is a concept that stems from both sociology and economics (Coleman, 1988), and refers to the benefits derived from interactions between people. This study focuses on SC in organizations and distinguishes between two SC levels – personal SC and intra-organizational SC. Personal SC can be defined as the individual's private and public connections as well as positioning in social networks (Yu and Junshu, 2013). Intra-organizational SC refers to the social connections between and within formal and informal groups in the organization (Ben-Hador, 2016a, b). The latter is composed of features such as trust, common goals, mutual assistance, reciprocity and sharing information and knowledge (Ben-Hador, 2017). These two SC levels have many interfaces, although they produce different effects and can lead to different outcomes. SC has received considerable scholarly attention, but demarcating the distinction between its levels is still in its infancy. This study attempts to address this theoretical gap by refining the distinction between SC levels in organizations (Ben-Hador and Eckhaus, 2018) as well as evaluating their impact on two organizational variables – gossip and performance.

Organizational gossip has scarcely been investigated due to its controversial nature. In general, gossip has a bad reputation, although it is a normal and frequent human behavior outside and inside organizations. In fact, understanding organizational gossip and its connections to SC and performance can contribute to better management (Akande and Odewale, 1994) and healthier everyday organizational life, because gossip can improve communication and strengthen relationships inside in organization (Michelson and Mouly, 2000). Therefore, understanding gossip mechanism and effects is important for organizational practitioners. Moreover, this study is expanding the research literature on

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gossip, and narrowing the research gap regarding the connection between gossip and performance (Brady *et al.*, 2017) and gossip and SC (Ellwardt *et al.*, 2012).

Employee performance is of great importance to organizations. Indeed, performance represents the "bottom line" in most organizations that employ workers. Expanding knowledge of factors linked to employee performance improvement is therefore important and beneficial for organizations (Majid and Cohen, 2015). This study focuses on the impact of SC (intra-organizational SC and personal SC) and organizational gossip on employee performance. As such, it sheds light on SC and gossip as antecedents of employee performance in organizations. In sum, three research goals can be enumerated:

(1) to evaluate the impact of two SC levels and gossip on employee performance, thereby clarifying antecedents of employee performance;

(2) to distinguish between two SC levels in organizations and stress the distinct role of each SC level – how each affects employee performance and is affected by gossip; and

(3) to investigate the organizational gossip variable in order to locate its impact on each SC level and employee performance.

By creating a holistic model that combines all the connections between the studied variables and assesses their common impact, important mechanisms that drive employee feelings and behavior can be elucidated. The proposed model is presented in Figure 1.

This research was carried out in five organizations in Israel in the fields of aviation and shipping. These organizations have relatively low profit margins and, therefore, employee performance is critical for their survival. Moreover, since most of the work in these organizations is based on teamwork (such as operating, dispatch and security teams), intra-organizational SC is extremely important. It is thus very interesting to use these industries as lenses for close comparison between intra-organizational and personal SCs, as the latter SC is the one that employees bring with them from home. Furthermore, in organizations based on teamwork, gossip is very common and widespread (Kniffin and Wilson, 2010). Assessing the relations between these variables and their impact on each other can improve organizational environments and managerial practices. The study's research hypotheses are examined in this sample because the unique characters of the specific organizations can refine the effect of intra-organizational and personal SC and gossip on performance and improve the distinction between them. The cultural aspect of the Israeli context enhances our understanding of the examined variables' cultural aspects (Kaasa *et al.*, 2014), and hence it is a novel contribution to this field's research.

Many social and emotional roles are reinforced through informal modes of communication. Gossip is a productive channel for these forms of reinforcement, although many managers fail to appreciate the importance of gossip. This failure stems from gossip's negative reputation

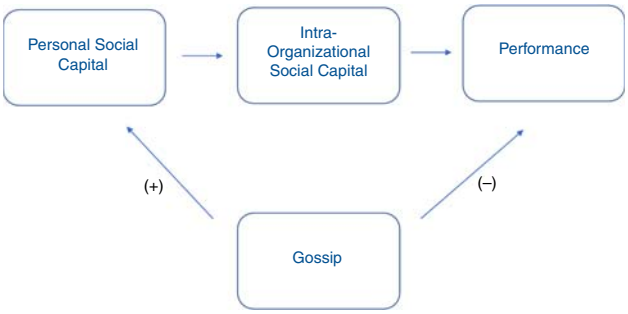

Figure 1. An illustrative model of the hypothesized relationships

and it is thus condemned or prohibited in many organizations. Moreover, in Israel there is a cultural element since Israel's main religion, Judaism, forbids gossip and slander (Sublette and Trappier, 2000) from ancient Biblical times (e.g. Leviticus 19:16[1]). Glinert *et al.* (2003) that interviewed ultra-orthodox Jewish women have marked few reasons for this prohibition, beyond that it is a divine command:

(1) It can hurt the reputation of others and might even disclose other people's secrets. In a small, closed society it is very undesirable.

(2) Gossip can be far-reaching; a conversation between two friends can be spread throughout the world – one does not even know how many people might be affected.

(3) Positive talk inspires good in the world, whereas negative talk damages oneself, as well as the person discussed. Since the difference between positive and negative talk is not always clear (Eckhaus and Ben-Hador, 2018), it is better not to talk about others at all.

Glinert *et al.* (2003) found that the interviewed women made a special effort not to talk about other people's behavior since it can be perceived as gossip and women are more inclined to gossip, but they explained that men also study daily the laws and principles of "harnessing the power of the tongue."

The secondary religion in Israel, Islam, does not approve of gossip either, due to reasons such as challenging individual and collective honor (Al-Huraibi and Konradi, 2012). For example, in Muslim schools in Israel, the expectation is that staff and student will not engage in gossip or slander (Court, 2006). Muslims also believe that women tend to gossip more than men (Sesanti, 2009).

Nevertheless, a recent study that was conducted in Israel suggests that people's attitudes toward gossip are ambivalent (Eckhaus and Ben-Hador, 2018). On the one hand, individuals oppose gossip and do not want to be perceived as gossipers, but on the other hand, they do gossip and to a large extent. Another study indicates that this ambivalence is stronger among men than among women (Eckhaus and Ben-Hador, 2019).

A more sophisticated understanding of gossip and gossiping in the workplace can improve employee communication. It can also contribute to increased positive perception of managerial roles. As such, this research should be construed as relevant to employees, managers and organizations alike.

1.1 Theoretical perspectives

This study focuses on three OB variables: employee performance, SC and gossip. Due to its importance to organizations, performance is one of the most researched variables in the OB field. Organizational performance has been studied intensively on the macro level. In this paper, performance was investigated from the employee point of view. This perspective is based on Pearce and Porter's (1986) classic study relying on performance appraisal theories. For SC levels, the theoretical approach drew on Ben-Hador's (2017) model on the different roles and functions of the various SC levels in organizations. For gossip, the groundbreaking research of Nevo *et al.* (1994) was used for a theoretical framework.

1.2 Research structure

First, a literature review of the study variables is carried out. Its range extends from the wide concept of SC in organizations to narrower elaborations of its organizational levels. Subsequently, the connections between SC levels and performance are described, leading into the first two hypotheses. This is followed by establishing the connection between SC levels and gossip, which culminates in the third hypothesis. The connection between gossip and performance is then presented, and this leads into the last hypothesis. Next sections are dedicated to methods, results and discussion. The discussion concludes with research

limitations as well as theoretical and practical implications. Although this study refers to concepts in the individual and organizational level, the discussion includes implications at the society level.

2. Theoretical framework and literature review

2.1 Organizational SC levels

SC is an intangible asset derived from interaction between people (Nahapiet and Ghoshal, 1998). The concept of SC is used by theoreticians and practitioners in many fields and research disciplines (Bourdieu, 1985) because social interactions are essential for goal achievement and life improvement (Lin, 1999).

In organizations, SC is an important concept clarifying the utility of employee social life in the workplace. It is well known that the benefits of social interactions are connected to individual health, mental health and welfare (Gao *et al.*, 2014). For teams and groups, social interactions can enhance coherence and creativity (Han *et al.*, 2014). Moreover, social interactions hold economic profit potential (Lee *et al.,* 2016) for the employees and for the organization.

SC has been conceptualized in various ways. Nahapiet and Ghoshal (1998) claimed that SC has structural and relational aspects, relying on Granovetter's (1973) definition of structural and relational embeddedness. They defined structural SC as the general pattern of all connections in a network and relational SC as the characteristics of relations between people: for example, reciprocity, trust and sharing information. They also added a cognitive aspect that relates to shared language and discourse for strengthening mutual understanding. Putnam (2000) made a differentiation between two kinds of SC – bonding and bridging. Bonding SC relies on strong connections such as with family, close friends and closed community. In contrast, Bridging SC is based on weak connections with acquaintances, people from other communities, and friends of friends. The benefits from bonding SC are usually emotional and financial support, while from bridging SC it is frequently receiving information, especially about opportunities such as job offers or business opportunities.

SC is a complex intangible that can exist on different levels. When measuring national SC such as the measurements of the world bank (O'Donovan, 2017) or SC of different groups in society, the local culture might have a great effect (Veronese *et al.*, 2018) Amit and Litwin (2010), for example, found that in Israel, the SC of an immigrant community is different from that of other communities. The current study deals with SC in organizations and therefore the organizational context is more prominent. Other studies from Israel indicate that in Israeli organizations the findings about SC are consistent with findings from organizations elsewhere in the world (Ben-Hador and Eckhaus, 2018).

Generally, three levels of social interaction can be discerned in organizations (Crossan *et al.*, 1999): first, between employee and social connections; second, within and between group interaction in the organization itself (formal and informal); and third, interface of organizational representatives with entities outside of the organization (e.g. customers, suppliers or competitors). Therefore, research (Oh *et al.*, 2006) has distinguished three levels of SC in organizations: first, personal SC that refers to individual interactions; second, intra-organizational SC encompassing the interactions between and within groups and units in the organization; and third, external SC that describes interactions of agents in the organization with factors outside of the organization (Kapucu and Demiroz, 2015).

These three levels of SC are interrelated and interdependent (Adler and Kwon, 2002), but are also distinct from one another. In this study, the focus is on the first two levels – personal SC and intra-organizational SC. This is because these levels are the basic foundations that have the potential to influence employee performance (Tansley and Newell, 2007).

Personal SC refers to the benefits the individual employee obtains from personal networks (Putnam, 2000) both inside and outside the organization, and stems from the

individual perspective on SC (such as Baker, 1990). Participating in networks (physical or virtual) can lead to a wide range of benefits (Gao *et al.*, 2014). Some of these are connected to work life such as finding a job, advancement between and within organizations (Gheasi *et al.*, 2014), organizational power, status and career development (Lazega *et al.*, 2006). Employees with high personal SC enjoy personal advantages that do not necessarily benefit the work unit or the organization (Boccuzzo *et al.*, 2016). In some cases, personal SC can even be harmful to the organization (Brass *et al.*, 1998), as when employee self-interest trumps the collective interest of colleagues and the work unit (Ibarra *et al.,* 2005).

Intra-organizational SC refers to organizational benefits derived from interactions in the workplace between and within formal and informal groups in the organization (Henttonen *et al.*, 2013). This level of SC derives from collective perspectives on SC (e.g. Han *et al.*, 2014). Most scholars agree that intra-organizational SC is composed of trust formation and knowledge (Nahapiet and Ghoshal, 1998) as well as reciprocity such as mutual assistance (Milana and Maldaon, 2015). Adler and Kwon (2002) warn that intra-organizational SC may not be cost-efficient in certain situations. Carmeli *et al.* (2009) measured intra-organizational SC in a questionnaire looking at the cooperation of employees and colleagues in the workplace and measuring mutual trust, caring and the extent of sharing common goals.

Yu and Junshu (2013) claim that the distinction between SC levels relies on Granovetter's (1973) theory of social networking ties. Granovetter (1973) distinguished between weak and strong ties, claiming that the latter are important for close relationships and support. The former, in contrast, are useful for career advancement, receiving information and opportunities such as finding a job. Yu and Junshu (2013) concluded that personal SC is primarily composed of weak ties because most people have many weak ties and somewhat strong ties (Burt, 1992; Van Schaik, 2002), while intra-organizational SC is based on strong ties within the organization because it is grounded in mutual trust (Fukuyama, 1995) such as is possible only when the ties are strong.

Nevertheless, there are many studies that refer to SC as a monolithic variable (Putnam, 2000). This research constitutes a refutation of this assumption, establishing a distinction between personal SC and intra-organizational SC by analyzing their connections to employee performance and organizational gossip.

2.2 SC levels and employee performance

Employee performance is a vital issue for organizations and has received copious research attention (Campbell *et al.*, 1990). It can be defined as achieving individual work goals and fulfilling expectations set by the organization (Audenaert *et al.*, 2016). For example, Mensah (2015) defines performance as the positive contribution of an employee to the success of the organization.

According to Borman and Motowidlo (1993), employee performance is composed of task and contextual components. Task performance encompasses behaviors that contribute to core and maintenance activities in an organization. It includes actions that are part of the formal reward system, addressing requirements specified in job descriptions. Contextual performance, in contrast, is related to factors that are not directly concerned with job demands and is embedded in psychological and social contexts in which tasks are performed. Ultimately, most performance definitions are constitutive of organizational interests.

Studies have proven that supportive work climates tend to cause higher organizational performance (Audenaert *et al.*, 2016). Specifically, it has been claimed that SC is connected to employee performance (Nahapiet and Ghoshal, 1998). Nevertheless, in many studies a direct impact of SC on employee performance was not confirmed (Ring, 1996; Leana and Van Buren, 1999). It is possible that making a distinction between intra-organizational and personal SC will facilitate the pinpointing of this impact. And, indeed, studies that found an impact of SC on employee performance referred to intra-organizational SC

(Lee *et al.*, 2014). Clopton (2011) and Rhee and Ji (2011) found that intra-organizational SC directly lead to performance.

It is harder to locate a direct connection between personal SC and employee performance. Studies indicate that personal SC turned out to be non-significant as a predictor of employee performance (Rhee and Ji, 2011). In fact, most performance definitions are representative of organizational interests. Consequently, intra-organizational SC is associated with employee performance, while personal SC is dedicated to individual welfare and may contradict organizational interests (Niehaus and O'meara, 2015). Stofer *et al.* (2006) examined the differences between impact of personal SC and intra-organizational SC on performance, concluding that the impact of the second is much stronger than the first. As a result, the first hypotheses are proposed as follows:

H1a. Intra-organizational SC will have a positive effect on employee performance.

H1b. The effect of intra-organizational SC on employee performance will be stronger than the effect of personal SC on employee performance.

On the other hand, it is possible that personal SC will lead to enhanced performance. In fact, personal SC used for the benefit of the organization can lead to intra-organizational SC. Leana and Van Buren (1999) explained that SC on the individual level logically benefits the individual. However, its connection to collective benefit is indirect. Employee performance is part of the organization's results. This strengthens the organization and, therefore, can be considered as a public good. As such, it can be concluded that personal SC has an indirect connection to performance.

In their classic paper, Adler and Kwon (2002) noted that scholars tend to relate differently to each kind of SC. However, they emphasized that exact distinctions between them are challenging as intra-organizational SC relies on personal SC. The basic SC that every individual has is personal SC; therefore, intra-organizational SC relies profoundly on personal SC (plus the holistic group effect that is included in intra-organizational SC). As argued in the previous hypothesis, intra-organizational SC leads to employee performance; hence, SC is positively affected by personal SC and then positively affects employee performance. As such, intra-organizational SC mediated the connection between personal SC and employee performance.

Therefore, the second hypothesis is as follows:

H2. Intra-organizational SC will mediate the relationship between personal SC and employee performance.

2.3 Gossip in organizations and SC

Gossip, or talking about others in their absence, is one of the most common human verbal activities across societies (Ellwardt, 2011). It usually includes an evaluation of a third person (Foster, 2004) and is important in human interaction because it can reflect personal beliefs about a situation or person (Eckhaus and Ben-Hador, 2019). Noon and Delbridge (1993) extend this definition to a process of unofficial communication that includes information on the social environment. Gossip is also useful to "fill in the blanks," and can function as a tool for compensating for situational uncertainty (Rosnow and Foster, 2005).

In organizations, gossip is an integral part of the workplace, bridging the gap for many employees between knowing and not knowing (Turcotte, 2012). A common point of view states that organizational gossip is negative by its very nature (Wu, Kwan, Wu and Ma, 2018). Gholipour *et al.* (2011), for example, defined gossip as the verbal transference of invalid information. Chua and De la Cerna (2014) agreed that gossip has been marked by many as a negative act and is often expressed in terms of malicious stereotypes that harm reputation, relationships and organizational citizenship behavior (Wu, Birtch, Chiang and

Zhang, 2018). For example, expressions such as "a knife in the back" are part of conventionalized discourse. Moreover, Turner *et al.* (2003) found that both positive and negative gossips are perceived negatively by friends and strangers.

However, it can also be argued that gossip in organizations plays a positive role. Michelson and Mouly (2000) point out that organizational gossip has many advantages such as faster data transfer, early assessment and evaluation of employee reaction to organizational initiatives and changes, preservation of social solidarity, and strengthening of social ties. Accordingly, gossip can generate SC, although levels of SC obtained by it remain unclear. Hafen (2004) suggests that gossip plays a role in building and maintaining community; it can unite employees and their team, leading to intra-organizational SC.

On the other hand, Decoster *et al.* (2013) claimed that employees who identify with their organization and their working unit (i.e. possess high intra-organizational SC) are less likely to gossip about their managers. According to Gholipour *et al.* (2011), the long-term result of gossip, no matter positive or negative, is mistrust of the organization and management, even if yielding short-term individual benefit. Trust is an important component of intra-organizational SC, and hence the latter is generally impaired by gossip. Altuntas *et al.* (2014) investigated the gossip practices of nurses, and found that they gossiped most frequently about working conditions and shared face-to-face information when angry. The nurses use gossip for ventilation and coping with stressful work conditions, but this nevertheless harmed intra-organizational SC and led to a reduction in organizational efficiency. By relying on these studies, it can be concluded that gossip does not contribute to intra-organizational SC. However, Stephenson and Lewin (1996) proved that gossip is a means for informal friendship between colleagues that transcends work relations, i.e. it contributes to personal SC. Ku *et al.* (2018) also found a positive impact of gossip in the workplace on personal relationship (namely, personal SC), Kiss *et al.* (2014) found a stronger relationship between gossip and individual SC as compared to workplace level, i.e., intra-organizational SC. The hypothesis that stems from these findings can be expressed as follows:

H3. Gossip will have a positive effect on personal SC, but not on intra-organizational SC.

2.4 Gossip and employee performance

Few studies have investigated the link between gossip and performance. In a qualitative study, Hafen (2004) found that gossip can affect employee performance, but that this effect is equivocal. Bordia *et al.* (2006) reported that in a period of organizational change, employees who engaged in gossip tend to feel more stressful than employees who abstained, along with the abundant evidence that excessive stress can harm performance (Leung *et al.*, 2016).

Grosser *et al.* (2010) found that employee gossiping activity (both positive and negative) is negatively related to supervisor evaluations of employee performance. They point out that, indeed, theories such as social comparison (Wert and Salovey, 2004) support a positive connection between gossip and performance, because the information that is conveyed in gossip strengthens the need to replicate or surpass others. But Grosser *et al.* (2010) claimed that this perception is unrealistic because an individual known to engage in a great deal of negative gossip is unlikely to be seen as a high performer by his superiors. Tian *et al.* (2019) supported that negative influence.

Based on Grosser *et al.* (2010) and Tian *et al.* (2019), it appears that gossiping is indeed associated with performance, but that the connection is negative. As a result, the following hypothesis is framed:

H4. Gossip will have a negative effect on performance.

3. Method

3.1 Sample and procedure

Data were collected from 682 employees in five Israeli organizations engaged in the fields of aviation and shipping. In Israel, there are about ten leading international forwarders and aviation service providers. Three of the five companies that allowed their employees to participate in the study are from "the Big 10," while the other two are smaller size companies. In total, 65 questionnaires were excluded due to reliability problems, leaving 617 valid cases. The study was carried out with the cooperation of the organizations. In two organizations, HR managers distributed and collected the questionnaires manually, while in the other three they were distributed and collected by the researcher. Of the respondents, 344 (55.8 percent) were women, with an average age of 37.5 (SD = 12.14), and an average seniority level in the organization of 13.38 years (SD = 5.55), 94 percent of the respondents were Jewish.

3.2 Measures

3.2.1 Employee performance scale. In many cases, employee performance was measured by superior evaluation (Martins and Tabiti, 2015). In order to compare performance evaluations from different locations around the world, Pearce and Porter (1986) developed a simple scale based on supervisor evaluation of quality of performance, accuracy and ability to get along with others.

In this study, performance evaluation is collected from a single source (the employees) and, therefore, may cause a common method variance. Shore and Tashchian (2002) noted that self-appraisal is a common method in organizations for evaluating employee performance. Although self-evaluation is commonly used in studies for measuring performance (Pousa *et al.*, 2018), it is also prevalent in organizations (Busco *et al.*, 2018; Santos Bento and Tontini, 2018). However, Shore and Tashchian (2002) mentioned several drawbacks such as employee tendency to over-rate themselves (self-appraisal bias). However, Campbell and Lee (1988) claimed that self-appraisal is as valid as other evaluation techniques. Self-rated employees can describe their advantages and disadvantages very accurately, although their average overall rating tends to be higher than that of their superiors. Moreover, Díaz-Vilela *et al.* (2015) compared self-appraisals to performance measures obtained from different appraisers and found that only self-performance measures (i.e. contextual and task related) were consistent, while inter-rater agreement disappeared. Self-ratings are of great importance in the appraisal process (Mann *et al.*, 2012) since they have a strong influence on behavior change and goal formation. Black and Porter (1991) used Pearce and Porter's (1986) scale in a self-reported evaluation and found it reliable and valid, justifying its use in the current study. The scale employs five questions; for example: "I achieve the goals of my job," and the internal reliability of the performance scale is 0.93 Cronbach's α.

3.2.2 Personal SC scale. Chen *et al.* (2009) developed a personal SC scale composed of personal investment in SC, personality traits and social support. This scale was later refined and shortened by Wang *et al.* (2014). The questionnaire consists of six categories, each containing several sub-categories with a total of 27 statements. Respondents were asked to indicate five levels of relevant people with whom they are acquainted, choosing from a scale in each category with a range of 1–5. For example: "Among the people in each of the following categories, how many can you trust?" (the categories are: your family members, your relatives, people in your neighborhood, your friends, your coworkers/fellows, your fellow countrymen; 1 = none to 5 = all). The reported reliability is 0.93 Cronbach's α.

3.2.3 Intra-organizational SC scale. The intra-organizational SC scale consists of five items conceptually based on the work of Carmeli *et al.* (2009). Participants were asked to indicate to what extent they feel close to their colleagues at work, can count on them, get help from them, share common goals with them and care for each other at work. The scale

employed a five-point Likert scale ranging from 1 – strongly disagree to 5 – strongly agree. The internal reliability of the IOSC scale is 0.84 Cronbach's α.

3.2.4 Gossip scale. Nevo *et al.* (1994) examined the tendency to gossip using a questionnaire consisting of 20 questions. Respondents had to indicate on a five-level Likert scale how much they gossip about a certain subject from 1 = never to 5 = almost always. An example of a question is "I like to talk with a good friend about the clothes of other people." Reliability is 0.87 Cronbach's α.

Control variable. Since demographic and organizational characteristics may affect the analysis (Siders *et al.*, 2001), the control variable in this study was age, accounting for personal differences between employees. Tenure, which accounts for working experience in the organization, however, was not accounted for as it was not significantly correlated with performance. Gender was also not appended because its contribution to the model was unnoticeable.

Questionnaires' language. The research was performed in Israel; whose native language is Hebrew. Two of the scales that were used in this study were originally developed in Hebrew – the gossip scale (Nevo *et al.*, 1994) and the intra-organizational SC scale (Carmeli *et al.*, 2009), hence the original questionnaires were used. The Black and Porter's (1991) performance scale is a classic scale that was translated and used in Hebrew in many studies such as Carmeli *et al.*'s (2009). The personal SC scale was translated to Hebrew in a double-blind process, with two different translators in order to strengthen the reliability of the translated questionnaire.

3.3 Data analysis

H1a, *H1b* and *H4* were tested by regressing individual performance as a dependent variable on personal and intra-organizational SC (for *H1a* and *H1b*) and gossip behaviors (for *H4*). *H2* suggested an indirect effects model (Cole *et al.*, 2008). In this model, the indirect connection (i.e. predictor → mediating variable → predicted variable) must be "stronger" than the direct connection (predictor → predicted variable). Relying on the indirect connections model of Preacher *et al.* (2007), Hayes (2013) developed a SPSS macro that facilitates estimation of conditional indirect effects. This SPSS macro was used to test *H2*, and a path analysis was performed according to Preacher *et al.* (2007). A structural equation model (SEM) was employed to test the model's goodness-of-fit. R software was used to estimate the model using the maximum likelihood estimation method. SRMR, CFI and TLI (Taku *et al.*, 2008) were examined. The SEM was also used to confirm *H3*.

4. Results

Table I presents the means, standard deviations and simple correlations between the research variables. Correlation coefficients were lower than 0.60, therefore indicating low concern for multicollinearity between research variables.

Variable	*M*	SD	1	2	3	4	5	6	7
1. Gender	–	–							
2. Age	37.5	12.1	0.06	–					
3. Tenure	13.3	5.55	−0.03	0.33**	–				
4. Education	13.5	2.24	0.02	0.18**	−0.03	–			
5. PSC	3.01	0.55	−0.06	0.02	−0.05	0.11*	–		
6. IOSC	3.54	0.64	−0.04	0.03	−0.10*	0.02	0.46**	–	
7. Gossip	2.40	0.67	−0.18**	−0.18	−0.01	0.18**	0.16**	0.80	–
8. Performance	3.8	0.70	−0.08	0.11*	0.03	−0.09	0.26**	0.38**	−0.02

Notes: $n = 617$, for gender, 1 = male. *$p < 0.05$; **$p < 0.01$

Table I. Means, standard deviations (SD) and correlations

In order to examine differences in SC levels, a paired sample *t*-test was performed ($t = 19.31$ (556) $p < 0.001$). Differences between SC levels were confirmed. Although the discriminant validity was low (nearly 21 percent of explained variance), the average variance extracted (AVE) from both constructs of personal and intra-organizational SC was adequate. Fornell and Larcker (1981) recommended values higher than 0.50 to indicate convergent validity. The computed AVE for personal SC was 0.54 and composite reliability was 0.83, while the AVE for intra-organizational SC was 0.66, with composite reliability of 0.89. The AVE values were greater than 0.50, indicating convergent validity. Therefore, the hypothesis that intra-organizational and personal SC will positively affect employee performance, notwithstanding a stronger connection of intra-organizational SC and performance, was confirmed. Table I indicates a positive correlation between SC levels and employee performance. A multiple linear regression was performed using performance as a dependent variable, with personal and intra-organizational SC as independent variables. The results equation is characterized by a coefficient of determination (R^2) of 0.15, where all variables are statistically significant. Therefore, *H1a* and *H1b* were supported. The regression results are summarized in Table II.

H2 was that intra-organizational SC mediates the relationship between personal SC and employee performance. As shown, personal SC is positively associated with performance (*H1a*) indicated by a significant unstandardized regression coefficient (total effect: $B = 0.33$, $\text{SE} = 0.06$, $t = 5.26$, $p < 0.001$). In initial support of *H2*, the relationship between intra-organizational SC and performance controlling for personal SC was significant ($B = 0.37$, $\text{SE} = 0.06$, $t = 6.4$, $p < 0.001$). However, the direct connection between personal SC and employee performance was not significant ($B = 0.12$, $\text{SE} = 0.06$, $t = 1.8$, $p = \text{ns}$). A significance test (assuming a normal distribution) verified that the indirect effect of personal SC on performance was significant (Sobel $z = 5.46$, $p < 0.01$). The mediation model is presented in Table III. Hence, *H2* was supported.

H4 claimed that gossip will be negatively associated with performance. However, the correlation table and the performed regression offer no such evidence. Therefore, *H4* was not supported.

Results of the regression test of all the study variables and control variable are presented in Table IV and support the findings with no effect of the gossip variable on the adjusted R^2.

SEM was constructed to test the model's goodness-of-fit. ISC was tested to see if it mediates the relation between PSC and PEREM, while GOSEM was tested as it predicts ISC and PEREM.

The results of the full model are shown in Figure 1. The model provides adequate fit to data ($\chi^2(113) = 378.47$, $p < 0.001$), root mean square error of approximation ($\text{RMSEA} = 0.074$), and comparative fit index ($\text{CFI} = 0.934$). All factor loadings were of adequate strength and statistically significant (range 0.64–0.86).

The SEM confirms *H3*, that gossip will positively affect personal SC, but not intra-organizational SC. As presented, the connection between gossip and personal SC is 0.214, $p < 0.001$, whereas the connection between gossip and intra-organizational SC was not found to be statistically significant. To test the mediation, the indirect effect (ab) was tested and found significant ($\text{ab} = 0.162$, $p < 0.001$), while CI was between 0.086 and 0.233 (Hayes, 2013).

The SEM complete model confirms the influential nature of the variables and presents those influences in a holistic model (Figure 2).

	Coefficients (B)	Statistical error (SE)	Weight (β)	R^2	ΔR^2
IOSC	0.360	0.06	0.32**	0.15	0.15**
PSC	0.147	0.06	0.12*		

Notes: $^*p < 0.05$; $^{**}p < 0.01$

Table II. Personal and intra-organizational SC effect on performance

		Mediator variable model		
	B	SE	*t*	*p*
Constant	1.70	0.19	9.14	0.001
PSC	0.56	0.05	10.87	0.001
Age (control)	0.003	0.002	1.11	0.27
		Dependent variable model		
	B	SE	*t*	*p*
Constant	1.80	0.24	7.50	0.001
IOSC	0.37	0.06	6.34	0.001
PSC	0.12	0.07	1.83	0.07
Age (control)	0.008	0.003	2.95	0.003
		Direct effect of X on Y		
	0.12	0.07	1.83	0.07
		Indirect effect		
	Effect	SE	*Z*	*p*
Sobel	0.21	0.04	5.46	0.001
		Bootstrap results for indirect effect		
	Effect	Boot SE	Boot LLCI	Boot ULCI
	0.21	0.04	0.12	0.29

Notes: $n = 607$, unstandardized regression coefficients are reported, Bootstrap sample size = 1,000. LL, lower limit; CI, confidence interval

Table III. Regression results for simple mediation

	Coefficients (*B*)	Statistical error (SE)	Weight (β)	R^2	ΔR^2
IOSC	0.360	0.06	0.32**	0.17	0.17**
PSC	0.142	0.07	0.15*		
Gossip	−0.032	0.05	−0.03		
Age	0.008	0.003	0.13*		

Notes: $*p < 0.05$; $***p < 0.01$

Table IV. The study variables effect on performance

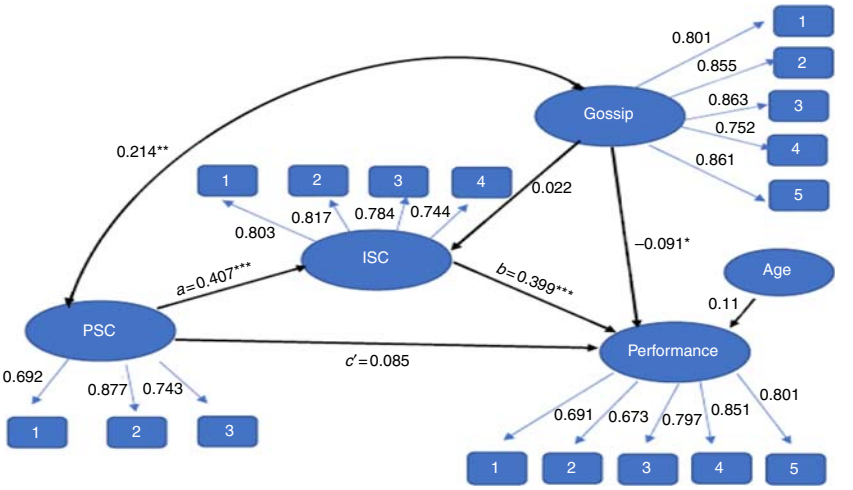

Figure 2. The final model – ISC as meditator between PSC and employee performance

5. Discussion

This research aimed to distinguish between intra-organizational SC and personal SC in organizations by focusing on the impact of each SC level on performance, and to investigate the organizational gossip variable to detect its impact on each SC level and employee performance. The hypotheses asserted that intra-organizational SC will have a direct positive effect on performance, while personal SC will be linked to performance via intra-organizational SC (by mediation). Moreover, it was claimed that gossip will have a positive effect on personal SC and a negative effect on performance. All hypotheses were confirmed except for the last one: gossip in the organization was not found to affect employee performance. It can, therefore, be concluded that differentiation between the two SC levels in organizations has been supported, as only intra-organizational SC leads directly to performance (Ben-Hador and Eckhaus, 2018). The finding that intra-organizational SC mediates the connection between personal SC and performance strengthens Ibarra *et al.* (2005), who claim that personal SC will be beneficial to the organization only if it will lead to intra-organizational SC (network congruence). If network congruence exists, then personal SC will lead to better employee performance. Therefore, the positive impact of gossip on personal SC that can be perceived as harmful is not necessarily negative, as it is contingent on the organizational context.

The surprising finding that gossip is not connected negatively to performance, in contrast to the expectations of Grosser *et al.* (2010), suggests that gossip is a neutral social phenomenon – neither negative nor positive. Hafen (2004) claims that gossip can both support the individual while damaging the organization and enhance the organization while harming the individual. The context for making any assessment is critical and has a great impact on the consequences of interpreting gossip (Mitchell, 2001).

Although SC is basically a positive variable (Coleman, 1988), it might also have disadvantages. In this study it was found that personal SC can help improve employee performance if there is a mediation of intra-organizational SC. Yet, the lack of mediation in the organization might result in a harmful personal SC because the employees might care only for their own benefits and not for the group/organization's own good (Niehaus and O'meara, 2015). As a result, they will not contribute to the organization. The connection between gossip and personal SC might also be affected by the sentiment and content of the gossip (Eckhaus and Ben-Hador, 2019). If the gossip is evil, it might enhance the disadvantages of the personal SC and harm the unity and coherence of the organizational groups. Moreover, Adler and Kwon (2002) and Hoffman *et al.* (2005) listed some drawbacks of intra-organizational SC, such as social sanctions for those who do not comply with the norms of the group. For example, whistle blowers in organizations are severely punished because they do not follow social norms (Jones and Kelly, 2014). Another example is how loyalty to a social group that results from close connections might interrupt the flow of new information or ideas (Willem and Scarbrough, 2006). Indeed, performance may possibly be enhanced, but other organizational variables might be harmed. To prevent these risks, it is recommended that managements and HR personnel will be aware of them and will make efforts for the congruent of intra-organizational and personal SC (as was suggested by Ibarra *et al.*, 2005), while ensuring that the intra-organizational SC will not segregate employees (Knorringa and van Staveren, 2007). Although this study deals with concepts in the individual and organizational level it is influenced by the local cultural background. In Israel, where the study took place, religious and social imperatives against gossip are common because Jewish religious law (which is the primary faith) strongly opposed gossip (Buddenbaum, 2014) as well as the Islam rules (Mohajer, 2013), which is also an official religion in Israel. Therefore, people tend to report that they are not gossiping even when in reality, they are (Eckhaus and Ben-Hador, 2018). Moreover, Israel has specific cultural characteristics. Karma and Vadi (2016) found that relationship orientation varies across countries, which means that the meaning of SC can be different in Israel than in other countries. Furthermore, the perception of gossip can also be

different in various cultures. As was presented in Israel, the population is affected by the main religions, and this effect might be culture-bound. For example, Randolph *et al.* (2018) reported that among youth in the American culture, gossip is considered legitimate and there are even very popular blogs and gossip sites operated by teenagers on the internet. Lee and Workman (2014) supported this perception for Korean adolescents. Indeed, religions such as Christianity (Capps, 2012) and Buddhism (Rich, 2007), just like Judaism and Islam hold more conservative values and oppose gossip (Loewenthal, 2014), but in the modern western world, gossip is a part of life and has a great impact on the media and public opinion (Jeremiah, 2018). Furthermore, Kaasa *et al.* (2014) suggested that considering the local context within countries is very important for managers and research, thus the inclusion of this study into a broad body of research expands the cultural scope and provides an additional perspective on the impact of levels of SC and gossip on performance.

The cultural codes also explain why the gossip variable had the lowest mean of all the variables (2.4 on five-point scale), whereas the performance variable had the highest mean (3.8 on five-point scale). The performance variable's high mean contradicts Hofstede's (1984) scale (www.hofstede-insights.com/product/compare-countries) in which Israel is located below the median (score 47 out of 100) in the masculinity dimension which measures competitiveness and achievements. A possible explanation can be that the organizations whose employees participated in the study are performance-driven organizations. The mean of the intra-organizational SC variable is also high, maybe since the work in these organizations is based on teamwork.

This study makes both theoretical and practical contributions. Theoretically, the research accounts for some mechanisms behind the relationships of SC as an organizational intangible asset and performance. It also refines the distinction between organizational SC levels, sharpening the links between SC and other variables. Moreover, the findings suggest that gossip is an antecedent of personal SC, and therefore it is beneficial to the individuals in organizations. Consequently, understanding the gossip role is an important supplement to the organizational study.

In practical terms, SC represents an important intangible asset to individuals, groups and organizations. A better understanding of SC components and their inter-relationships can improve organizational life and positively affect personal and organizational outcomes (Bhanthumnavin, 2003). Organizational leadership should learn how to reinforce intra-organizational SC as well as coordinate between personal SC and intra-organizational SC (Ben-Hador, 2018). This coordination should be accomplished throughout the employee's life cycle in the organization and ensured by HR (Lans *et al.*, 2016). For example, in recruitment of new employees, HR should assess which applicants have high personal SC, but also distinguish between those with high personal SC and those with the potential to possess high intra-organizational SC. This could be carried out by investigating previous employers. Personal and intra-organizational SC are generally reflected in the performance appraisal process (Ben-Hador, 2016a). As such, understanding differences between the two SC levels can help employees to more expertly navigate manager expectations, and thus act to the advantage of the organization. Moreover, manager appreciation of the fact that gossip is not necessarily negative and maybe a source of personal SC is also important. This insight may prevent unnecessary friction between employees and supervisors (Baker and Jones, 1996), provided that intra-organizational SC is strengthened. Investing in intra-organizational SC requires allocation of time and money (Adler and Kwon, 2002), however, this study proves that such a distribution of resources is profitable for organizations.

5.1 Limitations and future research directions

A noteworthy limitation in this research relates to the difficulty to fully differentiate between levels of SC in organizations. As noted, SC organizational levels are interdependent

and interrelated (Zhao and Roper, 2011). As such, it is far from simple to discern when one level starts overlapping with another, and such a risk exists between different levels (Ben-Hador, 2017). Another limitation is that the data were collected from five Israeli organizations in a specific field (aviation and shipping) and therefore it might harm generalizability, an additional limitation in this context is the unique character of the organizations that participated in the study, which emphasizes performance due to their low profit margins. It is possible that in other types of organizations, the influence on SC and gossip would be different. Moreover, it is possible that gossip is connected to contextual performance, but this hypothesis is still in need of confirmation. Further research on gossip in organizations, such as its impact on organizational performance, is merited as a means of shedding light on its influence and narrowing the research gap on gossip in organizations (Baker and Jones, 1996).

6. Conclusion

This work was informed by three research goals: first, to gain a more comprehensive understanding of employee performance antecedents; second, to distinguish between SC levels in organizations; and third, to evaluate the gossip variable and its impact on SC and employee performance. Addressing and providing answers to these issues support the view that investing in employees' SC is far from a waste of time and resources. In fact, it is a classic win-win situation for both employees, who gain a better social atmosphere and management, who receive higher levels of performance. Distinguishing between the SC levels enables more insight into the mechanisms and operations of SC in organizations. Focusing on the importance of gossip in organizations promotes a more realistic and productive approach to gossip. Managers who oppose close social ties in organizations tend to see gossip as a negative expression of social relations. However, this study attests that not only is gossip not necessarily negative, it supports SC in organizations.

Note

1. "Do not go about spreading slander among your people." Leviticus 19:16.

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A knowledge-based theory of the firm

Nexus of intellectual capital, productivity and firms' performance

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Abstract

Purpose – Drawing on the knowledge-based theory of the firm, the purpose of this paper is to examine the relationship between each facet of intellectual capital, productivity and firms' performance and further investigate, heretofore neglected, a mediating effect of productivity in the relationship between each facet of intellectual capital and firms' performance.

Design/methodology/approach – Data were garnered with a self-reported questionnaire from 232 firm managers working in various industries: banking, insurance, telecommunications and hotels. Reliability and validity of the instruments were confirmed using confirmatory factor analysis. Prior to hypothesis testing using structural equation modelling, as a caveat, tests for nonresponse bias and common method variance were employed.

Findings – The paper confirmed that intellectual capital is the pièce de résistance and established a strong connection with productivity. The results further disclosed a positive relationship between productivity and firms' performance. A mediated relationship between individual facets of intellectual capital and firms' performance through productivity was also affirmed.

Practical implications – Chiefly, the paper underscored the importance of intellectual capital in promoting productivity and firms' performance. It behoves human resource managers and practitioners to make the organisational arrangements to reinforce intellectual capital thereby boosting the productivity that brings organisations' success.

Originality/value – Previous studies in the sphere of intellectual capital have unequivocally discounted in establishing relationships between intellectual capital, productivity and firms' performance. The results of the paper are novel findings, unequivocally contributing to the frontiers of the knowledge-based theory of the firm and conjointly, the paper has made methodological and geographical contributions.

Keywords Intellectual capital, Productivity, Industries, Firms' performance

Paper type Research paper

Introduction

The conventional strategic options and managerial techniques that were successful are now inadequate in reaping competitive advantage in a dynamic environment featuring globalisation, technology advancement and instability of product lifecycles (Hayes *et al.*, 2005; Teece, 2007). As a response, the knowledge-based theory of the firm claims that knowledge-based resource, intellectual capital, is a central factor contributing to sustainable competitive advantage via lower cost, innovation and creativity, efficiencies and customer benefits and considered as a whole organisational performance (e.g. Asiaei and Jusoh, 2015; Crook *et al.*, 2011; Grant, 1996; Sardo *et al.*, 2018; Subramaniam and Youndt, 2005; Youndt and Snell, 2004; Zhang *et al.*, 2018). Consequently, research in the area of intellectual capital has paid significant attention to strategic human resource management, and more equal footing has been given to strategic management literature than before (e.g. Youndt and Snell, 2004; Wright *et al.*, 2001).

A consensus on the taxonomy of intellectual capital, namely, human capital, social capital and organisational capital, has been reached in recent studies (Adler and Kwon, 2002; Kostopoulos *et al.*, 2015; Youndt and Snell, 2004; Youndt *et al.*, 2004).

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Human capital is embedded in people, such as knowledge, skills, abilities and expertise, whereas social capital is the value that people gain via networks and relationship ties, and organisational capital is embedded in system, process, structure, culture, etc. (e.g. Nahapiet and Ghoshal, 1998; Youndt and Snell, 2004; Youndt *et al.*, 2004). Synthesising previous studies, intellectual capital is pivotal owing to its transferability across many firms, which creates a critical context in retaining talented people with superior intellectual capital (e.g. Frank and Obloj, 2014; Raffiee and Coff, 2016) and only a few research studies on intellectual capital have hitherto investigated organisational outcomes (see Crook *et al.*, 2011). The thrust of the notion is that the human-related concept should be linked to human-related outcomes, rather than the financial-related outcomes that have been strongly related to some other factors such as tangibles assets and infrastructure that an organisation possesses (see Grant, 1996). Previous studies have been skewed in explaining direct relationships between facets of intellectual capital and productivity (Asiaei and Jusoh, 2015; Mathew *et al.,* 2012; Sardo *et al.*, 2018). Therefore, the present study fills a void that has long been subject to wishful thinking.

Productivity and firms' performance are distinct concepts; nonetheless, the distinction between them has been heretofore overlooked in many earlier studies (see Bendickson and Chandler, 2019; Mathew *et al.,* 2012; Youndt and Snell, 2004). Rather, a piecemeal approach to establishing relationship between productivity and firms' performance has been made (e.g. Alsyouf, 2007; Grifell-Tatjé and Lovell, 1999; Mathew *et al.,* 2012); however, the findings are inconsistent (see Hitt and Brynjolfsson, 1996) and the relationship has also been made in a vacuum, without intellectual capital. Nonetheless, there is some, though insufficient, evidence towards making a firm conclusion about the relationship between productivity (efficiency and resource utilisation) and firms' performance, such as profitability, ROI, ROE, etc. (see Youndt and Snell, 2004). From that lens, the present study has paid attention in establishing a relationship between productivity and firms' performance. The conjecture is that superior labour pool, relationship ties and institutionalised knowledge are the key ingredients that would increase firms' performance through value creation (see Crook *et al.*, 2011; Grant, 1996) with learning, cooperation and innovation (Boxall, 1996). Therefore, this study contends that each facet of intellectual capital is instrumental in enhancing firms' performance through productivity.

The main aim of this paper is to investigate the relationship between intellectual capital and productivity and the mediating effect of productivity in the relationship between intellectual capital and firms' performance. Intellectual capital is unevenly sparse across employees and firms, and countries. Most the emergent countries in Asia are labour-intensive, such as India, China and Sri Lanka, where there is a serious lack of studies on intellectual capital. Therefore, this study focusses on one such disregarded country, Sri Lanka, to advance the theory of intellectual capital for a new area.

In a nutshell, disproportionately many of the earlier studies have focussed on the importance of operand resources for explaining firms' performance (e.g. Grant, 1996; Kristandl and Bontis, 2007; Kopelman *et al.*, 1990). Notwithstanding, drawing on the knowledge-based theory of the firm, this study introduces a complete, new model describing the influence of knowledge-based operant resource, intellectual capital, in explaining productivity and firms' performance. Succinctly, the present study chiefly contributes to the literature by establishing novel insights into the relationship between intellectual capital, productivity and firms' performance in three ways. First, the current study discloses a strong relationship between individual facets of intellectual capital and productivity. Second, productivity and firms' performance relationship is affirmed. Third, a mediating effect of productivity between each facet of intellectual capital and firms' performance is found. In addition to the above theoretical contributions, this study conjointly makes methodological and geographical contributions.

The study is based on robust theoretical, methodological and analytical methods that are discussed in consecutive sections. Lucidly, the remaining part of the paper proceeds as follows. First, the theoretical bases of the study are discussed and subsequently hinging on such theoretical ground, theoretical relationships among intellectual capital, productivity and firms' performance are expressed in terms of a set of hypotheses. The data and operationalisation are clearly delineated next. Anchored on strong philosophical assumptions, the study adopts a survey research strategy with a deductive approach over a cross-sectional time horizon. The study uses primary data that are garnered from 232 different firms' managers with a self-reported questionnaire using a respondent-driven snowball sampling technique. Then the results section describes data analysis in which the hypotheses are tested. The paper concludes with a discussion of results where contributions and implications of the study are made, limitations are acknowledged and suggestions for future directions are highlighted.

Theory and hypotheses

Drawing on the resource-based theory of the firm, identification and exploitation of strategic capabilities, such as resources and competencies, are strategically important sources of sustainable competitive advantage and firm success (Barney, 1986; Conner and Prahalad, 1996; Grafton *et al.*, 2010; Kristandl and Bontis, 2007; Liu, 2017; Takeuchi *et al.*, 2007; Wernerfelt, 1984). Despite a wide range of intangible and tangible assets such as employment of skilled personnel, brand names, in-house knowledge of technology, machinery, trade contacts, efficient procedures, capital, etc., intellectual capital (human and structural capital) has long been respected as a predominant subset of strategic resources (Kristandl and Bontis, 2007; Wernerfelt, 1984). So on firm grounds, a knowledge-based perspective of intellectual capital is a proximal concern of the resource-based theory of the firm (Conner and Prahalad, 1996).

Moving from the resource-based theory of the firm, more indicatively the knowledge-based theory of the firm focusses on the knowledge embedded in an individual employee and the firm overall, contrasting with the resource-based view of the firm that considers a firm's capabilities as the sources of competitive advantage (Barney, 1986; Grant, 1996). Remarkably, the knowledge-based theory of the firm is an outgrowth of the resource-based view of the firm, which constitutes that the utilisation of knowledge within the firm creates values through input to output transformation (Grant, 1996). Knowledge, intellectual capital, is the most pivotal strategic resource, addressing a wide range of fundamental aspects related to the theory of firm, including knowledge coordination within the firm, organisational structure, role of management, the theory of innovation and the like (Grant, 1996).

In earlier scholarly research works, intellectual capital was subsumed into human capital, structural capital (including organisational capital) and customer capital/relational capital; nonetheless, synthesising the previous works and the vantage of point of sociologists and organisational theorists, intellectual capital has now confined to three facets: human capital, social capital and organisational capital (Adler and Kwon, 2002; Kostopoulos *et al.*, 2015; Youndt and Snell, 2004; Youndt *et al.*, 2004). All these three facets of intellectual capital are more akin to the characteristics of knowledge as discussed in the knowledge-based theory of the firm (see Grant, 1996). Human capital explains the employee's knowledge, skills, abilities and expertise, whereas social capital ascribes the values of knowledge derived from employees' networks and relationship ties and consequently, social capital is sometimes referred to as relational capital (see Adler and Kwon, 2002; Coff, 2002; Youndt *et al.*, 2004). In contrast, organisational capital is the institutionalised knowledge in the organisation's own systems, processes, manuals, tools, structure, patents, culture, policies, etc., and consequently such organisational

capital is sometimes called structural capital (e.g. Nahapiet and Ghoshal, 1998; Youndt and Snell, 2004; Youndt *et al.*, 2004).

In strategic human resource management literature, performance is predominantly an overriding factor (Richard *et al.*, 2009), sporadically related to intellectual capital (see Gambardella *et al.*, 2013). Although performance has been measured with various indicators including ROI, ROE, Tobin's *q*, profitability, operational performance and the like (e.g. Mathew *et al.*, 2012; Wall *et al.*, 2004), the present study closely focusses on productivity and firms' performance (financial) as the two distinct key parameters (e.g. Alsyouf, 2007; Bendickson and Chandler, 2019; Combs *et al.*, 2005; Mathew *et al.*, 2012). As discussed earlier, the knowledge-based theory of the firm acknowledges that knowledge creates value via transformation of inputs into outputs, which is what we called productivity (see Grant, 1996). Concisely, productivity is efficiency in production, often expressed as an input–output relationship (Kopelman *et al.*, 1990; Syverson, 2011). Therefore, productivity is the internal efficiencies (input to output transformation); however, the financial performance is affected by both internal efficiencies and environmental factors such as competition (see Kopelman *et al.*, 1990). Ironically, measurement of productivity is an issue across a wide use of technology, multi-production companies (more than one product), labour measures (number of employees or number of employee-hours/wage bill, etc.) and service organisations (Syverson, 2011). For instance, the productivity in service organisations primarily considers the best use of capabilities, the right use of resources and cost efficiencies (e.g. Mathew *et al.,* 2012).

Intellectual capital and productivity

The first dimension of the intellectual capital is the human capital, the stock of employee knowledge, skills and abilities (Wright *et al.*, 2001). One of the characteristics of knowledge is appropriability, explaining the value that is created by the knowledge (Grant, 1996). The knowledge-based theory of the firm maintains that knowledge cannot be directly transferred in quantifiable terms, but as primarily all human productivity is dependent on knowledge, the appropriability of knowledge is attained through its application to productive activity (Grant, 1996). Moreover, better human capital can induce robust planning, problem-solving and troubleshooting that increase production efficiencies and thereby, enhance organisational efficiencies (Boxall, 1996; Youndt and Snell, 2004). Therefore, employees with superior human capital are more creative: perform a variety of tasks, exhibit effective workplace behaviour, efficient completion of standardized work and go the extra mile beyond the roles specified in the job description (e.g. Andriopoulos and Lewis, 2009; Birkinshaw and Gibson, 2004; Turner and Lee-Kelley, 2013). Consequently, it can be adduced that employees with significant human capital contribute to a high level of productivity by reducing inputs and increasing utilisation of resources that ends in lowering the production cost (see Youndt and Snell, 2004). Therefore, the present study assumes that the critical input is knowledge for value creation (see Grant, 1996; Liu, 2017) and employees with superior human capital outperform others, leading to greater productivity (see Crook *et al.*, 2011). Thus it can be hypothesised:

H1a. Human capital will be positively related to productivity at work.

In general, the production or output of a firm requires the integration of many people's knowledge (Grant, 1996). The social capital is the form of knowledge integration that induces productivity by synthesising collective information and ideas through internal–external ties (firm employees, customers, suppliers, etc., see Adler and Kwon, 2002; Kang and Snell, 2009). In the same vein, the corollary of knowledge created through relationships and networks with other employees, customers, suppliers and other parties can help process innovation and problem-solving that increase production efficiency (Youndt and Snell, 2004; Zhang *et al.*, 2018).

Moreover, organisations leverage a broad pool of knowledge through a transfer of knowledge via open communication among members, both compatible and opposing views, and ideas unequivocally lead to efficient utilisations (Gibson and Birkinshaw, 2004; Reagans and McEvily, 2003; Youndt and Snell, 2004). For instance, most recent studies suggest that informal networks and network ties among organisational members can have a positive impact on productivity (Cai and Du, 2017; Subramony *et al.*, 2018; White *et al.*, 2016). Therefore, it can be posited that employees with high social capital will fuel productivity, leading to pose a hypothesis:

H1b. Social capital will be positively related to productivity at work.

The third form of intellectual capital, organisational capital, is institutionalised knowledge that an organisation owns providing cost efficiencies to the organisation (Youndt and Snell, 2004). Such cost efficiencies can be reinvigorated by repeatedly minimising mistakes, and better utilisation of knowledge and information processing (Youndt and Snell, 2004). For instance, stored knowledge on customers' information helps to identify oscillating customer preferences, needs, behaviour, etc., over a period of time, and thereby an organisation can deploy its resources in a better way to retain their strategic customers. Therefore, organisational capital is somewhat similar to the coordination characteristics of the knowledge articulated in the knowledge-based theory of the firm: organisational structure, rules and directives and cultures. The organisational structure is the internal structure of a firm explicating the role of the hierarchy and the location of decision-making, facilitating access and integration of tacit knowledge of its employees and the sharing, distribution and creation of knowledge (Grant, 1996; Kannan and Aulbur, 2004). The rules and directives portray the standards and the exercise of authority that regulate interactions between individuals in forms of etiquette, politeness and social norms (Grant, 1996). The knowledge-based theory of the firm assumes that such rules and directives are in place to promote knowledge integration, epitomised by meshing together the knowledge into a production system to bolster the efficient use of resources (e.g. standard operating procedures and rules). The culture is about the shared values, beliefs and practices of the people who contain worthy ideas, make their voices heard and embody ways of doing business (e.g. Kannan and Aulbur, 2004; Youndt *et al.*, 2004). Succinctly, the organisational structure, rules and directives, and cultures exist to enhance integration of knowledge that creates values for the firm through input to output transformation (see Grant, 1996). Consequently, the present study postulates another hypothesis:

H1c. There will be a positive relationship between organisational capital and productivity at work.

Intellectual capital, productivity and firms' performance

Knowledgeable workers are instrumental in improving productivity and thereby, make a tremendous impact on firm performance by reducing costs, increasing product reliability and creating customer value (Youndt and Snell, 2004). In a similar vein, social capital can increase customer value and satisfaction, quality, reliability and flexibility through productivity and consequently, such outcomes would increase firms' performance, such as sales, profitability, growth, etc. (Subramony *et al.*, 2018; Youndt and Snell, 2004). Similarly, the organisational capital contributes to productivity and thereby, productivity leads to the firms' performance by satisfying customers' needs that would be expected to increase sales, profitability, growth, etc. (see Youndt and Snell, 2004). There is compelling evidence for a mediating role of the relationship between intellectual capital and firms' performance in past research studies. For example, recently, Kostopoulos *et al.*'s (2015) findings with a sample of 58 US Fortune 500 firms affirmed that intellectual capital contributes to the unit performance (measured in profit terms) through unit ambidexterity. Another recent study

examined how operational performance affects the financial performance of organisations with a sample of 30 Major League Baseball organisations (Bendickson and Chandler, 2019). They measured the operational performance in terms of the number of times a team wins the game and the financial performance based on revenue and ticket sales. The focus on productivity is somewhat similar to the operational performance and the financial performance is more akin to firms' performance (see Bendickson and Chandler, 2019). In a similar pattern, Crook *et al.* (2011) found that the relationship between human capital and firms' performance was mediated by operational performance such as customer service satisfaction or innovation. Further, FitzRoy and Kraft (2005) submit that the firm with increased productivity is successful in the market. A review of earlier studies concede that firm performance is mostly determined by internal and external factors such as tangible assets, competition, infrastructure and technology (see Beheshti and Beheshti, 2010; Grant, 1996; Kopelman *et al.*, 1990). Nevertheless, superior human capital, exploiting the routines and organisational structure, which may make employees more productive at work does not guarantee superior organisational performance (see Frank and Obloj, 2014). From the point of departure, it is imperative to understand how much variance in firm performance is explained by the productivity. In what follows, the present study contends that productivity directly and indirectly influences firms' performance. Hence, it is hypothesized that:

H2a. There is a positive relationship between productivity and firms' performance.

H2b. Productivity will mediate the relationship between facets of intellectual capital and firms' performance.

Data and operationalisation

Subjects and data collection

Since managers work closely with target performance and have autonomy in operating decisions and superior organisational knowledge and awareness of intellectual capital in generating profitable business (e.g. Frank and Obloj, 2014; Tayles *et al.*, 2007), they were felicitous for this study. Focussing on different types of industries maximises the variance of the variables and increases the generalisability of the findings (Youndt and Snell, 2004; Youndt *et al.*, 2004). The present study surveyed 232 different firms' managers across four service industries operating in Sri Lanka: banking, insurance, telecommunications and hotels. Owing to the data not being obtained through the public domain and it being hard to access the desired respondents, this study employed a respondent-driven snowball sampling (referral sampling) that builds on the contacts of managers in different organisations. The respondent-driven snowball sampling has been widely used in business and organisation research studies to glean data from a variety of firms and industries (e.g. Martins *et al.,* 2002; Powell and Greenhaus, 2010; Tepper, 1995) and gives the advantage of high response rates (Raineri, 2017). Meticulous care on statistical assumptions and analysis (examination of normality, nonresponse bias and common method variance (CMV)) has been paid to minimise the potential bias of this non-probability sampling technique, thereby maximising the generalisability of the findings (Hair *et al.*, 2014).

The data were garnered through a self-reported questionnaire. Out of 348 questionnaires issued, 236 were received, yielding a response rate of 67.8 per cent. Nonetheless, four respondents did not answer the important questions and thus they were discarded, so 232 questionnaires were used for this study. The data collection took place over the course of four months. Respondents were predominantly male managers, 61.6 per cent ($n = 143$), and the remaining 38.4 per cent were female managers ($n = 89$). The managers, on average, had 16.55 years (SD = 3.17) of job tenure with 6.73 years (SD = 3.12) of supervisory experience

with their current employer. Ages of respondents were measured using five consecutive scales from a minimum of 18 years to a maximum of over 55 years. The average age of respondents fell between 40 and 50 years (SD = 8.64). As for the marital status of the respondents, 12 per cent of them were single ($n = 28$), 85 per cent were married ($n = 197$), and the remaining 3 per cent were widowed ($n = 7$). The vast majority of the managers were well qualified, possessing master's degrees (71.8 per cent), bachelor degrees (82.2 per cent) and other professional qualifications (23.5 per cent). The average working hours per week of the managers was 45.40 (SD = 3.1), which is similar to that found in developed countries, such as 43.5 h for men working in the UK (Cousins and Tang, 2004).

Measures

Subjective measures are commonly used to measure people's involvement, organisational processes, employee performance and the like (e.g. Kannan and Aulbur, 2004). Notably, consistency was proven between subjective and objective measures of performance in previous studies, despite the objective measures being less prone to respondent bias (Sharabati *et al.*, 2010; Venkatraman and Ramanujam, 1986). Crook *et al.*'s (2011) study of a meta-analysis of the relationship between human capital and firm performance averred the use of subjective measures for human capital and firm performance across many studies. On firm ground, the current study employed subjective measures for all variables (e.g. Asiaei and Jusoh, 2015).

Intellectual capital

The multidimensional scale of intellectual capital originally developed by Youndt and colleagues was employed (Subramaniam and Youndt, 2005; Youndt and Snell, 2004; Youndt *et al.*, 2004). All 14 items measuring human capital (five questions), social capital (five questions) and organisational capital (four questions) are depicted in Table I. All questions were measured on a five-point Likert scale ranging from strongly agree (5) to strongly disagree (1). In reference to Table I, an example of each facet is "our employees are highly skilled" (human capital), "our employees share information and learn from one another" (social capital) and "our organisation's culture (stories, rituals) contains valuable ideas, ways of doing business, etc. (organisational capital). The Cronbach's αs for human capital, social capital and organisational capital were 0.94, 0.93, and 0.93, respectively (see Table II).

Productivity

Productivity is usually measured in quantitative terms by dividing units of output by units of input; nonetheless, such a measure is not appropriate for service and other types of organisations except manufacturing (e.g. Mathew *et al.,* 2012; Patterson *et al.*, 2005). The present study employed a subjective measure of productivity with resource utilisation and efficiency scale (see Mathew *et al.,* 2012; Patterson *et al.*, 2005). The resource utilisation was measured using a three-item scale borrowed from Mathew *et al.* (2012). Table I presents items included in the study. For example, a sample item is "this organisation makes the best use of the capabilities of its employees". The four-item efficiency scale was adapted from the popular organisational climate measure (Patterson *et al.*, 2005). As shown in Table I, an example item for the efficiency includes "Things could be done much more efficiently if people stopped to think". All questions were measured on a five-point Likert scale ranging from strongly agree (5) to strongly disagree (1). The internal consistency for productivity is $\alpha = 0.95$ (see Table II), indicating a strong reliability of the instrument used.

Items	Factors PR	HC	SC	OC	FP	COM
Our organisation makes the best use of the capabilities of its employees (PR2)	0.93					0.86
Right people are deployed at right jobs (PR1)	0.92					0.84
Resources are put to the best use in our organisation (PR4)	0.90					0.80
Time and money could be saved if work were better organised (PR5)	0.89					0.80
Things could be done much more efficiently, if people stopped to think (PR3)	0.89					0.82
Poor scheduling and planning often result in targets not being met (PR6)	0.85					0.75
Productivity could be improved if jobs were organised and planned better (PR 7)	0.82					0.68
Our employees are highly skilled (HC1)		0.96				0.92
Our employees are experts in their particular jobs and functions(HC2)		0.94				0.89
Our employees are creative and bright (HC3)		0.92				0.85
Our employees develop new ideas and knowledge (HC4)		0.91				0.84
Our employees are widely considered the best in our organisation (HC5)		0.82				0.79
Our employees share information and learn from one another (SC2)			0.96			0.93
Our employees are skilled at collaborating with each other to diagnose and solve problems (SC1)			0.92			0.85
Our employees partner with customers, suppliers, alliance partners, etc., to develop solutions (SC3)			0.91			0.83
Our employees interact and exchange ideas with people from different areas of the organisation (SC5)			0.91			0.82
Our employees apply knowledge from one area of the organisation to problems and opportunities that arise in another (SC4)			0.74			0.56
Our organisation's culture (stories, rituals) contains valuable ideas, ways of doing business, etc. (OC1)				0.95		0.94
Our organisation embeds much of its knowledge and information in structures, systems, and processes (OC4)				0.94		0.90
Our organisation uses patents and licences as a way to store knowledge (OC3)				0.91		0.83
Much of our organisation's knowledge is contained in manuals, databases, etc. (OC2)				0.84		0.71
Overall firm performance/success (FP2)					0.90	0.83
How does the profit in comparison to your main competitors (FP4)					0.82	0.67
How does the achievement of sales target (FP5)					0.80	0.64
How does the growth of net profit over the last three years (FP1)					0.79	0.67
How does the growth rate of sales (FP3)					0.78	0.62
						Total
Eigenvalues – PCA	5.86	4.33	4.01	3.35	3.10	
Eigenvalues – Parallel analysis	1.67	1.56	1.49	1.41	1.36	
Percentage of variance	22.56	16.64	15.43	12.89	11.91	79.43

Notes: $n = 232$. Extraction method: principal component analysis; Rotation method: oblimin with Kaiser normalisation. Rotation converged in four iterations: PR, productivity; HC, human capital; SC, social capital; OC, organisational capital; FP, firm's performance; COM, communality; Model fit indices (CFA): $\chi^2(290) = 566.90$, $p < 0.05$; CMIN/DF (1.95); CFI = 0.96; TLI = 0.95; PCLOSE = 0.90; RMSEA = 0.05; SRMR = 0.04

Table I. Results of exploratory factor analysis

Firms' performance

Owing to the industry variations and the influence of tangible assets, researchers in HR prefer to use subjective measures, and there is compelling evidence that subjective measures are on equal footing with objective measures (Delaney and Huselid, 1996; Govindarajan, 1988;

Mathew *et al.,* 2012; Venkatraman and Ramanujam, 1986; Wall *et al.*, 2004; Youndt *et al.*, 1996). Remarkably, a considerable number of seminal studies have confirmed a strong correlation between objective and subjective measures of firm performance (see Dawes, 1999; Sharabati *et al.*, 2010; Venkatraman and Ramanujam, 1986; Wall *et al.*, 2004). For instance, a seminal study of Wall *et al.* (2004) has irrefutably confirmed from three separate samples taken from UK companies that findings arrived at on the basis of subjective measures of firm performance will not be erroneous conclusions. Moreover, detailed information on financial performance for the current study is not readily available. On these grounds, a subjective measure was used to gauge firms' performance. The items included are shown in Table I: "Overall firm performance/success", "How does the profit in comparison to your main competitors", "How does the achievement of sales target", "How does the growth of net profit over the last three years", "How does the growth rate of sales?" (Dess and Robinson, 1984; Mathew *et al.*, 2012; Wall *et al.*, 2004). The respondents were asked to rate those statements using a five-point Likert scale ranging from 1 (poor) to 5 (outstanding). The study shows a strong internal consistency for the firms' performance $\alpha = 0.88$ (see Table II).

Controls. The present study controlled for firm size, firm age and the number of employees (FitzRoy and Kraft, 2005; Kostopoulos *et al.*, 2015; Takeuchi *et al.*, 2007). The types of industry were also controlled to negate potential industry effects (1 – telecommunications and hotels; 2 – banking and insurance) (e.g. Takeuchi *et al.*, 2007). As for firm size, managers were asked to indicate the size of their firms as either small or large). The sample encompasses: 135 small firms, 97 large firms, 144 banking and insurance firms, and 88 telecommunication and hotel firms.

At the outset, the questionnaire was pilot-tested with a small number of managers ($n = 12$) to ensure the questions measure what is intended to be measured and the clarity of the questions. The results of the pilot test did not give any serious concerns; nonetheless, a few questions were modified in response to the pilot-test feedback.

Results

Prior to executing hypothesis testing, as a caveat, the fundamental statistical assumptions for parametric tests were examined. Albeit the large sample size (> 200) negates detrimental effects of the violation of assumptions for multivariate analysis (e.g. Hair *et al.*, 2014), the study confirmed that univariate skewness (max. 1.46) and kurtosis (max. 3.08) were below the maximum thresholds (skew < 2, kurtosis < 7; Byrne, 2016) and Mardia's coefficient of 3.26 is indicative of multinormality of the data set (recommended < 5; Byrne, 2016). In addition, the value of the Durbin–Watson test is 1.89 explaining that any errors in the regression are independent (acceptable range between 1 and 3; Hair *et al.*, 2014). In the next stage, the response rate of 67.8 per cent warranted an examination of nonresponse bias (e.g. Dooley and Lindner, 2003); however, the response rates were well

Table II. Means, standard deviations, scale alphas, and bivariate correlations

	M	SD	1	2	3	4	5	6	7
(1) Firm size	1.42	0.49	–						
(2) Industry	1.62	0.47	0.13*	–					
(3) Human capital	3.98	0.62	0.05	0.03	*(0.94)*				
(4) Social capital	3.89	0.66	0.21*	0.10*	0.05	*(0.93)*			
(5) Organisational capital	3.88	0.72	0.23*	0.03*	0.19*	0.05	*(0.93)*		
(6) Productivity	3.96	0.35	0.37*	0.04	0.21*	0.58**	0.67**	*(0.95)*	
(7) Firms' performance	3.90	0.63	0.12*	0.01	0.14*	0.27**	0.27**	0.43**	*(0.88)*

Notes: $n = 232$. SD, standard deviation; Cronbach's α are shown in parenthesis. Firm size: 1 = Small, 2 = Large; Industry: 1 = telecommunication and hotels, 2 = banking and insurance. *$p < 0.05$; **$p < 0.01$

above those in similar studies (e.g. Asiaei and Jusoh, 2015; Mathew *et al.*, 2012). The investigation of nonresponse bias was examined with a "surrogate" method (Wallace and Mellor, 1988) using the *t*-test for independent samples. The results did not find any significant difference ($p > 0.05$) between early (treated 15 per cent of first received, $n = 35$) and late responses (treated 15 per cent of last received, $n = 35$) indicating the nonresponse bias is not problematic. Consequently, the results of the study can be generalisable without any caveats. Since gathering data using a single-sourced, self-reported questionnaire is a portent of CMV, the present study initially ensured procedural remedies suggested by Podsakoff *et al.* (2003): anonymity through de-identification, confidentiality and anonymous returns in data collection, translated version of the questionnaire (respondents' own language), and early stage of pilot study. Further, the commonly used Harman one-factor test was also employed for examining whether a single factor constitutes the majority of the covariance (Podsakoff *et al.*, 2003). Consequently, an unrotated factor analysis was performed and the results revealed a five-factor solution (based on the eigenvalues greater than 1, parallel analysis, and the scree plot) and the first factor accounted for 21 per cent of the variance. Following an exploratory factor analysis (EFA), all variables were loaded onto a single factor for employing a confirmatory factor analysis (CFA). Nonetheless, the single factor generated a poor fit ($\chi^2 = 5{,}232.55$ (df = 299), $p = 0.00$; CFI = 0.25; GFI = 0.37; RMR = 0.16; RMSEA = 0.27; SRMR = 0.25). Therefore, CMV is not a serious problem.

An EFA and a CFA were executed for all three measures, as suggested by Bagozzi and Foxall (1996). The measures of three facets of intellectual capital, productivity and firms' performance were all originally developed in culturally dissimilar countries (see Dess and Robinson, 1984; Mathew *et al.,* 2012; Youndt *et al.*, 2004) and therefore, as a caveat, before applying the questionnaire, it is important to confirm the factor structure (e.g. Bagozzi and Foxall, 1996). The 26 items measuring intellectual capital, productivity and firms' performance were subjected to principal component analysis (PCA) with oblique rotation with direct oblimin. The Kaiser–Meyer–Olkin (KMO) is 0.80, exceeding the minimum recommended value of 0.6 and Bartlett's test of sphericity χ^2 (325) = 6,616.54, $p < 0.01$ is significant.

As can be seen in Table I, five components had eigenvalues over Kaiser's criterion of 1 together explaining 79.43 per cent of the variance. Inspection of the scree plot (a clear break after the sixth component) and parallel analysis with 200 replications (the five components have eigenvalues exceeding the corresponding criterion value of the parallel analysis) supports the retention of five factors. Following the EFA, an integrated CFA was executed (see Table AI). The results indicate a good fit model: χ^2 (290) = 566.90, $p < 0.05$; CMIN/DF = 1.95; CFI = 0.96; TLI = 0.95; PCLOSE = 0.90; RMSEA = 0.05; SRMR = 0.04. Next, the psychometric properties of the model were assessed (see Table AI): the reliability and convergent validity were examined with the composite reliability (CR), the average variance extracted (AVE) and factor loadings. In the current study, the AVE exceeded the 50 per cent rule of thumb, the lowest AVE is 0.60, the CR is greater than 0.70 and highly significant factor loadings are all indicative of strong reliability and convergent validity of the instruments (see Hair *et al.*, 2014). For the discriminant validity, there should be reasonable factor correlations between factors and the AVE should be greater than the maximum shared variance (MSV) and the average shared variance (ASV) (see Hair *et al.*, 2014). The results show reasonable correlations between factors (see Table II), and MSV < AVE and ASV < AVE that are indicative of strong discriminant validity (see Table AI).

The values of mean, standard deviation and inter-correlation between seven variables are presented in Table II.

The table discloses mean value for all variables are very close to 4 indicating the majority of the respondents agreed with each statement. As can be seen in Table II, organisations possess a greater amount of human capital ($M = 3.98$, SD = 0.62), followed by social capital

($M = 3.89$, SD $= 0.66$) and organisational capital ($M = 3.88$, SD $= 0.72$). Similarly, productivity ($M = 3.96$, SD $= 0.35$) and the firms' performance ($M = 3.90$, SD $= 0.63$) were also at a high level indicating strong performance in general. As expected, inter-correlation between facets of intellectual capital and productivity were statistically significant: organisational capital and productivity ($r = 0.67$, $p < 0.01$), social capital and productivity ($r = 0.58$, $p < 0.01$) and human capital and productivity ($r = 0.21$, $p < 0.05$). Similarly, firms' performance was also significantly related to each facet of intellectual capital and productivity (see Table II).

The results of the multiple hypothesis testing are displayed in Figure 1. However, as can be seen in the path diagram, control variables are not displayed for simplicity, and procedures are in line with Richardson and Vandenberg (2005). As discussed earlier, firm age, number of employees, firm size and type of industries were all controlled for negating potential impact on the study variables. The results disclosed a non-significant impact of firm age on productivity ($\beta = 0.01$, $p > 0.05$) and firms' performance ($\beta = 0.09$, $p > 0.05$). In a similar vein, the number of employees working was not significant with both productivity ($\beta = 0.01$, $p > 0.05$) and firms' performance ($\beta = 0.05$, $p > 0.05$). Nonetheless, the firm size was significantly related to both productivity ($\beta = 0.03$, $p < 0.05$) and firms' performance ($\beta = 0.40$, $p < 0.05$). Similarly, types of industries were significant with productivity ($\beta = 0.03$, $p < 0.05$); however, it did not impact firms' performance ($\beta = 0.01$, $p > 0.05$).

H1a which surmised that human capital will be positively related to productivity at work was supported. The path coefficient between human capital and productivity is significant ($\beta = 0.05$, $t = 3.05$, $p < 0.01$) indicating that human capital has a positive impact on productivity. Similarly, *H1b* that predicted that social capital will be positively related to productivity at work was supported, the path coefficient was also significant: $\beta = 0.32$, $t = 22.91$, $p < 0.01$). Further, there is a significant path coefficient between organisational capital and productivity ($\beta = 0.33$, $t = 24.73$, $p < 0.01$) and thus *H1c* was also supported. Noticeably, intellectual capital accounted for 83.6 per cent of productivity. *H2a* was formulated to investigate the relationship between productivity and firms' performance. The results revealed a significant path correlation between productivity and firms' performance ($\beta = 0.77$, $t = 7.28$, $p < 0.01$) and consequently, *H2a* was supported.

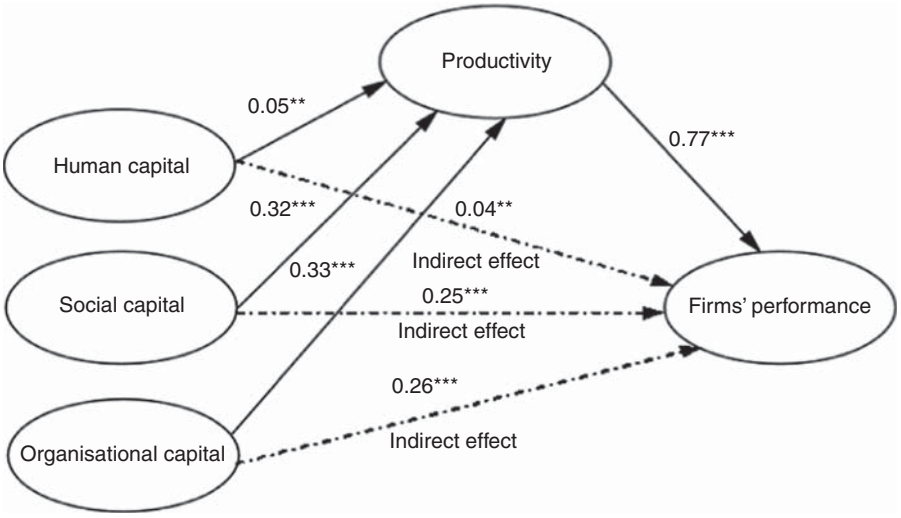

Figure 1.
Results of the model

Notes: $^{**}p<0.01$; $^{***}p<0.001$

Next, mediating *H2b* propose that productivity will mediate the relationship between facets of intellectual capital and firms' performance was examined. The mediating hypothesis is generally supported if the overall model fit would not be better fit by the additional direct paths from three facets of intellectual capital to firms' performance (Model 3, see Table IV). The results further showed that the direct paths were not significant for all facets of intellectual capital to firms' performance: human capital to firms' performance ($\beta = 0.07$, $t = 1.03$, $p = 0.30$); social capital to firms' performance ($\beta = 0.03$, $t = 0.25$, $p = 0.80$) and organisational capital to firms' performance ($\beta = 0.01$, $t = 0.08$, $p = 0.94$), and the path coefficients between three facets of intellectual capital and productivity, and between productivity and firms' performance remained significant. In addition, for robustness, mediation analysis was examined with 1,000 bootstrap samples, as advised by Cheung and Lau (2008). The results are presented in Table III. Integrating the analyses, results confirmed all three facets of intellectual capital impacted the firms' performance via productivity and thus *H2b* was supported.

Finally, four models were examined to ensure the extent to which the data supported the proposed model. As can be seen in Table IV, the proposed mediated Model 3 was very well fitted to the data in comparison with alternative models: χ^2 (3) = 1.12, $p = 0.77$; CMIN/DF = 0.37; CFI = 1.00; TLI = 0.99; RMSEA = 0.000; SRMR = 0.02.

Discussion

The current study primarily focussed on intellectual capital and its relationship with productivity and firms' performance. The results disclosed that firms have a high level of human capital, followed by social capital and organisational capital (see Table II); nevertheless, the mean difference between each facet of intellectual capital was very small. The findings are not consistent with previous studies, for example, studies carried out in developed countries found that social capital is predominant, and followed by human capital and organisational capital (see Youndt and Snell, 2004). The current study primarily focussed on intellectual capital and its relationship with productivity and firms' performance. The results disclosed that firms have a high level of human capital, social capital and

	Indirect effect	SE	95% confidence intervals Upper	Lower	Sig.
Human capital→Productivity→Firms' performance	0.04	0.02	0.07	0.02	0.003
Social capital→Productivity→Firms' performance	0.25	0.06	0.34	0.16	0.002
Organisational capital→Productivity→Firms' performance	0.26	0.06	0.34	0.16	0.002

Notes: 1,000 bootstraps samples were used. Two-tailed significance

Table III. Mediation analysis via bootstrapping

Structural model	$\sum^2$ ($n = 232$)	df	$\sum^2$/df	$\Delta\sum^2$	Δdf	CFI	GFI	TLI	RMSEA	SRMR
Model 1	23.10*	4	5.78	–		0.96	0.96	0.90	0.14	0.09
Model 2	15.53*	3	5.21	7.57	1	0.97	0.97	0.94	0.14	0.10
Model 3	1.12	3	0.37	21.98	1	1.00	1.00	0.99	0.00	0.02
Model 4	15.63*	3	5.21	7.47	1	0.97	0.98	0.91	0.14	0.09

Notes: Model 1, direct and indirect relationship between intellectual capital and productivity and firms' performance; Model 2, direct relationship between intellectual capital and productivity; Model 3, relationship between intellectual capital (correlated) and firms' performance through productivity; Model 4, direct relationship between intellectual capital and productivity and firms' performance

Table IV. Model comparison

organisational capital in that order (see Table II); nevertheless, the mean difference between each facet of intellectual capital was very small. The findings are not consistent with previous studies, for example, studies carried out in developed countries found that social capital is predominant, followed by human capital and organisational capital (see Youndt and Snell, 2004). The high level of human capital found in the current study can be attributed to the country-specific factors. For instance, Sri Lanka is a rapidly developing economy, with a good level of literacy, a high level of education and high level of unemployment rate which engender an abundant supply of highly skilled, creative and innovative labour force which could foster human capital (see Department of Census and Statistics, 2016). In a similar vein, strong network ties (guanxi) and a high level of trust that have been found in Asian contexts could be a good cause for the extant high level of social capital (see Burt *et al.*, 2018; Cai and Du, 2017; Subramony *et al.*, 2018). Further, the study evinces that Sri Lankan firms have a strong organisation-owned institutionalised knowledge, such as organisational structure, culture, databases, systems and processes.

The present study invoked the knowledge-based theory of the firm to explain the nexus of intellectual capital, productivity and firms' performance, where the conceptualisation that three facets of intellectual capital as an antecedent of productivity and productivity, in turn, contributed to the firms' performance has been heretofore overlooked in the literature (e.g. Asiaei and Jusoh, 2015; Mathew *et al.,* 2012). The results of the study affirmed a positive relationship between human capital and productivity. The findings are in congruence with the knowledge-based theory of the firm that superior human capital can be instrumental in creating value that would enhance resource utilisation and production efficiencies (see Grant, 1996). In a similar vein, results for social capital, the employees' knowledge through close internal–external ties with other employees, customers, etc., revealed a significant impact on productivity, congruent with the theoretical works of Grant (1996). As expected, the organisational capital influenced the productivity of the employees. Succinctly, organisation-owned institutionalised knowledge, such as organisational structure, culture and the like, can contribute to efficiency in production (see Youndt and Snell, 2004). In a nutshell, the relationship between each facet of intellectual capital and productivity is statistically significant, turning the wishful thinking of such relationship into proven fact that contributes to the knowledge-based theory of the firm by filling the gap.

The study confirmed that the relationship between productivity and firms' performance is significantly positive, indicating that productivity increases firms' performance. Only a few studies have looked at intellectual capital and organisational performance; nonetheless, those studied overlooked the differences between productivity and firms' performance (e.g. Sharabati *et al.*, 2010). In that conjecture, the earlier research studies in the sphere of intellectual capital have unequivocally discounted distinguishing the significant difference between productivity and firms' performance (see Youndt and Snell, 2004; Youndt *et al.*, 2004). This study, therefore, has made another unique contribution by segregation of productivity and firms' performance, heretofore overlooked in the intellectual capital literature.

Predominantly, this study found a mediating relationship between each facet of intellectual capital and firms' performance through productivity, totally disregarded in previous studies. The knowledge-based theory of the firm argues that intellectual capital can incubate a more productive environment, contributing to creativity and innovation, quality of the product, product efficiencies (low cost), satisfying the compelling desire of the customer etc. that would lead the firms' financial performance (see Crook *et al.*, 2011; Grant, 1996). Until now, a similar pattern of mediating the relationship between intellectual capital and unit performance through unit ambidexterity has been proved (Kostopoulos *et al.*, 2015). Therefore, the result, integration of intellectual capital, productivity, and firms' performance, is a novel finding contributing to the knowledge-based theory of the firm in general.

Remarkably, the present study made a methodological contribution by validating the measures developed in a diverse cultural context, negating the invocation of the criticism of the consistent application of the measurement developed in a particular cultural context (see Hassan *et al.*, 2010). The findings of the study have confirmed the psychometric properties of the intellectual capital scale, productivity scale and firm performance scale and consequently, the scales developed in a particular culture have had an exercise of its applicability beyond that culture, without any caveat. Last but not least, this study has made a geographical contribution as the study unearthed the relationships by focussing on a labour-intensive country, heretofore neglected Sri Lanka.

Managerial implications, limitations and future directions

A positive significant relationship between human capital and productivity implies that a high level of human capital accounted for a high level of productivity, such as resource utilisation and production efficiencies. Moreover, employees with excellent human capital show more effective work behaviour and perform multi-tasks and take extra responsibilities (e.g. Andriopoulos and Lewis, 2009; Birkinshaw and Gibson, 2004). As a result, the present study suggests that organisations should focus on recruiting employees with superior human capital such as knowledge, skills, ability and experience (Wright *et al.*, 2001) and engage with a stream of human capital development programmes such as training and development (Bendickson and Chandler, 2019; Zhang *et al.*, 2018), high performance work systems (Takeuchi *et al.*, 2007) and leadership (Subramony *et al.*, 2018) for developing human capital. Therefore, it behoves managers and practitioners to make the internal organisational arrangements to develop and retain superior human capital for an effective production system. On the contrary, the pièce de résistance of person–environment fit submits that employees with the perception of high human talents would result in voluntary turnover behaviour, job dissatisfaction and poor affective commitment (Maynard and Parfyonova, 2013). Since a superior labour pool is more widespread in developing countries (Gorg and Strobl, 2003), managers and practitioners, theretofore, should be vigilant and devise strategies to negate haemorrhage of superior labour from their organisations.

Moreover, since social capital is firmly related to productivity, managers should induce interpersonal and network linkage across employees, customers, suppliers and other stakeholders within and outside of the organisation to enhance productivity. For instance, recent studies supported the notion that acquiring and integrating supplier knowledge (Zhang *et al.*, 2018) and informal network ties promote individual performance (Cai and Du, 2017). In addition, since guanxi ties (strong ties) hinge on trust among members (see Burt *et al.*, 2018), managers should advocate a trusting atmosphere to promote social capital in their organisations. Similarly, the manager should also ensure that the structure, culture, databases, systems and processes of the organisation are more effective to improve productivity. For example, information systems and databases that hold knowledge automatically and systematically promote the application of the knowledge in product development (Zhang *et al.*, 2018). Notably, earlier managers have considered that only tangible assets and the infrastructure of the firms contribute to the financial performance (e.g. Kristandl and Bontis, 2007) and consequently, such an inclination has been supplanted by this research. As a result, managers need to give attention to intellectual capital on an equal footing with tangible assets. Further, as this study has validated the intellectual capital measure, productivity measure and firm performance measure developed in another culture, managers can use the same measures without any caveat. Finally, competing firms are watching like a hawk to poach employees with superior intellectual capital, which is a catastrophe for the targeted firm; for example, when employees with strong network ties are recruited by other competing firms, the targeted firm would suffer from the haemorrhage of qualified people and possible loss of other valuable colleagues (the Pied Piper effect)

(see Dess and Shaw, 2001). Since intellectual capital has a strong effect on organisational success, managers and practitioners should design effective human resource strategies to preserve intellectual capital.

Although the present study was strongly based on robust theoretical and methodological bases, certain limitations should be acknowledged. The major limitation was the cross-sectional design that makes it difficult to definitively identify causal relationships. Therefore, employing a time-lagged approach could be a robust strategy in arriving at a firm conclusion. In addition, the use of single-source and self-report survey data could result in a CMV. Despite the robust analysis of the current study not evidencing CMV, future research should focus on a multisource method. Since this is the first single study embarking on investigating the nexus of intellectual capital, productivity and firm performance, there is in need for similar studies across many countries and organisations. Moreover, future studies should also answer two pressing questions: how can intellectual capital be burnished in developing countries? And are culture and individual differences a matter of influence on intellectual capital? (see Burt *et al.*, 2018; Cai and Du, 2017). Anchored on a strong theoretical footing and in the absence of information on financial performance, this study employed subjective measures; nonetheless, objective measures could be a more accurate prediction of firm performance and therefore, there is a compelling need for comparative studies.

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Appendix

Indicator		Factors	Unstandardised solution Estimate	SE	CR	Standardised solution Estimate	AVE	MSV	ASV	CR
HC1	←	Human_Capital	1.00			0.96				
HC2	←	Human_Capital	1.10	0.03	29.25***	0.93				
HC3	←	Human_Capital	1.13	0.05	25.13***	0.90				
HC4	←	Human_Capital	1.04	0.04	24.23***	0.88				
HC5	←	Human_Capital	0.83	0.04	22.33***	0.81	0.80	0.004	0.002	0.94
SC1	←	Social_Capital	1.00			0.92				
SC2	←	Social_Capital	1.08	0.03	34.00***	0.98				
SC3	←	Social_Capital	0.87	0.04	19.36***	0.83				
SC4	←	Social_Capital	0.64	0.06	10.56***	0.60				
SC5	←	Social_Capital	0.98	0.04	24.03***	0.91	0.74	0.002	0.001	0.93
OC1	←	Organisational_Capital	1.00			0.98				
OC2	←	Organisational_Capital	0.77	0.05	16.32***	0.74				
OC3	←	Organisational_Capital	0.88	0.04	23.82***	0.86				
OC4	←	Organisational_Capital	0.94	0.02	40.50***	0.95	0.79	0.004	0.002	0.93
FP1	←	Firms_Performance	1.00			0.83				
FP2	←	Firms_Performance	1.18	0.06	18.22***	0.97				
FP3	←	Firms_Performance	0.74	0.07	10.52***	0.63				
FP4	←	Firms_Performance	0.71	0.06	11.32***	0.67				
FP5	←	Firms_Performance	0.85	0.07	12.42***	0.72	0.60	0.050	0.013	0.88
PR1	←	Productivity	1.00			0.88				
PR2	←	Productivity	0.99	0.04	23.84***	0.95				
PR3	←	Productivity	0.94	0.04	20.91***	0.90				
PR4	←	Productivity	0.92	0.06	16.56***	0.81				
PR5	←	Productivity	1.02	0.05	21.65***	0.92				
PR6	←	Productivity	0.87	0.05	17.61***	0.84				
PR7	←	Productivity	0.84	0.06	13.74***	0.73	0.75	0.050	0.014	0.95

Table AI. Results of integrated CFA

Notes: PR, productivity; HC, human capital; SC, social capital; OC, organisational capital; FP, firm's performance; AVE, average variance extracted; MSV, maximum shared variance; ASV, average shared variance; CR, composite reliability. Indicators (items) are described in Table I. ***Significant at the 0.001 level (two-tailed)

About the author

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The hidden value of intangibles: do CEO characteristics matter?

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Abstract

Purpose – A great deal of research has examined the relationship between a single CEO attribute and a single measure of firm performance; no attempts have been made to integrate them to create a more global vision of both. Therefore, trying to answer new calls from Wang *et al.* (2016) or Liu, Fisher and Chen (2018) about a more global vision of the CEO characteristics, the authors are going to take a step forward to combine different CEO characteristics with different firm performance measure in order to show that a certain managerial profile would have an impact on several variables of firm performance. This paper aims to discuss these issues.

Design/methodology/approach – Using a sample of 1,236 small firms in high- and medium-high-technology sectors and through the Canonical Correlation Analysis, the authors are able to create different CEO's profiles that influence on different combinations of firm performance variables.

Findings – The authors obtain different CEO's profiles that influence on different combinations of firm performance variables. Each CEO profile will enhance or diminish one kind of performance measure. The authors found that on the one hand, young, well-educated with external experience CEO profile will enhance innovative performance and firm growth, and on the other hand, old and more internal and external experience CEO profile will enhance the exploitation of external knowledge.

Originality/value – Through this analysis, the authors will be able to provide a more comprehensive analysis of the predictions about the role of CEOs in small firms.

Keywords Upper echelons theory, Firm performance, Intangible assets

Paper type Research paper

1. Introduction

The relationships between intangible assets and firm performance have been studied in recent years. One of the intangible assets that have been analyzed deeply is the human capital of the firm. Human capital includes knowledge, skills and abilities of people working in the company (Coff, 2002). In particular, there has been considerable debate regarding the impact of the CEOs on firm performance.

The role of the CEO on firm performance

Some scholars have argued that CEOs actions influence their firm performance (Quigley and Hambrick, 2015). Others have shown that CEOs are greatly constrained – by organizational inertia, path-dependence, rigid resource configurations and pressures to adopt institutionalized norms – such that, leaders do not have much influence on what happens to their companies (Fitza, 2014). This debate reveals the importance of the study of the CEO role in organizational science. Researchers have always tried to understand the impact that leaders have on their organizations (Peni, 2014). Thus, in this paper we want to answer some

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questions such as: to what extent do CEOs, in general, influence company performance? What are the CEO characteristics relevant to the company's results?

Upper echelons theory: different approaches of CEO characteristics and firm performance

Scholarly attention to CEOs remains robust (Hambrick and Quigley, 2014). From a theoretical point of view, Upper echelons theory (UET) has been the most important theoretical perspective to address the role of the CEO in the firm (Hambrick and Mason, 1984). The core thesis of UET is that "executives' experiences, values and personalities greatly influence their interpretations of the situations they face and, in turn, affect their choices (Hambrick, 2007, p. 1) and, through these choices, organizational performance" (Hambrick and Mason, 1984, p. 197).

From this, three approaches of research have emerged. The first one examines the individual CEO characteristics that are related to firm performance taking into account mediation strategies (Simsek *et al.*, 2010). The mediators highlighted in previous studies appear to account for different stages (e.g. TMT processes and strategic choices: Ling *et al.*, 2008) in the effects of CEO characteristics on firm performance. This first approach would be the closest to the core of the UET theory: the characteristics of the CEO affect the strategic decisions and those decisions determine the performance.

The second approach considers the influence of the CEO on decisions or choices, but not directly linked to firm performance, instead the CEO characteristics are associated with specific strategic choices, with the implicit assumption that these strategic choices have implications for firm performance. Thus, firm performance is not measured (Simsek *et al.*, 2010).

The third approach accounts for how individual CEO characteristics directly impact on firm performance (Gow *et al.*, 2016) assuming that there is an implicit behavior of the CEO that are mediating this relationship but without measuring it. Our work is framed within this last stream.

Wang *et al.* (2016) developed a meta-analysis investigation based on UET of the CEO influence to firm strategic actions and firm performance. The conclusions of this work provide a general vision on what characteristics of the CEO influence performance. That paper examined different CEO characteristics: demographic aspects of the CEO (age, sex), professional background (experience, tenure and training) as well as personality style (leadership, extraversion, self-esteem). Among the possible future research section, the authors suggested: "Encourage researchers to explore interplays among the CEO characteristics. There are ways that the CEOs' characteristics could interactively influence their strategic choices and future firm performance" (Wang *et al.*, 2016, p. 825).

The aim of this paper

Our work tries to explore that path suggested by Wang *et al.* (2016). A great deal of research has examined the relationship between a single CEO attribute and a single measure of firm performance, as far as we know, no attempts have been made to integrate them to create a more global vision of both. Therefore, we are going to take a step forward to combine different CEO characteristics with different firm performance measures in order to show that a certain managerial profile would have an impact on several variables of firm performance.

Our work makes some contributions to the literature. First, we contribute to the critical approach to examine the relationships between organizations' intangible assets and its performance, trying to explain whether and what kind of possibilities exist to increase performance through intangible assets, in particular, the human capital of the CEO. Second, we contribute to UET by taking into account different types of CEO characteristics that would impact on CEO decisions and therefore on the firm performance. Although the influence of owners on strategic decisions can be strong, CEOs have a direct influence on firm strategies. Third, instead of taking into account a single variable of firm performance, as previous

scholars, using a novel methodological approach to the topic, the canonical correlation analysis (CCA), we are able to create different CEO's profiles that influence on different combinations of firm performance variables. Finally, the context of small firms has a particular interest because understanding CEO background in the context of small enterprises is fundamental, as they are companies where resources and administrative systems are often lacking (Lubatkin *et al.*, 2006). There is a lot of applied research regarding large listed firms, but there is not much research on small firms. In short, we bring some light to the debate on the importance that an essential intangible can have on performance, the CEO.

The paper is organized as follows. The following section explains the theoretical reasoning that justifies our hypothesis. Section 3 describes the sample, the variables, and the CCA procedure. Section 4 summarizes the results of our empirical tests. The final section exposes the findings and provides discussion and conclusion of the paper.

2. Theoretical framework

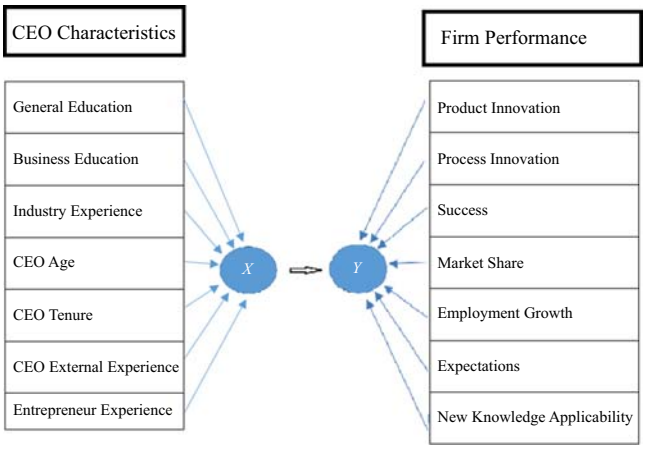
Human Capital has been studied as an intangible asset of great value to the company. More specifically, the characteristics of the CEO have been described as an indisputable part of the managerial capabilities of the company and have often been associated with organizational performance (Wang *et al.*, 2011). However, the influence of the CEO's on other type of performance measures has been less studied. A very consistent approach is offered by Hambrick and Quigley (2014).

According to these authors, the academic field of management relies in great part on the premise that the effectiveness of managers has certain consequences in the organization, which means that CEOs matter. Some researchers have emphasized the role of CEOs in setting strategy or make decisions about how to invest, how to compete and how to create value in these companies (Porter, 1980). On the other hand, it is widely accepted that executives, including CEOs, face considerable constraints on their actions. They are limited by their organizations' pre-existing asset configurations and entrenched cultures. Therefore, given the importance of the role of the CEO on the one hand and its restrictions on the other, this makes it very interesting to study, and this is why many researchers have pointedly explored the CEO impact on firm performance.

According to UET, the CEOs are the main decision makers of their companies, therefore, their way of being, their preferences and style of leadership will have a lot of influence in their organizations (Hambrick, 2007). The characteristics of the CEO are reflected in different strategic decisions, which in turn influence future firm performance. Hambrick and Mason (1984) showed that CEOs' cognitive bases and personality traits will influence their field of vision, perception and interpretation. In this way, these personality traits shape their strategic choices by influencing "their personalized interpretation of the strategic situations they face" (Hambrick, 2007, p. 334). Due to the difficulties of collecting data related to the personality of the CEOs, UET suggests that researchers can examine observable characteristics of the CEOs. In our study, we are going to use seven objective characteristics that define the background (see Figure 1).

As for the methodologies used, for more than 40 years, research has employed numerous variance partitioning methods (VPM) to calculate the CEO effect. This CEO effect is calculated once the effects of contextual factors are isolated. Lieberson and O'Connor (1972) used sequential ANOVA. They added the impact of the CEOs to the model after taking into account the variance explained by contextual factors. Most recently, Crossland and Hambrick (2007) used simultaneous ANOVA and in 2011 used multilevel modeling, which addresses the non-independence of effects. In sum, classical methodologies based on VPM have been used to examine relevant questions about the influence of the CEOs to the company performance or what are the CEO characteristics relevant to the company's results.

However, in recent years Fitza (2014, 2017) offers a very critical view with the methods based on variance partitioning. In his works, he considers that the CEO effect is oversized



Notes: Being *X* and *Y* linear combinations of the original variables. The CCA analysis will provide linear combinations of predictor variables (CEO characteristics) that correlate significantly with linear combinations of dependent variables (performance variables)

Figure 1.
Theoretical framework

since part of the success or failure of the company must be assigned at random and not to the CEO. On the other hand, Quigley and Graffin (2017) using the same data as Fitza (2014) and methodologies based on the Multilevel modeling show that 20 percent of the ROA (return on assets) variations may be due to the CEO effect. This stimulating debate is giving rise to a growing interest in quantifying the importance of the CEO in the firm performance. Table I summarize these studies.

The table shows that previous experience and work style seem to be predictive of future performance, while personal choices and background are only modestly predictive. Up to now, all the papers studying the CEO effect on firm performance have taken into account particular characteristics of CEOs on the one hand, and operational or economic performance on the other. Most of the papers have measured firm performance with the ROA (Hambrick and Quigley, 2014; Gow *et al.*, 2016). Although the ROA is a good and very common indicator of firm performance, there could be some characteristics of the CEO that can influence in other dimensions of performance such as firm innovation or growth. This could be a reason why some research has not found a significant influence of a unique CEO characteristic on ROA *per se*; for instance, CEO age and tenure could be more associated with firm growth than firm financial performance.

Trying to answer new calls from Wang *et al.* (2016) or Liu *et al.* (2018) about a more global vision of the CEO characteristics, we propose a more holistic view connecting different CEO characteristics to different firm performance variables. No matter how important the CEO may be about the company's results, it would be naive to think that a single characteristic of the CEO could have a direct huge impact on a single variable of results. Our aim in this paper is not to measure how much effect the CEO has over firm performance. Our goal is to show that a certain managerial profile would have an impact on several variables of firm performance.

As regard the dependent variables, in this work we use different measures of firm performance, which are the ones that the literature defines as the most susceptible to be modified by the CEOs' actions (see Figure 1). Some variables are related to the subjective evaluation of the CEO, who is the respondent, such as sales expectations, success in outperforming competitors (Simsek, 2007). However, there are other objective measures that capture employment growth

Authors	CEO attributes	Dependent variable	Sample	Findings
Thomas (1988)	Presence/absence of the CEO in the model	Profits, sales, and profit margin	12 British retail companies	CEOs are responsible for 3.9–7.0% of firm performance
Mackey (2008)	Presence/absence of the CEO in the model	ROA	92 CEOs at 51 companies.	CEOs account for 29.2% of variance in company profitability
Kaplan *et al.* (2012)	Personal and managerial attributes	Successful CEO	316 CEO candidates at 224 firms	Managerial attributes might be predictive of performance
Hambrick and Quigley (2014)	Managerial discretion	ROA	830 CEOs at 315 companies	CEOs account for 35.5% of firm outcomes
Fitza (2014)	Presence/absence of the CEO in the model	ROA	19,746 observations	CEO influences less than 5%
Falato *et al.* (2015)	CEO experience	ROA	2,195 CEOs at S&P 1500 companies	Experienced CEOs perform better
Cai *et al.* (2015)	CEO experience	ROA and Tobin's Q	2,335 CEOs at S&P 1500 companies	Managerial training is associated with better performance
Benmelech and Frydman (2015)	CEO with a military background	fraudulent activity	4,013 CEOs, 2,402 companies	CEO background might be predictive of outcomes
Gow *et al.* (2016)	CEO personality	ROA and cash flow	4,591 CEOs	CEO personality might influence outcomes
Wang *et al.* (2016)	Review of the research literature on CEO attributes and firm performance		Review	CEO age, tenure, formal education, and prior career experience are positively related to performance
Quigley and Graffin (2017)	Presence/absence of the CEO in the model	ROA	19,746 observations	CEO influences 20%
Liu *et al.* (2018)	CEO emotion and cognition, with TMT and organizational processes	Financial and non-financial measures.	Review	Link CEO attributes with firm Performance

Table I. Previous research on CEO attributes and firm performance

(increase in numbers of workers, Baum and Locke, 2004), innovative performance (Wu *et al.*, 2005) and market share. Through capturing and combining these subjective and objective measures, we are also getting a multidimensional approach to the overall idea of firm performance.

CEO characteristics and firm performance

Based on the UET, younger CEOs are less risk averse and more aggressive than older CEOs (Hambrick and Mason, 1984). Researchers at MIT and UPenn did find that firms with younger CEOs pursue innovation more aggressively, as measured by the number of patents they file. Besides, younger CEOs tend to hire younger inventors, and the presence of younger inventors correlates strongly with innovative activity. Consequently, younger CEOs would present higher levels of innovation. In addition, Serfling (2014) further agrees that firms with younger CEOs would invest more and have bigger growth opportunities.

Education is also a good indicator of an individual's value (Hambrick, 2007). A high level of CEO education can be viewed as a measure of the initial human capital invested in the firm (Cooper *et al.*, 1994), and it can significantly affect firms' strategic decision. Papadakis (2006)

found a positive association between formal education and product and process innovation. Almus and Nerlinger (1999) found that it had a positive impact on firms' growth while Bhagat *et al.* (2010) come to opposite conclusions.

Since CEOs may favor a specific business strategy based on their prior career experience (Hambrick and Mason, 1984), their professional experience would also be important (Colombo and Grilli, 2005). Top executives with work experience in technology sectors recognized better technological alliance opportunities than those with other kinds of experience (Tyler and Steensma, 1998). The rationale behind this is that a high level of experience can enhance a firm's knowledge resources (Hambrick and Mason, 1984). Previous experience provide to the CEOs strong information processing capability that enables an individual to search for and analyze complex knowledge taking advantage of the external knowledge.

In addition, Colombo and Grilli (2005) discovered that prior entrepreneurial experience could highly influence firms' growth. Similarly, Siegel *et al.* (1993) found that long industry experience in an entrepreneurial team is an important factor distinguishing high- and low-growth ventures. CEO work experience could hence be an important managerial guideline for innovation in SMEs. Long years spent in industry may enable CEOs to deal with the intrinsic uncertainty of innovation through their accumulated experience in other firms.

As regards of the CEO tenure, the literature suggests both a positive and a negative relationship. On the one hand, long-tenured CEOs are expected to have a deeper understanding of the firm's resources and links to its environment. This should help the firm to achieve greater operating efficiency and therefore to grow faster. On the other hand, Miller (1991) explains that longer-tenured CEOs become complacent and tend to cling to outdated paradigms. As a result, they become less open to change and less prepared to innovate and sustain the growth of their firms. The key could be in the type of tenure. If the CEO has more external tenure (years working in other similar companies as a manager), his/her mind could be more open to invest and growth. However, if the tenure comes from the same firm (years working as a manager in the same firm) the CEO could be accommodated to his/her work position becoming less risk averse and therefore less willing to growth.

Thus, according to all these arguments, we propose two hypotheses:

H1. Young, well-educated and external experiences CEO profile will enhance innovative performance and firm growth.

H2. Old and internal and external experiences CEO profile will enhance the exploitation of external knowledge.

3. Methods

Data collection

The data used in this research are a representative sample of small Spanish firms belonging to high- and medium-high-technology manufacturing and service industries. To get the sample, we use the SABI database, the most complete dataset of firms in Spain.

We searched for small firms, less than 50 employees, developing its primary activity in high- or medium-high-technology sectors (manufacturing or service industries). For this purpose, we employed the classification of the OECD and the National Statistical Office[1]. The population with those characteristics were 10,565 firms; we selected a sample of 10,200 firms. The selection sample process was made randomly taking into account representativeness of industrial sectors, legal form of the firm and size strata. With a confidence level of 95 percent sampling error was ±2.34 percent. Firms were randomly selected within each industry segment using computer-assisted telephone interviewing software. They were conducted in 2010 by a firm specialized in market studies. Finally, 10,200 of firms were contacted, of which 1,500 agreed to participate achieving a 14.70

percent response rate. It was the CEO who responds the questionnaire. Missing values and outliers[2] reduced the sample to 1,236 firms. In terms of size, industrial sector or legal form, there are no differences between firms that agreed to participate and those who refused.

Variables

CEO characteristics. To measure the background of the CEO, we have seven variables that we describe below. Table II shows mean (average), standard deviation and range of CEO characteristics:

(1) General education is the highest level of education that the CEO has achieved. Information is provided through an ordered variable that goes from 1 to 4. When the CEO has not completed studies or primary studies, the variable takes the value 1. It is equal to 2 when the CEO has a bachelor degree or vocational training. It is equal to 3 when the CEO has completed university studies and takes the value 4 if the CEO has completed postgraduate studies (master's or doctorate).

(2) Business education is measured by a dummy variable that takes the value 1 if he or she has any kind of formal education related to business administration and 0 otherwise.

(3) CEO internal tenure is a variable that measures the number of years as a CEO of the firm.

(4) Entrepreneur experience is a variable that captures the number of firms that he/she has participated in its foundation.

(5) CEO external tenure is a variable that measures the number of companies in which he/she has worked as manager for over a year.

(6) CEO age is a variable that measures the age of the CEO.

(7) Industry experience is a variable that measures the number of years of the CEO's labor experience in the industry sector in which he/she is working.

These seven variables collect varied information in terms of the main dimensions that make up CEO personal background.

Performance variables. In the survey we have a set of indicators that are clearly related to the company's performance not only in terms of its competitive advantage (change in market share, to what extent the firm exceeds its competitors, changes in workforce), but also in terms of the orientation toward innovation (products or processes) and future projection (ability to apply new knowledge and sales expectations). All the performance

	Mean	SD	Range
X1: general education	2.84	0.76	1–4
X2: business education	0.56	0.49	0–1
X3: CEO internal tenure	12.1	8.5	1–48
X4: entrepreneur experience	0.34	0.7	0–6
X5: CEO external tenure	1.28	1.5	0–10
X6: Age	45.3	10.2	21–76
X7: industry experience	19.2	11.4	0–57
Y1: process innovation	3.83	2.13	1–7
Y2: product innovation	3.40	1.91	1–7
Y3: success	2.58	0.91	1–5
Y4: market share	3.03	0.89	1–5
Y5: employment growth (%)	0.00	46	−90, 300
Y6: expectations (%)	6.12	18	−100, 150
Y7: applicability	3.88	0.78	1–5

Table II. Descriptive statistics of CEO's characteristics and firm performance variables

variables except expectations and new knowledge applicability are capturing the effect in the last three years. We describe below the variables (see Table II):

- Process innovation is a discrete variable measured on a seven-point Likert scale that captures the strength of innovation in new processes applied to existing products. The variable goes from "1 = no changes at all" to "7 = very important changes."
- Product innovation is a discrete variable measured on a seven-point Likert scale that captures the strength of innovation in new products or services. The variable goes from "1 = no new products or services" to "7 = many new lines of products and services."
- Success is a variable on a scale of 1–5 that measures to what extent the company has outperformed its competitors (none, some, several, almost all, and all).
- Market share is a variable on a scale of 1–5 that measures the evolution of market share (from it has worsened a lot to has improved a lot).
- Employment growth: in the survey, there is information on the number of full-time workers currently and three years ago. The variable used measures that difference relativized by the situation of the workforce three years ago. It is expressed in percentages.
- Expectations is a variable that measures the CEO expected sales for the next year. The answer is given in percentages (with positive or negative sign according to the expectation of sales).
- New knowledge applicability is a variable that measures the capacity of the company to apply new external knowledge to internal work; it is defined on a scale of 1–5.

Joint analysis

Business research is often concerned with analyzing relationships between two sets of variables. One suitable method for this issue is canonical correlation analysis (CCA). CCA is especially indicated when one wants to test the hypothesis that one set of independent variables (predictors) are related to another set of dependent variables (performance).

CCA addresses two main goals: identification of dimensions among the dependent and independent variable sets and maximization of the relationship between the dimensions.

Following Hair *et al.* (1998), we can consider CCA as a generalization of other multivariate methods: regression analysis and factor analysis.

Like factor analysis (FA), CCA can create an optimized structure for a set of variables. But as FA seeks to identify new variables that maximize the amount of variance, CCA identifies new variables in both sets (named canonical variables) with the requirement of maximizing the coefficient of correlation between them.

Denoting by R_{xx} the correlation matrix of predictors, R_{yy} the correlation matrix for dependent variables and R_{xy}, the correlation matrix between both sets, we need to calculate the eigenvalues of $R = R_{yy}^{-1} R_{xy}^{-1} R_{xx}^{-1} R_{xy}$ to get the maximum correlation between canonical variables.

Once the canonical pairs are obtained, hypothesis test based on Wilks Lambda or its F approximation are carried out to verify the significance of the correlation between canonical variables. It is a sequential procedure, starting from the highest correlation. At the moment that a relationship is not significant, the others are not checked because their correlation coefficient is smaller.

In order to interpret the new canonical variables, we look at their loadings in the way in which the original variables correlate with the newly constructed dimensions. In addition, it is interesting to know what part of the original information we maintain when we decide to retain the significant canonical couples.

4. Results

To carry out the analysis we consider the following issues:

- Adequacy of data.
- Statistical significance of the correlation between canonical variables.
- Practical significance and interpretation of canonical variables.
- Robustness check: stability of the solution.

Regarding the adequacy of the data, first, there is a significant relationship between predictor variables and dependent variables (R_{xy}) that can be seen in Table III. Second, we have carried out Bartlett's sphericity test within the set of variables of the same type (R_{xx} and R_{yy}) and an adequate structure of correlations is observed. In other words, there is a latent structure of interrelated variables both in the set of CEO characteristics and in performance variables[3].

Regarding the statistical significance of the correlation between canonical variables, the number of canonical pairs of variables that can be defined is seven. Only three of them show a significant correlation.

The correlation between canonical variables is moderate but statistically significant, with coefficients of 0.33; 0.16 and 0.13 for the first three pairs.

Although the main goal of CCA is not to capture the maximum variability of the original information, the three canonical variables constructed from CEO characteristics jointly collect around 60 percent of the variance and the three canonical variables identified from the performance measures jointly capture 56 percent of the variance.

Practical significance and interpretation of canonical variables: the three pairs of canonical variables present the following structure of correlations (see Table IV).

The first canonical variable that emerges from the CEO background variables captures information on educational background and external experience vs tenure and experience in industry. That is, the highest values in this canonical variable correspond to the CEOs with more training and less experience and tenure in the industrial sector or in the company itself. Besides, the variable relative to the CEO external tenure (experience as manager in other companies) points positively. Age or having been the founder of new companies have no statistical relevance in this first canonical variable. This linear combination of variables is positively and significantly related to the first canonical variable obtained from the set of performance variables. This canonical factor captures information on the variables of improvement in employment, market share and good expectations as well as proactive attitudes toward process and product innovation.

The second relationship associates a canonical variable that includes age, experience in the industrial sector, business education and managerial knowledge in other companies with the applicability of new knowledge and process innovation (see Figure 2).

	Process innovation	Product innovation	Success	Market share	Employ. growth	Expect.	Applica.
General education	0.151**	0.161**	0.083**	0.164**	0.152**	0.108**	−0.071**
Business education	0.179**	0.131**	0.054	0.067**	0.061**	0.097**	0.031
CEO internal tenure	−0.070**	−0.074**	−0.038	−0.122**	−0.184**	−0.120**	0.000
Entrepreneur experience	0.079**	0.075**	0.049	0.036	0.031	0.058**	0.016
CEO external tenure	0.112**	0.065**	0.081**	0.100**	0.131**	0.086**	0.059
Age	−0.014	−0.011	0.013	−0.060**	−0.114**	−0.045	0.069**
Industry experience	−0.064**	−0.065**	−0.026	−0.113**	−0.156**	−0.140**	0.089**

Note: **Significant at $p < 0.05$

Table III. Linear correlation's coefficients between dependent and independent variables

Table IV. Statistical significance of canonical pairs and correlations between original variables and canonical variables

	1	2	3
X1: General education	0.77	−0.27	0.27
X2: business education	0.51	0.55	0.39
X3: CEO internal tenure	−0.59	0.17	0.65
X4: entrepreneur experience	0.27	0.25	0.19
X5: CEO external tenure	0.5	0.43	−0.41
X6: age	−0.29	0.51	0.32
X7: industry experience	−0.61	0.55	0.22
Y1: process innovation	0.6	0.5	0.47
Y2: Product Innovation	0.54	0.19	0.44
Y3: success	0.31	0.21	0.05
Y4: market share	0.56	−0.14	−0.14
Y5: employment growth	0.63	−0.17	−0.65
Y6: expectations	0.56	0.02	−0.05
Y7: applicability	−0.09	0.82	−0.43
Statistical significance of canonical pairs			
Wilks's lambda (*p*-value)	0.110 (0.000)	0.027 (0.000)	0.018 (0.021)
Canonical correlation	0. 332	0.163	0.134
F (*p*-value)	4.5 (0.000)	2.08 (0.000)	1.66 (0.021)

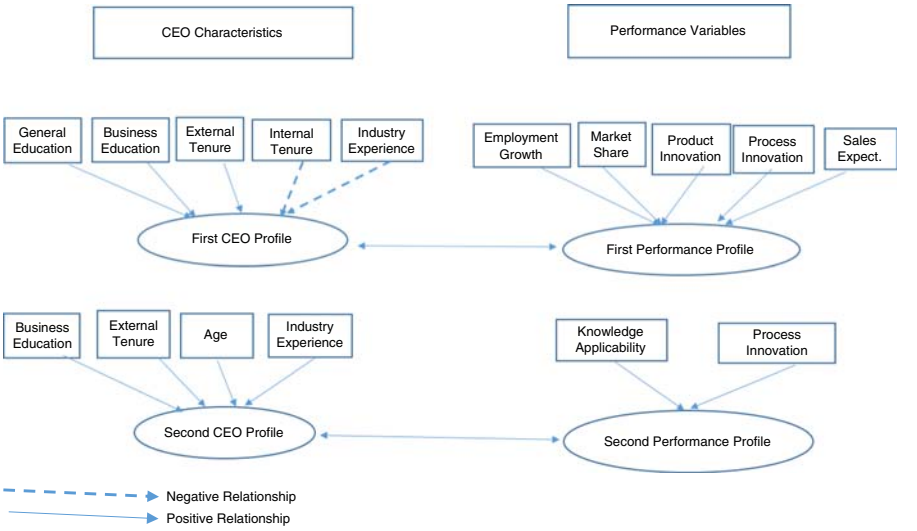


Figure 2. Simplified representation of the main variables in first and second pair of canonical variables

Regarding the third relationship, CEO profile with internal experience (years working as a CEO in the same firm) is more important than the CEO external experience. This profile is associated with a worse evolution in employment, although good results in innovation (see Figure 2).

In a first approximation to these results, we can observe that there are variables related to education, especially business education, which are positively associated with most performance variables. Besides, variables such as age, CEO internal tenure, and industry experience appear to be more frequent in all the profiles. On the contrary, variables such as "entrepreneur experience" and "success" do not appear with any significant presence in any of the canonical variables analyzed.

Thus, after having carried out the CCA we can support our two hypotheses: first and second relationship corresponds with the first and second hypothesis, respectively. We have also found a third relationship, but the solution is less robust.

Stability of the solution: in order to validate the significance of the CCA, we carry out a study of robustness of the results. For this purpose, we carry out six additional CCAs analysis for random subsamples with different sample sizes[4].

The first relationship remains stable in all simulations performed. As for the second canonical relationship, the results are stable in five of six of the analyses performed. Finally, the third canonical pair is stable in two of the simulations and turns out to be a less robust result. However, in all the subsamples, a larger internal tenure with little external tenure is associated with a stagnation of employment and a lower applicability of knowledge.

5. Conclusions, discussion, limitations and future research

Conclusions

The main contribution of this paper stems from the utilization of the UET in taking into account different kind of CEO characteristics that configure a managerial profile that has an impact on the results of the company.

Our results suggest that there are three significant relationships from which we can extract some interesting conclusions.

From the first functional relationship between the two sets of variables, we can conclude that there is a notable association between a particular CEOs profile that can be associated with better results of the firm in specific areas. It is expected as a result, that better training and external experience will produce better results. However, it should be noted that the canonical variable also includes the fact of having little experience in the sector and little seniority as a manager in the company. Thus, we have identified the profile of a successful CEO, well-trained and with external managerial knowledge, who, however, does not have much seniority in the company or the industrial sector (Figure 2).

Having a good general and business education makes the CEO very good at taking efficient decisions, with more vision and influence. CEOs with a high educational background are more self-confident and more proactive in taking risky decisions that could improve the innovative performance of the firm. In addition, having more external tenure in other companies makes it easier to identify opportunities and to deal with higher levels of uncertainty. On the other hand, long experience in the same industrial sector and in the same firm, can lead to a certain routine, a trend to accommodate to the reality, and be risk averse, without many aspirations for growth.

For the second relationship, we can conclude that external knowledge (industry experience, CEO external tenure) generates a deeper understanding of the environment and a greater applicability of new knowledge. This second relationship is associated with more specific results. The applicability of new knowledge is only possible if CEO knows the industrial sector in deep (industry experience and age), there is specific training in business, and some managerial experience in other companies (external CEO tenure). Besides, CEOs with these characteristics are associated with a bigger trend to innovate in process but not necessarily in products.

Finally, for the third relationship, we can conclude that a high internal experience linked to limited external experience in the company causes a stagnation in terms of employment, in the growth of the company. This relationship shows how an excessive seniority in the same company is not always a desirable attribute for a manager. This result should be observed with more caution due to less robustness.

Overall, we observe that the role of education combined with external tenure is essential in order to achieve better firm performance. By itself, experience does not guarantee good results. Finally, it is important to distinguish between different types of experience.

Discussion

Our results are consistent with the previous studies. In the first place, our study has responded to the call from Wang *et al.* (2016) trying to combine different characteristics of the CEO that can influence the results in a joint way. In addition, we have given response to the concern from Liu *et al.* (2018) that suggest that: "Although a great deal of research has examined elements of the relationship between CEO characteristics and firm performance, few attempts have been made to integrate them to create a more holistic picture" (Liu *et al.*, 2018, p. 789). In this sense, we have developed a global view for connecting CEO characteristics to firm performance.

Our results are hardly comparable with those of other authors due to the methodological approach followed. However, in general, our results can be considered closer to the conclusions of the other studies.

In the debate between Fitza (2014, 2017) and Quigley and Graffin (2017), where the former considers that the CEO has little relevance to performance while the latter assign a significant effect, our work clearly aligns with the second one: depending on the characteristics of the CEO, different performance is obtained.

Regarding the CEO education there are also mixed results. According to Ng and Feldman (2009) education has a clear influence on performance, while Bhagat *et al.* (2010) come to opposite conclusions. In our work, we find that the variable "Business education" always appears with a positive sign with significant coefficients and associated with good performance results. It must be highlighted, however, that this variable appears together with other characteristics as part of the canonical variables. In particular, a business education profile linked to external experience is associated with improvements in employment growth, market share and sales expectations as well as a more proactive attitude toward innovation.

In relation to the CEO's experience and tenure, from a theoretical perspective, greater experience has been associated with improved performance (Hambrick, 2007). From the empirical point of view, most of the papers that analyze the importance of the CEO experience refer to large companies. A similar context to our work is the one reflected in the work of Liu *et al.* (2018) that analyses, for small and medium-sized companies, the association between CEO tenure and a set of objective and subjective performance measures. These authors find a positive association between CEO tenure and firm performance. Our work differs from others in that we consider three possible variables of experience: CEO internal tenure, CEO External tenure and Industry Experience. According to our results, we cannot affirm, in general terms, that these three variables are associated with better performance. As already mentioned, the CEO external experience together with a good educational level is associated with strong growth in employment and good results in all indicators. On the contrary, the experience accumulated in the same industry and linked to a single company is associated with a negative employment growth. Miller (1991) also warned of the stagnation that could occur in the company when the CEO has been in the same company for a long time. In summary, our methodology and results differ from those other authors in the distinction we establish between external or internal tenure and industry experience, while other authors simply refer to "experience" or "tenure."

Regarding the entrepreneurial attitude of the CEO, it has been associated in the literature with a greater tendency toward innovation (Ardagna and Lusardi, 2010) while in our work it does not appear as a CEO characteristic that is significantly associated with the main result. Its presence in the three main canonical variables is irrelevant.

Finally, regarding the performance variables, we differenced ourselves from other scholars who used financial variables in order to measure firm performance such as revenue growth (Baum and Locke, 2004) or return on assets (Chung and Luo, 2013). This study accounts for alternative non-financial measures of firm performance, such as employment growth or applicability of new knowledge, highly relevant in the context of small technology companies in which our work is framed. Like other researchers we use self-report perceptional measures of firm performance (Simsek, 2007) incorporating, in addition, the idea of performance profile through the combinations of these self-report variables.

As regards to the specific context (firms with less than 50 employees operating in medium high and high-tech industrial or service sectors), we found two relevant aspects to consider. Regarding the managerial profiles that we have described as more valuable, it should be noted that large companies carry out their CEO selection processes following exhaustive procedures, often outsourced. In small companies, on the contrary, the CEO is sometimes the owner, the founder or has been chosen in a very restricted process. Our results emphasize the fact that, although the company is small, a well-trained CEO with external experience can bring great value to the company. The selection of a CEO in a small firm, as in any other, must be done with rigor, professional criteria and away from endogamy.

Regarding the performance variables associated with these managerial profiles, our results include innovation, employment growth and knowledge applicability. In high-tech sectors, innovation and knowledge applicability are at the core of their competitive advantage. Although the company is very small, you have to look for a CEO oriented to those results.

Our findings suggest that the CEO background is important, so, political choices should be made. We should promote training programs capable of supporting efforts related to the education and experience of the CEOs, keeping in mind that the individuals who hold the power to induce changes in their organizational environment are the CEOs.

Practical implications

Our research also has some practical implications.

In the first place, from the point of view of the CEO profiles, our results can help in the recruitment process of small companies that compete in high-technology sectors. The profile of the CEO, their characteristics and skills are very relevant to decide the strategies to develop in order to have an impact on the success or failure of the organization.

Based on our results, we can affirm that there are no good or bad characteristics of CEOs, but that there are profiles or groups of characteristics that affect possible results. In the selection processes, we should be able to detect those managerial profiles that emerge in our analysis. In general, all the characteristics studied for CEOs are desirable (education, knowledge of the sector, internal and external experience, etc.). However, our study shows that some of them, if another does not accompany them, can be harmful. For example, in the case of the internal experience variable, by itself, it seems an appropriate characteristic for a manager. A deep knowledge of the organization seems to be a minimum requirement for its survival. However, from our analysis, we deduce that a manager who only brings internal experience in the company (necessarily accompanied by age and knowledge of the sector) will lead his company to a certain stagnation. In the same way, a manager with a good educational level is always desirable, but if certain experience in other companies is incorporated, the CEO develops skills that are more easily aligned with growth and innovation objectives.

From the point of view of performance, practical implications are also deduced. Companies can have different objectives depending on their life cycle, the type of market in which they operate or intensity of competition. Thus, depending on these objectives, a

CEO profile will be more or less appropriate. In high- and medium-technology environments, there are many small companies that face constant innovations and find difficulties to apply new knowledge. For many of these small companies, their main objective, even temporarily, is to survive and adapt to a changing technological environment. These are companies that do not aspire, at least in a short term, to increase their workforce or to improve their market share. For these companies, a manager with a lot of experience in the industrial sector may be suitable, but who has developed his work in different companies and not only in a single one. This CEO profile is different from that required by well-established organizations that seek to expand their markets and grow in size and sales.

From the empirical point of view, we also have some findings that may be useful in the selection process of human resources. In our sample is easy to find managers of a certain age with a lot of experience accumulated in the same company and with a high knowledge of the industrial sector; however, these managers have less educational level than the average. On the contrary, in our sample, it is difficult to find managers who have had some entrepreneurial experience, but all of them also have external experience and educational level well above the average.

Taking into account all of this, this paper may offer some power to predict firm performance. This could led to a benefit for the strategist who is trying to predict a competitor's moves and countermoves. Predicting this move, the competitor could prepare an adequate countermove. This prediction capacity can become a competitive advantage of the company.

Finally, although it is true that, generally speaking, there are no good CEO characteristics *per se*, we have detected from all the analyses, robustness studies and reliability simulations of the canonical variables that: any managerial profile that is added formal education and external experience improves any type of result.

Limitations and future research

Our work has some limitations that need to be pointed out. First, our sample consists entirely of small Spanish firms in environmental context of economic and financial deep crisis. Any generalization to another geographical economic or financial context must be done with extreme caution.

Second, the global economic crisis context may have modified the competitive environment of firms, as well as influencing the impact of manager decisions on firm performance. It is difficult to know if these managers in a different competitive environment would have made the same decisions and what would have been their effect on the firm performance.

Third, this paper does not explain the way of how CEO's profile is connected to firm performance. We assume that some CEO characteristics would push them to take certain actions and decisions or even transfer these actions to the TMT (Liu *et al.*, 2018) that will have an impact on firm performance but we do not measure these choices or actions.

Fourth, the CCA technique in many cases there is great difficulty in interpreting results, as unusual combinations of variables are constructed.

A possible extension of this work would be to study the mediating role of the strategic decisions of the CEO. In addition to studying the mediating role, it can also be analyzed other variables of the CEOs associated with their personality, leadership style and self-confidence. All these characteristics have been recognized by academics of the industrial psychology as very relevant in the decision making process. Adding these personal characteristics will provide us a much more complete CEO profile.

In conclusion, we have shown that intangible assets matters in order to potentiate firm performance. We show how different combinations of CEO characteristics have an impact on different measures of firm performance.

Notes

1. See www.ine.es/daco/daco42/daco4217/lstsectcnae.xls for a list of high- and medium-high-technology industry sectors.
2. In order to avoid the influence of outliers on the results of the CCA, we have eliminated 13 observations following the criterion of leverage out of range, in the same way as it is done in the regression models.
3. In both sets of variables, the hypothesis that the correlation matrix is identity is rejected. The KMO statistic provides desirable values. For CEO characteristic variables: χ^2 statistic = 2,398; $p < 0.000$ (Reject Ho); KMO = 0.705. For the performance variables: χ^2 statistic = 474; $p < 0.000$ (Reject Ho); KMO = 0.613.
4. The results of the stability analysis are available upon request.

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The long-term effect of training and development investment on financial performance in Korean companies

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Abstract

Purpose – The purpose of this paper is to examine the relationship between training and development investment and financial performance over time. Human capital literature suggests that training and development investment may not immediately affect financial performance but may instead create effects that are realized over time. However, most existing cross-sectional research explores the influence of training and development investment on performance while overlooking training and development investment's long-term effects.

Design/methodology/approach – This study focuses on the recovery period following the Great Recession circa 2008 in the South Korean business context. Longitudinal data from 312 firms, including four distinct waves, were used. Latent growth modeling was used to help identify a pattern of reciprocal relationships between training and development investment and financial performance over time.

Findings – The results indicate that even though growth in training and development investment is stable over time, there are significant between-firm differences in training and development investment trajectories over time. Prior financial performance was shown to be positively related to higher levels of training and development investment, but it was not related to growth in training and development investment. The initial level of training and development investment did not predict subsequent profit, but growth in training and development investment was positively related to future financial performance.

Originality/value – This study suggests that as an organization's training and development investment increases over time, a delayed effect on financial performance may emerge because of this accumulated investment. Ultimately, the results highlight the importance of having a stock of human capital, rather than concentrating upon momentary flows that yield immediate effects.

Keywords Human capital theory, Training and development investment, Financial performance, Latent growth modeling

Paper type Research paper

As a focal human resource (HR) practice is used to develop human capital within firms, training and development represent a growing area of scholarly interest (Sitzmann and Weinhardt, 2018; Zula and Chermack, 2007). Continuous formal learning opportunities in accredited institutions form a critical pathway for developing general human capital, or capital that is applicable to any organizational context (Campbell *et al.*, 2012). Informal learning that occurs in the workplace can help employees to acquire tacit knowledge in performing higher task-complexity jobs and ultimately develop firm-specific human capital, or capital that is only meaningful within a specific organizational context (Dämmrich *et al.*, 2015). Previous meta-analytic studies have found that investment in training and development can lead to better financial performance (Crook *et al.*, 2011; Tharenou *et al.*, 2007).

Particularly, firm-specific human capital is difficult for competitors to replicate because the capital is optimally tailored to the work environment in which it was first cultivated (Hatch and Dyer, 2004). Researchers have argued that firms with ample training and development opportunities can more effectively yield firm-specific human capital and stimulate subsequent financial performance than can firms that do not offer training and development opportunities (Berk and Kaše, 2010).

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Even though these studies have provided empirical evidence of this relationship, doubts have been raised regarding the robustness of the results. Most cross-sectional research has explored the contributions of training and development to financial performance while overlooking the long-term effects of such investment (Rindfleisch *et al.*, 2008). This limitation means not only that the research model is inherently flawed (e.g. simultaneity bias; Delaney and Huselid, 1996), but also that the modeling is unlikely to demonstrate time compression diseconomies, which constitute one of the most significant aspects of training and development investment (Dierickx and Cool, 1989; Kim and Ployhart, 2014). Because the effects of training and development investment are experienced over a period of time, considerable lag time is required before these effects may be realized in the form of enhanced financial performance (Wright *et al.*, 2001).

Therefore, this study offers an examination of the relationship between training and development investment and financial performance over time by addressing two research questions:

RQ1. How does training and development investment change over time?

RQ2. How does growth in training and development investment influence financial performance over time?

In order to mitigate the limitations of the previous research, this study uses longitudinal data from 312 South Korean (hereafter Korean) firms covering four distinct waves from 2008 to 2013. This study explores the reciprocal and non-linear relationship between certain patterns of training and development investment and financial performance by using latent growth modeling (LGM). Finally, this study finds empirical evidence to suggest that as a firm's training and development investment increases over time, a delayed effect on financial performance may emerge because of this accumulated investment.

Theoretical background and development of hypotheses

The literature review consists of three parts: human capital theory as a conceptual framework, the relationship between training and development investment and financial performance, and an introduction to the present study.

Human capital theory

In the 1960s, Gary S. Becker coined the phrase "human capital" to refer to the stock of knowledge, skills, experiences, and other characteristics that serve as the central drivers of economic growth (Becker, 1993). Over 50 years later, this concept continues to help elucidate how investments in human capital can contribute to a firm's competitive advantages by enhancing employee productivity. Proposing a resource-based view (RBV), Barney (1991) pinpointed firm-specific human capital as a source of sustainable growth for companies and suggested that it cannot be perfectly acquired from strategic-factor markets (e.g. labor markets). Since valuable, rare and hard-to-imitate human capital acts as an isolating mechanism for sustainable growth, a firm's competitors are not able to replicate its advantages instantaneously (Crook *et al.*, 2011; Hoopes *et al.*, 2003).

Dierickx and Cool (1989) suggested that a "strategic asset is the cumulative result of adhering to a set of consistent policies over a period of time" (p. 1506). An appropriate time dependency through the benefits of human capital can produce certain "routines" embedded in an organizational system (Crossan *et al.*, 1999; Koch and McGrath, 1996; Penrose, 1959). Thus, prior human capital investments enable firms to enjoy early-mover benefits based on time compression diseconomies, which indicates that human capital investment is less successful if a firm tries to improve its financial performance too quickly (Dierickx and Cool, 1989; Jiang *et al.*, 2014). A given rate of human capital

investment over a certain time interval may produce a larger stock of human capital than a doubled rate of human capital investment over half the time. Time compression diseconomies are characteristic of a firm's intangible assets accumulation process, and they bring about resource heterogeneity to help the firm to maintain a competitive advantage (Knott *et al.*, 2003).

Training and development investment and financial performance

Strategic human resource management (SHRM) scholarship suggests that HR practices ultimately aim to generate multi-level performances (Barney and Wright, 1998). Dyer and Reeves (1995) specified a multidimensional model of such performances: HR-related performances refer to employees' attitudes and behaviors (e.g. turnover) that result from HR practices; organizational performances refer to the operational excellence of an organization (e.g. productivity); and financial performances refer to actual monetary values that result from business activities (e.g. return on assets).

Dyer and Reeves (1995) argued that because HR practices are designed to maximize purposeful HR-related performances, these HR practices first influence proximal HR-related performances and afterwards distal performances (i.e. organizational and financial performances; Wright *et al.*, 2003). Meta-analytic research (e.g. Jiang *et al.*, 2012) has shown that HR practices are more likely to affect HR-related, organizational and financial performances sequentially. On the other hand, Guest (1997) expressed skepticism about the "causal distance" between HR practices and relatively further distal performances, as increasing complications combine with internal and external factors to weaken the robust linkage between HR practices and financial performance (Boselie *et al.*, 2005; Rogers and Wright, 1998).

Some scholars have raised questions about this unidirectional mechanism, suggesting that HR practices influence financial performance via organizational performance (Wright *et al.*, 2005). They have proposed a reverse causality mechanism that suggests that high-performing organizations that are profitable are more willing to invest in HR practices than low-performing ones are (Edwards and Wright, 2001; Katou, 2012). These reverse relationships are assumed to develop because high-performing organizations have slack resources to be able to share their profits with their employees by providing competitive compensation, job security, selective hiring systems, extensive developmental opportunities and various forms of empowerment activities (Wright *et al.*, 2005; Pfeffer, 1998). These organizations are thus able to exponentially elevate their employees' capabilities. Capable employees are able to contribute to improved financial performance by bringing in more profit. This increased profit can then be reinvested in the employees.

Despite these debates about the relationship between HR practices and multi-level performances, the relationship between training and development investment and financial performance remains contested. The return on training and development investment is not bidirectionally or unidirectionally proportional to financial performance. Substantial investment in training and development may cause a temporary decrease in returns at the beginning as a result of the transformative changes that take place in an organization before the benefits of the training and development investment are offset by the costs of such investment (Bunderson and Sutcliffe, 2003; Morrison, 2008). A net benefit of long-term training and development investment might only be achieved after reaching the tipping point, or the point at which the organization starts to capitalize on its core competency in order to become competitive in its business environment (Gladwell, 2000). The skepticism regarding the linear relationship between training and development investment and financial performance suggests the importance of taking into account the dynamic nature of training and development in an organization as it affects financial performance. Therefore, it is necessary to explore the non-linear relationship between training and development investment and financial performance.

The present study

This study focuses on the recovery period following the Great Recession in the Korean business context. In September 2008, Korean firms were struck by an economic shock following the collapse of Lehman Brothers. The Korean economy heavily relies on export industries, which are extremely sensitive to exchange rates. The Korean won sank 28 percent against the US dollar from August to November 2008 (Chung, 2010). Because such a plummet puts equivalent firms' profits at risk, the fluctuations threw firms into turmoil. Throughout the Great Recession and beyond, the gross domestic product (GDP) growth rate dropped from 2.8 percent in 2008 to 0.7 percent in 2009, bounced back to 6.5 percent in 2010, and then recovered to approximately 2~3 percent growth after the Great Recession (Statistics Korea, 2018).

This study stems from this economic context, asking how training and development investment change in an economic recovery period. The onset of the recession in 2008 might result in a substantial decrease in training and development investment, but the quick recovery from the recession might have encouraged Korean firms to invest in training and development (Hawng *et al.*, 2016). Similarly, Ban (2012) found that the Korean economy had experienced its worst economic recession in 1998 and that there had been 5.98 percent growth in training and development investment from 1999 to 2004. However, the patterns of training and development investment in recovery periods are rarely explored. In general, among training and development professionals, it is widely believed that training and development investment usually decreases during economic downturns but may rise in economic surges.

The SHRM literature has suggested that training and development investment could contribute for post-recession profit (Kim and Ployhart, 2014). Firm-specific human capital that is acquired through cumulative training and development can be an intangible asset because it generates sustained economic rents that guarantee returns that exceed the firm's opportunity costs for training and development investment (Hatch and Dyer, 2004). Throughout the large-scale surveys of employers in UK before and after Great Recession, Felstead *et al.* (2013) identified that even though training and development could be constrained by budget rigidity, employers are likely to invest more in training and development due to outside pressures for market competition in the recovery period.

Post-recession recovery, which requires fundamental changes in business strategy, particularly needs to depend upon human capital that is formed by the rearrangement of work routines within firms or the creation of new skills and knowledge (Kim and Ployhart, 2014). Recognizing that training and development can provide opportunities for firms to develop firm-specific human capital as a lower-risk/higher-return project, this study explores whether firms used human capital-led acceleration strategies such as training and development investment to facilitate economic recovery in light of the 2008 recession (Barajas *et al.*, 2017). Therefore, this study assumes that there was growth in training and development investment among Korean firms in the post-crisis period to prepare the firms for future financial performance growth:

H1. There was a significant growth in training and development investment over time.

This study has a further interest in exploring whether variation exists in firms' training and development investment trajectories over time, thereby enabling the identification of between-firm differences. A severe economic recession forces firms to change strategy by performing resource reallocation. In order to avoid bankruptcy or to retain sufficient liquidity, risk-averse firms may postpone productivity-enhancing expenditures that are related to human capital (Santoro and Gaffeo, 2009). This radical reduction in human capital investment enables vulnerable firms to survive during severe downturns. Yet firms that are "swimming against the stream" may increase their expenditures to take advantage of the economic disturbances as a growth opportunity (Shakina and Barajas, 2014). Survivors can enjoy the transformed

competitive landscape due to reduced market competition, and they can strengthen long-term competitive advantages after the recession as a result of their efforts to enhance productivity (Santoro and Gaffeo, 2009):

H2. There were significant between-firm differences in training and development investment trajectories over time.

Previous studies have explored the unidirectional mechanism that extends from training and development investment to financial performance through enhanced employee attitudes and behaviors (Edwards and Wright, 2001; Katou, 2012). This approach can limit scholarly understanding of the dynamic nature of training and development investment, which is contingent on business strategies, while overlooking the causal order of the relationship. In order to test the reverse causality, this study hypothesizes that high-performing firms were likely to increase their investment in training and development:

H3. Financial performance (Time 0) was positively related to initial training and development investment (Time 1).

This study suggests that the starting point (Time 1) of training and development investment was not positively associated with the subsequent (Time 3) level of financial performance; however, growth in training and development investment was positively associated with the subsequent (Time 3) level of financial performance. The first part of this statement represents the causal distance between training and development investment and the relatively further distal outcome indicator of financial performance over time. The second part reflects the characteristics of the human capital that has been accumulated and the time-lagged effects of training and development investment. This means that regardless of the starting point of training and development investment, financial performance is accelerated by growth in training and development investment over time. While training and development investment may not affect a firm's immediate financial performance, the investment may create effects that are realized over time. Finally, this study assumes that training and development investment increased over time and that a firm's financial success emerged after continuous learning reaches a tipping point:

H4. Growth in training and development investment over time was positively related to financial performance (Time 3).

Method

Sample

This study used a data set from the Human Capital Corporate Panel (HCCP), which was administered by the Korea Research Institute for Vocational Education and Training (KRIVET, 2015). To perform a stratified and random sampling, the firm samples that were initially selected were those firms that had hired over 100 employees ($n = 4{,}109$). Based on the Korean Standard Statistical Classification, these firms were then classified according to a 3×3 matrix: industry (manufacturing, banking, and non-banking services) and firm size (100–299, 300–999 and more than 1,000 employees). Finally, 500 (12.2 percent) of the firms were sampled at random from each cell in the matrix to prevent possible over- or under-sampling. Although there were moderate changes in the sampling of the HCCP data set and unforeseeable shifts such as bankruptcies or mergers and acquisitions, a total of 381 firms were consistently sampled. This study used 312 of those firms' complete data with three repeated measurements. This study used the corporate-level data described here, as well as corporate financial data from 2008 (Time 0), 2009 (Time 1), 2011 (Time 2) and 2013 (Time 3). The descriptive characteristics of the samples used in this study, which are representative of the Korean business sector, are provided in Table I.

Measurements

The unit of analysis for this study was the organization. All data were normalized to reflect current financial values by applying the Korean Consumer Price Index that corresponded to each year of data collection (Statistics Korea, 2018). This process was corrected for inflation.

Training and development investment. HR directors of all the companies that were surveyed as part of the HCCP reported their actual corporate training expenditures every two years. In this study, training and development investment represent financial investment in workplace learning practices with the aim of helping employees develop job competencies. Total expenses for training and development, such as trainer fees, training materials and equipment and classroom rental fees, were included in training and development investment. Due to the high kurtosis of the data, a log transformation was performed.

Financial performance. HCCP provided corporate financial data based on firms' annual financial statements. This study's assessments of financial performance were operationalized using the ratio of ordinary income to total assets, which was determined by dividing each firm's ordinary income by its total assets.

Data analysis strategy

The data for this study were analyzed using LGM in order to identify the effects of changes on the association between training and development investment and financial performance over time (Bollen and Curran, 2006; Ployhart and Vandenberg, 2010). LGM is a statistical technique that applies structural equation modeling (SEM) to the analysis of longitudinal data. Traditional longitudinal analytical methods use repeated multiple regressions or the SEM method while simply assuming that the temporal precedence of training and development affects financial performance (e.g. training and development investment at Time 1 results in a stronger financial performance at Time 2). Such research designs do not prevent the specification of measurement errors (Chan, 1998; Dierdorff and Surface, 2008).

Model specification

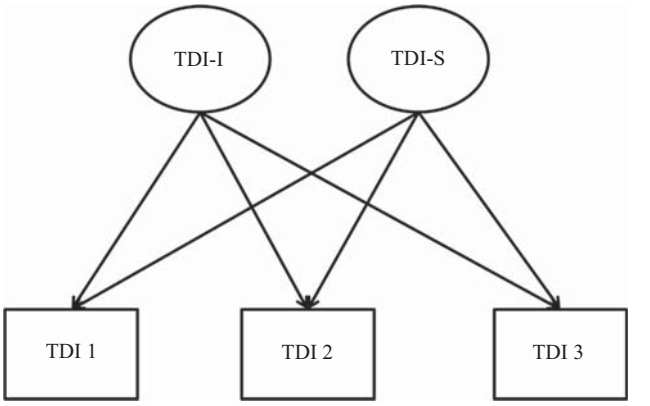
Rogosa (1988) suggested using a two-step LGM approach to determine reciprocal relationships. The first step is to identify changes in an independent variable over time, while the second step is to incorporate predictors that result in important effects on changes in the independent variable and determine whether the changes in the independent variable lead to the subsequent dependent variable. In this study, the first step of LGM was used to test the hypothesis that there is a significant growth and variance in training and development investment over time (see Figure 1).

During the second step, analyses were conducted to examine training and development investment as a predictor and consequence of financial performance (see Figure 2).

Industry	Entire Korean business sector				HCCP samples in this study			
	Organization size[a]							
	100~299	300~999	> 1,000	Total	100~299	300~999	> 1,000	Total
Manufacturing	2,436	593	158	3,187	109	88	36	233
Banking	69	41	48	158	2	7	11	20
Service	581	140	43	764	27	24	8	59
Total	3,086	774	249	4,109	138	119	55	312

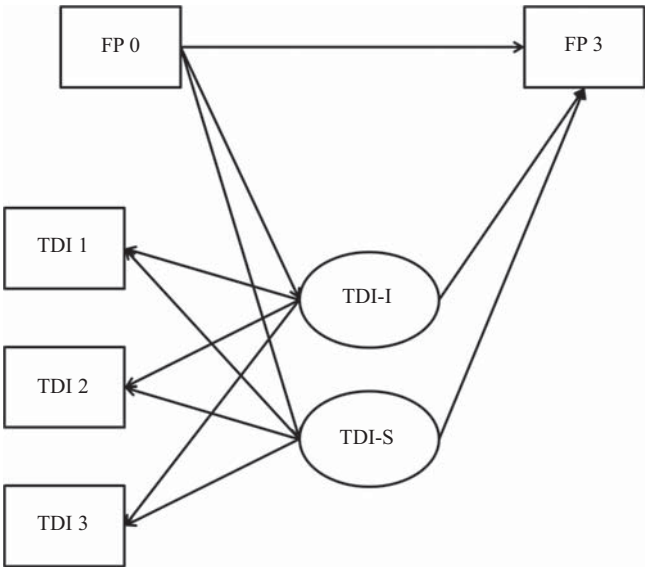
Notes: This table is based on the 2009 HCCP data. For the sake of clarity, the descriptive characteristics of the sampled data are regrouped from the original categories. [a]Numbers of employees

Table I. Descriptive characteristics of the samples used



Notes: TDI, training and development investment; FP, financial performance; I, intercept (i.e. initial status); S, slope (i.e. change over time)

Figure 1. Three-wave LGM for training and development investment



Notes: TDI, training and development investment; FP, financial performance; I, intercept (i.e. initial status); S, slope (i.e. change over time)

Figure 2. Conceptual research framework: Training and development investment as predictor and consequence of growth

Model identification

The two models in Figures 1 and 2 both satisfy the necessary *t*-rule by having three and five observed variables, respectively (Kline, 2011). Moreover, because these two models are recursive models without feedback loops, reciprocal relationships or correlations between disturbances, the models are identified.

Model estimation

Maximum-likelihood (ML) estimation was performed using SPSS 18.0 and Mplus 6.12 software to identify simultaneous interactive relationships. In the first step, an LGM was specified to test the hypothesis regarding the growth trajectory of training and development investment over time. A starting point (i.e. intercept) and a rate of change (i.e. slope) were used to characterize the trajectory of training and development investment (Mason, 2001). The intercept and slope provided information about mean and variance, respectively. All intercepts and slopes were specified to co-vary (Chan and Schmitt, 2000).

More specifically, five estimates were provided in LGM: the mean intercept represents the estimate of the average training and development investment across firms at the initial measurement, the mean slope indicates the average training and development investment change across firms over repeated measurements, the variance of the intercept represents the extent of variability across firms in training and development investment at the initial measurement, the variance of the slope represents the variability in change trajectories of training and development investment across firms over repeated measurements, and the covariance of growth parameters shows the relationship between the intercepts and slopes of training and development investment (Dierdorff and Surface, 2008; Kline, 2011). In order to interpret the fit of the model, this study used four fit indices: χ^2 goodness-of-fit test, the comparative fit index (CFI; Bentler, 1990), the Tucker–Lewis Index (TLI; Tucker and Lewis, 1973) and the root-mean-square error of approximation (RMSEA; Steiger, 1990).

The latent variables provided information that was estimated from the data to test *H1* and *H2*. Financial investment as a predictor and consequence of training and development investment was subsequently specified to test *H3* and *H4*. Financial performance at Time 0 as an exogenous predictor of growth was specified to have a direct effect on both the intercept and slope of training and development investment and the intercept and slope were specified to impact financial performance at Time 3. The financial data from 2008, Time 0, was used as a baseline for the initial level of training and development investment. The financial data from 2013 were used as the most appropriate benchmark for assessing the effects of previous training and development investment on financial performance, given that a firm's long-term strategic plan generally spans a five-year time frame.

Results

The descriptive statistics for the data are presented in Table II. Log-transformed training and development investments showed high correlations but did not exceed 0.85, although one correlation nearly reached the threshold (Kline, 2011). To examine the univariate normality of the data, the skewness and kurtosis of training and development investment and financial performance were evaluated. All skewness values were between −1.5 and 1.5 and all kurtosis values were between −1.3 and 7. Thus, the gathered data showed a mild form of univariate non-normality.

Variables	*M*	SD	Skewness	Kurtosis	1	2	3	4	5
TDI 1	11.336	1.900	0.211	−0.238	1				
TDI 2	11.262	2.045	0.170	−0.158	0.849**	1			
TDI 3	11.400	2.011	0.149	−0.057	0.803**	0.859**	1		
FP 0	5.26	8.000	0.270	1.263	0.189**	0.191**	0.169**	1	
FP 3	2.927	7.390	−0.740	2.636	0.056	0.110	0.132*	0.329**	1

Notes: $n = 312$ firms. TDI, training and development investment; FP, financial performance; *M*, mean; SD, standard deviation. TDI 1 reflects the data for 2009; TDI 2 for 2011; TDI 3 for 2013; FP 0 for 2008; and FP 3 for 2013. $*p < 0.05$; $**p < 0.01$.

Table II. Descriptive statistics

The estimation of the LGM of training and development investment indicated an acceptable fit to the observed data, even though the RMSEA just exceeded 0.10 (Chen *et al.*, 2008; Kline, 2011). The predictor and consequence of growth in training and development investment showed a good fit to the data (see Table III).

Hypothesis testing

In the first step, the mean starting point of training and development investment was estimated to be 11.331 ($p < 0.05$), and the mean rate of change was estimated to be 0.033 ($p > 0.05$). The mean starting point of training and development investment was significant, but the mean rate of change was non-significant. Variance estimates for the intercept (3.531) and the slope (0.344) were greater than zero ($p < 0.05$), indicating significant differences in the initial and growth points of training and development investment for each firm. The estimated covariance between the intercept and the slope was −0.227 ($p > 0.05$); thus, initial levels of training and development investment were negative, but they were not significantly correlated with growth in training and development investment. Ultimately, *H1* was rejected, but *H2* was supported (see Figure 3 and Table IV).

Table III. Overall fit of the models

	χ^2 (df)	CFI	TLI	RMSEA
LGM for training and development investment	$\chi 2$ (1) = 4.431, $p = 0.035$	0.996	0.988	0.105
Predictor and consequence of growth in training and development investment	$\chi 2$ (4) = 8.702, $p = 0.054$	0.995	0.987	0.061

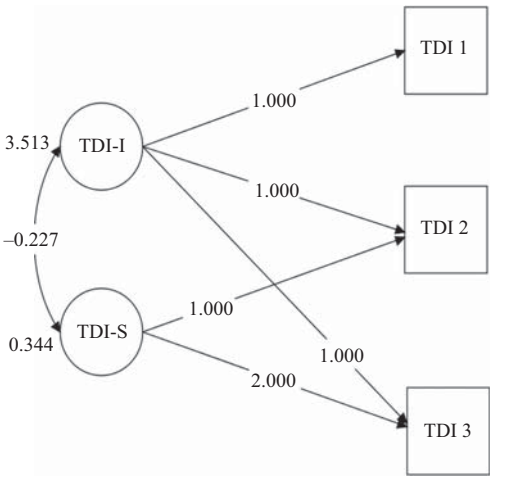


Figure 3. Three-wave LGM for training and development investment with unstandardized coefficient estimates

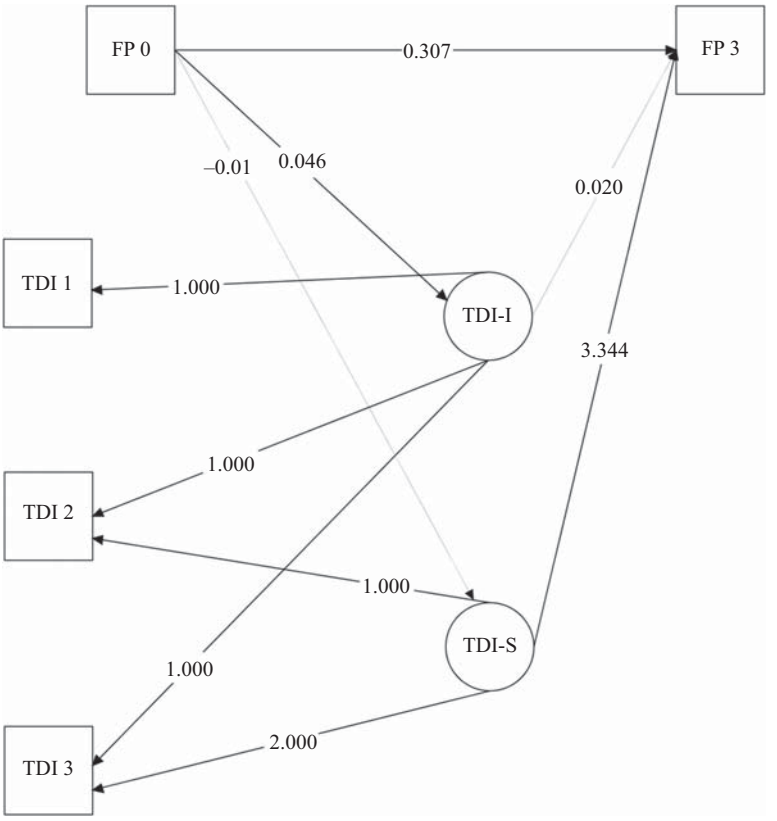
Table IV. Parameter estimates of LGM for training and development investment

	Mean		Variance		Intercept ↔ Slope
	Intercept	Slope	Intercept	Slope	
Training and development investment	11.331***	0.033	3.513***	0.344***	−0.277

Note: ***$p < 0.001$.

In the second step, the results showed that financial performance at Time 0 ($\beta = 0.026$, $p < 0.05$) was related to higher initial levels of training and development investment, but it was not related to the training and development investment slope ($\beta = -0.003$, $p > 0.05$). Prior financial performance predicted the initial level of training and development investment, but it did not predict growth in training and development investment. In conclusion, *H3* was supported. With regard to *H4*, while the initial level of training and development investment was not related to subsequent (Time 3) financial performance ($\beta = 0.005$, $p > 0.05$), growth in training and development investment was related to financial performance at Time 3 ($\beta = 0.192$, $p < 0.05$). Even though the initial level of training and development investment was not related to future financial performance, if a firm's training and development investment increased over time, its financial performance was stronger (see Figure 4 and Table V).

Based on the results of the model estimations, all suggested hypotheses were examined. First, there was a significant mean difference in initial training and development investment, but growth in training and development investment was not observed. There were significant between-firm differences in the initial levels and rates of change in training and development investment. Second, financial performance (Time 0) was positively related to initial training and development investment (Time 1). Prior financial performance was positively related to higher subsequent levels of training and development investment, but it



Note: Dotted lines indicate non-significant paths

Figure 4. Final model with unstandardized coefficient estimates

was not related to growth in training and development investment. Third, growth in training and development investment over time was positively related to financial performance (Time 3). The initial level of training and development investment did not predict subsequent profit, but growth in training and development investment was positively related to future financial performance.

Discussion

The study provides a new perspective on training and development investment in the recovery period of the Great Recession by pairing human capital theory and LGM statistical modeling. The results of this study suggest possibilities for employing the time-dependent characteristics of human capital and longitudinal research designs in order to test the underexplored nature of training and development investment.

The results of *H1* and *H2* provide a richer understanding of patterns in training and development investment. A certain stable increase or sudden drop in the training and development investments of Korean firms were not observed. At first, this result identifies that the impact of the Great Recession was not as severe as the concern that training and development investment would have fluctuated widely according to the overall state of the economy. There are further considerations to interpret the trends in training and development investment during the recovery period. Recent studies have argued that a firm's ability to manage skill flexibility is a core competency in maintaining the firm's productivity and financial returns particularly during the time of market turbulence (Bhattacharya *et al.*, 2014; Kim and Ployhart, 2014). By selectively hiring individuals with general human capital that fits the firm's business strategies firms could leverage this general human capital to maximize organizational outcomes rather than investing in firm-specific human capital that may take more time to develop. Thus, talent acquisition and retention and investment in labor expenses could become the primary methods by which organizations gained general human capital from the external labor market (Bhattacharya *et al.*, 2014; Van Iddekinge *et al.*, 2009). During the post-recession period, some South Korean firms seemed to focus on acquiring general human capital by reducing new recruitment, particularly for early career talent who needs substantial training and development investment at the beginning and increasing recruitment of skilled employees from the external labor market (OECD, 2017).

Additionally, there were systematic differences in the level of training and development investment among firms. This result is consistent with the findings of Felstead *et al.* (2013), who identified that employers' willingness to invest in training and development was differed by the nature of the market competition. The firm-specific human capital through training and development is highly rooted in complicated social systems in the firm, thus making it difficult to transfer without incurring considerable dynamic adjustment costs (Crook *et al.*, 2011; Hatch and Dyer, 2004) and eventually remains a possible strategic asset that cannot be quickly manipulated by competitors (Bollinger and Smith, 2001). Some firms did consistently invest in training and development despite economic uncertainties in recovery period, seeing this investment as a stimulant of future financial performance growth.

Table V. Standardized path coefficients of the final model

	TDI-I	TDI-S	FP 3
FP 0	0.026***	−0.003	0.042***
TDI-I			0.005
TDI-S			0.192*

Notes: *$p < 0.05$; ***$p < 0.001$.

With respect to *H3* and *H4*, this study found that prior financial performance is positively related to subsequent training and development investment, but the starting point of training and development investment does not guarantee future profit. This result supports Wright *et al.*'s (2005) reverse causality and Guest's (1997) causal distance argument. It is important to note, however, that the results do not prove that temporal precedence predicts a firm's budget allocation. Rather, since the human capital that is acquired from training and development investment may become eroded or obsolete at any given point in time, firms may lose their sustainable competitive advantages if they lack continuous flows of new skills and competencies (Dierickx and Cool, 1989; Garavan *et al.*, 2001; Ployhart *et al.*, 2009).

Finally, the strongest finding of this study supports the importance of growth in training and development investment. Consistent with prior research by Van Iddekinge *et al.* (2009), this study's findings indicate that more training and development investment is likely to predict better financial performance over time. Unlike labor expenses that may vary according to a firm's contextual factors (Bhattacharya *et al.*, 2014), training and development investment should be consistent and stable in order to take advantage of the firm-specific human capital that can accumulate among employees, tasks, tools and routines, as well as in the combination of these entities (Yuan *et al.*, 2010). Ultimately, the results suggest the importance of having a stock of human capital, rather than concentrating on momentary flows that yield immediate effects (Seoul National University College of Engineering, 2015).

Implications for theory

The existing literature on intangible assets assumes a log-linear relationship between intangible assets and performance (Adler and Clark, 1991; Gruber, 1992). The central argument made is that individuals or organizations monotonically acquire knowledge and skills, and their productivity is enhanced commensurately as they apply what they acquire. According to the classic learning curve theory, accumulated learning generates a linear progress curve in productivity and performance (Argote, 1996). This learning curve is represented by the progress ratio, which suggests that an increase in units of cumulative learning results in an increase in productivity from units of output at a uniform rate. Finally, cumulative learning acts as an intangible strategic asset for enhancing organizational performance in the long term (Teece and Pisano, 1994).

Beyond a linear assumption of the relationship between intangible assets and performance, the learning curve theory suggests non-linear patterns in intangible assets accumulation and development through learning by doing (Muth, 1986). Developing new knowledge is often accompanied by a significant drop in productivity in the early stages of the learning curve; this drop is represented as an initial downward concavity on the learning curve (Morrison, 2008; Muth, 1986). For example, employees begin to learn a set of work routines that is optimized to maximize the performance of a specific task; as such, it takes time to develop new stable work routines (Zollo and Winter, 2002). At the same time, since employees are less likely to achieve complete mastery of new skills and knowledge, employees are more likely to make errors and need additional training to acquire tacit skills (Hatch and Dyer, 2004). Likewise, the initial downward concavity on the learning curve emerges when the benefit from cumulative learning does not offset the cost of learning. Moreover, there can be a flattening of the learning curve without any distinctive gains in productivity despite investment in intangible assets and a subsequent commitment to deliberate practices (Dorroh *et al.*, 1994). This plateau happens when the economic potential of cumulative learning is building: The plateaued learning curve reaches a higher level of sustained proficiency with the accumulated learning (Morrison, 2008; Thompson, 2012).

After a significant plateau state with seemingly little improvement, sudden improvement may occur as a result of the sufficient accumulation of learning (Lapré and Nembhard, 2011). Hax and Majluf (1982) suggested that cumulative learning generates steeper learning curves. As organisms, organizations are made up of multiple subsystems that perform their own functions but in coordination with other functions (Kofman and Senge, 1993). Even though learning by doing aims to benefit the overall organization, the subsystems in the organization are unable to internalize such benefits equally. There are local variations of absorptive capacity in subsystems of an organization (Cohen and Levinthal, 1990). Since overall organizational performance relies on the integration of absorbed knowledge that enables different subsystems to come together, cumulative learning is rapidly realized when all of the subsystems accrue enough learning to bridge a critical threshold (Azariadis and Drazen, 1990; Kim *et al.*, 2013; Morrison, 2008).

Implications for research

Morrison (2008) illustrated the bifurcation dynamics of intangible assets investment, using a learning curve that depicts initial downward concavity and a subsequent plateau. On the one hand, in order to reduce the opportunity cost of learning without adding prompt outputs, additional investment in intangible assets can be hesitant, meaning accumulated learning fizzles and fails (Li and Rajagopalan, 1998). On the other hand, an organization may find a tipping point that yields economic rent through continuous learning by doing (Gladwell, 2000; Repenning *et al.*, 2001). The issue is that the monetary realization of intangible assets accumulation is difficult to pre-estimate and shows stochastic and non-linear dynamics (Erden *et al.*, 2014).

In this regard, the results of this study may motivate a more focused consideration of the substantive role of "time" in intangible assets investment. Since intangible assets research implicitly addresses issues of change without considering the mutable characteristics of individual and organizational behaviors in workplace contexts, its research results may be misinterpreted or fail to demonstrate strong causal inferences about the mechanisms behind a given change (Bono and McNamara, 2011). Therefore, the application of rigorous research designs can contribute to understand the role of time while designing and conducting intangible assets research. Longitudinal statistical designs can help researchers to investigate how firms' intangible assets investments contribute to the creation of competitive advantages, elucidating the specific mechanisms via empirical data. Various longitudinal research designs (including LGM, repeated-measures general linear modeling, and random coefficient modeling) can help shed light on the dynamic nature of intangible assets over time (Ployhart and Vandenberg, 2010).

Moreover, much of the prior research regarding human capital investment assumes that the labor market for human capital is perfectly competitive and firm-specific human capital is the inhibitor to trading human capital in the labor market (Chadwick, 2017). Investing in general human capital is likely to be a financial drain since talented employees with general human capital are more visible in the labor market, meaning that their mobility is inevitably higher than that of their colleagues (Riley *et al.*, 2017). Thus, firms are required to focus their investments in human capital on firm-specific human capital that can be maintained within the individual firms and cannot be applied easily to other firms (Coff and Raffiee, 2015). For firms, firm-specific human capital is an isolating mechanism that enables sustainable growth, but for employees, it is an investment dilemma since employees with firm-specific human capital may recognize that they could become locked into particular firms and suffer significant penalties in the labor market (Coff and Raffiee, 2015; Snell and Dean, 1992).

However, the argument that enables this approach is valid primarily for western economies and particular private sectors that generally show high levels of job mobility. This study examined its research questions using data drawn exclusively from the Korean

private sector and its labor market, which is meaningfully different from the labor markets of Western countries (OECD, 2017). Acknowledging the relatively lower job mobility characterizing Korea's labor market, in which lifelong employment still exists, this study suggests the need for new research directions for human capital theory. In particular, it is necessary to explore the relationship between intangible assets and financial performance in more diverse research contexts and environments in order to revisit the general assumption of human capital theory.

Limitations and future research

Many researchers have sought to corroborate the relationship between various estimations of human capital and firm performance, thereby establishing a novel theory and identifying new implications in intangible assets research. This study operationalized training and development investment by using the financial factor of training expenditures. Future research might consider estimating human capital as the aggregate form of employees' knowledge, skills, and attitudes within a firm (Bhattacharya *et al.*, 2014). Moreover, the present study extends the idea that human capital emerges and evolves over time and that there are various predictors that influence human capital. The patterns of training and development investment may vary by industry characteristics, for example, because firms in different industries face distinctive competitive business environments (Kim and Ployhart, 2014). Firm size can be a primary determinant of the a firm's ability to provide sizable and continuous training and development investment. Large firms may have more training and development resources (e.g. facilities, equipment, and training and development professionals) because of the firms' economies of scale (Aycan, 2001). Likewise, there are many opportunities for the further investigation of human capital, the results of which would be valuable to training and development research and practice.

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Dimensions of organisational innovativeness and company financial performance in the biotechnology sector

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Abstract

Purpose – The relationship between organisational innovativeness (OI) and company performance has been studied extensively, and the associations found have mostly been positive. However, as OI is a multidimensional concept, more nuanced research is needed to identify which dimensions of innovativeness companies should focus on. The purpose of this paper is to longitudinally investigate the links between dimensions of OI and company financial performance, based on a sample of Finnish and Estonian pharmaceutical biotechnology companies.
Design/methodology/approach – Interviews inquiring about OI were conducted in 26 biotechnology companies and then their performance was measured over three subsequent years using objective financial data. Due to limited sample size, qualitative comparative analysis is employed in addition to non-parametric statistical tests.
Findings – Overall, OI did not decisively influence financial performance in the studied sector. There were, however, dimensions related to human resource policies that appeared to have more potential to positively impact financial performance, whereas the strategic dimension was actually aversive to certain performance indicators.
Research limitations/implications – The study limitations are a small sample, possible managerial bias in the assessment of OI, and focus on financial measures only.
Practical implications – The study demonstrates that OI is a multidimensional construct and not all dimensions play an equal role in financial performance. Innovation-supportive human resource policies and strategic flexibility contributes to financial performance in the pharmaceutical biotechnology sector.
Originality/value – The contribution of the study is the analysis of a specific sector with a longitudinal approach by bridging quantitative and qualitative approach.

Keywords Finland, Estonia, Company performance, Biotechnology, Organizational innovativeness

Paper type Research paper

Introduction

The ability to innovate is claimed to be a prerequisite of any company's survival and success in the current dynamic economic environment (Hult *et al.*, 2004; Rhee *et al.*, 2010). Innovation is thought to lead to higher productivity, growth and wealth, which manifests first at a company level and then at national and global levels. According to Kramer *et al.* (2011), the ability to innovate is determined by two micro-level intangible assets: organisational and network capital. These intangibles reflect organisational culture and company-level activities related to innovation (Tellis *et al.*, 2009; Dulger *et al.*, 2016), also

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known as organisational innovativeness (hereafter, OI) from a process perspective. This view suggests that there are certain competitive abilities and cultural traits possessed by innovative firms which are absent in non-innovative firms (Tellis *et al.*, 2009). Hurley and Hult (1998) suggested that company performance models should incorporate innovativeness. 20 years later, the innovativeness–performance link they posited has been studied extensively and positive associations confirmed by several authors (see Finoti *et al.*, 2017 for an overview in the small- and medium-sized enterprise context).

However, there are several caveats in prior studies that call for additional research. First, innovation and innovativeness are sometimes used interchangeably (Garcia and Calantone, 2002), and OI, in particular, comprises both the firm-level enablers of innovation and realised innovations in the form of adopted new ideas or even new products or services on the market (Hult *et al.*, 2004; Wang and Ahmed, 2004). As such, antecedents for and outcomes of innovation are part of the same construct, which causes confusion (Woodside, 2005).

This study departs from the notion that one should distinguish between innovativeness as a cultural precursor providing the social capital to facilitate innovative behaviour and the degree of innovations actually produced or adopted by the organisation, like Hurley *et al.* (2005) and Woodside (2005) have suggested. This paper focusses on the facilitative aspect or antecedent dimensions of OI, i.e., it adopts the process view. Many authors support such a conceptualisation of OI, which has been defined, for example, as "an aspect of organisational culture that precedes innovation" (Hurley and Hult, 1998, p. 47), and Woodside (2005, p. 276) states that "Innovativeness is a cultural trait that affects innovative capacity". Finally, Santos *et al.* (2018, p. 260) claim that the capability to innovate is "an organizational resource with cumulative nature of investments in the dimensions that constitute it, such as human capital, internal capital and relational capital". Both the capability to innovate and innovative capacity are distinct from innovation.

Second, while it is widely recognised that innovativeness is a multidimensional construct (Wang and Ahmed, 2004; Shoham *et al.*, 2012; Pallas *et al.*, 2013), empirical studies often treat innovativeness as a single variable. Only a few previous studies (Kmieciak *et al.*, 2012; Dulger *et al.*, 2016) provide insight on the potential varying effects of different dimensions of OI on different performance indicators. A multidimensional approach would enable the analysis of the factors underlying performance in greater detail, forming a basis for strategic decisions and allocation of resources.

Third, most studies use data from a single period (Calantone *et al.*, 2002; Cho and Pucik, 2005; Kmieciak *et al.*, 2012) or, even measure performance prior to OI (Kyrgidou and Spyropoulou, 2013; Pallas *et al.*, 2013). Such a method is inappropriate within the theoretical framework emphasising causality from innovativeness to performance, although the reverse may also be true (Hurley *et al.*, 2005; Rubera and Kirca, 2012). This paper maintains the more conventional view that innovativeness is desirable because it helps boost performance. We employ two techniques to strengthen this argument: first by imposing time lag between the measurement of OI and financial performance. Second, we apply qualitative comparative analysis, which identifies antecedents of a given outcome (Ragin, 2008), not just correlates.

Finally, conducting sector-specific innovativeness studies is among the current challenges of this field (Santos *et al.*, 2018), and there are only few studies focussing on the performance of biotechnology companies. Existing papers explore the relationships with narrowly defined aspects of innovativeness, such as university–industry links (George *et al.*, 2002) or degree of openness (Michelino *et al.*, 2015). This paper attempts to cast a wider net of OI by covering more potentially relevant dimensions.

The aim of this study is to investigate the links between dimensions of OI and company financial performance in the biotechnology sector, based on a sample of Finnish and Estonian pharmaceutical biotechnology companies. In our study, the time difference in

measuring independent variables, i.e., dimensions of innovativeness, and company financial performance as a dependent variable aligns more accurately with the theory. Also, this study examines the dimensions of OI individually, allowing for the possibility that not all dimensions are equally relevant to financial performance in the studied sector. The paper first elaborates the dimensions of OI, after which we review the literature on the relationship between innovativeness and performance. After the description of sample and methods, the results follow. The paper ends with a discussion of findings and their implications for managers working in the biotechnology sector and other knowledge-intensive industries. Ideas for future studies are suggested in the concluding remarks.

Dimensions of organisational innovativeness

As mentioned in the Introduction, OI refers to the proclivity, orientation and tendency to innovate, but not explicitly to innovation itself. In search of specific dimensions of OI, we rely on the work by Martins and Terblanche (2003), who discussed in detail the determinants of organisational culture, which influence creativity and innovation in organisations. They do not use the term "innovativeness", but given the OI definitions above, it is evident that the concepts are essentially the same. Five dimensions (determinants) are mentioned by Martins and Terblanche (2003): strategy, structure, support mechanisms, behaviour that encourages innovation and communication. This is not to say that those dimensions are universally accepted or unquestioned, see, for example, Shoham *et al.* (2012), Dobni (2008) or Wang and Ahmed (2004) for alternatives. Martins and Terblanche (2003) admit that there is an overlap and interaction among these elements; no clear-cut distinction exists.

Strategy

It is reflected by vision, mission and purposefulness (Martins and Terblanche, 2003). This dimension can be juxtaposed with strategic innovativeness, as Wang and Ahmed (2004) have done. Some authors use the terms "future orientation" or "long-term focus" (Tellis *et al.*, 2009; Shoham *et al.*, 2012), operationalised via the abovementioned strategic elements: vision, mission and goals. Clear objectives was considered one of the most important factor necessary for fast development of a new drug in Dorabjee *et al.*'s (1998) survey of the UK pharmaceutical industry. Martins and Terblanche (2003) place innovation-supportive values under the "structure" dimension, but we maintain that these are elements of strategy since organisational values are closely linked to mission and vision. Here authors suggest that innovation, growth, freedom, flexibility and ambitiousness should be mentioned explicitly among values (Martins and Terblanche, 2003; Lau and Ngo, 2004; Dombrowski *et al.*, 2007).

Structure

It supports creativity and innovation, which is characterised by flexibility, job autonomy and co-operative teams (Martins and Terblanche, 2003). An innovative organisation is one in which employees have some independence and autonomy to choose assignments and ways to fulfil them (Lau and Ngo, 2004; Mazzei *et al.*, 2016). However, Gebert *et al.* (2003) warn that having too much autonomy (which the authors call "situation control by the led") is detrimental unless accompanied by targeted integration strategies. Clear focus and consensus on the strategic course of the company are examples of integration initiatives; hence, loose structure has to be balanced by a well-defined strategy (Gebert *et al.*, 2003).

Another aspect of structure is participative and quick decision-making (Dorabjee *et al.*, 1998; Martins and Terblanche, 2003), even though these may be somewhat mutually exclusive. Participative decision-making was also found to be the strongest determinant of

innovative capacity in Hurley and Hult's (1998) study. Quick decision-making indicates a lack of hierarchy, which in itself is good for innovativeness (Dombrowski *et al.*, 2007; Tellis *et al.*, 2009). For example, decentralisation has been found to have a positive effect on innovativeness (Kramer *et al.*, 2011; Shoham *et al.*, 2012).

Working in teams (Martins and Terblanche, 2003; Lau and Ngo, 2004; Kramer *et al.*, 2011) is key to innovativeness, enhanced by internal mobility and flexible structures. In case of pharmaceutical companies, teamwork was the number one determinant of fast development of a new medicine (Dorabjee *et al.*, 1998). It has even been suggested that managers physically co-locate employees from different disciplines and functions (Coradi *et al.*, 2015). As Foss and Laursen (2005) conclude that firms with the ability to innovate use planned job rotation and quality circles in order to integrate knowledge and share.

Support mechanisms

It refer to resources and incentives to innovate (Martins and Terblanche, 2003). Resource allocation decisions determine the recruitment of creative people in the first place, for example, hiring employees with a focus on their creative potential, risk-taking and innovation orientation (Hunter *et al.*, 2012; Mazzei *et al.*, 2016) and then providing time and space for innovation activities (Dombrowski *et al.*, 2007). In this paper, we pay special attention to the personalised motivation system, proposed by many scholars (Dombrowski *et al.*, 2007; Mazzei *et al.*, 2016). Pallas *et al.* (2013) went so far as to suggest that this aspect is so relevant to innovation that it should be a separate dimension. Indeed, it has been demonstrated on Danish sample that innovative firms and those operating in dynamic sectors tend to adopt pay-for-performance compensation system (Foss and Laursen, 2005). In short, personalised rewards are characteristic to OI by facilitating employees' innovative behaviour.

Behaviour that encourages innovation

It is an enormous field and is rather difficult to quantify as it includes elements such as support for change, learning culture, risk-taking, idea generating and mistake and conflict handling (Martins and Terblanche, 2003). It resembles the behavioural innovativeness dimension according to Wang and Ahmed's (2004) categorisation. The most studied variable within this dimension is openness to new ideas or openness to change, and proactiveness (Wang and Ahmed, 2004; Dobni, 2008; Shoham *et al.*, 2012; Pallas *et al.*, 2013). New ideas may come from internal sources (e.g. teams) or external sources, ideally by combining both (Criscuolo *et al.* 2018).

Risk-taking is emphasised almost universally (Lau and Ngo, 2004; Wang and Ahmed, 2004; Dobni, 2008; Tellis *et al.*, 2009; Shoham *et al.*, 2012; Pallas *et al.*, 2013). Risk-taking and OI are linked in the strategic resilience paradigm, which warns organisations against status quo. Innovative organisations are willing to engage in activities that have no certain return (Lau and Ngo, 2004; Dobni, 2008; Tellis *et al.*, 2009). It is interesting to note that pharmaceutical companies had, on average, low propensity to take risks compared to mechanical, electronic and chemical industries (Dorabjee *et al.*, 1998). However, risk-taking is extremely difficult to translate into a specific behavioural manifestation. There is perhaps just one aspect that has received attention in earlier studies: cannibalising one's products and services for novel solutions even if it involves significant uncertainties.

Employee training and development (Lau and Ngo, 2004; Dobni, 2008) is a part of "continuous learning culture" in Martins and Terblanche's (2003) framework. The importance of induction programmes or formal socialisation practices in accelerating the acculturation of new employees has also been emphasised (Dobni, 2008; Mazzei *et al.*, 2016). Generally, the behaviour dimension largely reflects human resource policies, for example, Vanhala and Ritala (2016) inquired about training and development, performance

evaluation schemes, participation in decision making, career opportunities, communication and purposeful job design. They concluded that these were significantly and positively related to all dimensions of OI, meaning that these policies also influence structural and strategic dimensions of OI.

Communication

Martins and Terblanche (2003) emphasise open communication among individuals, teams and departments. Horizontal and vertical links ensuring information flow are also observed by Price (2007) and Mazzei *et al.* (2016), among many others. In addition to internal communication, external networking plays an important role in OI, enabling information to flow between market participants (Dombrowski *et al.*, 2007; Price, 2007; Pallas *et al.*, 2013). In their recent study of young firms' innovative performance in Europe, Protogerou *et al.* (2017) conclude that the ability to interact and access external knowledge sources, particularly formal technology collaborations, is a significant predictor of innovative activity. In the context of biotechnology, external networking and collaborative approaches extending organisational boundaries are believed to be particularly important (Michelino *et al.*, 2015; McKelvey and Rake, 2016). It is common for prior empirical studies investigating the performance of biotechnology companies to analyse precisely this aspect of innovativeness. For example, George *et al.* (2002) analysed the performance effect of the number of firm overall linkages and, linkages with research universities, in particular. In the same vein, Michelino *et al.* (2015) analysed the effect of open innovation using four types of openness ratios.

OI and company financial performance

We assume a direct link from OI to financial performance because OI reduces the firm's costs of acquiring and improves its access to resources, enables the firm to recognise new opportunities in the marketplace and makes the firm more efficient in utilising its resources (Rubera and Kirca, 2012). In the short term, however, OI may harm financial performance, especially the measures that involve costs such as return on investment (ROI) and return on assets (ROA). Negative effect is what Davis *et al.* (2013) hypothesised and confirmed in their study: higher innovativeness harmed short-term profitability. Likewise, Michelino *et al.* (2015) found that the degree of openness positively correlated with R&D costs per employee. The assumption in this study is that potential investments related to OI remain in the past and at the time of performance measurement benefits of investments accrue.

There are numerous empirical studies investigating the link between OI and financial performance, but large majority operationalise firm performance via the subjective opinions of respondents. In keeping with our own empirical approach, Table I reports the studies in which financial performance is measured by objective data. Also, definitions of OI in empirical studies vary, either focussing only on selected aspect of OI or, more frequently, treating innovation performance as part of OI. Table I reports only those studies in which process view of innovativeness was discernible; therefore, studies on "climate for innovation", "ability to innovate", "innovation capability" or "innovative culture" were also included.

As the table reveals, the link between OI and objective financial performance is inconclusive. Only three studies (Calantone *et al.*, 2002; Cho and Pucik, 2005; Santos *et al.*, 2018) conclude significant positive relationships between OI and all financial performance indicators selected, whereas in the study of Calantone *et al.* (2002) innovation performance was included in the innovativeness scale. It is more common to find on-significant or mixed results, for example, when Davis *et al.* (2013) distinguished between innovativeness and risk-taking in their survey they report a negative effect on short-term profitability in case of innovativeness and positive effect in case of the risk-taking. Similarly, Michelino *et al.* (2015) investigated several financial indicators and the results were different depending on the

Author	Sample characteristics	OI operationalisation	Financial performance measure	Result
Calantone *et al.* (2002)	187 US companies from *CorpTech Directory of Technology Companies*	Survey on OI and innovation activity	ROI; ROA; ROS	Positive
George *et al.* (2002)	147 publicly traded US biotechnology companies	Overall firm network linkages and linkages with research universities	Net sales to total assets	ns
Cho and Pucik (2005)	488 US companies from *Fortune* reputation survey	Score of innovativeness published in *Fortune* magazine	Growth (total assets, total revenues, market capitalisation); profitability (ROA, ROE, ROI); market value (market-to-book, Tobin's *q*)	Positive
Berson *et al.* (2008)	26 Israeli publicly traded companies	Innovation culture survey	Sales growth; sales-to-employee ratio	Positive ns
Kmieciak *et al.* (2012)	109 Polish SMEs	Adapted survey on climate for innovation	Income growth rate; change in profitability	ns
Davis *et al.* (2013)	104 nursing homes in the USA	Survey on entrepreneurial orientation comprising innovativeness, proactiveness, and risk-taking	Total margin ratio	Negative with innovativeness, positive with risk-taking
Santos *et al.* (2014)	Panel of 2,116 Brazilian companies in PINTEC database	Innovative effort and relational capital	ROA	ns
Mackelprang *et al.* (2015)	Panel of 9,243 US firms in COMPUSTAT database	R&D/sales ratio per cent rank, i.e. within-industry firm innovativeness	Adjusted ROA	Inverted U-shape
Michelino *et al.* (2015)	126 EU biotechnology and pharmaceutical companies	Firm total openness ratio and types of openness	Revenues per employee; EBIT per employee; market capitalisation on assets; annual increases of revenues, EBIT and market capitalisation	Mixed
Santos *et al.* (2018)	Annual Industrial Survey and PINTEC databases covering, on average, more than 8,000 Brazilian companies per year	Ability to innovate: human capital, internal and relational capital	ROA; cash generation	Positive

Table I. Relationship between OI and objective financial performance in prior studies

firm segment (biotechnology vs pharmaceutical firms) and particular performance indicator. The table also demonstrates the variety of scales that the authors use to capture OI, ranging from perceptual surveys of culture or climate (Berson *et al.*, 2008; Davis *et al.*, 2013; Kmieciak *et al.*, 2012) to hard data on firm R&D/sales ratio (Mackelprang *et al.*, 2015).

In our subsequent empirical study, we use three financial performance measures: earnings before interest and taxes (EBIT) per employee, ROA calculated as EBIT divided by average annual total assets, and annual sales revenue percentage growth. These indicators were chosen mainly for two reasons: first, in cases of non-listed companies, these indicators are available in annual reports and business registers. Second, ROA, EBIT and annual

sales growth reflect success in the market reasonably well and are less subject to account manipulations than profits. EBIT per employee reflects company productivity directly, the other two indicators indirectly.

EBIT and sales growth reflect the gains from the implementation of innovative ideas on the market; creativity and facilitation of new ideas are embedded in all innovativeness dimensions. Therefore, it is expected that EBIT (*H1*) and sales growth (*H2*) are positively linked to OI dimensions. Specifically, we expect that:

H1. EBIT per employee is positively related to all OI dimensions.

H2. Annual sales growth is positively related to all OI dimensions.

ROA does not measure business performance in absolute terms, but indicates earnings relative to total assets. It is a measure of efficiency and proxy for profitability; a higher ROA shows that the company uses its resources wisely, provided it is compared to the firms in the same industry. In relation to OI dimensions, ROA should be positively related to strategy, the role of which is to determine and prioritise resource allocations. As indicated above, a loose structure which favours creativity tends to scatter the resources and may hinder a company's efficiency; we therefore anticipate a negative relationship between structure and ROA. Hence:

H3a. Strategy dimension is positively related to ROA.

H3b. Structure dimension is negatively related to ROA.

Figure 1 provides an overview of the study framework.

Study context, sample and methods

The context

The biotechnology sector is extremely heterogeneous. In the current study, red biotechnology, i.e. drug diagnostics and development of pharmaceutical products, is examined because this particular sector has the highest overall R&D intensity; it is also claimed to be "a key asset of the European economy" (European Federation for

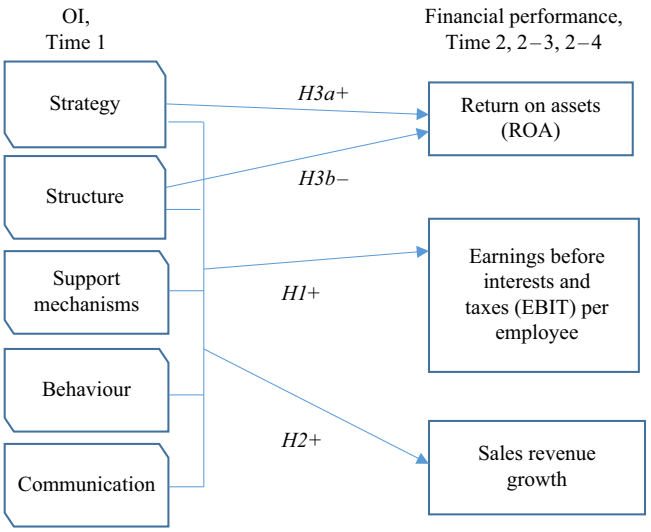

Figure 1.
The framework of the current study

Pharmaceutical Industries and Associations, 2017, p. 3). The market of such companies is either global or regional, so their performance does not depend on the geographical location or economic situation of the home country.

`The study site encompassed Finland and Estonia, two small European countries with GDPs per capita (between 2014 and 2016) were 109 and 75 per cent compared to European Union average, respectively (Eurostat, 2018b). While the number of enterprises in Finland is about triple to that of Estonia, over 90 per cent of companies in both countries are micro enterprises, i.e., employing less than ten employees. The biotechnology sector has been nurtured by both countries' governments albeit Finland started investing about ten years ahead of Estonia. For example, in 2010 Finland's per capita spending in biotechnology was the highest in the European Union (Eurostat, 2018a). In Estonia, biomedicine and biotechnology have been defined as strategic growth sectors since 2002, enjoying a special status in public and private investments until 2020. Compared to Finnish biotechnology companies who have better access to public and private investments, Estonian biotechnology companies have been successful in attracting European Union grant funding (Lauri, 2014).

The sample

Three inclusion criteria for the study were company being listed in the biotechnology sector, having at least five regular employees (not necessarily full-time) in 2009, and having R&D activity in Estonia or Finland. Therefore, local subsidiaries without independent R&D and companies that only sold medical products were not included. All applicable companies were contacted. In total, 39 and 35 per cent of all companies operating in Finland and Estonia during 2009 consented to participate, respectively. In this study, the sample comprises 14 companies in Finland and 12 in Estonia since companies operating in agricultural (green) and industrial (white) biotechnology segments were omitted from analysis. Additionally, a few companies' financial data were not available for 2012–2014 due to their merger or bankruptcy. That said, the small absolute number of companies also stems from industry specifics: it is common that biotechnology companies to be run by only one to two people[1]. Our focus was on companies that had matured beyond the idea phase, of which there are few. The list of companies is provided in Table AI, and descriptive data of the sample are presented in Table II.

The table illustrates that at given average age, the companies were not start-ups and should have been earning from the market. However, that does not seem to be the case: even though revenues were growing 10 per cent a year, on average, companies reported aggregate losses from 2012 to 2014. There was also slight downsizing within five years in the sector.

Procedure

We conducted structured interviews with managers in 2009 and 2010 to inquire about OI in their companies. All interviews were carried out in Estonian or Finnish and mostly face-to-face, although some were held by telephone and two Finnish participants agreed to participate on the condition that they could respond in writing. Interviewees were CEOs, development managers or HR managers. On a few occasions, CEOs asked their teams to participate. Interviews lasted 60–85 min and were recorded if consent to record had been given.

Sample characteristics	Age as of 2015 (years)	No. of employees in 2009	Growth in employees by 2014 (%)	Sales revenue growth 2012–2014 (%)	EBIT per employee 2012–2014 (euros)	ROA 2012–2014 (%)
Mean (SE)	14.6 (2.4)	45.0 (25.6)	−4.3	28.9 (18.3)	−14,154 (9,775)	−0.07 (0.07)

Table II. The study sample

Otherwise, notes were taken by the interviewer during the interview. The choice of structured interviews over surveys relied on Rhee *et al.*'s (2010) notion that innovativeness is a behaviour-based construct: it is not a matter of opinion or attitude, but is about real actions. Hurley *et al.* (2005, p. 282) stress that "tangible manifestations of the innovativeness" are needed for perceptions of innovativeness to take shape; we sought evidence of such manifestations by making sure that respondents understood the question and asking for specific examples.

Due to limited sample size, the study employs two methods: non-parametric statistical analysis performed in STATA 14.0 and fuzzy set qualitative comparative analysis in fuzzy set qualitative comparative analysis (fsQCA) software. The latter method allows for the possibility that the outcome results from several different combinations of conditions. Qualitative comparative analysis is a case-oriented method in which a small-to-medium number of observations, i.e., 20–50 is preferable and it has gained more popularity in recent years (Roig-Tierno *et al.*, 2017).

Measurements

Dimensions of OI. Participants were asked 27 questions on dimensions of OI (see Table AII). Following the categorical coding procedure, the answers were coded on a scale of 1 to 3, where "1" is marked a lack of activity in the given category, "2" partial presence of innovative activity and "3" full execution of innovative activity. Interview results were also checked for inter-reviewer reliability, i.e., the degree to which two interviewers independently coded answers identically. Audiotapes of three random interviews were distributed to two interviewers who had not conducted those interviews to be double-coded. Agreement coefficients (total number of agreements divided by total number of coding decisions), were calculated. The results were 81, 84 and 88 per cent per interview, which is considered satisfactory to obtain reliable results.

Unfortunately, the items representing Martins and Terblanche's (2003) five dimensions did not demonstrate acceptable internal consistency, and it was impossible to find alternative solutions via factor analysis due to our limited sample. Therefore, items in each dimension for which scale reliability coefficient would be above 0.60 were retained for further analysis in consideration of the fact that short scales can have relatively low α values (Voss *et al.*, 2000). We omitted communication dimension from the study because there was a very little variation in this category: only two companies did not participate in networks and four companies had less than maximum score in internal communication. Those 12 questions can be seen in Table III.

Financial performance. Three financial performance indicators (EBIT per employee, ROA and annual sales growth) over 2012–2014 were collected from the companies' annual reports and business register databases. Consequently, the time lag between OI and financial performance is utilised. Two to four years should be a sufficient period for innovation-related activities to appear in the performance. As annual financial results are quite volatile, we use three intervals to test the relationships: 2012, two-year average of 2012–2013, and three-year average of 2012–2014.

Results

Quantitative analysis

In this section, we discuss the means of and correlations between OI dimensions as well as the group comparisons of innovative vs non-innovative firms. Also, operating vs bankrupt companies as of 2017 with a view to their OI are commented. Table IV shows descriptive statistics of OI dimensions. Structure scored the highest ($M = 2.58$), followed by behaviour that encourages innovation ($M = 2.39$) and strategy ($M = 2.18$). The dimension with the lowest score was support mechanisms ($M = 1.85$), and since it was measured by one item

Questions	Dimension	Cronbach's α
1. Does the company have a vision statement?	Strategy	0.71
2. Does the company have a mission statement?		
3. Does the company have a values statement?		
4. Do the values reflect "purposefulness, freedom, flexibility, co-operative teamwork, and support for change or innovation"?		
1. Does your organisation allow teleworking (from home, satellite offices, etc.)?	Structure	0.67
2. Are development projects organised by teams that represent different departments/functions?		
1. Do employees who have come up with innovative ideas get personalised rewards (monetary or non-monetary)?	Support mechanisms	–
1. Have innovative ideas come from employees?	Behaviour that encourages innovation	0.61
2. Have innovative ideas come from the management?		
3. Does your company have an induction programme for newcomers?		
4. Does your company hold (bi)annual development discussions with employees on an individual basis?		
5. Are the products that will definitely replace organisations' existing products developed?		

Table III. Study items per dimensions of OI

Variable	Mean (SE)	1	2	3	4	5	6
1. Strategy	2.18 (0.12)	1					
2. Structure	2.58 (0.15)	0.11	1				
3. Support mechanisms	1.85 (0.17)	0.18	0.07	1			
4. Behaviour	2.39 (0.09)	0.32	0.07	0.20	1		
5. No. of employees (logged)	2.75 (0.22)	0.42*	0.45*	0.21	0.35	1	
6. Country (1 = Est; 0 = Fin)	–	−0.18	0.03	−0.28	−0.19	0.10	1

Note: Pairwise Spearman's correlations: $*p < 0.05$

Table IV. Descriptive statistics and correlations between variables

representing personal rewards, we conclude that this practice was not prevalent in the studied sector.

It can be seen from the Table IV that OI dimensions were not significantly correlated with each other. Company size (logged number of employees) generally favoured OI. Estonian biotechnology companies appeared less innovative, but the difference was not statistically significant.

Pairwise correlations between performance and control variables, firm size and country, were also calculated. It appeared that the size of the company affected positively ROA in 2012 and the country variable was statistically significant in case of revenue growth in 2012 ($p < 0.05$). However, in both instances, the effects disappeared when two-year and three-year averages were used.

Next, for each OI dimension companies were divided into high- and low-innovative firms based on sample means, such that companies scoring higher than the mean were assigned 1 (highly innovative) and below the mean 0 (not innovative). Mann–Whitney U-test was then applied to compare financial performance indicators between the two groups, the results are presented in Table V.

Concerning *H1*, i.e., EBIT per employee, the differences between highly innovative and non-innovative groups in any dimension were not large enough to be significant. Annual revenue growth did not go together with strategic clarity: companies scoring higher in the strategy dimension tended to grow less. This was contrary to our expectations in the light of *H2*.

Table V. Mann–Whitney U-test of OI dimensions affecting financial performance

Grouping variable	Strategy			Structure			Support mechanisms			Behaviour supporting innovation		
Outcome variables	Rank sum high OI $n=14$	Rank sum low OI $n=12$	p-value	Rank sum high OI $n=19$	Rank sum low OI $n=7$	p-value	Rank sum high OI $n=14$	Rank sum low OI $n=12$	p-value	Rank sum high OI $n=18$	Rank sum low OI $n=8$	p-value
EBIT per employee 2012	207	144	0.35	280	71	0.17	194	157	0.80	253	98	0.58
EBIT per employee 2012–2013	212	139	0.24	279.5	71.5	0.18	191.5	159.5	0.90	255.5	95.5	0.49
EBIT per employee 2012–2014	218	133	0.14	284	67	0.11	191	160	0.92	259	92	0.37
ROA 2012%	194	157	0.80	270.5	80.5	0.42	180	171	0.64	261.5	89.5	0.30
ROA 2012–2013%	197	154	0.68	278.5	72.5	0.20	180.5	170.5	0.66	256.5	94.5	0.45
ROA 2012–2014%	203.5	147.5	0.46	278	73	0.21	189.5	161.5	0.98	248.5	102.5	0.76
Revenue growth % 2012	149	202	*0.04*	253	98	0.84	187	164	0.92	247	104	0.82
Revenue growth % 2012–2013	151	200	*0.05*	252	99	0.79	189	162	1.00	234	117	0.62
Revenue growth % 2012–2014	142	209	*0.02*	253	98	0.84	174	177	0.44	227	124	0.37

With regard to *H3a–b*, in which we anticipated that strategy would be positively and structure negatively related to ROA, no differences in either dimension were discernible.

By 2017, 4 companies out of 26 were bankrupt. Mean values of dimensions of OI for bankrupt and non-bankrupt companies were compared, but no statistically significant differences were found. It appeared that OI in the firms that dissolved six to seven years after the study was not much different from that of healthy companies.

Statistical analysis yielding non-significant results is not surprising given the small sample size. We, therefore, apply an alternative technique that bridges qualitative and quantitative analysis (Ragin, 2008).

Qualitative comparative analysis

Fuzzy set qualitative comparative analysis (fsQCA) operates with causal conditions (OI dimensions) and outcomes (financial performance indicators). All variables are calibrated to fuzzy set scores from 1 to 0, which indicate full membership in a given set and full non-membership in a given set, respectively. In addition, a crossover point, where there is maximum ambiguity concerning the case belonging to either of the mentioned sets (fuzzy score 0.5), must be indicated. All dimensions were set as high in innovativeness at 3 and low in innovativeness at 1, and the ambiguity anchor was 2. In case of performance indicators, the third-highest value was set as an anchor for high performance, the third-lowest value as an anchor for low performance, and the sample median value was chosen as a cut-off point.

Standard analysis in fsQCA results in three solutions. Table VI reports the results of intermediate solutions which are preferable to complex and parsimonious solutions (Cheng *et al.*, 2013). Crosses in the table represent the presence of a causal condition, and minuses indicate the absence or negation of a condition. Cells denoted with 0 represent conditions that do not matter for a given outcome. The table also includes coverage and consistency indices for each configuration and for the solution as a whole. Consistency refers to the percentage of causal configurations of a similar composition giving a particular outcome, i.e. how many cases generate the result. Raw coverage and solution coverage measure the extent to which the configurations account for the outcome (Roig-Tierno *et al.*, 2017). If consistency exceeds 0.8, it means that configurations are sufficient conditions to cause high outcome in the given category, and coverage values above 0.4 indicate that the configurations explain a large proportion of the outcome (Cheng *et al.*, 2013).

Three observations from Table VI are notable: first, while consistency indicators are satisfactory, coverage values are in most cases lower than 0.4, indicating relatively small explained variance in company financial performance. This is in line with the quantitative analysis results above. Second, for many performance indicators there are several alternative paths to financial success. And finally, small and large companies seem to employ different combinations of OI dimensions to enhance financial performance.

To begin with EBIT per employee, smaller biotechnology companies have two strategic options to increase this measure with OI: to stress flexible structure and facilitate innovative ideas with explicit incentives (the so-called outcome-oriented approach), or to work on strategy and exhibit innovative behaviour (the process-oriented approach). It is unlikely for small companies to excel at all four dimensions, and our results suggest that one approach dominates at the expense of the other. For larger companies, there is one path associated with higher EBIT per employee: innovativeness should focus on all dimensions except strategy. Therefore, *H1*, which anticipated all OI dimensions to have a positive relationship with EBIT per employee, was only partly confirmed.

In the case of ROA, the results are rather ambiguous. Our hypothesis that more strategy and less flexible structure are associated with higher ROA held for ROA 2012, but not for longer-term average values. Even in the case of one-year ROA, the strategy dimension should be accompanied by behaviour that supports innovation. Overall, *H3a* is rejected.

Table VI. Qualitative comparative analysis output (intermediate solution)

Performance indicator	Path	Causal conditions: Strategy	Structure	Support m.	Behaviour	Company size	Coverage: Raw	Unique	Consistency	Solution: Coverage	Consistency
EBIT per employee 2012	1	–	X	X	–	–	0.142	0.036	0.810	0.349	0.807
	2	X	–	–	X	–	0.208	0.121	0.876		
	3	–	X	X	X	X	0.187	0.086	0.804		
EBIT per employee 2012–2013	1	X	–	–	X	–	0.211	0.211	0.840	0.211	0.840
EBIT per employee 2012–2014	1	–	X	X	–	–	0.158	0.042	0.832	0.368	0.782
	2	X	–	–	X	–	0.213	0.118	0.824		
	3	–	X	X	X	X	0.204	0.092	0.804		
ROA 2012	1	–	X	0	X	0	0.398	0.305	0.785	0.500	0.780
	2	X	–	–	X	0	0.194	0.101	0.839		
ROA 2012–2013	1	–	X	X	–	–	0.150	0.043	0.841	0.241	0.815
	2	–	X	X	X	X	0.198	0.090	0.831		
ROA 2012–2014	1	–	X	0	–	–	0.268	0.268	0.828	0.268	0.828
Sales revenue growth 2012	1	–	X	X	–	–	0.147	0.032	0.805	0.468	0.826
	2	–	X	X	X	X	0.233	0.075	0.960		
	3	X	X	–	X	X	0.346	0.203	0.837		
Sales revenue growth 2012–2013	1	–	X	X	–	–	0.163	0.050	0.916	0.549	0.847
	2	0	X	–	X	–	0.368	0.270	0.800		
	3	–	X	X	X	X	0.227	0.116	0.957		
Sales revenue growth 2012–2014	1	–	X	0	–	0	0.285	0.285	0.844	0.285	0.844

Notes: X, presence of the condition; –, absence of the condition; 0, condition does not matter

Contrary to our *H3b*, ROA seems to benefit from loose structure, measured in our study as enabling telework and forming *ad hoc* teams across departments. *H3b* is thus rejected, too.

For larger and smaller companies alike, turnover growth is facilitated by loose structure, rewarding innovative ideas and a relative lack of strategy (here, the only significant result in Table V is replicated). The difference between smaller and larger companies lies in the behaviour dimension: larger ones need to add it the aforementioned dimensions, whereas smaller companies should refrain from doing so. This is intuitive: induction programmes and formal development discussions are better suited for larger companies to motivate their employees. The same is true for cannibalising one's products: it is unlikely that small companies have a portfolio of products to enable cannibalisation at the outset. Given the strategy's unexpected aversive role, *H2* is only partially confirmed.

Discussion and implications

First, we must note that the innovativeness dimensions (strategy, structure, support mechanisms, behaviour and communication) did not form consistent scales reflecting various aspects suggested by the literature. Notwithstanding Martins and Terblanche's (2003) categorisation *per se*, our study suggests that several items within the categories are independent of or even contradictory to each other. For example, in the structure dimension, giving employees more freedom and autonomy tends to come at the expense of systematic rotation. While both strategies add to innovativeness, it is unlikely that companies apply them simultaneously. Therefore, careful selection of items to form coherent dimensions is needed when studying OI.

Our study affirms Woodside's (2005) multiple-path perspective: some firms achieve high performance without being innovative. To be more precise, we believe our sample companies were relatively innovative; however, higher OI in all dimensions did not lead to better performance in terms of EBIT per employee, ROA and annual turnover growth. With this result, our study joins those that have reported insignificant relationships between overall OI and objective financial performance: George *et al.* (2002), Kmieciak *et al.* (2012) and Santos *et al.* (2014). On the other hand, we found that OI dimensions formed specific combinations in relation to particular performance outcomes: consequently, a company should choose which aspects of OI to develop, and focussing on those seems to be a better strategy than trying to increase overall OI. As an example, higher EBIT per employee is achieved by implementing either loose structure and personalised rewards or strategic clarity, but not both. This is similar to the study by Cheng *et al.* (2013) which found that there are mutually exclusive routes to product innovation.

The strategy dimension demonstrated the most surprising and perhaps disappointing results, as it was not a positive causal condition to ROA and had a negative association with annual revenue growth. This is contrary to the findings of previous studies emphasising benefits of strategic clarity for business performance. We can only say with certainty that the strategy dimension does not hinder EBIT per employee if accompanied by behaviour that supports innovation and creativity. Exploratory finding by Perkins *et al.* (2017) was that a vision is a framing mechanism for idea generation in the context of SME. Strategy (vision) facilitates creativity because employees are more confident to voice innovative ideas that contribute to the achievement of a company's goals. Equally importantly, visions self-selectively inhibit futile ideation as these set "cognitive limits to the process of developing initiatives" (Gebert *et al.*, 2003, p. 45). We maintain, however, that vision or strategy is not enough; also everyday behavioural manifestations have to be present in order to enhance business performance.

In the strategy dimension, the values of the company, among other things, were inquired about. While the effect of organisational values in dynamic environments is debatable, we agree with Dombrowski *et al.* (2007) that clear values are beneficial when they match the

environment of the industry. Chatman *et al.* (2014) studied high-technology companies and found that when employees supported and appreciated "adaptability", better financial performance occurred three years later. They measured adaptability using employees' perceptions about their companies' willingness to experiment, innovate, quickly take advantage of opportunities, take risks and fast actions and not be too focussed on setting numerical targets. This aligns with our interview question about the content of values in the companies. However, high adaptability and strategic flexibility are very similar and according to our study, the companies with less fixed strategy grew faster. This implies that the biotechnology sector favours strategic flexibility in order to capitalise on emerging opportunities and consequently, be financially successful. Such a statement should not be surprising given the study by Nadkarni and Narayanan (2007), who demonstrated that in fast-changing industries strategic flexibility, i.e., refraining from a tight focus was positively related to sales growth, ROI and net income growth.

Behaviour and structure appeared to be positively associated with EBIT per employee and ROA, although in many instances these were substitutes for each other. Together, these dimensions of innovativeness describe human resource policies, also known as high-performance work practices, HPWPs (in the context of innovative behaviour discussed by Mazzei *et al.*, 2016). We assumed that in highly innovative companies, these policies are not *ad hoc* but systemic and well contemplated. The meta-analysis by Combs *et al.* (2006) showed that many HPWPs (e.g. incentive compensation, training, internal promotion, selectivity, HR planning and flexitime) were related to company performance. The high-technology sector benefits from human capital-enhancing policies in the form of sales growth (Collins and Smith, 2006), and biotechnology companies in our study confirmed this via qualitative comparative analysis. Thus, managers and owners of biotechnology companies should take note that skilled leadership aimed at the careful recruitment and socialising of newcomers, attention to the development of existing employees, giving employees autonomy and organising team-based work are worthwhile for their financial returns.

Individual rewards for innovative activities are heatedly debated in the literature, and we studied them under support mechanisms dimension by asking managers if employees who generate innovative ideas get personal monetary or other rewards. Statistically, these were not related to any performance measure, but qualitative comparative analysis revealed that they may indeed contribute to better financial performance, though only when bundled with loose structure and innovation-supportive behaviour. We thus agree with those authors who assert that such a motivation system is an important element in innovativeness (Tellis *et al.*, 2009; Pallas *et al.*, 2013), but refrain from claiming that it independently contributes to company performance. Rather, we agree with Combs *et al.* (2006) and Mazzei *et al.* (2016), who noted that there is a synergistic effect of HPWPs when they are bundled together. Clearly, one cannot rely on personalised rewards alone.

According to Martins and Terblanche (2003), part of innovative behaviour is an active search for new ideas both inside and outside the firm. Unfortunately, holding regular creative workshops and co-developing products with customers or suppliers did not fit the behaviour scale in our data. We believe that openness is necessary in biotechnology since there is a high proportion of start-ups, intellectual property transactions, spin-offs and funding from governmental bodies. Owing to this, such companies pursue various collaborative agreements with universities, medical and research centres, and other bio-pharmaceutical companies (McKelvey and Rake, 2016). Indeed, all but two of the companies we studied belonged to international networks or had co-operation agreements. We agree with Michelino *et al.* (2015, p. 22), who concluded that "For biotech companies open innovation is not only an innovation strategy, but rather the core business model".

Yet the above does not imply that openness necessarily offers an advantage in financial performance in this sector. According to Michelino *et al.* (2015), a negative correlation

occurred between the degree of openness and EBIT per employee among biotechnology and pharmaceutical companies. More generally, Park *et al.* (2012) note that in unpredictable environments it is better to focus on technology rather than markets to generate higher revenues. Criscuolo *et al.* (2018) conclude that it is dangerous for managers to solely rely on the external sourcing of knowledge.

To conclude the discussion, our study offers weaker support than expected for a link between OI and financial performance in the red biotechnology sector. We believe the specifics of the sector are the main reason for this. In general, the performance of the companies was weak, which seems to be characteristic of the sector in the studied countries. More than a decade ago, researchers claimed that most biotechnology companies in Finland do not earn profits and product development is low despite heavy public investment (Hermans *et al.*, 2005; Luukkonen and Palmberg, 2007). As for Estonia, only a few companies actually generate revenue from the market, and this situation has not changed within the last ten years (personal communication, 18 May 2016). Hence, OI may ensure that biotechnology companies can compete on the market, but it does not enable significant financial success. Dimensions relating to human resource policies rather than strategy or communication had positive association with financial performance.

Conclusion

There is an abundance of studies that suggest innovativeness has a positive effect on company performance, but very few have taken into account the multidimensionality of innovativeness and the need to use objective performance data after the measurement of innovativeness. We aimed to address these shortcomings in the presented study. We conclude that OI may be a prerequisite to stay in business for biotechnology companies engaged in R&D but that overall, it does not ensure better financial performance or even guarantee survival. Nevertheless, our results also suggest that companies in this sector should make human resource policies their first priority to achieve better financial results.

Our study has several limitations, including small sample size, constraints stemming from financial performance measures and only a single source of data when measuring innovativeness. While having CEOs as key informants of company data is a widespread practice, Dorabjee *et al.* (1998) showed that they were more optimistic about the level of their OI compared to the staff members. In the current study, we assume that such an upward bias, if present, was similar in all companies, however, additional source of OI measure is highly recommendable in future studies.

We also suggest that future studies with enlarged data set should ensure that the companies are comparable with regard to their business models. In the biotechnology sector, grant funding and customer-generated income should ideally be separated when measuring revenue creation. If possible, performance measurements should perhaps include sustainability and general welfare. This is because immense differences in earnings may be caused by the factors that have little to do with innovativeness. For example, many biotechnology companies rely on only one product or service, leaving their income extremely vulnerable to the emergence of a new competitor and to changes in the customer base. These factors are statistically difficult to control for; thus, broader view of performance and in-depth qualitative research is more promising. Despite this, our study suggests there is value in investigating the dimensions of innovativeness separately.

Note

1. To illustrate, in 2009 there were 55 R&D engaging biotechnology companies in Estonia, including green and white biotechnology firms. Out of 55, only 20 companies had five or more employees (Lauri, 2014).

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Appendix

Company name	Year of establishment	Country
Abacus Diagnostica Oy	2004	Finland
Asper Biogene OÜ (former Asper Biotech OÜ)	1998	Estonia
Bioferme Oy	1977	Finland
Bioretec Oy	1998	Finland
BioSilta Oy	2007	Finland
Celecure OÜ	2002	Estonia
Development Centre for Cancer Research Technologies	2004	Estonia
FibroTx OÜ	2005	Estonia
Icosagen AS	1999	Estonia
Kevelt AS	1991	Estonia
Macrocrystal Oy	1993	Finland
Medix Biochemica	1985	Finland
Next Biomed Technologies NBT Oy	2006	Finland
Novamass Oy	2002	Finland
Orfix Oy	1994	Finland
Oy Reagena Ltd/Reagena Internati	1987	Finland
Pharmatest Services Oy	1998	Finland
ProtoBios OÜ	2003	Estonia
PharmaSynth AS	2004	Estonia
Quintiles Estonia	2000	Estonia
Solis Biodyne OÜ	1995	Estonia
Synlab Estonia OÜ (former Quattromed HTI)	2005	Estonia
Tammer-Tutkan Maljat Oy	1987	Finland
TBD-Biodiscovery OÜ	2006	Estonia
Zora Biosciences Oy	2006	Finland
Wallac Oy (PerkinElmer)	1950	Finland

Table AI. List of sample companies

Dimension	Questions
Strategy	1. Does the company have a vision statement?
	2. Does the company have a mission statement?
	3. Does the company have a values statement?
	4. Do the values reflect "purposefulness, freedom, flexibility, co-operative teamwork, and support for change or innovation"?
	5. Does the company have clear goals for the next year?
Structure	1. Can employees choose the projects to work on?
	2. Can employees decide how to fulfil the task at hand (methods, resources)?
	3. Does your organisation allow teleworking (from home, satellite offices, etc.)?
	4. Do employees have a say in strategic planning?
	5. Compared to your competitors, is your organisation quicker or slower in decision-making?
	6. Are development projects organised by teams that represent different departments/functions?
	7. Are the employees systematically rotated internally (regionally or functionally) or regular redivision of responsibilities takes place?
	8. How many coordination levels are needed to pass a strategic decision?
Support mechanisms	1. Is R&D job applicants' innovation orientation assessed or measured?
	2. Does an organisation have a "safe space" where employees can work and experiment away from their daily routine?
	3. Do employees who have come up with innovative ideas get personalised rewards (monetary or non-monetary)?
Behaviour that supports innovation	1. Have innovative ideas come from employees?
	2. Have innovative ideas come from the management?
	3. Have innovative ideas (marketing, products, processes) come from customers/suppliers?
	4. Are customers involved in the product development process?
	5. Does your company have an induction programme for newcomers?
	6. Does your company hold (bi)annual development discussions with employees on an individual basis?
	7. Is there a training budget in your company?
	8. Does your organisation regularly organise internal creative workshops?
	9. Are the products that will definitely replace organisations' existing products developed?
Communication	1. How often do employees in your organisation need to communicate with people from other departments/functions/research teams, on average?
	2. Does your company participate in international networks/associations or co-operation agreements?

Table AII. Interview questions based on Martins and Terblanche (2003)

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Does the pursuit of more complex products contribute to the productivity of exporting firms?

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Abstract

Purpose – The purpose of this paper is to contribute to the literature on learning by exporting by investigating whether an increase in the complexity of exported products contributes to higher productivity at the firm level.

Design/methodology/approach – The study implements an empirical analysis for Estonian manufacturing firms involved in exporting for the period 2008–2014, adding product complexity as an explanatory variable in the production function estimation. An increase in product complexity is interpreted as an indirect proxy for an increase in firm capabilities, capturing both tangible and intangible elements of competitiveness and reflecting the learning effects.

Findings – A relatively weak correlation between product complexity and productivity was found using a simple OLS estimation – exporters with higher product complexity have generally higher productivity levels. Somewhat surprisingly, no evidence for the learning by exporting was found among exporters, meaning that the increased complexity does not seem to be a channel for productivity upgrading. This result seems to be robust, irrespective of estimation methods and sampling preferences.

Research limitations/implications – The sample is representative of exporting firms.

Practical implications – The results show that the pursuit to more complex product does not necessarily contribute to productivity for exporting firms. The findings suggest that the firm-level upgrading due to increased export orientation is likely to take place through the other channels like moving up in global value chains and differentiating by product quality.

Originality/value – This is one of the first papers to investigate the effect of product complexity on productivity at a firm level. The results provide new insights into the learning-by-exporting hypothesis, with focus on potential learning among the existing exporters.

Keywords Productivity, Global value chains, Product complexity, Manufacturing, Learning by exporting

Paper type Research paper

1. Introduction

Does there exist a channel for learning by exporting that works through the effect of changes in product complexity on firm-level productivity? With this paper, we aim at answering this question by adopting a micro-level perspective.

Exporting is one of the factors that have gained lots of attention among the determinants of firm-level productivity. Regardless of that, there is no clear cut consensus in the academic debate on the channels of "learning-by-exporting". It is presumed that by entering export markets and becoming exposed to international competition, firms learn and acquire new capabilities that allow them to increase their productivity (Grossman and Helpman, 1993). One of the limitations in the majority of firm-level studies is taking exporting as a black box – primarily due to the lack of detailed data and adequate measurement methods (Roberts and Tybout, 1996; Bernard and Jensen, 1999; Masso and Vahter, 2015). Hausmann *et al.* (2007) have claimed in their influential paper that "not all goods are alike in terms of their consequences for economic performance" (p. 1). There is empirical evidence on the country and regional level that higher productivity growth rates are achieved in countries that have managed to shift the production structure from simple goods towards more complex product categories (Bournakis, 2014; Hausmann *et al.*, 2007; Hausmann and Hidalgo, 2011; Rodrik, 2009; Jarreau and Poncet, 2012; Xu, 2010; Buccellato, 2016). Only little

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is known on these relations at the firm level. The firm-level approach has been used by Maggioni *et al.* (2014) for analysing the relationship between output volatility and product complexity and by Javorcik *et al.* (2017) for analysing FDI spillovers, but these studies do not directly address the relationship between product complexity and productivity.

Producing and exporting more complex products requires more capabilities on the firm level (Radosevic and Yoruk, 2018). Successful learning requires particular firm-level capabilities, often termed as absorptive capacity in the literature – "the ability of a firm to recognize the value of new, external information, assimilate it and apply it to commercial ends" (Cohen and Levinthal, 1990, p. 128). Novel measures of product complexity (Hidalgo and Hausmann, 2009) seek to quantify the different capabilities required for particular products into a product complexity index. Differences in product complexities are explained with the variety of capabilities they require. This provides an effective framework for the research on productivity and the production structure of a firm, especially for analysing the learning effects. Capabilities are accumulated through learning (Kim *et al.*, 2000) and the changes in product complexity should characterise changes in the underlying firm-level capabilities. Product complexity could be therefore a channel for explaining productivity differences derived from changing capabilities at the firm level.

The role of product complexity as a proxy for capabilities in the process of learning by exporting at the firm level has not been addressed in the empirical literature. Hence, applying the product complexity index for firm-level productivity has novelty value in the literature of learning by exporting.

The aim of this study is to identify whether an increase in the complexity of exported products contributes to higher productivity at the firm level. The study implements an empirical analysis for Estonian manufacturing firms involved in exporting for the period 2008–2014. The empirical exercise is focussed on the manufacturing sector as it has been defined as the leading sector in the process of national level productivity growth due to the strong forward and backward linkages, widespread opportunities for knowledge spillovers and technological upgrading (Hausmann *et al.*, 2007). We use system-GMM to address the potential endogeneity between product complexity and total factor productivity (TFP).

Our work is related to the literature on productivity and exports and, more specifically, to the learning-by-exporting stream of thought (De Loecker, 2007; Grossman and Helpman, 1993; Van Biesebroeck, 2005; Wagner, 2007). The main strand of learning-by-exporting literature is concentrated on entry effects. Since our sample is representative of already exporting firms, we will relate our work to the broader definition of learning by exporting defined as the continuous process whereby exporting leads to higher productivity (De Loecker, 2013). On a more technical level, our paper builds on recent literature on the measures of product complexity (Hidalgo and Hausmann, 2009; Iacovone and Javorcik, 2010; Lall *et al.*, 2006). The findings matter for policy. The results help to shed light on the complex ways through which product complexity and firm-level productivity are related.

The remainder of the paper is structured as follows. In the next section, the concept of product complexity and the corresponding measures, as well as the most relevant findings in the empirical literature, are described. Section 3 then presents the methodology, empirical approach and data sets used. In Section 4, the results are presented as well as robustness checks. Section 5 provides discussions. Lastly, Section 6 concludes.

2. Literature review

The papers of Bernard and Jensen (1995, 1999, 2004) started the literature of analysing differences between exporters and non-exporters in various dimensions of firm performance, including productivity. Two alternative hypotheses exist for explaining why exporters are expected to be more productive than non-exporting firms – the self-selection and learning-by-exporting hypothesis. The self-selection hypothesis assumes that selling goods in

foreign countries involves additional costs related to transportation, distribution, marketing, etc. Therefore, only the most productive firms can compete and successfully enter international competition. The other mechanism, the "learning-by-exporting" hypothesis, presumes that entering into export markets and becoming exposed to international competition helps to increase post-entry performance. The mechanism of increased post-entry performance is explained with vertical spillovers – new knowledge and technical expertise acquired from foreign clients increases the capabilities of exporters (Grossman and Helpman, 1993). Exporting might also boost productivity through other channels such as increased competition or increased incentives to upgrade product quality.

Whereas various authors (Bernard and Jensen, 1999; Yang and Mallick, 2010) have found evidence for the self-selection hypothesis, the learning-by-exporting hypothesis is not so clearly confirmed (Van Biesebroeck, 2005). Among works that have found some evidence for learning by exporting, there is a recent study by Benkovskis *et al.* (2017) on Estonia and Latvia. Larger effects were found in the case of export services compared to manufacturing goods, and, in the case of intermediates, compared to final goods.

There are several difficulties in analysing the learning-by-exporting phenomenon due to the lack of data for the counterfactual situation (Wagner, 2007). The common approaches to tackle these difficulties in empirical studies are using matching approach methods (e.g. De Loecker, 2007) or the application of quantile regression introduced by Yasar *et al.* (2006). The latter allows testing for the differences in the effects of exporting on a plant if the plant moves along the productivity distribution and identifying the areas where these effects are weak or strong. However, the common limitation in most of these studies is taking exporting as a black box and not addressing the differences in export baskets.

The idea that some products promote productivity growth more than others is not new (Grossman and Helpman, 1993; Hausmann *et al.*, 2007). A significant positive correlation has been found between product complexity and aggregated growth at the country level (Hidalgo and Hausmann, 2009; Minondo, 2010; Wang and Wei, 2010) as well as at the regional level (Jarreau and Poncet, 2012; Xu, 2010; Buccellato, 2016). However, relatively little is known about the correlations between product upgrading and productivity at the firm level. The literature suggests that firm-level product upgrading is a sequential process towards a more complex production structure (Iacovone and Javorcik, 2010; Lall, 2000, 1992). More complex products can be sold at higher prices and should exhibit more productivity growth than low-complexity products (Grossman and Helpman, 1993).

Product complexity might be linked to productivity through the within-firm factors, structural factors and their complementarities. From within-firm factors, average product complexity might be increased because of introducing new export products (extensive margin of exporting effects) or increasing the share of more complex products (intensive margin of exporting effects). Product complexity and productivity might be also related through product quality. Firms with higher productivity might specialise in higher quality products within the same product categories as suggested by Schetter (2016). Also, product complexity might be linked to productivity through the position in a global value chain (Radosevic and Yoruk, 2018; Baldwin, 2016). Taglioni and Winkler (2016) differentiate between three types of economic upgrading in the framework of global value chains: product upgrading – moving into more sophisticated products in the existing value chain; functional upgrading – integrating or moving into more sophisticated tasks; and inter-sectoral upgrading – moving into new supply chains with higher value added shares.

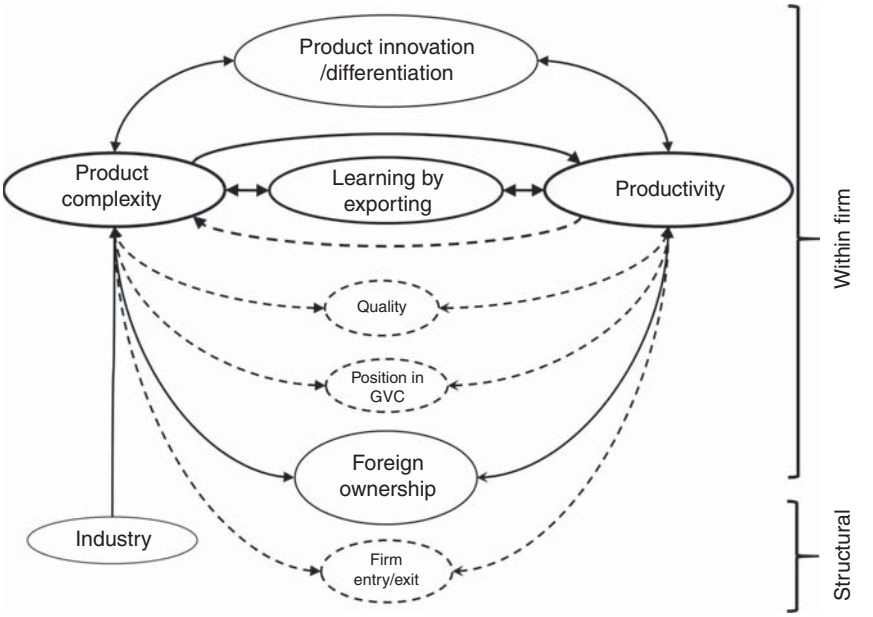
Another channel through which complexity and productivity might be linked is foreign ownership. The direct channel of influence is the conception that foreign firms are typically producing higher quality goods than domestic firms (Iacovone and Javorcik, 2010; Wang and Wei, 2010). The indirect channel appears to be that product upgrading may be facilitated by various spillovers induced by multinational firms (Javorcik *et al.*, 2017). Similar argumentation

regarding knowledge spillovers has also been denoted to processing trade where the focus is on the assembly of imported inputs into end products and goods (Poncet and Starosta de Waldemar, 2013). From structural factors, product complexity and productivity might be related through the entry and exit of firms – new entrants may have a more complex production structure and higher productivity (see e.g. Foster *et al.*, 2001 for an overview). Product complexity and productivity might be related through other mechanisms and this is not an exhaustive list of channels. In addition, the causal link between product complexity and productivity is likely in both directions – higher productivity might be also contributing to production structure upgrading of a firm. Addressing the endogeneity issue has been therefore a challenge (De Loecker, 2007, 2013).

Figure 1 shows the potential channels through which product complexity and productivity are related as described in the previous paragraph. The dashed lines represent connections that are not observed as variables in the empirical part of this paper[1]. However, these dashed connections are still used to explain our results in the discussion part of this paper. While we do not mention capabilities directly in Figure 1, except for industry, all other factors in the figure are related to capabilities or are an expression of certain firm capabilities.

The challenge in the literature has been the measurement of product complexity and linking it with the increased capabilities of the firm. In the following paragraph, we discuss several approaches of how to measure product complexity and how to link it to firm capabilities. However, we will not contrast these approaches with each other further in the methodology section of this paper because our focus in this paper lies on the product space framework by Hidalgo and Hausmann (2009). Therefore, we do not make claims about which measuring approach is superior to the others.

Due to the data availability, most of the existing literature on the production structure and productivity tends to equate upgrading in production sophistication with an increase



Note: The dashed lines represent connections that are not observed in this paper

Figure 1.
The channels of causal pathways between product complexity and productivity

in unit values (Harding and Javorcik, 2012; Bas and Strauss-Kahn, 2013). However, unit values are not perfect proxies for measuring product complexity as other aspects like market power, input costs, etc., might distort them. Next to unit values, most product classifications and taxonomies are based on the principle that a product is considered technology-intensive if the certain industry, under which it has been produced, is considered technologically intensive (e.g. Lall *et al.*, 2006). Whereas, theoretically relevant, the main problem is that trade data are available at a highly disaggregated level, but technology and R&D data are not available at that detailed a level. The R&D data are difficult to estimate – most of the firms manufacture many products rather than one, but do not allocate their R&D expenditures across products and publish the R&D data at the firm-level. Therefore, combining R&D data and trade data causes considerable problems from aggregation as products from the same industrial category but different technological features will be put together (Lall, 2001). In addition, the technological characteristics of activities change over time.

In recent years, important contributions have been made in using trade data for measuring the complexity and capability content of products (Lall *et al.*, 2006; Hausmann *et al.*, 2007). Manufacturing various products requires different inputs and productive knowledge – productive capabilities. The product space framework proposed by Hidalgo and Hausmann (2009) directly links product complexity with the capabilities that are required to manufacture them. Different products require different combinations of capabilities. The vast literature on firm-level capabilities distinguishes between technological and social capabilities. Technological capabilities represent the ability to make effective use of technological knowledge in efforts to assimilate, use, adapt and change existing technologies. Social capabilities are more vaguely defined, capturing the level of education, experience in the organisation and management, as well as honesty and truth. Concepts such as "social capability" (Abramovitz, 1990), "technological capability" (Kim, 1997; Kim *et al.*, 2000), "absorptive capacity" (Cohen and Levinthal, 1990) and "innovative capacity" (Furman *et al.*, 2002) have been defined and extensively studied in the empirical literature (see Fagerberg *et al.*, 2010 for an overview). Hausmann *et al.* (2007) have combined the idea of capability content with the export structure of countries and firms into a so-called product-capability framework. Products are seen as the combinations of embedded chunks of knowledge, non-tradable and non-transferable inputs called capabilities that are modularised at the individual, organisational or even broader level (Hausmann *et al.*, 2013). Capabilities refer in this context to: the combination of human and physical capital, the legal system, institutions, etc., that are needed to produce a product; at the firm level, capabilities are the "know-how" or working practices embodied in the group of individuals comprising the firm; and the organisational abilities that provide the capacity to form, manage and operate activities that involve large numbers of people (Hausmann and Hidalgo, 2011).

Different perspectives are suggested for the role of capabilities in the process of learning by exporting. Capabilities determine the production structure and technologies that firms are able to develop (Hausmann and Hidalgo, 2011). This assumes a rather mechanistic relationship between the process of upgrading and investments in productive capacities. From the global value chain perspective, capabilities have been seen as a more dynamic function in defining the behaviour of firms and economies when performing tasks such as investing, innovating, solving problems and learning (Dosi *et al.*, 2001; Lall, 1992, 2000).

The idea of the product-capability correspondence in the process of learning by exporting seems reasonable, but the challenge has lain in the measurement, as it is not possible to directly count the number of capabilities required for a certain product. The methodology for calculating product complexity as a measure of capabilities in a simple mathematical way as of Hausmann *et al.* (2007) is described in the next section.

3. Data and methodology

3.1 Data description

The investigation of the connection between firm-level product complexity and productivity requires matched micro-level data sets for these domains. Three firm-level data sets for years 2008–2014 were used:

(1) annual product complexity database from The Atlas of Economic Complexity;

(2) statistics Estonia firm-product destination-market level trade data set of the full population of exporting firms in Estonia; and

(3) Estonia's Commercial Registry data set of firms' annual reports.

Product complexity measures were used (1) for 4,987 products of the Harmonized System (HS07) six-digit level classification for years 2008–2014[2]. The complexity indices in the dataset are already standardised to have the mean 0 and variance 1.

As a second dataset, a comprehensive trade data set (2) of every import and export transaction in Estonia was used, including the product category based on the Combined Nomenclature (CN) eight-digit code, volume and monetary value of the transaction as well as indices for the type of trade, means of transport and others. For the empirical analysis, the transactions have been aggregated on a firm-year basis. For matching with the data set of complexity measures (1), correspondence tables for HS07-CN have been used.

The firm-level product complexity is then calculated as the average over the product complexity index for each of the firm's products weighted by the share in the firm's export basket:

$$ProdComp_{it} = \sum_{p=1}^{N_{it}} PCI_{pt} \times \frac{x_{ipt}}{\sum_{p=1}^{N_{it}} x_{ipt}}, \tag{1}$$

where i denotes a firm; N_{it} the number of products exported by the firm i at the time t; and x_{ipt} is the value of product p exported by firm i at time t. PCI_{pt} denotes the product complexity index of product p at time t. $ProdComp_{it}$ denotes the product complexity of a firm at a given time, in our case in a given year. We discuss the limitation of this measure in the discussion section.

To measure the product complexity of a firm we rely on the Product Complexity Index of Hausmann and Hidalgo (2011). This method is based on the information from a bipartite network structure of countries and products and uses two sets of data – the list of countries and the list of products exported with revealed comparative advantage (RCA)[3]. This complexity measure is solely based on the data of the network structure of countries and the products they export.

The method is based on the idea that the set of capabilities required for manufacturing a certain product could be inferred from its ubiquity and the diversity of the export baskets of countries exporting it. In other words, a good is considered complex if it is exported by a few countries with RCA and these countries have very diverse export baskets.

Products that require capabilities that are more exclusive are considered more complex. Complexity is therefore linked with the combination of necessary capabilities required to manufacture a certain product (product complexity) or the full set of capabilities available in the economy (economic complexity).

The information on a firms' product complexity is then matched with the data set of firm-level performance indicators derived from Estonia's Commercial Registry data set (3), based on the annual business reports of companies. The data set covers the full population of Estonian firms, but our sample is representative of exporting firms. This database is used for constructing different productivity measures such as value added per person employed

and TFP based on the traditional variables for labour, capital and intermediate input. This database is also used for firm-level controls such as size, capital-labour-ratio, ownership structure, age and industry.

Error! Reference source not found provides a description of our key variables for the productivity analysis. Net value added is our dependent variable; capital, labour and product complexity are our explanatory variables; and intermediate inputs are a proxy for the TFP, which is needed for the production function estimation[4] (Table I).

We do not have information for every variable for every firm. Therefore, the number of observations per variable varies[5]. Focussing only on firms which export throughout the whole sample period halves the number of observations. This illustrates a rather inconsistent export behaviour of manufacturing firms in Estonia and is in line with the previous understanding of nonlinear export patterns (Moen and Servais, 2002), especially for small firms (a comprehensive overview is provided by Monteiro *et al.*, 2013) (Table II).

There is no significant correlation between the complexity variable and the other variables used in the following empirical research, as shown in Table III.

This is an indication of our later results that complexity is not or only weakly related to productivity and other production factors.

3.2 Methods

We analyse our data as follows. At first, we estimate a Cobb–Douglas production function with labour productivity as a measure of productivity (Equation (2)) as our baseline model. Then, we estimate another Cobb–Douglas production function (Equation (3)), but this time with the control-function approach. The predicted residuals from this estimation are used as an estimate of the TFP. Then we regress TFP on a set of control variables like the ones used for the regression with labour productivity (Equation (4)). To deal with the potential reverse causality between TFP and product complexity, we modify Equation (4) to get a dynamic panel data model (Equation (5)) which we estimate with the Arellano–Bond GMM estimator.

As the estimation of TFP relies on a couple of different assumptions, whose validity we cannot control, we also use labour productivity as an alternative measure for a firm's productivity. We regress labour productivity on a set of control variables like the ones used for the regression with TFP. Labour productivity acts as a robustness check because the estimation relies on less strict assumptions, but it does not account for potential simultaneity biases which the control-function approach tries to avoid, and it does not model explicitly the investment decisions of a firm. For the main empirical analysis, we estimate the association between firm-level product complexity and productivity. First, assuming a

Variable	Description	Data source
(Log-)Net value added	Net gross input – internal inputs[a]	Estonia's Commercial Registry dataset of firms' annual reports
(Log-)Capital	Capital stock deflated	Estonia's Commercial Registry dataset of firms' annual reports
(Log-)Labour	Number of employees	Estonia's Commercial Registry data set of firms' annual reports
Product complexity	Sum of PCI of each product in the firm's product basket weighted by its share of the total product value[b]	Combination of Annual product complexity database and Statistics Estonia firm-product destination-market level trade dataset
(Log-)Intermediate Inputs	Goods, raw materials, materials, services	Estonia's Commercial Registry dataset of firms' annual reports

Notes: [a]Deflated by the producer price index in each year; [b]See Equation (1)

Table I. Description of key variables

Table II. Descriptive statistics of key variables

Variable	Obs.	Firms	Mean	SD	Min.	Max.
Manufacturing firms						
Log VA per employee	8,426	2,402	9.983	0.776	2.990	13.299
Log employment	10,670	2,919	2.855	1.418	0.000	7.765
Log capital stock	11,540	3,056	12.109	2.250	2.301	20.960
Product complexity	9,371	2,403	0.029	0.764	−2.765	2.210
Foreign-owned	11,171	3,053	0.23	0.42	0	1
Export share	12,202	3,284	0.60	0.40	0	1
Manufacturing firms continuously exporting throughout the sample period						
Log VA per employee	3,688	637	10.060	0.649	2.990	12.560
Log employment	4,932	824	3.570	1.180	0.000	7.760
Log capital stock	5,254	830	13.110	1.890	2.530	20.960
Product complexity	5,352	832	0.020	0.750	−2.770	2.110
Foreign-owned	5,088	831	0.33	0.47	0	1
Export share	7,469	1,216	0.63	0.36	0	1

Table III. Correlation between core variables

	loglpv	log tfp	lnemp	lnk	export_complexity
Manufacturing firms					
loglpv		0.93	−0.02	0.16	0.20
log tfp	0.93		−0.036	−0.04	0.18
lnemp	−0.02	−0.036		0.72	−0.06
lnk	0.16	−0.04	0.72		0.04
export_complexity	0.20	0.18	−0.06	0.04	
Manufacturing firms continuously exporting throughout the sample period					
loglpv		0.91	−0.06	0.30	0.24
log tfp	0.91		−0.07	−0.01	0.19
lnemp	−0.06	−0.07		0.68	−0.03
lnk	0.30	−0.01	0.68		0.10
export_complexity	0.24	0.19	−0.03	0.10	

classical Cobb–Douglas production function with logs, we regress labour productivity on product complexity. The formal regression specification is as follows:

$$y_{it}^{LP} = \alpha + \beta_1 C_{it} + \beta X_{it} + \varepsilon_{it}, \tag{2}$$

where y_{it}^{LP} is the log value added per person employed of firm i at time t; C_{it} denotes the product complexity of the firm; X_{it} is a vector of control variables; α is the constant; and ε_{it} is an idiosyncratic output shock distributed as white noise. The control variables are the logarithm of capital and employment, the ownership form, firm age and age squared as well as location[6]. We also include the full set of industry and yearly dummies.

We calculate the TFP based on the control-function approach for the estimation of the production function with (net) value added as the dependent variable. We follow here in parts the description of production function estimation provided in Mollisi and Rovigatti (2017)[7]. We apply different semi-parametric approaches for the TFP calculation, namely, we use the Levinsohn and Petrin (2003) method (LP) with the Ackerberg *et al.* (2015) correction (ACF) as well as the Wooldridge (2009) (WRDG) approach.

For the TFP calculations, we assume a Cobb–Douglas production function with logs:

$$y_{it}^{NVA} = \alpha + w_{it}\beta + x_{it}\gamma + \omega_{it} + \varepsilon_{it}, \tag{3}$$

where y_{it}^{NVA} is the logarithm of gross output or (net) value added, w_{it} is a $1 \times J$ vector of log free variables, x_{it} is a $1 \times K$ vector of log state variables and α is the constant. The random component ω_{it} is the unobservable productivity or technical efficiency (TFP), and ε_{it} is an idiosyncratic output shock distributed as white noise. In our case, we use the log of the number of a firm's employees as the free variable. Our state variable is the log of deflated capital stock. In line with the LP approach, we use the intermediate inputs as our proxy variable for the productivity shock. For further details of the estimation methods, the reader is referred to the discussion in Mollisi and Rovigatti (2017). We then use the predicted residuals from the above control-function estimation as an estimate of the TFP. The logarithm of TFP becomes our new productivity measure, which is regressed on a set of control variables. The formal regression specification is as follows:

$$y_{it}^{TFP} = \alpha + \beta_1 C_{it} + \beta X_{it} + \varepsilon_{it}, \tag{4}$$

where y_{it}^{TFP} is the log TFP, C_{it} denotes the product complexity of the firm, X_{it} is a vector of control variables and α is the constant. ε_{it} is an idiosyncratic output shock distributed as white noise. The control variables are ownership form, firm age and age squared and location of the firm. We also include the full set of industry and yearly dummies.

Finally, we try to address the potential reverse causality between productivity and product complexity as shown in Table I. We modify our approach from Equation (4) and estimate now a dynamic panel model with the Arellano–Bond GMM estimator (Arellano and Bond, 1991). While this estimator is not the only available GMM estimator, it is the most common one for a setting with many individuals/firms and only a few time periods which our dataset is exactly. The main equation for this approach is now:

$$y_{it}^{TFP} = \alpha + \rho_1 y_{i,t-1}^{TFP} + \beta_1 C_{it} + \rho_2 C_{i,t-1} + \beta X_{it} + \mu_i + \varepsilon_{it}. \tag{5}$$

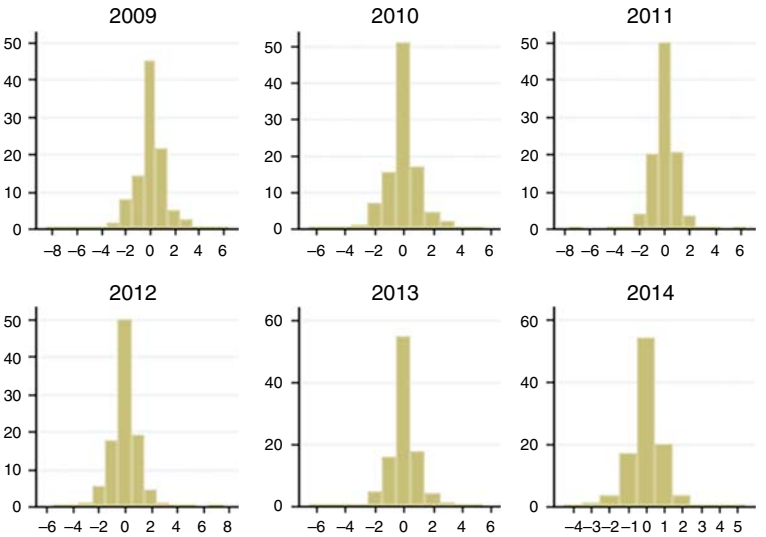
We added the lagged value of TFP and product complexity as additional regressors with ρ_1 and ρ_2 being the respective autocorrelation coefficients and firm-specific time-invariant fixed effects (FE) μ_i[8] The Arellano–Bond estimator now removes the FE via taking first-order differences. Then all available lags of the endogenous variables are used as instruments. In our case the endogenous variables are TFP and product complexity and the lags 2–6 are used as instruments. We present examples of the estimation results in Table VI. We rely for our estimations on the implementation of this estimator the user-provided xtabond2 Stata command (Roodman, 2009a, b)[9].

4. Results

4.1 Dynamics of complexity distribution

The decile distribution of firm-level product complexity reveals that very radical changes in the deciles are rare (Figure 2). The greatest share of firms by far has stayed within the same decile of complexity (40 per cent) or moved up (20 per cent) or down (20 per cent) by one decile.

Diverse patterns appear over the years. The share of firms that have upgraded their average product complexity by more than one decile was higher during the recovery from the previous economic crisis. The upgrading towards higher complexity deciles was more considerable within the firms that were initially slightly below the average complexity level. This might indicate that it is more difficult to further increase the complexity of the production basket if the base level is already comparatively high. However, firms in the



Notes: *x*-axis represents the number of deciles changed from one year to another; *y*-axis the percentages

Figure 2. Changes in product complexity distribution over time

lowest complexity deciles did not show significant upgrading, which might indicate the existence of a low-complexity trap. Foreign-owned firms have shown considerably higher levels of product complexity compared to domestic owned firms, albeit the dynamics of complexity were very similar.

4.2 Product complexity and productivity

The baseline OLS and panel FE regression[10] results are presented in Table IV. The logarithm of net value added per employee as a productivity measure was regressed on the complexity indices and a set of control variables[11]. The main interest is the coefficient related

	Dependent variable: log (value added/number of persons employed)			
	(1)	(2)	(3)	(4)
Product complexity	0.033*	−0.013	0.048	−0.041
Log employment	−0.323***	−0.425***	−0.307***	−0.395***
Log capital per employee	0.089***	0.044***	0.100***	0.037***
Age	0.021**		−0.013	
Age^2	−0.001***		0.0001	
Foreign ownership	0.118***	0.002	0.081**	−0.022
Firm fixed effects	No	Yes	No	Yes
Constant	6.084***	9.939***	6.904***	6.972***
Observations	6,056	6,056	3,526	3,526
Firms	1,699	1,699	634	634
R^2	0.433	0.188	0.532	0.210

Notes: The standard errors were clustered at the firm-level; columns 1 and 2 show the full sample of manufacturing firms, while columns 3 and 4 show only those firms which we observed in all seven years. Yearly, industry and regional dummies are included in all estimations. Empty parameters were dropped due to being too small to display or collinear with other independent variables. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table IV. Firm productivity and product complexity (OLS and panel fixed effect)

to product complexity. The results from the OLS regression suggest that higher product complexity is associated with a higher level of productivity. An increase in product complexity by 1 standard deviation[12] corresponds to an increase in productivity by 3.3 per cent.

However, when including plant-specific and time-invariant attributes in FE, the increased product complexity did not boost the net value added of exporting firms. In other words, no evidence was found that product complexity is a channel for productivity upgrading.

In Table V, the results are presented for TFP as the dependent variable/productivity measure estimated with the LP, ACF and WRDG approach[13] for the total sample of all exporting firms. The results remain the same independent of the used TFP estimation method. The results are qualitatively close to the ones in Table IV. Hence, the relationship between product complexity and productivity appears to be independent of the measure.

The results depend on which method was used for TFP estimation. As already reported, there are differences between the results from using the Ackerberg–Frazer correction and using the Wooldridge and original LP method.

Table VI shows the results of using the Arellano–Bond GMM estimator for Equation (5). The results look like the ones in Table V, indicating that endogeneity or reverse causality did not influence our initial estimations. This table shows only one of the many other potential settings for this estimator. However, the results did not differ significantly, whether we used more lags for the endogenous variables, one or two step estimations or used slightly different implementations of the GMM estimators. Using labour productivity instead of TFP did not change the results. Hansen's-*J* statistic for the validity of the over-identifying restrictions is insignificant at the 5 per cent level except for one case.

4.3 Robustness checks

To further check the robustness of the relationship between product complexity and productivity, several other settings were estimated similar to Table III. The effect of complexity change on productivity may not be instant. Firms might need time to adjust to the different market conditions, fine-tune the production process or train employees. Relatively short lags of key variables are often referred as one of the main reasons why the spillover effects found are very small (Görg and Greenaway, 2004). Using one-period lags for product complexity resulted in a slightly stronger correlation with productivity; however, the coefficients were again not significant with FE estimation. Using two-period lags further increased the correlation between product complexity and productivity with OLS, but the coefficient remained insignificant for FE estimation. Using the different

	OLS			Panel fixed effects		
	LP	LP_ACF	WRDG	LP	LP_ACF	WRDG
Product complexity	0.0537	0.0531*	0.0535	−0.017	−0.018	−0.016
Age	0.049***	0.007	0.051***			
Age^2	−0.002***	−0.0001*	−0.002***			
Foreign ownership	0.333***	0.130***	0.348***			
Firm fixed effects	No	No	No	Yes	Yes	Yes
Constant	10.11***	8.105***	10.16***	10.64***	8.371***	10.71***
Observations	6,056	6,056	6,056	6,056	6,056	6,056
Firms	1,699	1,699	1,699	1,699	1,699	1,699
R^2	0.134	0.134	0.135	0.065	0.078	0.066

Notes: The standard errors were clustered at the firm-level. Yearly, industry and regional dummies are included in all estimations. Empty parameters were dropped due to being too small to display or collinear with other independent variables. LP, ACF, WRDG denote the predicted TFP from these methods. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table V. Total factor productivity and product complexity

	Exported at least in one year			Exported in all years		
	LP	LP_ACF	WRDG	LP	LP_ACF	WRDG
TFP ($t-1$)	0.404***	0.253***	0.335***	0.505***	0.490***	0.504***
Product complexity	0.169	0.193	0.170	0.0522	−0.105	0.0527
Product complexity ($t-1$)	−0.117	−0.0995	−0.118	−0.0219	−0.0168	−0.0221
Age	0.0466	0.0480	0.0478	0.0624	−0.187	0.0627
Age^2	−0.117	−0.156	−0.118	−0.199	0.310	−0.200
Foreign ownership	0.187***	0.098***	0.193***	0.112***	0.0876***	0.113***
Observations	4,190	4,190	4,190	2,812	2,812	2,812
Firms	1,200	1,200	1,200	599	599	599
Hansen-J statistic (p-value)	0.075	0.226	0.07	0.071	0.031	0.071
AR(1) (p-value)	0.00	0.00	0.00	0.00	0.00	0.00
AR(2) (p-value)	0.670	0.793	0.674	0.139	0.201	0.139
Instruments	73	73	73	73	73	73

Notes: Hansen-J statistic = Hansen test for joint validity of the instruments; AR(X) = Arellano–Bond autocorrelation test. The standard errors were clustered at the firm-level; yearly, industry and regional dummies are included in all estimations; The constant was dropped in most of the estimations due to collinearity; Clustered robust standard errors at the firm-level were used. IV-instruments are all dummy variables (year, industry, regional, ownership), foreign ownership and the age variables. GMM-instruments are all available lags of TFP and product complexity. LP, ACF, WRDG denote the predicted log-TFP from these methods. *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$

Table VI. Total factor productivity and product complexity (Arellano–Bond GMM estimator)

combinations of lead and lag variables or using the first-level differences of complexity did not change the results.

The estimations were repeated for different firm size intervals (Table VII). The effect is strongest for firms between 10 and 20 employees. These firms account for roughly 30 per cent of the manufacturing firms. Excluding microenterprises with less than ten employees (around 36 per cent of the sample) results in estimating a coefficient for product complexity, which is two, or three, times larger compared to the estimations reported in Table IV.

The calculations were also repeated for firms in different quantiles of the product complexity distribution. The observed correlation between product complexity and productivity was higher among the firms below the mean level of product complexity. Further improvements seem to be

	Dependent variable: log(value added/number of persons employed) column names: (Xa) = no. of employees < 10, (Xb) = no. of employees≥10					
Variable\model	(1a)	(1b)	(2a)	(2b)	(3)	(4)
Product complexity	−0.061	0.094**	−0.08	0.008		
Product complexity$_{t-1}$					0.06*	0.015
Log employment	−0.527***	−0.066	−0.707***	−0.312*	−0.264***	−0.511*
Log capital per employee	0.185***	0.17***	0.11*	0.051***	0.183***	0.047***
Age	0.016	0.023*	−0.03	0.049***	0.006	0.033*
Age^2	−0.002	−0.001*	0.002	0.000	−0.001*	0.000
Foreign ownership	0.09	0.138***	0.178	−0.001	0.116**	0.027
FE	No	No	Yes	Yes	No	Yes
Constant	8.670***	8.526***	9.338***	9.960***	8.661***	9.976***
Observations	1,608	4,448	1,608	4,448	4,675	4,675
Companies	704	1,156	704	1,155	1,329	1,329
R^2	0.277	0.365	0.072	0.104	0.317	0.083

Notes: Dependent variable – log of net value added per employee. The standard errors were clustered at the firm-level. Yearly, industry and regional dummies are included in all estimations. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table VII. Product complexity and firm size

more difficult for the companies already at the complexity frontier. In addition, the same calculations were done for the quantiles of the productivity measure distribution. The estimations indicate a slightly increasing effect of product complexity on productivity.

To control for the diverse export behaviour – some firms are temporary exporters – the calculations were repeated with the subsample of firms that have continuously been exporting for all seven years of the dataset. The results are similar and are available upon request.

These findings further support the idea, that there is only a rather weak correlation between the productivity measure and product complexity at the firm level. Hence, there seems to be a puzzle that although product complexity seems to be a significant measure for explaining the productivity differences across countries (Hausmann *et al.*, 2007; Hausmann and Hidalgo, 2011; Rodrik, 2009; Jarreau and Poncet, 2012; Buccellato, 2016), it has relatively weak explanatory power at the firm-level. The possible explanations for this result are discussed in the next section of the paper.

5. Discussion

Our results implicate that the connection between product complexity and productivity might go beyond the boundaries of individual firm. The investigation of product complexity as a factor in production function estimation at the firm level has shown a relatively weak explanatory power. No proof was found for learning by exporting among the existing exporters, meaning that increased complexity does not seem to be a channel for productivity upgrading among the existing exporters. These results seem to be robust, irrespective of estimation methods, subsamples or productivity measures. Our results suggest that product complexity does not capture all the capabilities relevant for productivity upgrading. In other words, it is likely that changes in the production structure are not always an indication of changes in capabilities relevant for productivity upgrading. This result supports the idea of a more complex relation between export product complexity and productivity among the existing exporters.

We could expect that upgrading in tasks is the more likely a channel how productivity increases are caused by internationalization, not necessarily via changes in the product portfolio. It seems plausible that in some cases increased product complexity is not related to increased capabilities from learning but is determined by the position in a global value chain (Baldwin, 2016)[14]. Global value chains have become the central players in the global economy, accounting for more than 85 per cent of the total volume of international trade in 2016 (UNCTAD Stat, 2017).

Openness to international collaboration has triggered the so-called "trade in tasks" (Grossman and Rossi-Hansberg, 2008). From the functional upgrading perspective (Taglioni and Winkler, 2016), firms seek to join international production arrangements to become competitive and acquire new capabilities to grasp more high-value positions in higher-value production chains. The value-added along the value chain is not distributed equally. Usually, the pattern of value-added along the value chain is represented by the "smiling curve" where the value-added is becoming increasingly concentrated at the upstream (basic and applied research and design) and downstream (marketing, sales, after-sales service) ends of the value chain (Mudambi and Puck, 2007). The activities in the middle of the value chain – manufacturing and assembly – generally provide less value-added.

Even more importantly, the application of knowledge and creativity is much more intensive at the ends of the value chain (Mudambi, 2008). Therefore, being locked in the "wrong" position in a value chain means that the possibilities to learn and acquire new capabilities are limited (Figure 3). This locking is especially relevant in the case of international corporations where the mandates of subsidiaries are of utmost importance. The autonomy of the subsidiary is often very limited within certain value-adding business functions and the subsidiary is discouraged from promoting any initiatives for increasing capacities (Birkinshaw, 1996; Birkinshaw and Hood, 1998). In these cases, the knowledge base for increased complexity might be imported

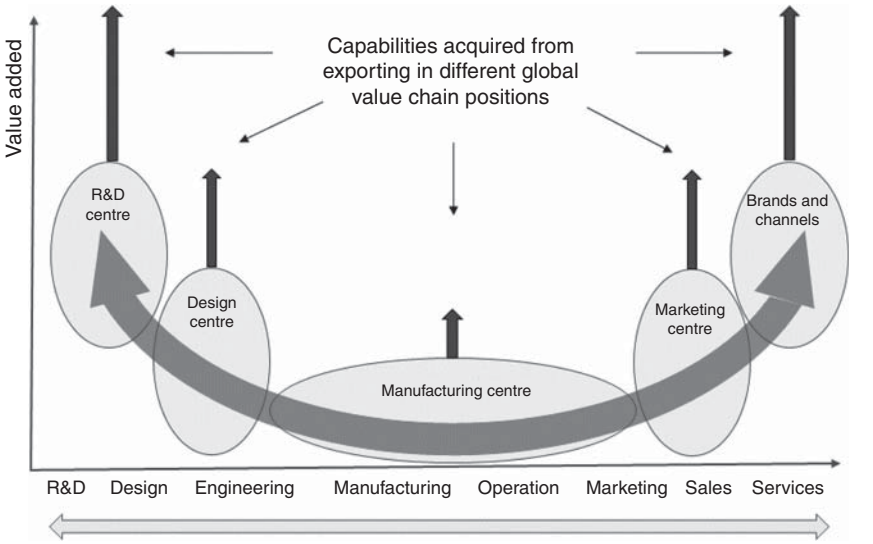


Figure 3. Capabilities acquired from exporting in different positions of the global value chain

Source: Developed based on Mudambi (2008)

from the parent company without any actual learning by exporting taking place. The firm might increase product complexity, but increased complexity is not related to increased capabilities from learning but rather received from the partners of the value chain. Therefore, it is crucial to understand the mandate of a firm in a global value chain because exporting of the same product might take place from very different positions and under different circumstances. In these cases, the product complexity does not explain learning and increased capabilities and thus is unable to explain the productivity change.

To generalise this idea, it is likely that product complexity as the channel to productivity upgrading at the firm level might work differently in country groups with low and high involvement in global value chains. Within countries with high involvement in global value chains, the mandate of the subsidiaries is notably important if local subsidiaries are only performing a limited number of tasks (Monteiro *et al.*, 2008). In these cases, the position in the value chain, as well as the required capabilities, are determined outside of the subsidiary. Subsidiaries may export complex products but perform only a fraction of the task of the value chain. Estonia presents a perfect example of this type of country as companies with foreign ownership account for 60 per cent of the exports[15]. We observe in our analysis that foreign-owned companies have a higher stock level of product complexity compared to those Estonian-owned firms, but the dynamics over time are nearly the same. This is in line with the previous argumentation (Figure 3).

Another reason why we may not observe a stronger connection between product complexity and productivity is that product complexity does not reflect the quality of products (Schetter, 2016)[16]. A higher quality of the product can only be reflected in increased product complexity if it leads to a higher RCA. It is likely that the product-level upgrading might not necessarily take place with the introduction of more complex product categories but through an increase in production quality. This is particularly important when the quality of goods is observable by consumers prior to the purchase. To illustrate this idea – the designer watch from Switzerland sells at higher prices and creates more value-added compared to some other watches.

The mechanism from complexity to increased productivity might be partially through the process of firm entry and exit. In other words, firms with lower complexity are more

likely to fail and new entrants tend to have a higher product complexity level. Further research should be done to decompose the aggregate product complexity change and distinguish the effect of entry and exit as well as between- and within-firm change using the FHK type of decomposition (Foster *et al.*, 2001).

From the technical side, the measure of product complexity might suffer from conceptual and practical problems as discussed by Tacchella *et al.* (2012). Product complexity indices compress the information about the competitive environment and/or the competitiveness of the firms into a single number. However, only to a certain extent is it possible to control the dataset for factors which influence the relative comparative advantage of firms, but which are not related to the productivity or skill level of the firms. Unobserved and unaccounted changes in these factors might explain why we cannot observe a strong influence of product complexity on productivity.

6. Conclusions

Influential works that introduced the concept of product complexity and its positive aggregate effect on economic development have strived the governments to find policies supporting upgrading of the national export structure. This paper argues that in the globalised world, the changes in the structure of exported products on the firm-level fail to explain the changes in capabilities and productivity levels.

This study aimed to identify whether an increase in the complexity of exported products contributes to higher productivity for exporting firms. Product complexity was used as a measure for capabilities needed in productivity upgrading for exporting firms. The relation between production structure and productivity at an aggregate country level has been analysed before; however, the novelty lies in using firm-level data for analysis of the effects of product complexity changes, and a novel measure for product complexity. An empirical analysis for the exporting Estonian manufacturing firms for the period 2008–2014 was implemented, using a firm-level product complexity score for each of the manufacturing exporter firm in Estonia involved in foreign trade.

There is a significant albeit weak correlation between complexity and value added per employee using a simple OLS estimation. The link is largest during the aftermath of the economic crisis and for the firms with 10–20 employees. Several robustness checks suggested that the effect of complexity is higher in the case of exporters with below-average complexity. Using TFP as a dependent variable shows that the results are robust regardless of the used productivity measure. However, no evidence was found for learning by exporting, meaning that increased product complexity within a firm does not have a positive effect on productivity. This is the key result of the paper. This result seems to be robust irrespective of estimation methods and subsamples. Our results do not claim that capabilities proxied by product complexity and productivity are not related, but rather suggests a more complex relationship through which product complexity and firm-level productivity upgrading are connected.

Capabilities proxied by product complexity and productivity might be related through other variables like quality or position in the global value chain (Figure). We could expect that functional upgrading is the more likely channel how productivity increases are caused by internationalization, not necessarily via changes in the product portfolio. A firm might export while performing distinct functions in global value chains. Increased product complexity might be "imported" from the partners of the value chain or from the parent company without actual learning or additional capabilities acquired from exporting. We proposed that a clear distinction can be made for country groups with low and high involvement in global value chains. The effect of increased product complexity on productivity is likely to be higher for firms in country groups less connected to global value chains.

Also, arguing in the same way as Schetter (2016), product complexity, as such, might not always be crucial and the capabilities to increase the quality might be more important for productivity upgrading. More research is needed to focus on analysis of functional

upgrading in GVCs of the same product, as product-level "upgrading" itself does not necessarily lead to higher productivity.

Further research should be done to decompose the aggregate complexity change and distinguish the effect of entry and exit as well as between- and within-firm change using the FHK type of decomposition (Foster *et al.*, 2001). Another natural progression of this work is to analyse the determinants of firm-level complexity, especially among the firms that have managed to successfully increase their complexity. This information can be used to develop targeted interventions aimed at increasing the overall competitiveness of the manufacturing sector.

Notes

1. This figure does not show all potential channels, but rather a simplified illustration of a more complex network of relations. We also do not observe product complexity for each firm individually, but rather proxy it by a weighted sum of the share of each product in the export basket multiplied with its Product Complexity Index (PCI) which is based on trade flows of the entire world.
2. Derived from the Observatory of Economic Complexity (http://atlas.media.mit.edu/en/rankings/hs07/2014/?depth=6). It must be acknowledged that the number of products is slightly different in every year, due to the gradual changes in HS composition and splitting or extraction of product categories. However, these changes do not have a significant effect on the product rankings or the results of the analysis as the yearly indices for complexity are used that allow us to take account of these changes.
3. The revealed comparative advantage is the ratio of the export share of a given product in the country's export basket to the same share at the worldwide level (Balassa, 1964). Mathematically:

$$RCA_{jk} = \frac{x_{jk}/X_j}{\sum_j \left(x_{jk}/X_j\right)}.$$

4. More explanation about the role of the proxy will be provided in Section 3.2. Mollisi and Rovigatti (2017) provide more details about the role of the proxy for production function estimation.
5. Since we observe firms for several years, the number of observations is roughly five to six times higher than the actual number for firms.
6. We use three regions to classify the location of a firm. The first region is the capital city Tallinn and the surrounding county; the second region is the North-East of Estonia which is dominated by heavy industry; and the third region being the rest of Estonia.
7. We also rely on their Stata package "prodest" for the estimation of the production functions.
8. We denote the firm-specific effects here explicitly similar to the notation in Roodman (2009a, b).
9. For further details about the estimator, the interested reader is referred to Roodman (2009a, b).
10. As described in Section 3.2, Equation (2).
11. The control variables are age and size (number of employees), industry, share of export in sales, log of capital intensity per employee, ownership, production place and year.
12. This is comparable from moving from producing metal buttons to producing iron/steel frames for doors and windows, or from fire alarms to lawn mowers.
13. As described in Section 3.2, Equation (3).
14. As already shown in Figure 1, the position in the global value chain is one of the factors which cannot observe in our data, but which influence both productivity and product complexity.
15. Statistics Estonia (www.stat.ee/en).
16. As already shown in Figure 1, quality is one of the factors associated with productivity and complexity which we do not observe in our data set.

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Age-related productivity decrease in high-waged and low-waged employees

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Abstract

Purpose – The purpose of this paper is to clarify whether the age-productivity curve is different for low-waged and high-waged employees.

Design/methodology/approach – Productivity growth is decomposed at the firm level into contributions by hired, separated and staying workers. Based on a matched employer-employee database of Estonian firms from 2006 to 2014 and considering the age as well as wages of employees, a panel data model with fixed effects is constructed to show the relative productivity of each cohort of employees.

Findings – High-waged employees appeared to be relatively more productive than low-waged employees and middle-aged were more productive than young or old employees. However, the productivity difference between young and old employees was not statistically significant. The age-productivity curve of high-waged employees appeared to be flatter than that of low-waged employees. Only in knowledge intensive services were the low-waged old employees statistically significantly less productive than high-waged old employees. In the manufacturing industry, the young were more productive than in services, in knowledge intensive services the old were less productive than in traditional services.

Research limitations/implications – The productivity of employees is only analysed for cohorts of employees.

Practical implications – Employers can be encouraged to hire older employees because old employees are shown to remain at least as productive as young employees.

Originality/value – The decomposition of labour productivity at the firm level is further developed, as the statistical difference between the productivity of different groups of employees is analysed.

Keywords Skills, Human capital, Estonia, Ageing, Employee productivity, Firm employment decisions, Labour flows

Paper type Research paper

1. Introduction

The decline in the share of prime-working-age population (25–54 years) is projected to result in a 19 per cent decrease in per capita income growth over the next 50 years (Manyika *et al.*, 2015). Retaining the current standard of living requires firms to adjust to an ageing labour force. If the age-related productivity decline is not similar for all employees, focussing on the productivity of the groups with the largest decline might yield the greatest benefits.

Some empirical surveys show occupational differences in the age-productivity curve. According to Veen (2008), the productivity of lawyers, professors, managers, medical doctors and engineers increases in older age. Van Ours (2009) similarly could not find any age-related decline in the productivity of economics professors. Avolio *et al.* (1990), looking at non-managerial workers, also find declining productivity in only one group out of five. Without considering age, Kampelmann and Rycx (2012) show that occupations at the top of the wage hierarchy are overpaid with respect to their marginal productivity and occupations at the bottom underpaid. To our knowledge no survey has examined the shape of the age-productivity curve separately for high-waged and low-waged employees.

Productivity is difficult to measure for certain groups of employees. Longitudinal studies for example tend to overestimate productivity levels due to non-random attrition and test

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practice[1] (Skirbekk, 2004), while assessments by managers are biased depending on their contact with older employees (Henkens, 2005). Generalisations cannot be made on the basis of field-specific studies. One strand of literature deals with testing the theories of wage determination based on production function estimation (Hellerstein *et al.*, 1999). The relationship between pay structure, productivity and profitability has been analysed (Abowd *et al.*, 1999; Cardoso *et al.*, 2011). The more general econometric production function tries to estimate statistically the part of total productivity growth attributed to a certain factor (Griliches, 1979). In growth accounting decomposition the growth of the output of a firm is divided between different sources based on the growth of inputs. Ilmakunnas and Maliranta (2007, 2016) developed a general method to evaluate the productivity of employees of different age groups by decomposing total labour productivity growth into productivity of hired, separated and staying employees based on changes in employment. Maliranta *et al.* (2009) have also used the method, but the wage level of employees has not been included in the same manner as in our analysis. Including changes in employment makes the method similar to industry-level studies where entries and exits to and from industry have been taken into account in productivity decompositions (Baily *et al.*, 1992; Griliches and Regev, 1992).

The current paper aims to extend existing knowledge on the relationship between age and productivity by clarifying the shape of the age-productivity curve for high-waged employees and low-waged employees. The method also takes into account how the structure of the work force is determined and how labour flows influence labour productivity in firms. Data from Estonian employee payroll taxes for 2006–2014 has been matched with financial data from annual reports of all firms in Estonia. We decompose the changes in the labour force and distinguish between hired, separated and staying workers following Ilmakunnas and Maliranta (2007, 2016). A panel data model with firm-level fixed effects is estimated, where the parameters can be interpreted as the relative productivity levels of the different employee cohorts. First, we compare high-waged and low-waged employee productivity. Second, we repeat the analysis of Ilmakunnas and Maliranta to present our case study. Finally, we divide the workers into three age groups and two wage groups. We contribute to developing the decomposition of labour productivity at firm level. Using two wage groups provides some proxy for the education and occupation of employees and hence gives a better understanding of how the shape of age-productivity curve can be related to the different work experience of high-waged and low-waged employees. We also statistically test the productivity differences between the groups.

Estonia is a particularly interesting case for analysis because it is one of the EU countries where labour productivity increased after the 2008–2009 financial crisis. At the same time, the decrease in GDP in 2009 was one of the largest in the EU at −14.6 per cent (Masso and Krillo, 2011). Due to a flexible labour market especially in terms of numerical flexibility, the adjustment in employment mostly took place through a reduction in the number of workers instead of the number of working hours for each worker (Meriküll, 2011; Roosaar *et al.*, 2014). Moreover, due to the relatively high labour force participation among the older population in Estonia (Sinclair *et al.*, 2013), there are more older employees in our data than in other countries, where older employees have less incentive to work[2].

The rest of the paper is organised as follows. The theoretical framework and hypotheses are introduced in the next section. Section 3 presents the data and methodology. Section 4 describes the results of the econometric models. The last section summarises and concludes.

2. Theoretical framework

According to human capital theory, the stock of human capital is diminishing with ageing; thus, productivity also decreases with age (Becker, 1994). In the life-cycle model employees maximise human capital over their life-cycle choosing the optimum between working and training or alternatively between different jobs that offer various combinations of training and earning.

In the alternative learning-by-doing model, employees learn about market activities while participating in them and their productivity depends on the time they spend in market activities, but also on the accumulation of past market experience (Killingsworth,1982).

Killingsworth (1982) offers a joint theory of investment and learning-by-doing, where he identifies four stages in the life-cycle of an individual, depending on the share of time spent on investment (hereinafter *I*), working (*H*) and leisure (*L*):

- Stage 1: "Pure schooling", where $I > 0, H = 0$, and $L > 0$.
- Stage 2: "On-the-job training", where $I > 0, H > 0$, and $L > 0$.
- Stage 3: "Pure work", where $I = 0, H > 0$ and $L > 0$.
- Stage 4: "Pure leisure", where $I = 0, H = 0$ and $L = 1$.

In our analysis, we are interested in cases where individuals go through all four stages (passing each stage only once). Individuals are said to have human capital *K* either (i) rise at the start of stage 3 but begin to fall continuously prior to the start of stage 4, or (ii) fall monotonically from the end of stage 2 onwards. Figure 1 illustrates how the difference between the productivity of these two can increase by the end of stage 3, although they had similar levels of human capital at the beginning of stage 3.

Arrow (1962) indicates that learning takes place through experience, but he adds that a steady increase in productivity requires stimulus situations that are steadily evolving not only repeating. Therefore, in Killingsworth's model, we can assume that for case (ii) there are more stimulus situations while working in stage 3 than for case (i). In comparison to blue-collar jobs, white-collar jobs are expected to offer more stimulus situations. However, the level of education (the length of stage 1 in the model) also affects the level of human capital because more highly educated individuals have been found to earn considerably more than their less-educated counterparts in the same occupation (Carnevale *et al.*, 2011). As we do not have data concerning employee education or occupation, we have to assume that a new employee's wage is the numerical indication of his/her value to the employer. In the theory of human capital, investment in education and training increases productivity; consequently, demand for those workers rises and as a result their wages also improve. Although the wage may partly reflect how much a job is valued or how strong unions are, global evidence concerning human capital and wages is consistent with the theory (see, e.g. Holmes 2017). Therefore, it is reasonable to start with the following hypothesis:

H1. High-waged hired employees in general are more productive than low-waged hired employees.

In the joint model of investment and learning-by-doing, productivity declines for cases (i) and (ii) at the end of stage 3. Some empirical papers find that the productivity of workers

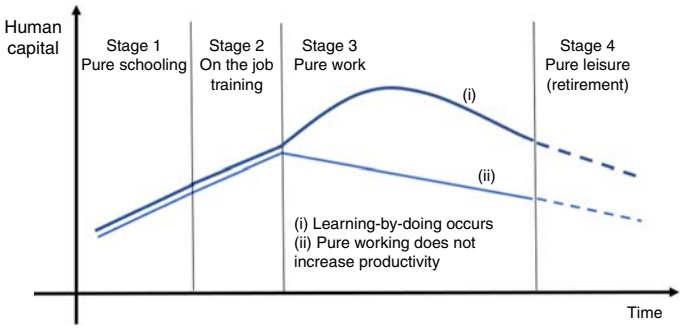

Figure 1. Possible scenarios in the evolution of human capital for cases (i) and (ii) based on Killingsworth (1982)

indeed declines with age (e.g. Lallemand and Rycx, 2009; Ilmakunnas and Maliranta, 2016), but others cannot confirm this (e.g. Göbel and Zwick, 2009). Therefore, we also empirically test the following:

H2. Old employees are less productive than middle-aged employees.

Presumably, stage 3 (pure work) for case (i) offers more stimulus situations. This is related to the increase in crystallised abilities (e.g. strategic thinking and language skills) that improve with accumulated knowledge (Skirbekk, 2004; Johnson *et al.*, 2011). Empirical surveys indicate that work experience can compensate for the decline of some basic cognitive processes (Ilmarinen, 2012). Lawyers, managers, medical doctors and engineers (Veen, 2008) as well as (economics) professors (Van Ours, 2009) have been shown to have stable or increasing productivity in older age. We investigate whether this result could be generalised to all high-waged jobs and whether cases (i) and (ii) can be distinguished based on wage level. Therefore, we set the third hypothesis as follows:

H3. Separating old employees by wage indicates that the high-waged old employees are more productive than low-waged old employees.

The empirical results concerning sectoral differences in the age-productivity curve have been contradictory. Göbel and Zwick (2009) confirmed considerable variation in the age-productivity profile amongst establishments in the economy, but in their later article (Göbel and Zwick, 2012) they found no significant differences in age-productivity profiles between sectors. Nevertheless, high shares of older adults in manufacturing plants for example have been found to increase labour productivity compared to large shares of younger adults (Malmberg *et al.*, 2008). Innovativeness (Backes-Gellner and Veen, 2013) and working in teams (Börsch-Supan and Weiss, 2010) may also positively affect the productivity of older employees. Therefore, we test the following hypothesis:

H4. Sectoral differences in the age-productivity curve can be found as older employees are more productive in industry than in services.

3. Data and methodology

3.1 Data

We analyse the Estonian data for 2006–2014 using payroll tax records from the Estonian Tax and Customs Board matched with records from the Commercial Register of Estonia (data set of annual reports). The sample has been aggregated to one unique observation for each firm-employee-year combination because firm-level data are also gathered once a year. Therefore, only data from January is included from the monthly database of employees. In addition, each year we only include employees' main jobs – the jobs where the wage was the largest. Although we cannot separate part-time employment from working full-time, it presumably does not affect our results because the share of employees working part-time in Estonia is low (1.9 to 4.3 per cent for 2006–2014, Eurostat).

We use one-year periods to define labour flows and changes in productivity. Therefore, the flows and changes are defined for eight periods: 2006–2007, 2007–2008, 2008–2009, 2009–2010, 2010–2011, 2011–2012, 2012–2013 and 2013–2014. Our observation unit as in Ilmakunnas and Maliranta (2007) is a firm. All the firms are from the industrial and service sectors; agricultural, real estate and financial intermediation firms are excluded. The industrial sector comprises mining, manufacturing and public utilities. In the largest sector, services, which consists of retail and wholesale trade, business services and personal services, we distinguish between knowledge intensive services (as defined by Eurostat[3]) and traditional services. We conduct a separate analysis of firms in construction, as that sector is exceptional in the period 2006–2014 due to the housing bubble in the Baltic states

and the decrease of employment in construction was considerable during the recession (Masso and Krillo, 2011). The housing crisis in Estonia was followed by the global recession that affected the country mainly through capital flow and trade (Brixiova *et al.* 2010).

Comparing the average changes in labour productivity (our dependent variable) (see Appendix 1), the largest negative changes are documented in the third period (2008–2009). Only in two periods (2009–2010 and 2010–2011) is the productivity change positive (in knowledge intensive services only in one period). Differences in the productivity change between sectors can be noticed, but the standard deviations are very large compared to the average level in all the sectors. We assume that the wage structure did not change considerably during the period.

For comparability reasons, our definition of young, middle-aged and old workers coincides with that of others (e.g. Ilmakunnas and Maliranta, 2007; Mahlberg *et al.*, 2013a, b; Vandenberghe, 2011). Young are less than 30 years old, middle-aged are 31–50 years old and old employees are over 50 years. To define wage groups, the average wage was calculated for each 2-digit level NACE industry. Then, all the employees were divided into the high-earners group (wage was higher than the average in industry in that year) and low-earners group (wage was equal to the average or less).

Statistical analysis of the data used in the decomposition shows that the Great Recession in general resulted in a temporary increase in all separation rates and a notable decline in hiring rates. In all sectors, the share of young employees decreased, and the share of old employees increased. The average age across our sample increased by about two years, from 41.5 to 43.4 through 2006–2014. Figure 2 provides the young, middle-aged and old employees with high wage and low wage from the flow analysis. Young employees are the least among hired employees, while middle-aged employees form over 40 per cent of hired employees. The shares of different groups of hired employees remain rather similar. Compared to high-waged employees, more low-waged employees were hired 2006–2008 (before the crisis) and also after the crisis. More statistical information can be found in Appendix 2.

3.2 Method

Our method is based on a decomposition technique proposed by Ilmakunnas and Maliranta (2007). The dependent variable in our analysis is labour productivity growth measured as a one-year (t and $t-1$) rate of change in value added per employee in deflated terms. Note that in the current study, compared to Ilmakunnas and Maliranta (2007), we use three different ways to divide the employees – first, by two wage groups; then, by three age groups, like

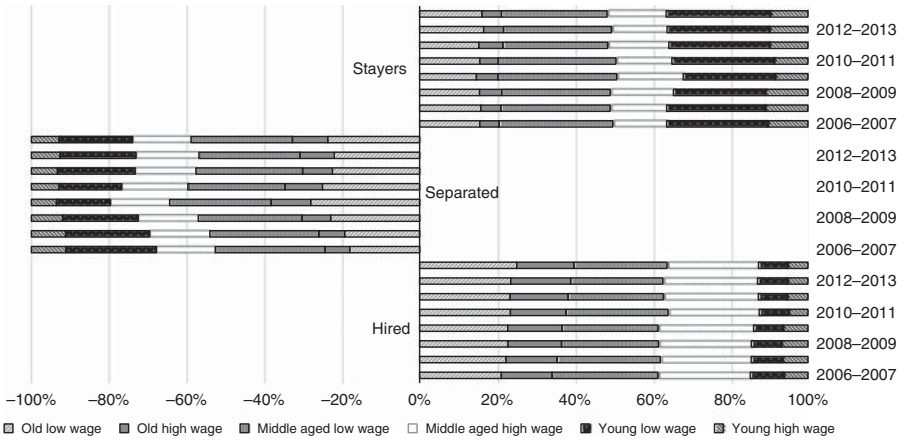

Figure 2. Shares of different age and wage groups in each period among hired, separated and staying employees

Ilmakunnas and Maliranta, 2007, 2016; and finally, by combinations of age groups and wage groups, and so we have two, three or six groups of employees among hired, separated and staying employees. Another difference from Ilmakunnas and Maliranta (2007) is that newly hired and separated employees are weighted by 0.5 instead of one as they are with the firm only during part of the period.

Ilmakunnas and Maliranta (2007) assume that the labour of an enterprise consists of M different age groups and added value at year $t=1$ (Y_1) can be defined as the sum of all added values generated by M age groups:

$$Y_1 = \sum_j^M Y_{1j}. \tag{1}$$

In our case, M is equal to two, three or six (two wage groups times three age groups) and j denotes each individual group separately. For the labour productivity of the enterprise, we divide both sides of Equation (1) by the sum of the total of the labour groups L_1 and use the average labour productivities of M groups weighted with their employment shares:

$$\frac{Y_1}{L_1} = \sum_j^M \frac{L_{1j}}{L_1}\frac{Y_{1j}}{L_{1j}}, \tag{2}$$

where:

$$L_1 = \sum_j^M L_{1j}.$$

We can divide each of these M age groups into newly hired workers (hire) and stayers (stay) based on whether they work in the enterprise at the beginning of the period ($t=0$) or at the end of the period ($t=1$).

Therefore, the firm's labour productivity can alternatively be presented as:

$$\frac{Y_1}{L_1} = \sum_j^M \frac{L_{1j,\text{stay}}}{L_1}\frac{Y_{1j,\text{stay}}}{L_{1j,\text{stay}}} + \sum_j^M \frac{0.5L_{1j,\text{hire}}}{L_1}\frac{Y_{1j,\text{hire}}}{0.5L_{1j,\text{hire}}} + \varepsilon_{Y/L,1}, \tag{3}$$

where:

$$L_1 = \sum_j^M L_{1j,\text{stay}} + 0.5\sum_j^M L_{1j,\text{hire}}.$$

Using the fact that the shares of hired workers and stayers add up to one:

$$\sum_j^M \frac{L_{1j,\text{stay}}}{L_1} + \sum_j^M \frac{0.5L_{1j,\text{hire}}}{L_1} = 1. \tag{4}$$

Equation (3) can be rewritten as:

$$\begin{aligned}\frac{Y_1}{L_1} &= \sum_j^M \frac{L_{1j,\text{stay}}}{\sum_{1j} L_{1j,\text{stay}}}\frac{Y_{1j,\text{stay}}}{L_{1j,\text{stay}}}\frac{\sum_{1j} L_{1j,\text{stay}}}{L_1} + \sum_j^M \frac{0.5L_{1j,\text{hire}}}{L_1}\frac{Y_{1j,\text{hire}}}{0.5L_{1j,\text{hire}}} \\ &= \sum_j^M \frac{L_{1j,\text{stay}}}{L_{1,\text{stay}}}\frac{Y_{1j,\text{stay}}}{L_{1j,\text{stay}}} + \sum_j^M \frac{0.5L_{1j,\text{hire}}}{L_1}\left(\frac{Y_{1j,\text{hire}}}{0.5L_{1j,\text{hire}}} - \frac{Y_{1,\text{stay}}}{L_{1,\text{stay}}}\right).\end{aligned} \tag{5}$$

A similar approach is used for separated employees (sepa), those present in the firm at the beginning of the period and have separated before the end of the period.

Using the additional assumption $L_{0j,\text{stay}} = L_{1j,\text{stay}}$, the following equation is obtained for the change in labour productivity:

$$\begin{aligned}\frac{Y_1}{L_1}-\frac{Y_0}{L_0} &= \left(\sum_j^M \frac{L_{1j,\text{stay}}}{L_{1,\text{stay}}}\frac{Y_{1j,\text{stay}}}{L_{1j,\text{stay}}}+\sum_j^M \frac{0.5L_{1j,\text{hire}}}{L_1}\left(\frac{Y_{1j,\text{hire}}}{0.5L_{1j,\text{hire}}}-\frac{Y_{1,\text{stay}}}{L_{1,\text{stay}}}\right)\right)\\ &\quad -\left(\sum_j^M \frac{L_{0j,\text{stay}}}{\sum_{0j}L_{0j,\text{stay}}}\frac{Y_{0j,\text{stay}}}{L_{0j,\text{stay}}}+\sum_j^M \frac{0.5L_{0j,\text{sepa}}}{L_0}\left(\frac{Y_{0j,\text{sepa}}}{0.5L_{0j,\text{sepa}}}-\frac{Y_{0,\text{stay}}}{L_{0,\text{stay}}}\right)\right)\\ &= \sum_j^M \frac{L_{0j,\text{stay}}}{\sum_j L_{0j,\text{stay}}}\left(\frac{Y_{1j,\text{stay}}}{L_{1j,\text{stay}}}-\frac{Y_{0j,\text{stay}}}{L_{0j,\text{stay}}}\right)\\ &\quad +\sum_j^M \frac{0.5L_{1j,\text{hire}}}{L_1}\left(\frac{Y_{1j,\text{hire}}}{0.5L_{1j,\text{hire}}}-\frac{Y_{1,\text{stay}}}{L_{1,\text{stay}}}\right)\\ &\quad +\sum_j^M \frac{0.5L_{0j,\text{sepa}}}{L_0}\left(\frac{Y_{0,\text{stay}}}{L_{0,\text{stay}}}-\frac{Y_{0j,\text{sepa}}}{0.5L_{0j,\text{sepa}}}\right).\end{aligned} \tag{6}$$

The first set of terms on the right-hand side of Equation (6) indicates the productivity growth accumulating over time for workers who stay in the firm. This term is positive if the average productivity growth of the stayers is positive. The second set of terms shows the productivity effects of hired workers in different groups. The third set of terms shows the separation of type j workers. Note that adjustment costs are implicit, and the relative productivity of the hired as well as separated workers is net of adjustment costs[4].

Similar to Ilmakunnas and Maliranta (2007, 2016), the equation for estimating productivity gaps between groups can be presented as:

$$\frac{\Delta(Y/L)}{\overline{(Y/L)}} = \alpha+\sum_j^M \beta_{LP,i,t,j,\text{hire}}HR_j+\sum_j^M \beta_{LP,i,t,j,\text{sepa}}SR_j++\sum_j^{M-1}\chi_{LP,i,t,j,\text{stay}}STAYSH_j+\delta'Z+\varepsilon, \tag{7}$$

where $\overline{(Y/L)} = 0.5[(Y_0/L_0)+(Y_1/L_1)]$ is the average productivity in the two periods, hiring rate $HR_j = (L_{1j,\text{hire}}/L_1)$ and separation rate $SR_j = (L_{0j,\text{sepa}}/L_0)$ are the shares of hired workers and separated workers and $\text{STAYSH}_j = (L_{0j,\text{stay}}/L_{0,\text{stay}}) = (L_{1j,\text{stay}}/L_{1,\text{stay}})$ represents the share of employees who stay in the enterprise.

Firm level panel data are used because in each period we look at the same firms (although due to entries and exits the sample is unbalanced). Therefore, there are indexes for firm (i) and period (t) in Equation (7). We interpret the coefficients as:

$$\beta_{LP,i,t,j,\text{hire}} = \frac{(Y/0.5L)_{1,i,t,j,\text{hire}}-(Y/L)_{1,i,t,\text{stay}}}{\overline{(Y/L)}}, \tag{8}$$

that measure relative productivity of newly hired employees and:

$$\beta_{LP,i,t,j,\text{sepa}} = \frac{(Y/L)_{0,i,t,\text{stay}}-(Y/0.5L)_{0,i,t,j,\text{sepa}}}{\overline{(Y/L)}}, \tag{9}$$

that measure the relative productivity of the separated employees before they leave.

As we use firm level panel data, the variables describing labour flows are aggregated at firm level. For labour flows, we compare employees in firms at the end (t) and at the beginning ($t-1$) of the period. In each period, age is calculated according to the actual age of the employee at the end of year t. Similarly, we determine the wage group for an employee in year $t-1$ and assume that in year t his/her wage group has not changed. For hired employees their wage from year t has been used.

Ilmakunnas and Maliranta (2007) used the ordinary least squares method (although firms in their sample were the same in each period) and instrumental variables (shares of homeowners for separations and lagged number of at least secondary level graduates for hirings). The latter was not feasible with our data. In pooled ordinary least squares equations ignoring the object-specific term (characterizing, e.g. the quality of management) leads to errors that are highly autocorrelated. Additionally, the F-test that all $u\_i = 0$ indicated that the fixed effects model should be preferred to the ordinary least squares model (Prob $> F = 0.000$). The result of the Breusch-Pagan Lagrange multiplier test (Prob $> \chi^2 = 0.000$) showed that the random effects model should be preferred to the simple ordinary least squares model. The Hausman test indicated that the fixed effects model should be preferred to the random effects model (Prob $> \chi^2 = 0.000$).

Reverse causality may affect our results because changes in wage groups may be related to productivity changes in the firm. Therefore, the estimators may be biased. Productivity is likely to affect hiring and separation decisions and due to the resulting endogeneity, our estimators are not consistent. Presumably, the bias changes the coefficients of hired employees in a similar manner and direction. So, the results concerning the significance of productivity differences are valuable and interesting. Moreover, productivity is calculated at firm level while wage group is documented at individual level; therefore, at firm level complementarity effects and working in teams intervene, reducing endogeneity. Defining wages as employers' evaluations of newly hired employee education and occupation, we admit that employers do not use a common scale. There is also a chance that firms with high labour productivity hire only middle-aged employees, who are the most productive and therefore age-related productivity difference may result from the productivity difference between firms. However, the prevalence of such matches is affected by personal preferences, such as distance of a firm from an applicant's home.

4. Empirical results

First, we conducted the decomposition of Ilmakunnas and Maliranta (2007) based on two wage groups. In all the models in the current paper we used the same sample and same control variables. The coefficients of hired employees in Table I measure the relative productivity of hired workers in each wage group compared to all staying workers. All the coefficients of interest were statistically significantly different from zero and in all sectors they showed that high-waged were relatively more productive. However, the Wald tests for equality of coefficients indicated that the high-wage and low-wage employees did not have statistically significant differences of productivity in industry ($p = 0.146$), in knowledge intensive services ($p = 0.147$) or in construction ($p = 0.978$) (see also Appendix 3). This result implies the average wage in these sectors does not differentiate well between more productive and less productive employees. High-wage employees were relatively more productive than low-wage employees in traditional services ($p = 0.006$) and in the whole sample ($p = 0.007$). This result contradicts Kampelmann and Rycx (2012), who cannot reject the hypothesis of a flat productivity profile. In contrast, we separate only two categories; including more categories might have changed our result. Concerning the sector-related differences in productivity, pairwise tests for each pair of sectors indicated statistically significant differences between the productivity of low-waged employees in the whole sample and services ($p = 0.010$); in services and traditional services ($p = 0.046$); and in traditional and knowledge intensive services ($p = 0.040$).

Table I. Fixed effects panel data regression results, dependent variable productivity change in the firm

Variables	Industry, services or construction (1 = 2+3+6)	Industry (2)	Services (3 = 4+5)	Knowledge intensive services (4)	Traditional services (5)	Construction (6)
Stayers' share, high wage (reference)						
Hiring rate, high wage	−0.259*** (0.033)	−0.183** (0.071)	−0.290*** (0.04)	−0.473*** (0.078)	−0.224*** (0.046)	−0.214* (0.090)
Hiring rate, low wage	−0.359*** (0.022)	−0.301*** (0.044)	−0.428*** (0.027)	−0.609*** (0.056)	−0.367*** (0.030)	−0.216*** (0.063)
Separation rate, high wage	0.793*** (0.033)	0.967*** (0.073)	0.767*** (0.039)	0.989*** (0.075)	0.682*** (0.046)	0.602*** (0.090)
Separation rate, low wage	0.646*** (0.021)	0.737*** (0.042)	0.650*** (0.026)	0.634*** (0.058)	0.650*** (0.029)	0.505*** (0.058)
Stayers' share, high wage	0.044** (0.015)	0.02 (0.030)	0.046** (0.018)	0.106** (0.036)	0.027 (0.020)	0.047 (0.042)
Stayers' share, low wage (reference)						
Log wage level	−0.116*** (0.012)	−0.097*** (0.025)	−0.075*** (0.015)	−0.137*** (0.029)	−0.051** (0.018)	−0.162*** (0.035)
Log productivity level	−0.462*** (0.005)	−0.477*** (0.010)	−0.416*** (0.006)	−0.353*** (0.012)	−0.439*** (0.007)	−0.598*** (0.015)
Log capital(1)-log capital(0)	0.060*** (0.003)	0.080*** (0.007)	0.051*** (0.003)	0.045*** (0.006)	0.053*** (0.004)	0.090*** (0.010)
Location dummies	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)
Period dummies	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)
Industry dummies	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)
Constant	5.290*** (0.177)	5.417*** (0.311)	4.899*** (0.165)	4.583*** (0.382)	4.977*** (0.185)	7.180*** (0.296)
Number of obs.	43,783	11,570	25,503	5,824	19,679	6,710
F-test statistic	264.101	172.196	255.331	94.01	281.48	190.766
R^2	0.369	0.393	0.348	0.344	0.354	0.44
R^2 adjusted	0.215	0.246	0.193	0.181	0.201	0.263

Notes: Standard errors in parenthesis. (1 = 2+3+6) and (3 = 4+5) indicate which columns are included in the respective category. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

Second, we analysed productivity differences in age groups. The results in the upper section of Table II indicate that the coefficients in all sectors were statistically significantly different from zero (except for old employees in construction). In general, our results confirmed the inverted U shape of the age-productivity curve. A statistically significant difference existed across the sample between middle-aged and old employees at significance level $\alpha = 0.05$ ($p = 0.043$) and between middle-aged and young employees at $\alpha = 0.001$ ($p < 0.001$). Interestingly, the difference between the coefficients for old and young across the sample was not statistically significant ($p = 0.278$). In industry, there were no statistically significant differences in productivity between any of the age groups (see p-values in Appendix 3). This result contradicts Malmberg *et al.* (2008), who found large shares of older adults in manufacturing plants increase labour productivity compared to large shares of younger adults. We analysed newly hired employees, while they used shares of employees of different age groups already in the firm.

Our results partly repeat those of Ilmakunnas and Maliranta (2007, 2016), but in their equation older employees are relatively less productive than young employees in services. Compared to Ilmakunnas and Maliranta (2007, 2016) our coefficients are larger. The larger coefficients for Estonian data must be related to analysing the crisis period and including smaller firms. Ilmakunnas and Maliranta did not empirically test whether the productivity difference between age groups (e.g. in industry) was statistically significant.

To test *H4* concerning sectoral differences, we checked the equality of coefficients in the equations for different sectors. Young in industry were more productive than young in services and the difference was statistically significant $p = 0.014$ (see also Table AIV in Appendix 4 for other p-values). This was the only statistically significant difference between coefficients for employees in industry and services. Old were less productive in knowledge intensive services ($p = 0.031$) compared to traditional services and also less productive ($p = 0.030$) than old employees in industry.

Third, we analysed the productivity differences between combinations of age and wage groups. The coefficients for hiring rates in the lower part of Table II indicate that productivity was higher for high-waged compared to low-waged employees in each of the three age groups for the whole sample. Nevertheless, that productivity difference was statistically significant only for young ($p = 0.013$). Not too many old employees are hired compared to employees in other age groups and dividing the older into two wage groups further increases the confidence intervals (see Appendix 3 and Appendix 4, Table AV for exact p-values). While there were no statistically significant differences between age groups of high-waged employees and the p-values remained rather high (above 0.4), in the group of low-waged employees the p-values were rather low –young and old were statistically significantly less productive than middle-aged (at significance levels $\alpha = 0.05$ and $\alpha = 0.1$, respectively); the productivity difference of young and old in this wage group was not statistically significant, but the p-value remained rather low ($p = 0.155$).

In industry we can only compare the productivity of low-waged employees of different ages, but we found no statistically significant differences between the productivity of the three low-waged age groups (see Appendix 3 for exact p-values). In services the pattern of the coefficients was the same as in the whole sample, but the differences between coefficients were not statistically significant. We only found statistically significant productivity differences between old low-waged employees and old high-waged employees in knowledge intensive services ($p = 0.040$) where the low-waged employees were less productive.

Concerning *H4* about productivity differences between economic sectors: the productivity of old low-waged employees in industry was statistically significantly higher than in knowledge intensive services. In services, the productivity of old low-waged employees and young low-waged employees was lower than in the whole sample ($p = 0.069$ and $p = 0.005$, respectively). This result contradicts the conclusions of Göbel and Zwick (2009), who did not find significant differences in age-productivity profiles between sectors.

Table II. Fixed effects panel data regression results, dependent variable productivity change in the firm; independent variables include age groups (upper part) and combinations of age and wage groups (lower part)

Variables	Industry, services or construction (1 = 2+3+6)	Industry (2)	Services (3 = 4+5)	Knowledge intensive services (4)	Traditional services (5)	Construction (6)
Hiring rate, up to 30	−0.413*** (0.032)	−0.325*** (0.079)	−0.491*** (0.036)	−0.640*** (0.068)	−0.435*** (0.043)	−0.325*** (0.094)
Hiring rate, 31–50	−0.242*** (0.030)	−0.217*** (0.062)	−0.252*** (0.036)	−0.392*** (0.078)	−0.196*** (0.040)	−0.184* (0.084)
Hiring rate, 51 and over	−0.354*** (0.044)	−0.283*** (0.084)	−0.468*** (0.054)	−0.709*** (0.117)	−0.395*** (0.061)	−0.06 (0.133)
Constant	5.052*** (0.168)	5.199*** (0.287)	4.651*** (0.151)	4.043*** (0.362)	4.846*** (0.166)	6.995*** (0.245)
Number of obs.	43,783	11,570	25,503	5,824	19,679	6,710
F-test statistic	254.739	158.402	239.234	83.703	257.671	168.234
R^2	0.37	0.393	0.348	0.342	0.355	0.442
R^2 adjusted	0.215	0.246	0.193	0.178	0.202	0.265
Hiring rate, up to 30, high wage	−0.302*** (0.060)	−0.229 (0.158)	−0.390*** (0.068)	−0.507*** (0.120)	−0.330*** (0.081)	−0.155 (0.176)
Hiring rate, up to 30, low wage	−0.473*** (0.036)	−0.357*** (0.089)	−0.528*** (0.042)	−0.639*** (0.077)	−0.470*** (0.049)	−0.383*** (0.107)
Hiring rate, 31–50, high wage	−0.222*** (0.051)	−0.164 (0.114)	−0.187** (0.061)	−0.399*** (0.115)	−0.081 (0.071)	−0.291* (0.144)
Hiring rate, 31–50, low wage	−0.274*** (0.035)	−0.250*** (0.074)	−0.292*** (0.043)	−0.400*** (0.101)	−0.250*** (0.048)	−0.142 (0.099)
Hiring rate, 51 and over, high wage	−0.258* (0.101)	−0.134 (0.204)	−0.337** (0.121)	−0.180 (0.252)	−0.365** (0.136)	−0.035 (0.310)
Hiring rate, 51 and over, low wage	−0.382*** (0.049)	−0.310** (0.095)	−0.501*** (0.061)	−0.850*** (0.137)	−0.402*** (0.068)	−0.057 (0.146)
Constant	5.335*** (0.103)	5.424*** (0.313)	4.902*** (0.166)	4.674*** (0.353)	4.995*** (0.186)	7.286*** (0.299)
Number of obs.	43,783	11,570	25,503	6,171	19,679	6,710
F-test statistic	457.741	128.437	200.771	63.712	204.276	122.515
R^2	0.379	0.393	0.349	0.335	0.356	0.443
R^2 adjusted	0.228	0.246	0.194	0.168	0.203	0.265

Notes: Standard errors in parenthesis. (1 = 2+3+6) and (3 = 4+5) indicate which columns are included in the respective category. Both models include separation rates and stayer shares and control variables that are not shown here. Full models are available upon request. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

In addition to the economic sector, they could take into account gender, nationality, share of apprenticeships, age variance, qualification groups, average tenure, technical conditions of the equipment, the share of part-time workers and an export dummy. Our method was more limited in its capacity to include individual level indicators of employees.

As a robustness test (tables available upon request), we redefined the high-waged employees and low-waged employees by raising and lowering the threshold of the average wage of the employees in each NACE 2-digit industry by one standard deviation. Across the sample, neither of the changes altered our result of higher productivity of high-waged compared to low-waged employees (significance level $\alpha = 0.05$). In the model combining age and wage groups, the productivity of young low-waged employees remained statistically significantly lower than the productivity of middle-aged employees (for both age-groups), and old low-waged employees remained statistically significantly less productive than middle-aged high-waged employees at significance level $\alpha = 0.05$. In services, lowering the threshold by one standard deviation resulted in a statistically significant difference between low-waged old and high-waged old employees ($p = 0.002$) where low-waged old were less productive. The similar result for low-waged and high-waged old in knowledge intensive services was robust because the p-value remained near 0.1 when the threshold was decreased and valued 0.040 in the case of the increased threshold. The results concerning sector-specific differences mentioned above did not change in robustness tests.

5. Conclusion

The current study aimed to identify productivity differences between high-waged and low-waged employees based on age. Links between age and productivity have been analysed extensively, but the decomposition of the productivity of employees in different wage groups had not yet been carried out. By combining the theory of human capital investment and learning-by-doing there may be cases where the productivity of an individual increases at the beginning of pure work stage before it starts to decline and in other cases it just gradually decreases.

We hypothesised that high-wage employees have more stimulus situations at work and this positively impacts their productivity in older age through learning-by-doing. Our analysis of matched Estonian employee-employer data consisted of a fixed-effects firm-level panel data regression that decomposed the productivity change in firms through the hiring and separation of workers differentiated based on age and wage.

We showed that high-waged employees were in general more productive than low-waged employees and this result held in the case of an increase or decrease in the threshold of the average wage of the NACE two-digit code. The sector-specific results were nevertheless dependent on the threshold. Concerning the age-productivity curve, we confirmed the reverse U curve between age and productivity. We could see that middle-aged were more productive than old or young, but the productivity of old was not statistically significantly different from the productivity of young.

The results for the combination of wage and age groups indicated that the age-productivity curve had the shape of an inverse U as predicted in both wage groups. In contrast to our expectations the curve was flatter for high-waged employees than for low-waged employees. The theoretical difference in the productivity of old low-waged and old high-waged employees (see Section 2) only emerged in knowledge intensive services. Also, the low-waged young and old were significantly less productive than middle-aged high-waged employees (even with the change in the wage threshold). Sector-related differences were found in the productivity of employees in industry compared to services. In industry, the productivity of young employees was statistically significantly higher than in services. The old were less productive in knowledge intensive services compared to traditional services and also less productive than old employees in industry.

We separate only three large age groups, but the productivity difference of high-waged and low-waged old may appear after the age of 55. We look at the cohorts of employees and although our study has a panel dimension, it is not long enough to cover the whole life-cycle of an employee. Smaller occupational groups (as in Veen, 2008) include more homogenous employees (in terms of life cycle, human capital level, etc.) and therefore smaller age-related productivity decreases can be documented. The sector-level comparisons are dependent on average productivity level, which can differ greatly between sectors. In knowledge-intensive services, for example, the average productivity level is high; therefore, the low-wage old (who most likely are not involved in knowledge intensive activities) cannot be very productive compared to stayers.

Based on our results firms can be encouraged to hire older employees. The productivity of old employees is relatively lower than that of middle-aged employees but does not fall below the productivity of young employees. While young are more prone to change jobs, the stability of older employees may be advantageous. In services we found a difference in productivity between high-waged and low-waged old employees, while such a difference could not be documented in industry. Further research could reveal the reasons behind this sectoral difference.

Our data limited us from identifying voluntary separations and involuntary firings; therefore, we do not analyse separations in our paper. In some cases the individual productivity of a single employee does not seem to affect the value added of the firm to the extent that it becomes visible with our method. Further research comparing the productivity of older and younger employees could complement our results to identify whether business cycle can cause similar productivity levels in the two groups.

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Notes

1. Test practice means that people who take the same test for the second, third or fourth time may perform better than the people who take the test for the first time, only because the test is familiar to them. People who have already taken the test may intentionally practice before the next test, because they know what to practice (Kulik *et al.*, 1984).

2. In Estonia, working old-age pensioners can receive a wage and the national pension at the same time and national pensions are rather low compared to other EU countries. In 2014, the average national pension as a percentage of the average gross wage was only 34.6 per cent (Riikliku vanaduspensioni jätkusuutlikkuse analüüs, 2016). In 2011, the employment rate of 65–69-year-olds was 19.5 per cent, while in the EU27 the respective number was 10.5 (Dubois and Anderson, 2012). In 2015, the median age in Estonia (41.6 years) was similar to the median age in more developed countries in the United Nations (41.1 years) (United Nations, 2017).

3. Knowledge intensive services include high-tech knowledge-intensive services (NACE rev 2: 59; 60; 61; 62; 63; 72), knowledge-intensive market services (excluding financial intermediation and high-tech services) (NACE rev 2: 50; 51; 70; 71; 73; 74; 78; 80), knowledge-intensive financial services

(NACE rev 2: 64; 65; 66; excluded in our analysis), other knowledge-intensive services (NACE rev 2: 58; 75; 84; 85; 86; 87; 88; 90; 91; 92; 93).

4. Labour adjustment costs include the costs of recruiting, screening and training new employees, layoff notice periods and mandatory severance pay. To a large extent the labour adjustment costs are related to labour market regulation. One of the consequences of the high costs is hindered reallocation of labour resources from less to more productive firms, and therefore, also slower economic growth in general (Trapeznikova, 2017).

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Appendix 1

Table AI. Average productivity change, standard deviation and the number of firms in different sectors

	Industry			Services			Construction		
Periods	Change (%)	SD	*n*	Change (%)	SD	*n*	Change (%)	SD	*n*
2006–2007	−0.018	0.435	1,605	−0.007	0.431	3,457	−0.055	0.549	1,054
2007–2008	−0.096	0.459	1,548	−0.167	0.439	3,371	−0.169	0.631	1,029
2008–2009	−0.224	0.574	1,466	−0.266	0.521	3,222	−0.470	0.747	879
2009–2010	0.144	0.518	1,471	0.034	0.471	3,244	0.177	0.768	801
2010–2011	0.048	0.482	1,336	0.033	0.423	3,058	0.124	0.685	775
2011–2012	−0.075	0.409	1,471	−0.013	0.390	3,223	−0.028	0.609	776
2012–2013	0.000	0.376	1,379	−0.014	0.355	3,044	−0.143	0.562	703
2013–2014	0.015	0.363	1,294	−0.019	0.354	2,884	−0.100	0.566	693
Total	−0.028	0.469	11,570	−0.054	0.439	25,503	−0.089	0.670	6,710
	Knowledge intensive services			Traditional services			Industry, services and construction		
Periods	Change (%)	SD	*n*	Change (%)	SD	*n*	Change (%)	SD	*n*
2006–2007	−0.007	0.436	753	−0.007	0.429	2,704	−0.018	0.454	6,116
2007–2008	−0.072	0.403	749	−0.195	0.445	2,622	−0.149	0.484	5,948
2008–2009	−0.253	0.546	752	−0.270	0.513	2,470	−0.287	0.582	5,567
2009–2010	−0.022	0.472	756	0.050	0.469	2,488	0.084	0.540	5,516
2010–2011	0.035	0.440	676	0.033	0.419	2,382	0.051	0.487	5,169
2011–2012	−0.004	0.417	743	−0.016	0.381	2,480	−0.032	0.433	5,470
2012–2013	−0.015	0.401	711	−0.014	0.340	2,333	−0.028	0.398	5,126
2013–2014	−0.009	0.379	684	−0.022	0.345	2,200	−0.022	0.395	4,871
Total	−0.045	0.448	5,824	−0.057	0.437	19,679	−0.052	0.490	43,783

Appendix 2

Variable name and definition	Mean	SD
Change of labour productivity	–0.052	0.490
Number of employees by enterprise	33.254	107.493
Hiring rate, young (< 31), high wage	0.019	0.046
Hiring rate, young (< 31), low wage	0.047	0.080
Hiring rate, middle-aged (31–50), high wage	0.023	0.050
Hiring rate, middle-aged (31–50), low wage	0.046	0.075
Hiring rate, old (> 50), high wage	0.007	0.023
Hiring rate, old (> 50), low wage	0.024	0.050
Hiring rate, all age and wage groups		
Separation rate, young (< 31), high wage	0.016	0.041
Separation rate, young (< 31), low wage	0.040	0.072
Separation rate, middle-aged (31–50), high wage	0.024	0.050
Separation rate, middle-aged (31–50), low wage	0.046	0.073
Separation rate, old (> 50), high wage	0.008	0.026
Separation rate, old (> 50), low wage	0.030	0.057
Separation rate, all age and wage groups		
Stayers' share, young (< 31), high wage	0.074	0.136
Stayers' share, young (< 31), low wage	0.110	0.164
Stayers' share, middle-aged (31–50), high wage	0.225	0.233
Stayers' share, middle-aged (31–50), low wage	0.284	0.254
Stayers' share, old (> 50), high wage	0.099	0.146
Stayers' share, old (> 50), low wage	0.208	0.223
Log of initial wage level in the company	7.377	0.536
Log of initial productivity level in the company	10.142	0.880
Log of capital level at the beginning of the period minus log of capital level at the end of the period	0.012	0.788
Industry (dummy, 1 if firm belongs to industry sector)	0.264	0.441
Services (dummy, 1 if firm belongs to services sector)	0.582	0.493
Construction (dummy, 1 if construction firm)	0.153	0.360
Knowledge intensive services (dummy, 1 if belongs to knowledge intensive services)	0.133	0.340
Traditional services (dummy, 1 if belongs to traditional services)	0.449	0.497
Northern Estonia	0.553	0.497
Central Estonia	0.074	0.262
North-Eastern Estonia	0.070	0.254
Western Estonia	0.103	0.304
Southern Estonia	0.201	0.401

Table AII. Descriptive statistics, whole sample of employer-employee data without outliers

Appendix 3

Table AIII. Pairwise tests of differences between coefficients of hiring rates in Tables I and II in the main text (F-statistic and the corresponding p-value)

	Industry, services and construction (1 = 2+3+6)		Industry (2)		Services (3 = 4+5)		Knowledge intensive services (4)		Traditional services (5)		Construction (6)	
	F	p-value	F	p-value	F	p-value	F	p-value	F	p-value	F	p-value
High-waged vs Low-waged	7.186	0.007	2.116	0.146	9.115	0.003	2.107	0.147	7.527	0.006	0.001	0.978
Young vs Middle-aged	15.165	0.000	1.082	0.298	22.532	0.000	5.684	0.017	16.938	0.000	1.231	0.267
Young vs Old	1.177	0.278	0.139	0.709	0.135	0.713	0.275	0.600	0.303	0.582	2.721	0.099
Middle-aged vs Old	4.108	0.043	0.353	0.552	10.349	0.001	4.647	0.031	6.982	0.008	0.595	0.441
Young high wage vs Young low wage	6.126	0.013	0.508	0.476	3.146	0.076	0.546	0.460	2.287	0.130	1.300	0.254
Young high wage vs Middle-aged high wage	0.642	0.423	0.097	0.756	4.527	0.033	0.479	0.489	4.868	0.027	0.318	0.573
Young high wage vs Middle-aged low wage	0.152	0.697	0.015	0.903	1.553	0.213	1.157	0.282	0.748	0.387	0.004	0.949
Young high wage vs Old high wage	0.000	0.986	0.129	0.720	0.146	0.702	1.290	0.256	0.048	0.827	0.106	0.744
Young high wage vs Old low wage	1.182	0.277	0.203	0.653	1.490	0.222	2.786	0.095	0.468	0.494	0.186	0.666
Young low wage vs Middle-aged high wage	14.862	0.000	1.795	0.180	22.099	0.000	2.595	0.107	21.367	0.000	0.277	0.599
Young low wage vs Middle-aged low wage	14.636	0.000	0.782	0.377	15.478	0.000	4.418	0.036	10.451	0.001	2.571	0.109
Young low wage vs Old high wage	2.626	0.105	1.033	0.310	2.258	0.133	2.523	0.112	0.538	0.463	1.139	0.286
Young low wage vs Old low wage	2.018	0.155	0.127	0.722	0.136	0.712	1.669	0.196	0.675	0.411	3.299	0.069
Middle-aged high wage vs Middle-aged low wage	0.439	0.508	0.407	0.524	2.023	0.155	0.080	0.778	4.082	0.043	0.786	0.375
Middle-aged high wage vs Old high wage	0.293	0.589	0.014	0.905	1.130	0.288	0.451	0.502	3.118	0.077	0.487	0.485
Middle-aged high wage vs Old low wage	4.601	0.032	1.008	0.315	13.322	0.000	5.555	0.018	10.861	0.001	1.394	0.238
Middle-aged low wage vs Old high wage	0.052	0.819	0.291	0.589	0.123	0.726	0.298	0.585	0.631	0.427	0.109	0.741
Middle-aged low wage vs Old low wage	2.997	0.083	0.221	0.638	7.157	0.007	6.961	0.008	3.095	0.079	0.218	0.641
Old high wage vs Old low wage	0.564	0.453	0.586	0.444	1.422	0.233	4.228	0.040	0.058	0.809	0.004	0.948

Note: (1 = 2+3+6) and (3 = 4+5) indicate which columns are included in the respective category

Appendix 4. Pairwise tests of differences between coefficients of hiring rates in Table II in the main text

	Industry, services and construction	Industry	Services	Knowledge intensive services	Traditional services
Industry					
Young	12.223 (0.000)				
Middle-aged	0.000 (0.995)				
Old	2.659 (0.103)				
Services					
Young	12.223 (0.000)	6.100 (0.014)			
Middle-aged	0.000 (0.995)	0.065 (0.798)			
Old	2.659 (0.103)	0.735 (0.391)			
Knowledge intensive services					
Young	5.623 (0.018)	6.711 (0.010)	1.361 (0.243)		
Middle-aged	0.913 (0.339)	0.294 (0.588)	1.080 (0.299)		
Old	6.978 (0.008)	4.649 (0.031)	4.832 (0.028)		
Traditional services					
Young	5.623 (0.018)	4.595 (0.032)	0.757 (0.384)	1.160 (0.282)	
Middle-aged	0.913 (0.339)	0.395 (0.530)	1.453 (0.228)	1.177 (0.278)	
Old	6.978 (0.008)	0.028 (0.866)	4.185 (0.041)	4.705 (0.030)	
Construction					
Young	3.575 (0.059)	0.003 (0.960)	6.174 (0.013)	6.806 (0.009)	4.689 (0.030)
Middle-aged	0.591 (0.442)	0.470 (0.493)	0.321 (0.571)	1.195 (0.274)	0.042 (0.838)
Old	6.229 (0.013)	2.365 (0.124)	5.917 (0.015)	10.569 (0.001)	3.262 (0.071)

Note: χ^2 test statistic and the corresponding p-value in parenthesis

Table AIV. Pairwise tests of differences between the coefficients of different age groups of hired employees in upper part of Table II

Table AV. Pairwise tests of differences between the coefficients of different age groups of hired employees in lower part of Table II

	Industry, services and construction	Industry	Services	Knowledge intensive services	Traditional services
Industry					
Young high wage	0.139 (0.709)				
Young low wage	3.550 (0.060)				
Middle-aged high wage	0.159 (0.690)				
Middle-aged low wage	0.078 (0.780)				
Old high wage	2.005 (0.157)				
Old low wage	0.144 (0.704)				
Services					
Young high wage	4.778 (0.029)	0.879 (0.349)			
Young low wage	7.941 (0.005)	6.019 (0.014)			
Middle-aged high wage	0.469 (0.493)	0.309 (0.578)			
Middle-aged low wage	0.100 (0.752)	0.007 (0.933)			
Old high wage	0.073 (0.787)	0.887 (0.346)			
Old low wage	3.305 (0.069)	0.246 (0.620)			
Knowledge intensive services					
Young high wage	4.457 (0.035)	2.234 (0.135)	1.968 (0.161)		
Young low wage	2.162 (0.141)	4.604 (0.032)	0.237 (0.626)		
Middle-aged high wage	0.742 (0.389)	0.126 (0.723)	1.572 (0.210)		
Middle-aged low wage	0.227 (0.634)	0.058 (0.810)	0.157 (0.692)		
Old high wage	0.991 (0.320)	0.016 (0.899)	0.971 (0.325)		
Old low wage	13.103 (0.000)	7.026 (0.008)	10.118 (0.001)		
Traditional services					
Young high wage	0.229 (0.633)	0.245 (0.621)	1.892 (0.169)	1.962 (0.161)	
Young low wage	3.071 (0.080)	5.184 (0.023)	0.176 (0.675)	0.219 (0.640)	
Middle-aged high wage	1.711 (0.191)	0.807 (0.369)	1.181 (0.277)	1.465 (0.226)	
Middle-aged low wage	0.072 (0.788)	0.111 (0.739)	0.803 (0.370)	0.252 (0.616)	
Old high wage	0.378 (0.538)	1.788 (0.181)	1.220 (0.269)	1.049 (0.306)	
Old low wage	0.099 (0.753)	0.179 (0.672)	9.066 (0.003)	10.033 (0.002)	
Construction					
Young high wage	1.375 (0.241)	0.196 (0.658)	2.376 (0.123)	3.977 (0.046)	1.145 (0.285)
Young low wage	2.179 (0.140)	0.092 (0.761)	3.865 (0.049)	3.225 (0.073)	3.261 (0.071)
Middle-aged high wage	0.002 (0.967)	0.075 (0.784)	0.039 (0.844)	0.357 (0.550)	0.284 (0.594)
Middle-aged low wage	0.788 (0.375)	0.520 (0.471)	0.569 (0.451)	0.643 (0.423)	0.258 (0.612)
Old high wage	0.419 (0.517)	1.564 (0.211)	0.325 (0.569)	1.116 (0.291)	0.043 (0.836)
Old low wage	8.077 (0.004)	4.308 (0.038)	7.621 (0.006)	17.359 (0.000)	3.647 (0.056)

Note: χ^2 test statistic and the corresponding p-value in parenthesis

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