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Science and technology in the framework of the sustainable development goals

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Abstract
Purpose – In September 2015, the UN member states approved an ambitious agenda toward the end of poverty, the pursuit of equity and the protection of the planet in the form of 17 Sustainable Development Goals (SDGs) and 169 targets. The purpose of this paper is to raise a concern about the context and framework that science, technology and innovation have in the finalized text for adoption that frames the SDGs especially regarding environmental degradation. The authors argue that emphasizing technology transfer in the agenda has the risk to do not recognize other technological alternatives such as eco-technologies, and endorse a limited vision of the role of science and innovation in the achievement of the SDGs. Science for sustainability has to go further than technology transfer, even questioning the limits of the current patterns of intensive use of natural resources and inequity in consumption. By discussing the historical backgrounds of this paradigm and elaborating on the role of science to achieve sustainability in a broader sense. It is in these terms that inter- and intra-discipline and the roles of researchers in sustainability transitions acquire relevance.

Design/methodology/approach – Although many theories regarding human development are in place and under discussion, the dominant view, reflected in the UN agreement, is that the progress of a country can be measured by the growth in the per capita gross domestic product. This variable determines if a society is able to reduce poverty and satisfy its basic needs for present and future generations (Article 3: United Nations (UN), 2015). Progress and economic growth in several aspects of human development has been substantial over the past 40 years. However, at the same time, the state of the environment continues to decline (UNEP, 2012). The obvious inquiry of these opposing trends is whether progress irremediably comes at the cost of environmental degradation. In 1972, the Club of Rome’s report entitled “Limits to growth” (Meadows et al. 1972) confronted the viability of perpetual economic growth. The report alerted of the impossibility of endless growth in population and production in a finite planet (Gómez-Baggethun and Naredo, 2015). The essay forecasted future crises of food and energy if the population and economic growth continued to grow at the same rate of the first half of the twentieth century. Nevertheless, the catastrophic projections were not met, mostly because of great advances in agriculture, water and energy technologies.

Findings – The SDGs constitute a relevant international recognition of the importance of the three edges of sustainable development. However, the pathways toward the achievement of the SDGs need to fully recognize that poverty, inequalities and global environmental problems are expressing a deeper crisis in the shape of economic growth, patterns of production and consumption and, in general, the logic of no limits in the exploitation of natural resources (Sheinbaum-Pardo, 2015). For this reason, the science of sustainability requires a deep understanding of the technological change and that technology is not the only approach toward sustainability.

Research limitations/implications – The paper reflects a conceptual discussion of the narrow vision of science and technology in the SDGs and their UN framework. The most important objective in the UN documents is technology transfer. This has the risk to do not recognize other technological alternatives such as eco-technologies, and endorse a limited vision of the role of science and innovation in the achievement of the SDGs.

Practical implications – An important discussion of the key points regarding SDGs is developed.

Social implications – “Transforming our world: The 2030 agenda for sustainable development (UN, 2015)” presents a narrow vision and a limiting role to the science of sustainability. Moreover, if these issues are not recognized, the achievement of the SDGs will continue to gain only marginal success.

Originality/value – It brings out a very important discussion of the role of science and technology in the ambitious UN agenda of the SDGs.

Keywords Technology, Sustainable development goals, Science, Limits

Paper type Conceptual paper
1. Introduction
One of the key outcomes of the United Nations Conference on Sustainable Development (Rio+20), held in Rio de Janeiro in June 2012, was the agreement among the member states to launch a process to develop a set of sustainable development goals (SDGs; United Nations, 2012). Following a route of inter-governmental negotiations and based on the proposal of the open working group on SDGs, the member states agreed on a finalized text for adoption called “Transforming our world: The 2030 agenda for sustainable development (UN, 2015).”

The text of the SDGs constitutes an ambitious agenda toward the end of poverty, the pursuit of equity and the protection of the planet. In contrast to the Millennium Development Goals launched in 2000, the SDGs show empathy in the three dimensions of sustainable development, i.e., the economic, social and environmental aspects, in a future vision that engage all of the countries of the world. Nevertheless, there are certain concerns about the SDGs and the finalized text for adoption. For example, the International Council for Science and the International Social Science Council (2015) raised the concern that the SDGs are presented in “silos” with the danger of conflict among different goals and even trade-offs between overcoming poverty and moving toward sustainability. Namely, an action to meet one target could have unintended consequences on other goals if they are pursued separately.

In addition to the concern about the inter-linkages among SDGs in this paper we raised another important concern very much related to the how and the means to achieve the SDGs, and it is the context and normative framework that science, technology and innovation (STI) have in the finalized text for adoption, as well as in SDG 17th (Table I).

In the resolution adopted by the UN General Assembly on SDGs, the main focus of science and technology is “promoting the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries” (target 17.7) and the creation of “technology facilitation mechanisms (TFM)” (Article 70) to enable knowledge and technology transfer. Although this emphasis is important, it strongly supports the ideas that science operates only for the development of technology, which limits its role in the sustainable development vision and exalts technology transfer from north to south. It is interesting to note that in the finalized text for adoption (UN, 2015) that consists of 29 pages, the word culture appears five times, the word science appears ten times, and the word technology appears 36 times.

In this paper, we elaborate on the role of science for sustainability in a broader sense, beyond science for technology innovation and transfer. Under this context we recall that science is a human activity and that the choices we face are not only technological but mainly societal ones. In this view, the question of how to achieve the SDGs is indivisible with the SDGs themselves and, therefore, philosophical, social and economic sciences as well as other sources of knowledge must contribute as much as the natural and technical sciences toward an approach where the quality of life and sustainable patterns of

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Table I. Targets regarding technology SDG 17th
consumption and production can reconcile to reduce the environmental degradation,
poverty and inequalities (MacKenzie and Wajkman, 1985; Asara et al., 2015; Institute for
The narrative of this paper presents four sections in addition to the introduction. Section 2 revises the role of SDI in the text of the UN resolution. Section 3 provides a critical historical background on the contemporary assumptions of the role of science and technology. Next, a revision of technology and the ecological limits of growth are presented. In Section 5, throughout a literature review of the complexity of the achievement of the 17 SDGs, we elaborate on the need to a broader assumption of STI, and show how technology transfer is a very narrow vision of the means toward sustainable development. The last section presents some conclusions.

2. SDG 17th and means of implementation
The resolution adopted by the General Assembly on September 25, 2015 (A/70/L.1)
“Transforming our world: the 2030 Agenda for Sustainable Development” is divided in five
main segments: Preamble and definitions; Declaration; Sustainable Development Goals and
targets; Means of Implementation and the Global Partnership; and Follow-up and review.
The core of the document is the definition of the 17 SDGs and their 169 targets. SDG 17th is
on strengthening the means of implementation and revitalizing the global partnership for
sustainable development. Targets of SDG 17th are divided in five segments: Finance;
Technology; Capacity Building; Trade; and Systemic issues (that include policy and
institutional coherence; Multi-stakeholder partnership; data, monitoring and accountability).
Regarding technology, SDG 17th has three targets (Table I).

In addition, in the section of Means of Implementation, the UN (2015) agreement
launched the TFM[1], that will be based on a “multi-stakeholder collaboration between
Member States, civil society, the private sector, the scientific community, United
Nations entities and other stakeholders and will be composed of a United Nations inter-
agency task team on science, technology and innovation for the SDGs a collaborative
multi-stakeholder forum on science, technology and innovation for the SDGs and an
online platform.”

Although target 17.6 and the TFM mentioned science and innovation, the main focus of
the document is on technology transfer. Even the fact that science and innovation is not
considered as the principal mean but as part of technology, shows the vision of the SDGs
framework in the sense that regarding STI, technology transfer is the principal mean for
sustainable development.

Placing technology transfer as the main resource toward the achievement of the SDGs
limits the role of science and innovation toward sustainable development. The risks of this
orientation are at least on three areas that historically have been already questioned:
conceive science and technology as if they were a power outside of societal and political
decisions; disregard that there are ecological limits of growth that technology transfer
cannot solve; neglect the role of social sciences, humanities, and different sources of
knowledge and minimize the role of other echo-technological approaches (Ortiz-Moreno
et al., 2015) toward the achievement of SDGs. In the next sections, these concerns are
discussed. Even in the case of firms, technology transfer is part of component toward
sustainability as discussed in Schneider (2014) and Hahn et al. (2015).

3. Historical background on the vision of science and technology
There is a predominant view that science is a human activity dedicated to understand
nature and “reveal its language and laws” (Pinch and Bijker, 1987, p. 18). This approach has
led us to conceive science and technology as if they were a power outside of societal and
political decisions (MacKenzie and Wajkman, 1985, p. 7) that enables people to intervene in
and alter the world (Ozolina et al., 2009, p. 9). Probably, this view started with Plato (428-348 BC) who thought that mathematics was a special way to learn about the universe, and a language that did not require the involvement of the senses. For Plato (2005) numbers were ideas that had the characteristic of being eternal and the best of all; they did not demand the need of senses to establish accurate knowledge.

A few centuries after this Greek philosopher, Rene Descartes (1596-1650 BC) proposed his ideas, most of which reminds us of those of Plato. As the latter, Descartes also believed that the senses were not a truthful way of knowing the material world: Descartes was convinced that he had to think of a method that could guarantee the achievement of truth. Today we know it as the scientific method. This methodical guide was grounded in mathematics: “There is no more than one truth for each thing in mathematics. The one who finds it knows all that there is to know about it […] the method teaches how to follow the right and true order of things. It also enumerates with precision all of the circumstances that you are looking for and it confers the certainty of the arithmetic rules” (Descartes, 1999, 2013).

This perspective about science was the predominant view for a long time and was even accentuated with the enlightenment, where “after the work of Copernicus, Kepler, and Galileo, the Newtonian philosophy gave us nothing less than the coordinates for constructing the coordinates of reality” (Thiher, 2001, p. 13). In other words, the world established by the mathematical language constituted the cornerstone of our representation of reality. It seems that science was an external object and objective of construction that human beings use for the purpose of knowing the truth.

Contrary to this thinking, Giambattista Vico stated that science is a human construction. Even mathematics, the eternal and perfect language that Plato and Descartes claimed as the way of reaching the truth, is a human construction. It is as subjective as any other human way of understanding the world and, as any other subjective knowledge, it is anchored to the subject that is using and constructing it. Science is another way that human beings use to understand the complex and chaotic world that surrounds us (Vico, 1984).

To follow the argument above, we also should say that everything that is constructed or achieved in the name of science necessarily responds to human interests. There is no partial or disinterested knowledge; all of it comes from a subject, from an individual or a group of individuals who have a particular history. This history or path moulded their way of thinking and approaching the world. It also influenced the interests, inquiries and pursues that they will pursue in the name of science. Thus, we believe that the scientific knowledge is not intention free.

Likewise, it is fundamental to recognize that technology, made from scientific knowledge, can never be neutral. As Hebert Marcuse (1987) explains “progress is not a neutral term, it moves toward specific goals and these goals are defined by the possibility of improving human conditions” (p. 38).

Theodor Adorno and Max Horkheimer (1987) in the Dialectic of Illuminism sustain that: “What man wants to learn about nature is the way to use it to achieve the integral dominion of nature itself and of mankind” (p. 16). Therefore, technology is not only the way of dominating nature, but it has also become the way of dominating humans. It is time that we re-evaluate our relationship with nature and our conception of progress. This particular conception has dire consequences, for example, the destruction of the environment, as we know it and an economic system that only displays the inequality and dominion of man over man.

We could argue that if scientific knowledge is a social construction, then it is possible to assume that there is nothing epistemologically special about the nature of scientific knowledge. This statement does not disregard the importance to promote and develop STI. We want to emphasize that understanding the epistemology of science helps us to clarify that the choices we face are societal choices, not “scientific” or “technical” ones. Hence, the STI for sustainable development offers immense opportunities to reciprocally connect science with society, culture and traditional knowledge.
4. The benefits and limits of technology innovation and transfer

In 1972, the Club of Rome’s report entitled “Limits to growth” (Meadows et al., 1972) confronted the viability of perpetual economic growth. The report alerted of the impossibility of endless growth in population and production in a finite planet (Gómez-Baggethun and Naredo, 2015). The essay forecasted future crises of food and energy if the population and economic growth continued to grow at the same rate of the first half of the twentieth century. Nevertheless, the catastrophic projections were not met, mostly because of great advances in agriculture, water and energy technologies.

In agriculture, for example, the so-called green revolution and the post green revolution led the developing world to witness a period of food crop productivity growth. Although the population had more than doubled, the production of cereal crops tripled during the last 50 years, with only a 30 percent increase in cultivated land area (Pingali, 2012). However, the increase in agriculture productivity had consequences on the water use and soil degradation that affected at the end not just affect the natural environment but also the yields (Foley et al., 2005).

In the case of energy, a decoupling between energy consumption and GDP growth was achieved in developed countries due to energy efficiency technologies. Between 1973 and 1985, the total energy use per capita in OECD countries decreased by 6 percent, while per capita GDP increased by 21 percent (Goldemberg, 2004). However, in spite of the achievements in energy efficiency, the fossil fuel consumption increased and nowadays is the main cause of greenhouse gas (GHG) emissions that lead to the increase in the surface temperature of the planet (Intergovernmental Panel for Climate Change (IPCC) 2013).

These examples show the larger benefits of technology innovation, but also its limits. This apparent contradiction brings out a more general discussion on the ecological limits to both, economic and population growth and the role of technology. For these reason, Turner et al. (1994) recall the precatory principle in the sense that even if it is not certain that there are limits to growth, it would be prudent to behave as if there were to prevent or, at least, reduce major environmental damages that could seriously affect human well-being.

Several authors have proposed alternative theories and pathways to pursue human well-being and protect the environment, such as the steady-state economy (Daly, 1973, 1996, 2010; Jackson, 2009), the new economics of prosperity, or even the economy of degrowth (NEF, 2009; Schor, 2011; Nørgaard et al., 2010; Odum and Odum, 2001; Rees, 2006; Victor, 2010; Kallis et al., 2012; Martinez-Alier, 2009, 2012; Martinez-Alier et al., 2010; Scott-Cato, 2009). More recently, the UNEP (2011) defined a green economy as the one that results in “improved human well-being and social equity while significantly reducing the environmental risks and ecological scarcities.”

It is not the goal of this paper to discuss the difference of these approaches, but to recognize that there is an important international dialog and debate on how to transform the global and national economic systems into a pathway that recognizes the importance of poverty eradication, social equity and environmental protection for present and future generations, besides technology.

The underlying debate on the limits of growth is probably to understand that, besides technology, the reconciliation between nature and development needs to question the entire conception of progress and development, as we know it today. As the Mexican philosopher Luis Villoro notes, humanity has to stop seeing nature as a tireless exploitable object. We need to understand it as a never-ending source of revelations and as a worm dwelling (Villoro, 1993).

5. The need for a broader vision of STI, means and policies for the SDGs

Asking the right questions is the essence of good science (Lévi-Strauss, 1987). Some of the underlying questions of the decoupling between resource consumption and development are how to promote social welfare with limited resources? and how to enhance human
development and reduce environmental degradation? These are, of course, part of the core of the international debate on sustainable development, and they are far from being solved. What is essential to recognize is that there are different questions and answers for different regions and countries that exceed the aspect of the technological transfer.

Under this background, literature revision shows different orientations toward the achievement of SDGs that we propose to group in four major areas: (a) technology transfer to ensure that scientific and technological developments are accessible to a wider range of users; (b) eco-technologies defined as the use of technological means for ecosystem management based on deep understanding of principles on which natural ecological systems are built and on the transfer of such principles into ecosystem management (Straškraba, 1993; Funtowicz and Ravetz; 1995; Ortiz-Moreno et al., 2015); (c) inter-disciplinary science approach defined by the National Academies’ (2004) report as a mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice (Kaufmann and Cleveland, 1995; Rotmans and Loorbach, 2009; Scholz and Steiner, 2015); and (d) socio-economic policies, which refers in this analysis to public policies that are not necessarily related to technology innovation and transfer; and finally we include an additional area related to (d). Encounter visions that expose that there is no consensus but a scientific discussion on the visions to achieve some of the SDGs (Table II).

In the following sub-sections we discussed the 17th SDGs in the context of the five areas proposed above, according to literature review. Table II presents a qualitative expression of these review.

5.1 End of poverty and food security (SDGs 1 and 2)

An open discussion of different scientific disciplines is dedicated to study poverty (Sen, 1981, 2011). It is not our objective to review them in this paper, but to link them to the discussion of food security. It is clear that meeting the world’s future, the food availability must grow substantially while the activities that provide it shrink their environmental footprints considerably and adapt to climate change (Foley et al., 2005; UNEP, 2011; UN Department of Economic and Social Affairs (UNDESA), 2013). Some of the transformations in agriculture, livestock and fisheries production that are desirable to reach food security are:

- The change in production technologies and methods toward halting agricultural expansion, closing “yield gaps” on underperforming lands, increasing cropping efficiency by shifting from heavy mechanized with intense use of water, inorganic pesticides and fertilizers to organic systems and precision agriculture and improvements in livestock management in order to reduce pasture area (echo-technologies); still there is an important discussion on the impacts of technology that even reach genetically modified organisms and food security (encountered visions) (Foley et al., 2005; UNEP, 2011; UNDESA, 2013; Reddy et al., 2016).

- Recognize the complexity of production systems within diverse social and ecological contexts (inter-disciplinary approach).

- Shift from high-input industrial farming and large vessels to traditional systems run by small farmers and fishers to produce the majority of stable crops and animal protein needed to feed the world population. This will require secure land rights, good governance, greater commercialization and integration of small farmers and fishers into supply chains with infrastructure development (socio-economic policies) (UNEP, 2011).
### Qualitative importance of technology, inter-discipline, policies and visions in the discussion of achievements of the SDGs

<table>
<thead>
<tr>
<th>Goal</th>
<th>Technology transfer</th>
<th>Echo-technologies</th>
<th>Inter-disciplinary approach</th>
<th>Socio-economic policies</th>
<th>Encountered visions</th>
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<tbody>
<tr>
<td>1 End poverty in all of its forms everywhere</td>
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<td>2 End hunger, achieve food security and improved nutrition and promote sustainable agriculture</td>
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<td>3 Ensure healthy lives and promote well-being for all at all ages</td>
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<td>4 Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all</td>
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<tr>
<td>5 Achieve gender equality and empower all women and girls</td>
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<td>6 Ensure availability and sustainable management of water and sanitation for all</td>
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<td>7 Ensure access to affordable, reliable, sustainable and modern energy for all</td>
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<td>8 Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all</td>
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<td>9 Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation</td>
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<td>10 Reduce inequality within and among countries</td>
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<td>11 Make cities and human settlements inclusive, safe, resilient and sustainable</td>
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<td>12 Ensure sustainable consumption and production patterns</td>
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<td>13 Take urgent action to combat climate change and its impacts</td>
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<td>14 Conserve and sustainably use the oceans, seas and marine resources for sustainable development</td>
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<td>15 Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss</td>
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<tr>
<td>16 Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels</td>
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<td>17 Strengthen the means of implementation and revitalize the global partnership for sustainable development</td>
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**Notes:** + means less important; +++ means more important
5.2 Education, health and gender equity (SDGs 3, 4 and 5)

Provide inclusive and equitable quality education at all levels, and provision of health care is related to access to energy and technologies, but clearly, this SDGs are related highly to public policies in high-, medium- and low-income countries, as well as other means such as access to finance for infrastructure especially for LDCs. SDG related to gender equity is also clearly related to other means, besides technology transfer.

5.3 Water and energy (SDGs 6 and 7)

Around 600 million people lack access to drinking water and about 35 percent of the world population do not have improved sanitation facilities, with poor rural population being the most affected. It is estimated that at any given time, over half of the world’s hospital beds are filled with people suffering from water-related diseases (United Nations Development Programme (UNDP), 2006; United Nations Environmental Programme and United Nations Development Programme, 2012; Pruss-Ustun et al., 2008; Olmstead, 2010). In this case, technology access is clearly an important variable of the equation, but knowing that most of the water goes to irrigation; echo-technologies are again an important element to agriculture productivity (Ortiz-Moreno et al., 2015). Also water appropriation (Hoekstra and Mekonnen, 2012) and water governance (Bogardi et al., 2012; Cook and Bakker, 2012; Pahl-Wostl et al., 2013) represent an important challenge to water accessibility (socio-economic policies).

By 2010, around 15 percent of the World’s population lacked access to electricity and about 29 percent of the World’s population relied on the traditional use of biomass. There is a wide consensus that the eradication of extreme poverty as well is linked to the access of modern energy, especially electrification (UN, 2005). In 2010, the IEA and the UNDP developed an assessment on universal access to energy. Results were remarkably interesting. According to this study “to meet the more ambitious target of achieving universal modern energy services by 2030, additional investment of $756 billion or $36 billion of US dollars per year is required. This is less than 3 percent of the global energy investment in the new policies scenario of IEA to 2030. The resulting increase in primary energy demand and CO2 emissions would be modest. In 2030, global electricity generation would be 2.9 percent higher, oil demand would have risen less than 1 percent and CO2 emissions would be 0.8 percent higher, as compared to the new policies scenario” (International Energy Agency (IEA), 2012).

The paths to a low-carbon economy to reduce GHG emissions are highly related to the access of more efficient and renewable energy technologies. However, even in this case, technology transfer is not the only variable of the equation, but also other technological approaches. But even more, technology efficiency has physical limits ruled by the second law of thermodynamics. At some point, the following question arises: is technology efficiency enough to meet the very ambitious emission reduction targets proposed by climate scientists? According to Allwood et al. (2013), in the case of industrial energy, within the present conditions of material substitution and technology efficiency it is simply not possible. According to these authors, the world is reaching the efficiency limits for certain
industrial technological processes, and the ambition to reduce industrial emissions can only be attained through an increase of material efficiency which includes recycling and re-using components, but also reduction of overall material demand by promoting longer life of products as well as intensifying its use (UNDESA, 2013).

5.4 Economic growth, employment and industrialization (SDGs 8 and 9)
A deeper discussion on this matter is presented in Section 4. But in this case a large discussion that involve economic sciences, social sciences and even philosophical and ethical inquiries are in place. In this special case, there are encountered visions. One vision to the apparent contradiction between economic growth and environment argues that setting up the right signals to the market, internalizing externalities and strengthening property rights will solve this predicament. Based on historical data on agriculture yields and energy intensity, this (rather dominant) school of thought postulates that if a stock of non-renewable resources is consumed, technological innovation and price signals will prevent shortages. “As a resource becomes scarcer, the rising of relative prices mean higher potential profits for innovators and for the owners of assets that can be substituted for the diminished scarce resource” (United Nations Development Programme (UNDP), 2011). This idea leads to the approach that focuses on the total capital stocks (sum of physical, human and natural) and the possible substitution between production factors (Turner et al., 1994; UNDP, 2011).

Another school of thought raises the limits of this approach by questioning the validity of the perfect substitution. Certain basic natural assets have no real substitutes and, thus, must be preserved. This perspective sets biophysical limits to the growth of economic activities in view of the irreversibility of certain processes that have triggered an impact on nature (United Nations Economic Commission for Latin America and the Caribbean et al., 2003). These encountered visions are open discussions that certainly go beyond technology and technological transfer.

5.5 Inequalities (SDG 10)
If unequal distribution of income is maintained, a greater increase in GDP is needed for the poor to get access to better incomes because the economy has to fulfill the requirements of the highest income groups (United Nations Economic Commission for Latin America and the Caribbean (ECLAC) et al., 2002; Rosas et al., 2010). A study for Latin America shows that even very small reductions in inequality can have very large positive impacts in terms of poverty reduction (ECLAC et al., 2002). In the horizon of the ecological limits of growth, equity acquires an additional value for the environment. Boyce et al. (2007) go even further when he proposed that wider political and economic inequalities tend to result in higher levels of environmental harm.

However, the 2011 HDR shows that income inequality has deteriorated in most countries and regions – with some exceptions in Latin America and Sub-Saharan Africa, although these regions continue to be the more unequal region and the poorest region in the world, respectively, (UNDP, 2011). Technology access could be important in the reduction of inequalities; however, it is clear that other areas of knowledge that redound in policies are needed to reduce the huge inequalities within and among countries.

5.6 Sustainable cities (SDG 11)
The percentage of global population living in urban areas has reached 50 percent at the beginning of the twenty-first century and is expected to reach 60 percent by 2030; the fastest rates of urbanization are found in the developing world (UNHabitat, 2013). Jenks and Jones (2009) suggest that there are four dimensions of the sustainable city: land use and build form, environmental conservation, environmental recycling and reuse, and communication
and transport. The IPCC chapter (2013) on human settlements, infrastructure, and spatial planning proposes regulations, integrated spatial planning and implementation that go beyond technology transfer, in order for cities to mitigate climate change and be more resilient to climate change variability (Solecki et al., 2013). Again, technology transfer is a small part of the agenda toward sustainable cities.

5.7 Sustainable consumption (SDG 12)
According to the ecological footprint it would take three to four Earths to meet the consumption demands of the current human population, if every human consumes at the level of the average US inhabitant (Wackernagel and Rees, 1996; Wilson, 2002); and GHG emission will reach 3.8 times actual emissions if population in developing countries uses the same amount of fossil fuels per capita that developed countries use (IPCC, 2007). Technology has enabled growing efficiency of resource use, but it has its limits and unsustainable lifestyles with excessive consumption of energy, materials, and goods among the richer segments, place enormous pressure on the environment (Allwood et al., 2013). The poorer segments, meanwhile, are unable to meet food, health care, shelter and educational needs. Changing consumption patterns will require focusing on demand, rather than only in technology transfer, meeting the needs of the poorest, and changing lifestyles and excessive material and energy demands of the richest. This requires building a new paradigm of success that is not based on increasing consumption.

5.8 Climate change, oceans, forest and biodiversity (SDGs 13, 14 and 15)
Climate change is possibly the most dangerous of all environmental threats. Climate is changing mainly as a result of human activity (IPCC, 2013). Increased use of fossil fuels, particular industrial processes, land use change and heavily fertilized agriculture have augmented GHG emissions and their concentration in the atmosphere, leading to an increase in Earth’s surface temperature with consequences on sea level, hydrological cycle, and higher presence and intensity of extreme events (IPCC, 2007; IPCC, 2013). The climate deal adopted in UNFCC COP 21 brings light to mitigate and adapt to climate change. In this case, technology transfer is highly important, however, to avoid dangerous climate change requires technological (accompanied by different regulatory and economic instruments) and behavioral changes made in many different sectors. Not one sector or technology can address the entire mitigation challenge but different technologies and measures from energy to agriculture and forest to waste management are needed in order to contribute to the total reduction of global GHG emissions (IPCC, 2007, 2013; UN, 2015).

Forests are a fundamental part of the Earth’s ecological richness, and forest goods and services. Deforestation, although showing signs of decline, is still alarmingly high at 13 million hectares per year. Although net forest area loss amounts to five million hectares per year, this is a result of new plantations that provide fewer ecosystem services than natural forests (UNEP, 2011). Reduce deforestation and increase forest ecosystem services and goods is possible by promoting long-term financial, technological and training supports and policies for sustainable management that value forest goods in contrast to agriculture and livestock for land owners, promoting other activities with lesser impacts such as ecotourism and agroforestry, and valuing ecosystem services (Merino-Pérez and Barry, 2005; Fisher et al., 2009; Food and Agriculture Organization of the United Nations, 2010; Toledo-Aceves et al., 2011).

Concerning biodiversity loss and the changes in human activities that are linked to it, it is difficult, expensive, or impossible to reverse or fix through only technological solutions (Hooper et al., 2005). The main causes of biodiversity loss are land use change (habitat change), overexploitation, pollution, invasive alien species and climate change, which is expected to become the first or second greatest driver of global biodiversity loss (Hooper et al., 2005; UNCDB, 2010; Heller and Zavaleta, 2009).
Biodiversity loss is a clear example of irreversibility, not only because the permanent loss of certain species, but because it harms the ecosystem services, including the access to water and basic materials for a satisfactory life and security (Díaz et al., 2006). Climate change is also an example of irreversibility because the major GHGs can remain in the atmosphere for tens to hundreds of years after being released; thus past emissions will have future impacts.

5.9 Peace and justice (SDG 16)
It does not need a larger discussion to understand that peace and justice within and among countries is a human objective that requires more than technology transfer.

6. Conclusions
The SDGs constitute a relevant international recognition of the importance of the three edges of sustainable development. However, the pathways toward the achievement of the SDGs need to fully recognize that poverty, inequalities and global environmental problems are expressing a deeper crisis in the shape of economic growth, patterns of production and consumption and, in general, the logic of no limits in the exploitation of natural resources (Sheinbaum-Pardo, 2015). For this reason, the science of sustainability requires a deep understanding of the technological change and that science for sustainability goes beyond technology transfer especially the recognition of eco-technology innovation and promotion, inter-disciplinary approaches, socio-economic policies and the recognition of encountered visions to achieve SDGs.

As Asara et al. (2015, p. 381) noted in their particular discussion about degrowth, science needs to open the debate about the relations between economy, society and sustainability, including their cognitive, material and political interactions, to re-politicize the debates on science and the practice of sustainability. From our point of view, even if it does not agree with the degrowth approach, science needs to truly question the limits of growth. Under these circumstances, inter- and intra-discipline acquire relevance. Likewise, the roles of researchers on sustainability transitions (Wittmayer and Schäpke, 2014; Klay et al., 2015; Scholz and Steiner, 2015) should address that science is a human activity and that the choices we face are not technological, but manly societal and human ones.

For this reason, we believe that the finalized text for adoption, i.e., “Transforming our world: The 2030 agenda for sustainable development (UN, 2015),” presents a narrow vision and a limiting role to the science of sustainability. Moreover, if these issues are not recognized, the achievement of the SDGs will continue to gain only marginal success.

Social sciences, humanities and different sources of knowledge must contribute as much as the natural and technical sciences toward an approach where the quality of life and sustainable patterns of consumption and production can be reconciled to reduce the environmental degradation, poverty and inequalities. This approach will also lead to increasing peace and security.

Further research on the different approaches, methodologies for specific countries and regions on the need to develop new science for sustainability in an integrate vision to achieve SDGs needs to be developed.

Notes
1. The TFM is also part of the “Addis Ababa Action Agenda of the Third International Conference on Financing for Development” held in July 2015.
2. These estimations are based on a minimum electricity consumption of 250 kWh/year in rural areas and 500 kWh/year in urban areas and 22 Kg of LPG per person per year (in comparison, average US consumption per household in 2011 was 11,280 kWh of electricity/year and 900 kg of LPG/year).
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**Further reading**


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Artisanal gold mining’s impact on local livelihoods and the mining industry in Ivory Coast

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Abstract

Purpose – In rural regions, mining is an activity that employs many people due to the fact that the barriers to entry are sometimes trivial, with very low technology, capital fund, and no specialized skills required. Many people including children are engaged in artisanal mining in Ivory Coast because they can earn higher incomes in mining than through other traditional activities such as agriculture, which is the main activity in the country. Artisanal mining contributes to reduce abject poverty prevalent in the country and it offers many others opportunities. However, this activity has many negative social impacts. Local people including miners are risking their lives everyday as they are exposed to unsanitary conditions, prostitution, chemical contaminants, and alcoholism, and also due to the large degradation of lands. The paper aims to discuss these issues.

Design/methodology/approach – All the data collected during this study were analyzed before some of it was corrected. For data analysis and interpretation, the authors used Word and Excel and other software, and other statistical tools for maps, graphs, and tables.

Findings – The main objective of this paper is to understand how artisanal gold mining in the Ivory Coast affects local livelihoods and the environment.

Research limitations/implications – This study was carried out during the author’s study in China. The data collection between the two countries was too difficult due to the long distance. Many times the network was not reliable for any call and discuss with miners when we are not in the country. The hesitation of miners to give real information to the authors was also a main problem because most of them are illegal miners. Some of the guided questionnaires stayed without feedback for almost three months. The production was sold on a day-to-day basis by the miners in the illegal mining sites, so the authors could not obtain with precision the monthly and annual production to calculate income of the miners.

Originality/value – Some key recommendations for addressing artisanal mining activities in order to have a good option for sustainable management of mineral resources in the country are proposed.

Keywords Environments, Artisanal mining, Ivory Coast, Mining industry

Paper type Research paper

1. Introduction

1.1 Definition
Many potential mining deposits have been discovered in the country such as in Bonikro, Hire, and Abgova. These cities are in the central part of Ivory Coast, around 300 kms from the economic capital (Abidjan). More than three licenses had been obtained by Newcrest the third largest world mining company for exploration and exploitation of the mineral resources in this area. The main intention of this mining company is committing a campaign of exploration in the country in order to discover major mineral resources especially gold.

“Artisanal mining” is an activity that consists of an adequate use of tools to extract mineral resources, generally with a good market. (Hentschel et al., 2002; Banchirigh and Hilson, 2010) Artisanal mining is a real and ongoing situation in Ivory Coast but at the same
time it is also substantial for many people today. Foreigners and indigenous population are all attracted to this profitable activity because of the high price of gold (Bolay, 2014; Reuters, 2015; Dillon et al., 2012).

Most of the rural population including women and children are generally affected by this hazardous work. The deforestation and land degradation are some of the key problems of artisanal mining. Local people are being exposed to infectious diseases. Artisanal miners generally try not to connive with the mining laws and the environment issue set by the government (Manuel, 2011).

Nowadays, artisanal mining is seen as a livelihood sustaining activity for rural population. This activity leads to low productivity, social security issues, environmental problems (pollution, degradation), and illegal jobs due to the very reduced degree of mechanization or organization (Drechsler, 2001; Kouame et al., 2015). The inhalation of mercury and welding fumes is a great danger to these miners because it could lead to death because of the content of molten metal in the fume, which will be vaporized.

The artisanal and small-scale mining is analogous to an unofficial mining extraction due to the fact that the miners do not use sophisticated machinery and high technology, combined with the lack of (or very minimal use of) machinery, which is dominant across the country (Ivory Coast) and some others countries over the world such as the countries in the southern part of America, Africa and Oceania countries with an estimated more than 100 million people involved in this activity. (Hentschel et al., 2002; Hilson and McQuilken, 2014). As the World Bank Group said in 2013, the largest poverty-driven activity is small-scale mining. The majority of people involved in this activity are itinerants with unstable employment options, and they normally operate the activity in isolated small towns in all parts of the country without any good administrative regulations (World Bank Group, 2013).

It is impossible to detect the people involved in gold mining activities and also the number of illegal mining sites operating in the Ivory Coast. Nevertheless, the working estimation according to the state’s mining company (SODEMI) is that more than 5,400 people (indigenous, foreigners, old, women, men, children) are actively working in or around any of the 300 illegal mining sites, located in 21 of the 36 regions of the country (AFP, 2014; AIP, 2013; ASSIE, 2009; Randgold Resources Ltd, 2012).

This study aims to identify the key problems of Ivory Coast’s mining industry. The sustainable management of the natural resources in general, especially the mineral resources, is seen in this paper as key recommendations.

1.2 The objectives
This study intends to apply the research outcome in China to the mining industry of Ivory Coast. Although this kind of research has already been done in other parts of the world, the question is, what is the advantage of Chinese research outcome compared to researches in other parts of the world, and how Chinese research outcome is more beneficial in the mining industry of Ivory Coast. That is why we try to enumerate the similarity problems in the mining industry of China with the mining industry of Ivory Coast.

We have tried to understand the fast expansion of artisanal mining in almost all the parts of Ivory Coast since the political unrest in 1999. Our research discusses an interesting issue about the evasion of major population especially children in mining activities, the hesitation of foreign investors, and the new advanced technology. The difference between the Ivory Coast and modern countries is that the Ivory Coast is not a well-developed country and does not have a good industry; therefore, the mining products need to be sold for raw materials, but in modern countries they are sold as produced products. Mining industry supports others industries. Some recommendations suggest modernizing Ivory Coast, in order to improve the artisanal gold mines, to attract foreign investors and avoid selling mining products for raw materials.
In fact due to the high levels of risk in the mining industry, the workers need to be supported. This issue has been done well in China. The Government of China carries out a series of policy and laws to encourage and balance the development of mining industry that is why we try to find out what the Chinese government policy is and how it can support the mining industry in Ivory Coast in the coming years.

2. Materials and methodology
We had proceeded by producing a “research questionnaire.” Boore was our privileged place. We tried to obtain the maximum information about gender, age, origin of miners, and the reasons for their presence on the mining sites instead of being in their plantations. At the same time attempt has been made to find out the different problems they meet everyday and their relationship with the state’s government and the national mining company (SODEMI).

2.1 Presentation of Boore mining sites
The Boore gold mine which is one of the main interests in this paper was detected due to the actively effort of the government of Ivory Coast supported by some organizations such as the University Center for Research and Application in Remote Sensing (CURAT) and CMA (Africa Mining Company).

This remains insignificant; more indepth researches are required to discover the real mining potential in this area. Boore is located in the central part of Ivory Coast, close to the political capital Yamoussoukro (Figure 1). Boore is part of the “Reigion des Lacs” in the district of Nzé-comoe is the sub-prefecture of Dimbokro. The vegetation of Boore is composed of savannah and forest. Due to the fact that most of the local populations of Boore are farmers, the forest of Boore has been highly deteriorated.

The cultivation of cocoa, coffee, yams, and bananas is extreme in this region. The region of Boore comprises two major features. The river Bandama is one of the natural gifts in this area that led to mining transportation facilities.

With more than 68,000 people, Dimbokro is the second largest city after Yamoussoukro, the political capital of the country in the Lacs Region. It is located at latitude 6.65, longitude – 4.71 and situated at an elevation of 94 meters.

2.2 The data collection
Different methods that led to collect the data for this study are the following:

- Several existing reported documents from SODEMI, CMA, CURAT, and many concerned bodies, websites, and institutions. Consistent literature review of articles, books, and laws and regulations about mining code, mining operation, and mining activities was one of our basic information sources.

- Recurrent visit to some mining and illegal mining sites both in China and Ivory Coast was also done to understand the mining industry in the two countries.

More than 100 people involved in the mining activity were interviewed about their livelihood, advantages, consequences, and environment problems. The information obtained from the miners, local people, landlords, children present in the illegal mining sites, and other people after the interviews allowed us to collect data on their income, to understand the main reason of expansion of illegal mining over the country. The guided questionnaire also helped us to evaluate different problems facing the mining industry in the Ivory Coast:

- some technology tools were used for photograph maps and other issues;
- a number of focus-group discussions have taken place; and
- we had done some consultations with stakeholders and SODEMI.
2.3 Data analysis
All the data collected during this study were well analyzed before some of it was corrected. For data analysis and interpretation, we used Word and Excel and other software, and also other statistical tools for maps, graphs, and tables.

2.4 The study’s limitations
This study was carried out during my study in China. Data collection between the two countries was too difficult due to the long distance. Many times the network was not reliable for any call and discussion with miners when we are not in the same country. The hesitation
of miners to give us real information was also a main problem because most of them are illegal miners. Some of our guided questionnaires stayed without feedback for almost three months, so we were unable to obtain with precision the monthly and annual production to calculate the income of the miners.

3. Results
Even though artisanal mining is dangerous to the people of the Ivory Coast, at the same time it also saves their lives. Artisanal gold mining in the Ivory Coast unquestionably affects the livelihoods of the local people. It provides employment, in turn reducing the high levels of poverty. Because of artisanal gold mines some parents can earn a significant amount of money (alongside the current solitary and universal source of income – agriculture) to pay their children school’s fees.

Schools and hospitals are being built in the mining areas. Those actions and donations by miners greatly improve the local people livelihood.

3.1 The probe’s biological data
3.1.1 Age of artisanal miners. As mentioned more than two million children are involved in child labor. Most of these kids spend their time trying to earn money for a better future, than actually wanting to go to school for a better education.

According to our investment results, only 20 percent of miners are above the age of 40 years (12 percent in the age group from 40 to 55 years and 8 percent from 55 to 60 years of age). Most of the miners are in the age group from 14 to 40 years, as artisanal mining activity is a labor requiring strong young people. We found that 24 percent of miners are aged between 14 and 18 years. Few of those children worked temporarily on holidays as part-time jobs and some had dropped out of school due to the fact that their parent’s financial situation was not good (Table I). Of the miners, 56 percent are aged between 18 and 40 years.

3.1.2 The gender of miners. The number of women in mining sites is not high. Only few women are involved in mining activities in the Ivory Coast but sometimes not directly because mining requires a lot of physical strength. Women cannot do the digging by themselves. Most of these women are the wives of miners so they just support them in their duties (Figure 2).

3.1.3 The origin of miners. People who work in gold mines in the Ivory Coast are indigenous and foreigners from the neighboring countries. From 120 miners we found 45 Ivorian nationality miners (37.5 percent), 30 miners from Burkina Faso (25 percent), 22 miners from Mali (18.34 percent), 13 miners from Guinea (10.83 percent), and 10 miners from other African countries (8.33 percent). Most of those foreigners had entered the Ivory Coast illegally during the political unrest and. More than 76 percent of children in the mining sites are mostly foreigners (Table II). Child trafficking is recurrent in the northern part of Ivory Coast (McAdam and Willman, 2013; Dillon et al., 2012).

3.1.4 Leadership. The person who discovers the mining deposit is called the leader. He will request for some professionals such as the people who are working in some existing illegal mines for exploration and exploitation. An organogram will be established including family, relatives, and workers.

3.1.5 Labor and remuneration. People work by groups or sometimes alone with the assistance of their relatives and friends so they do not need to hire. Miners do not permanently work at the same place. They move from one site to another site. The workers

<table>
<thead>
<tr>
<th>Table I. Age of miners</th>
<th>14-18</th>
<th>18-40</th>
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<td>Age ranked (years of age)</td>
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<td></td>
<td>24</td>
<td>56</td>
<td>12</td>
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have duties like digging and washing. They are paid daily, weekly, or even monthly according to the productions. It is about US$40 (CFA 2,500) per day.

3.1.6 Artisanal mining evolution and change in Ivory Coast. Different techniques are used in mining in the Ivory Coast. The material used for digging and washing are the same the old ones used since the independence, only few materials have changed. Many countries like China and others foreign countries are helping by providing materials and increasing the production of the products. These countries are very important to Ivory Coast, because without them the mining industry would be a disaster. The materials cost depends on their performance and utility (Table III).

4. Discussion and analysis

4.1 Discussion
In the Ivory Coast, as proved by previous researchers, it is clear that the artisanal gold mining has an environmental impact and even cultural and socioeconomic impact.

This activity of gold extraction that started after the political unrest is more considering the rural people due to their fastness to earn much fortune. Agriculture ranks today the second level because it is periodical. Actually, it does not rain much as before in the Boore, so the agriculture production has decreased. The local people are hoping that the current
government legalizes artisanal gold extraction. However, informal activity is really acute because the negative side remains big. The products used by miners are toxic and are dangerous to the health of people. The environment and the water bodies are exposed to high pollution. Infectious diseases are spreading. The plantations are destroyed everyday and the lands are sold to foreigners.

Many clandestine mining sites had been closed by the government in order to regulate this activity, but it still it is not effective as the miners prefer working in the illegal way due to the fact that they do not want to face outlays like tax, license, and others administrative documents fee.

Landholders are selling their lands and conniving with miners because they see that normal. It is not acceptable that the government is interfering into their own properties.

Local people believe that the gold in their plantations is godsend. It is like a gift. Nobody can convince them to not exploit it by themselves or dismiss it as heritage to whomever they want.

The current government should try to develop the mining sector because mining itself can do many great things such as construction of schools and hospitals in the localities with the capital. The mining areas can be rehabilitated and miners will use some appropriate tools and products. Then the negative impacts will be reduced greatly.

4.2 Analysis

The fast expansion of artisanal mining all over the Ivory Coast and the large prevalence of artisanal mining activities with the unauthorized selling of land to the miners remains a problem (problem of artisanal mining). That is why it is necessary to do an ongoing study on the subject. Clandestine gold miners threaten the significant potential mineral resources (Plate 1).

4.2.1 Effect of the political unrest from 1999 to 2011. The insecurity due to the political unrest since 1999 has helped foreigners who are from the neighboring countries to enter the Ivory Coast in the most illegal way. Once in the country, they are involved in gold extraction (United Nations Security Council, 2011). The restoration of the security in the system and to deal with other pertinent issues such as the tribal conflicts, xenophobia, and improving the standard of living of the people in these parts of Ivory Coast are complex issues.

4.2.2 Poverty and unemployment. It assesses the rapid expansion of artisanal mining sites in the country. More than two million individuals involved in artisanal gold mining and extraction depend on benefiting from gold mines and its revenues due to the high-abject poverty. Artisanal mining is so important and will always be important to the people of Ivory Coast as long as abject poverty exists in the country. Seeing how the world is evolving, we are still a long way from getting rid of abject poverty.

4.2.3 Bad organization. Actually, the disregard is evident. Several huge mineral deposits have been discovered in the Ivory Coast (gold, nickel, manganese, cobalt,
tungsten, diamonds, bauxite, copper, monazite, iron ore, etc.), but agriculture still remains the main activity.

A bad organization in the sector always leads to several consequences. Even in the neighboring Ghana, the Oboassi mine, which is the largest in the country, is currently closed because of excess of illegal activities.

The large presence of artisanal miners who are mining in some regions frequently affect the operations of gold mining by foreign investors.

Agriculture not too profitable. Boore is full of people everyday. The abject poverty is the main reason. Many cocoa plantations become old and the production cannot solve any problems, even food. The price of cocoa is not as high as that of gold. Gold is more lucrative than cocoa because of the faster production time.

What one can elucidate from these examples is that artisanal gold mining in the Ivory Coast lacks the necessary implementation of an adequate mining code in large part due to the lack of political support perhaps owing to the “attractive” incentives in the mining sector. It is also apparent that there is an infrequent revision of mining code for a policy of sustainable development in the mining sector. This combined with a non-extension of existing legislative texts relating to the environment, such as simple documents or emissions (mass media) to accelerate their adoption, implementation, and to raise awareness on a national basis. Moreover, the low capacity of enforcement in the sector, growing insecurity in mining areas, hesitation of foreign investors due to the political insecurity in the country add to the problem.

4.2.4 Insignificant Infrastructures for children. Some children in the Ivory Coast prefer going to extract gold instead of going to school (Plate 2).

Many problems including the recurrent strikes and violence in the school areas do not encourage parents schooling their kids and mostly children from the neighboring countries are following this (Human Rights Watch, 2012). This is one of the major issues leading to the presence of children being involved in illegal gold mines. These children are tricked into doing illegal work that moreover requires a lot of strength. Such jobs are not suitable for children of such ages.
5. Conclusion
In this paper, we suggest that the investment in mining industry and others sectors will help the agriculture to boost the Ivory Coast national economy. It also recommends solving the security problem and establishing good regulations and law for the mining sector.

As a result, the gold product in Ivory Coast will attract more foreign buyers. The buyers will not hesitate to invest many funds in the country’s gold production. Ivory Coast can be the largest gold producer in West Africa and will rank a great position among the whole of Africa. The economy of Ivory Coast will be greatly boosted. The government will use the funds from the mining sector to solve some main problems such as insecurity, poor health conditions, poor education, etc. The local people will have better standards of living because most of the workers who will work in the mining sector will be indigenous as notified in the new mining code. The mining sector will actively be interested in the investors from developed countries. There will be an invasion of foreign investors into the Ivory Coast mining industry. The economy of Ivory Coast will grow rapidly like China. Furthermore, children will not be dragged into this sector and they can continue school and have a better education.

5.1 Key recommendations
This paper also gives further suggestions that the government of Ivory Coast pays more attention and invest in the new economic sectors with particular reference to the mining sector to strengthen the national GDP by Law, regulation, and environment.

5.1.1 Tax holidays. The government of Ivory Coast may offer at least two to four years’ tax holidays to mining investors in order to encourage and attract them. This should be an exceptional case and effort from the current government to help investors.

5.1.2 New trends and future perspectives by adopting the new mining code in Ivory Coast’s mining industry. It means, immediately adopting the new mining code.

The decentralization of the activity sector as new trends and future perspectives due to the advantages granting to the rural people by the new mining code will play a great contribution to the development of the mining sector.
Foreigners and local people will both be stakeholders, involved in the mining activities with efficient due process. The recurrent conflict between the local people and the miners will be ameliorated because we will assist efforts to improve the relationship between the government and the local people.

Ivory Coast will learn from the Chinese markets and grow the national GDP of Ivory Coast to increase and better the lives of the population: subsidence and environmental control-mining equipment and technology.

5.2 Creation of mining group company
The creation of the mining group company will be introduced into four modes:

(1) The sale of mineral deposits.

The country will appeal to the foreign mining company to invest in Ivory Coast.

(2) Local mining companies with foreign mining companies.

The local mining companies in Ivory Coast have to connive with foreign mining companies especially Chinese mining companies to build some new mining group companies which will lead to other business such us trade and education, tourism to set money and technology.

(3) Sustainable development – good equipment and devices from China.

Local companies will ask for foreign expertise from China and some good mining equipment that will help to develop all fields in the mining industry of the Ivory Coast.

(4) Technology.

Introducing the mining information technology that can help the mining sector in the country like strengthening of geological infrastructure, research, and data acquisition – using GIS in Ivory Coast gold mines.

GIS Software serves as an effective solution for solving artisanal gold mine challenges, while seeking to promote a safer mining industry in Ivory Coast.

As such, the development of GIS-based graphic safety technology with an integrated visual information management system, aimed at enhancing the level of mine safety management in Ivory Coast is essential and will certainly prove beneficial.

5.3 Further perspective: implications of the new advanced mining technology in the mining industry in China and its application in Ivory Coast
In this part of our research, we discuss on a new and interesting issue about the new advance technology. As a matter of fact and high level of risk in mining industry, the workers need to be supported. This issue has been done well in China.

This is when China can play a big part in helping Ivory Coast by providing new and improved materials to make mining easy for miners in Ivory Coast. China is known for being creative and innovative; they could help save lives and reduce the percentage of damages in mining sites simply by offering the machinery.

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Further reading


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Role of government towards adoption of cleaner technologies for climate proactivity

A survey-based empirical study of Indian firms

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Abstract
Purpose – There is a need for considerable attention on the adoption of cleaner technologies (CT) by firms for climate proactivity for developing countries such as India. Literature survey suggests that government, market and civil society are the key drivers of CT adoption (CTA) in developing countries. The purpose of this paper is to investigate the mediating and moderating role of the government in CTA for climate proactivity.

Design/methodology/approach – The data collected from a survey of Indian firms were analyzed through exploratory factor analysis and multiple regression analysis to examine the mediating and moderating role of the government.

Findings – The empirical outcome was compared with the current government policies to summarize the research findings.

Research limitations/implications – There is scope of future research to examine the moderating and mediating role of market and civil society in CTA for climate proactivity.

Practical implications – The study will provide significant insight into various stakeholders associated with the CTA such as government, technology manufacturers, marketing community, environmental professionals and associated researchers. The research model will be useful for policymakers, managers and researchers for understanding CTA in the Indian context.

Social implications – The output model will be useful for the government to formulate forward-looking strategies toward the adoption of CT by industries for climate proactivity.

Originality/value – Unlike previous studies in which the government was recognized as a key driver of CTA, this study makes an attempt to test the moderating/mediating role of government in CTA in India. The findings of the study are supported by adequate empirical evidence.

Keywords Government policy, Cleaner technologies adoption, Climate proactivity, Indian firms, Moderating and mediating role

1. Introduction
What is the role of government toward the adoption of cleaner technologies (CTs) by firms in India? While many studies have been carried out in developed countries on CT adoption (CTA), very less research is evident on developing countries such as India. In the early 1970s, most of the developed countries such as USA and Canada established stringent environmental regulations to address the concern of environmental pollution and the threat of climate change. This resulted in an increase in their pollution abatement investments significantly. For example pollution abatement expenditure of USA was increased by 137 percent over the period 1979-1994 (Berman and Bui, 2001). Similarly, Canada had to increase its pollution abatement expenditure by 27 percent during 1995-2002 to meet the new environmental norms (Statistics Canada, 2004). A recent study
finds that CT diffusion in India is only 12 percent compared with 59 percent by China (Dechezleprêtre et al., 2009).

CTs use lesser natural resources and have reduced environmental impact (OECD, 2014; Truffer, 2012) compared with the conventional technologies. Current studies show that technological innovation is strongly focusing on the development of CTs for various applications (Jacobsson and Bergek, 2011). Despite the urgent need for CTA, very few studies have been carried out in the developing countries pertaining to technological innovation, which limits access to the clean-tech potential in emerging economies such as India and China (Bai et al., 2009; Binz et al., 2014, 2012; Gosens and Lu, 2013; Hansen and Nygaard, 2013; van Alphen et al., 2008; Vasseur et al., 2013).

Multinational companies operating in the regions of negligent environmental compliance requirement, but with presence in the mature global marketplaces with a demand for environment-friendly goods, are more inclined toward the adoption of CTs (Luken and Van Rompaey, 2008; Calleja et al., 2002; Luukkanen, 2003).

As developing countries such as India, China and Africa are rapidly industrializing, it is important for them to develop and adopt CT right from the design stage of new projects. Since the Rio Conference of 1992, environmental performance of the industries in developing countries has achieved major improvements. Between 1990 and around 2002, developing countries have fared better in terms of reducing water pollution and energy conservation. Developing countries have achieved a 27 percent reduction in energy intensity and a 49 percent reduction in water pollutant intensity during this period. In contrast, the developed countries have achieved only about an 8 percent reduction in energy intensity and a 29 percent reduction in water pollutant intensity during the same period (Luken and Castellanos-Silveria, 2006). However, despite this, developed countries remain better placed in terms of pollution reduction compared with their counterparts in developing countries. The energy use, water use, water pollutant and carbon dioxide emission of industries in developing countries remain almost three times, more than 11 times, six times and four times higher, respectively (Luken et al., 2008). The gap needs to be analyzed by the governments of developing countries and the factors need to be identified to step up the speedy adoption of CT.

Developing countries will be the most impacted by the climate change effects; in particular, the poor populations will suffer the most because of their inability to sufficiently adapt to the change (World Bank Report, 2013). Therefore, climate change offers ample opportunity for the developing countries to formulate their own strategy to promote local cleaner industries that can lead to economic, social and environmental benefits. CTA is extremely essential to tackle the issues arising from environmental pollution resulting in climate change. A study of past research work on CTA indicates that ample research has been carried out on the adoption of CT at factory as well as sector levels (Montalvo, 2002; Wijk et al., 2001). As it is evident that widespread adoption of CT will help mitigate the climate change effects, it is essential to determine the factors affecting CTA for climate variability (Sangle, 2011).

1.1 Need and significance
Technology and human activities are the pivotal causative agents of climate change. Literature survey suggests that a reduction in GHG emissions can only be achieved through adoption of CT by companies and eco-friendly technology-based product adoption by individuals. As India is becoming a major player in the global economy in the twenty-first century, it is necessary that it takes steps to address the climate change issue through policies and regulations. Investing in CTs holds the greatest promise toward addressing these challenges while generating superior returns and job creation. As a rising economy of the twenty-first century, India is under global pressure to reduce its GHG emissions while
achieving economic growth. Hence, in view of the above scenarios, the present research study aims to identify the role of civil society, government and market in the adoption of CTs by companies and to determine the determinants of technology-based product adoption by consumers in the context of climate change.

Very few studies (e.g. Luken et al., 2008) have shed light on the role of civil society, government and market in promoting CTs. Also, it may be perceived from the literature study that only some studies have reported on the adoption of CTs in the context of climate change. Only a few studies are reported (e.g. Montalvo, 2008; World Bank Report, 2000) in the literature with respect to the adoption of CT in India.

1.2 Objective of the study
The aim of the proposed research work is to study the mediating and moderating role of government in firms, technology and stakeholders toward the adoption of CTs for climate proactivity.

2. Conceptual background for CTA by companies
With growing global attention toward environmental concerns during the end years of the twentieth century, it was also eminently clear that technical improvements are the key approaches for providing environmental and social sustainability. Various studies have been carried out in the past 20 years in the field of CTA in different countries. This section summarizes the key determinants responsible for CTA, mainly in the developing countries. A review carried out by Montalvo (2008) classifies the various factors affecting CTA. These factors are environmental regulations, economics, markets, pressure from community and society, social status, technical expertise and organizational abilities. The elements reported in the empirical studies could be drivers and (or) barriers of CTA on the basis of the conditions, period and perspectives in which they are considered.

The literature shows that government policies and implementation of the regulations are one of the key drivers of environmentally accountable performance by the industries (Battisti, 2008; Clayton et al., 1999; Vollebergh and van der Werf, 2014). A few studies also report that government policies are not the promoters of pollution prevention at source (Rothwell, 1992; Granderson, 1999) and it was also found that the government regulations are not intended to encourage industries to develop and adopt CTs (CSIS, 1997; Huhtala, 2003; Government of India (GOI), 2014; Groba and Breitschopf, 2013; Kalamova et al., 2013). Cleaner production has a large potential to influence the economic aspect of firms. As there is an urgent requirement for the replacement of older technologies with state-of-the-art new technology, the economy of the twenty-first century will be dependent on technology adoption for long-term sustainable growth (CSIS, 1997; PCSD, 1999). Market plays an important role in the adoption of CT. Past studies have evidenced that environmental problems have resulted in market failure; this is because of the fact that many countries do not accept products that are harmful to the environment (Pearce and Turner, 1991; Tietenberg, 1992). Pressure from communities and society is one of the major attributers for the adoption of CT by the industries. Better social image and public acceptability pertaining to ecological aspects are drivers that motivate the firms to aim for cleaner production (Steger, 1993; Jurgen and Holliday, 2002). Hence, pressure from community, consumer demand and NGOs are all drivers of ecological safeguard (Visser et al., 2008; Dillon and Baram, 1993; Duffy et al., 1999; Hart and Ahuja, 1996; Rondinelli and Vastag, 1996; Hartman and Stafford, 1997; Luukkanen, 2003). The attitudes and social values are supplemented by the fact that the decision to adopt CTs is influenced by the positive approach, philosophy and personality of senior executives of the firm (Calleja et al., 2002; Duffy et al., 1999; Steger, 1993; Everett et al., 1993; Andrews, 1998).
Technological opportunities and capabilities are important in adopting new pollution prevention technologies. It is evident that a lack of cleaner production/design experts (Tukker et al., 2000), lack of capacity enhancement at the firm level (Koeletoed and Buckley, 2008; Huhtala, 2003) and the lack of expertise in cleaner production project implementation (Stamiskis and Stasiskiene, 2003; del Rio et al., 2013) collectively affect the adoption of new cleaner production processes and technologies innovation (Plotnikova et al., 2015). Organizational capabilities such as unlearning old skills, acquiring new skills, ability to collaborate with suppliers and engaging with the customers are very critical for firm-level CTA (Roome, 1994; Murphy and Gouldson, 2000; Florida, 1996; Van Dijken et al., 1999; Kerndrup et al., 1999; Duffy et al., 1999; Eder et al., 2003; del Rio et al., 2013).

A study by Adeoti (2002) covering 122 plants in the food, beverage and textiles sub-sectors in Nigeria shows that government regulation is a key promoter of EST (PAT & CT) adoption. As per his study, the major driver for pollution prevention (CTA) is plant size and plant internal capacity, whereas environmental policy is a very insignificant variable. According to Luken and Van Rompaey (2008), high production cost, current environmental laws and expected future environmental rules are the three most important drivers for adopting EST in the developing countries. Adeoti (2002), however, reported a different study outcome on this. Adeoti found that environmental regulation, accident prevention and improving environmental image are the three key drivers for EST adoption. Similarly, according to the study by Luken and Van Rompaey (2008), high cost of implementation, unavailability of alternative technology and deficiency of technical skills are the three most important barriers for EST adoption in developing countries. Again, Adeoti (2002) reported a different opinion on the barriers. According to Adeoti, high capital cost of pollution control equipment, no convincing reason to spend in EST and absence of awareness of EST are the three most important obstacles to EST adoption.

Most of the studies in the developing countries investigated the influence of regulatory pressure on the compliance of environmental norms and adoption of the CTs/EST. The studies focused on two factors, i.e., contextual (external, such as pressure from community and market) and plant-specific (internal, such as skills, organizational capability and cost). The research on CTA in the developing countries is focused on either contextual or plant-specific factors or the combination of the two factors (Hettige et al., 1996; Aden et al., 1999; Aden and Rock, 1999; Seroa da Motta, 2006; Gangadharam, 2006; Wang and Wheeler, 2000; Adeoti, 2002; Blackman and Kildegaard, 2004; Montalvo, 2003; Wheeler and Martin, 1991; Reppelin-Hill, 1999; Veugelers, 2012).

### 2.1 Development of hypotheses

The literature cited in the previous section suggests that government acts as a driver for CTA. One key finding of a survey conducted by Montalvo (2008) was that government policies are one of the main drivers of CTA in industry. The framework by Sangle (2011) brings together the technology, firm and stakeholder for CTA for climate proactivity. The World Bank “New Model” mentions that “Government is more like a mediator rather than a dictator, because it exerts influence through numerous channels,” and suggests more empirical research in this direction (World Bank Report, 2003). Therefore, this research study makes an attempt to empirically determine the role of government as moderator and (or) mediator toward CTA for climate proactivity.

Venkatraman (1989) identifies six models of fit: mediation, moderation, matching, gestalts, profile deviation and co-variation. The mediation and moderation models of fit are suitable for the current purpose because they are capable of conceptualizing the fit between two constructs and can be anchored to performance. To understand the role of
government as moderator or mediator, the following hypotheses have been proposed for empirical validation.

Moderation can be described as the scenario wherein a third variable governs the impact of a predictor variable on the criterion variable, Venkatraman (1989). To investigate the moderating role of government on firm, technology and stakeholder in CTA for climate proactivity, the following three hypotheses are proposed. Government will be tested as moderator, firm, technology and stakeholder are independent variables and CTA for climate proactivity is the dependent variable:

H1. Government plays a moderating role between firm and CTA for climate proactivity.

H2. Government plays a moderating role between technology and CTA for climate proactivity.

H3. Government plays a moderating role between stakeholder and CTA for climate proactivity.

Mediating role indicates the existence of a significant intervening mechanism between an antecedent variable and the consequent variable, Venkatraman (1989). As government intervention is key to CTA (Montalvo, 2008; World Bank Report, 2003), we propose the following three hypotheses to investigate the mediating role of government on firm, technology and stakeholder in CTA for climate proactivity. Government will be tested as mediator, firm, technology and stakeholder are independent variables and CTA for climate proactivity is the dependent variable:

H4. Government plays a mediating role between firm and CTA for climate proactivity.

H5. Government plays a mediating role between technology and CTA for climate proactivity.

H6. Government plays a mediating role between stakeholder and CTA for climate proactivity.

The six hypotheses proposed above are presented in Figures 1-6, respectively.

3. Research methodology

In this section, the questionnaire design, data collection and data analysis techniques used for the study have been detailed; also, potential biases and their removal techniques have been briefly summarized.
Unit of analysis shall be “firms/organizations” for CTA. As the case may be, it can be the complete organization or sub-part of an organization where the strategy under consideration has been in practice. The role of government, market and civil society in adoption or non-adoption of clean technology in the context of climate change was discussed among the middle to top management staff.

3.1 Questionnaire design
As this research is exploratory in nature, a questionnaire-based survey was chosen as an appropriate approach (Bailey et al., 1995). Primarily, such a method of data collection has multiple benefits of being a relatively faster, cost-effective easy of analysis (Bowling, 1997).
A literature survey was conducted to confirm the determinants/variables for questionnaire preparation. On the basis of the literature survey, research gap and the objective of the research work, a questionnaire design was used to conduct the primary survey for empirical analysis. Due attention was paid to make the questions respondent-centric and easy to understand. The language of the questionnaire was “English” because the target respondents were well versed with the language. The language and words were kept simple and straightforward to ensure that the respondents understood it easily. Care was taken to minimize the social desirability bias while designing the questions. A draft questionnaire was prepared on the basis of the literature survey and in line with the research objectives. A focus group discussion was carried out with a few experts to understand the gaps in the questionnaire. During the focus group discussion, a few questions were modified while a few repetitive or irrelevant ones were removed. As per the research objective, the questionnaire was designed focusing on the selected five factors, i.e., government, CTs, stakeholders, organizations and climate proactivity. The questionnaire was finalized and a pilot study was carried out to collect 185 samples. Pilot study responses were analyzed and further minor corrections were made for the final survey.

3.2 Scale used for the survey
A seven-point Likert scale was used in the pilot survey, with 1 indicating strongly disagree and 7 indicating strongly agree (Table I).
Named after its developer, Rensis Likert, this is a widely used rating scale that requires the respondents to indicate the degree of agreement or disagreement with each of a series of statements about the stimulus objects (Likert, 1932). The Likert scale has several advantages. It is easy to construct and administer. Respondents easily understand how to use the scale, making it suitable for mail, telephone, personal or electronic interviews.

3.3 Data collection

The data were collected in an electronic format (i.e. online questionnaire) for the study. The data were fed into Microsoft Office Excel 2007. Pilot testing of the data was carried out through exploratory factor analysis (EFA) using principle component analysis in SPSS version 20. The results of the factor analysis have been discussed in the following section. The EFA data were further used for multiple regression (MR) analysis in SPSS version 20. The following steps were followed for the research work and to validate the research models.

In total, 242 questionnaires were received within six weeks of the questionnaire being sent to different industries across India. Of the 242 respondents, 148 (61 percent) were from large-scale and 94 (39 percent) respondents were from small- and medium-scale industries (SMEs). In total, 75 (31 percent) respondents were from the organizations publishing sustainability report as per GRI guidelines, whereas the rest of the 167 respondents (69 percent) were not publishing any non-financial report. In total, 94 percent (228) of the respondents were private firms whereas 6 percent (14) of the respondents were from government/PSU firms. In total, 175 (72 percent) responses were from middle and senior employees, whereas 67 (28 percent) responses were from junior managers with more than eight years of experience and working in corporate headquarters. In total, 205 (85 percent) respondents were from ISO 14001-certified companies whereas 37 (15 percent) responses were from non-EMS-certified companies. Overall, 242 positive replies were received, yielding a 76 percent response rate. The survey cannot be considered biased following Moser and Kalton (1971), who hold that the results of a postal survey are biased if the return rate is lower than the range 30-40 percent.

3.4 Data analysis

The study utilizes factor analysis to support the factor structure of the variables and to ascertain that the variables used in the study were conceptually different. EFA using principal component analysis with varimax rotation was carried out to achieve a simple data structure. Further, MR analysis was carried out to verify the factor structure of the observed variables.

MR is a statistical technique that simultaneously develops a mathematical relationship between two or more independent variables and an interval-scaled dependent variable. This technique is used to test the moderating and mediating role of a variable in the study. This method has been used in the present study to ascertain the moderating/mediating role of government in CTA for climate proactivity. Further, the Sobel (1982) test was carried out to confirm the significance of the mediation effect.

The data collected were processed in the SPSS software for EFA, followed by MR analysis. The results of the EFA and MR analysis are explained below.

<table>
<thead>
<tr>
<th>Table I. Seven-point Likert scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disagree</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>
3.4.1 EFA. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy measure was found to be greater than 0.5, i.e., 0.690, which indicates that the sample is adequate for the given number of variables used for the factor analysis (Hutcheson and Sofroniou, 1999).

Table II shows the KMO and Bartlett’s test of sphericity values from SPSS. Cronbach’s $\alpha$ (Cronbach, 1951), which quantifies the degree of internal consistency (reliability) of a set of items, was calculated for each subscale as well as the overall scale. In general, a Cronbach’s $\alpha$ value of at least 0.7 is the criterion used to establish an acceptable level of reliability. Cronbach’s $\alpha$ values are presented in Table III.

It may be observed from the cumulative percent column that the five factors extracted together accounted for 57.775 percent of the total variance. This is remarkable because the EFA could able to economize on the number of variables from the original 17 to 5 underlying factors. The total variance explained is shown in Table IV.

In Table V, the rotated factor matrix has been reported; from this, the following observations can be made.

International norms, international support, policy and regulation and incentives and recognition are the variables related to government. Hence, these factors are collectively named as GOVT. Economic risk (ECO), organizational learning, strategic alliance and collaboration capability (COL) are the variables related to firm. This factor is, therefore, named as FIRM. High capital cost, research and development and awareness (AWA) are the variables related to technology. Hence, these are named as TECH. Community (COM), social media and industry association are the variables related to stakeholders. These factors are, therefore, named as STAKEH. CTA1, CTA2 and CTA3 are the factors related to CTA for climate proactivity. Hence, these three factors were named as CTA.
Convergent validity was checked and it was found that the factors are highly correlated. Also, divergent validity confirmed that there was no cross loadings for any of the 17 variables.

3.4.2 MR analysis of the factors from the EFA study

On the basis of the above inferences from the EFA study, all the factors, i.e., firm, technology, stakeholder, government and CTA for climate proactivity were identified for MR analysis. MR considering the variables are grouped under the factors identified in the above EFA.

3.4.2.1 Moderating role of government. To establish moderation, it must be shown that a moderator interacts with an independent (initial) variable to yield a dependent (final) variable (Baron and Kenny, 1986). Statistically, a moderator exists when there is a significant interaction. A moderator may increase the strength, decrease the strength or alter the direction of a relationship. The following sections discuss the moderating role of Government clarified through MR analysis.

The MR output is shown in Table VI; it shows a standardized regression value with CTA as a dependent variable. The direct relation between FIRM and CTA is significant (\( \beta = 0.172 \) and \( p = 0.028 \)) and the direct relation between GOVT and CTA is significant (\( \beta = -0.215 \) and \( p = 0.001 \)), but negative. The combined interaction of FIRM and GOVT with CTA is not significant (\( \beta = 0.084 \) and \( p = 0.264 \)), which explains that GOVT is not acting as a moderator between FIRM and CTA.

The MR output is shown in Table VII; it shows a standardized regression value with CTA as a dependent variable. The direct relation between TECH and CTA is not significant (\( \beta = -0.105 \) and \( p = 0.123 \)) and the direct relation between GOVT and CTA is significant.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Component 1</th>
<th>Component 2</th>
<th>Component 3</th>
<th>Component 4</th>
<th>Component 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic risk (ER)</td>
<td>0.766</td>
<td>0.124</td>
<td>0.064</td>
<td>0.096</td>
<td>-0.035</td>
</tr>
<tr>
<td>Organizational learning (OL)</td>
<td>0.779</td>
<td>0.168</td>
<td>0.011</td>
<td>-0.154</td>
<td>0.061</td>
</tr>
<tr>
<td>Strategic alliance (SA)</td>
<td>0.769</td>
<td>0.120</td>
<td>-0.137</td>
<td>-0.138</td>
<td>-0.034</td>
</tr>
<tr>
<td>Collaboration capability (COL)</td>
<td>0.815</td>
<td>0.044</td>
<td>-0.062</td>
<td>0.034</td>
<td>0.147</td>
</tr>
<tr>
<td>High capital cost (CC)</td>
<td>0.040</td>
<td>-0.046</td>
<td>0.652</td>
<td>-0.068</td>
<td>-0.106</td>
</tr>
<tr>
<td>Research and development (RD)</td>
<td>-0.209</td>
<td>0.019</td>
<td>0.728</td>
<td>-0.090</td>
<td>-0.147</td>
</tr>
<tr>
<td>Awareness (AWA)</td>
<td>0.025</td>
<td>0.162</td>
<td>0.645</td>
<td>0.220</td>
<td>0.133</td>
</tr>
<tr>
<td>Community (COM)</td>
<td>0.031</td>
<td>-0.050</td>
<td>0.258</td>
<td>0.574</td>
<td>0.028</td>
</tr>
<tr>
<td>Social media (SM)</td>
<td>-0.014</td>
<td>-0.038</td>
<td>-0.317</td>
<td>0.586</td>
<td>0.001</td>
</tr>
<tr>
<td>Industry association (IA)</td>
<td>-0.218</td>
<td>0.227</td>
<td>0.015</td>
<td>0.622</td>
<td>0.165</td>
</tr>
<tr>
<td>International norms (IN)</td>
<td>0.154</td>
<td>0.829</td>
<td>0.147</td>
<td>0.099</td>
<td>-0.088</td>
</tr>
<tr>
<td>International support (IS)</td>
<td>0.088</td>
<td>0.831</td>
<td>0.202</td>
<td>0.030</td>
<td>-0.058</td>
</tr>
<tr>
<td>Policy and regulation (PR)</td>
<td>0.021</td>
<td>0.745</td>
<td>-0.048</td>
<td>0.071</td>
<td>-0.061</td>
</tr>
<tr>
<td>Incentives and recognition (IR)</td>
<td>0.233</td>
<td>0.692</td>
<td>-0.158</td>
<td>-0.105</td>
<td>-0.018</td>
</tr>
<tr>
<td>CTA1</td>
<td>0.114</td>
<td>-0.196</td>
<td>-0.117</td>
<td>0.248</td>
<td>0.618</td>
</tr>
<tr>
<td>CTA2</td>
<td>-0.041</td>
<td>-0.108</td>
<td>0.049</td>
<td>-0.431</td>
<td>0.689</td>
</tr>
<tr>
<td>CTA3</td>
<td>0.039</td>
<td>0.029</td>
<td>-0.059</td>
<td>0.124</td>
<td>0.681</td>
</tr>
</tbody>
</table>

Table V. Rotated component matrix

Table VI.

<table>
<thead>
<tr>
<th>Model 1</th>
<th>Unstandardized coefficients</th>
<th>Standardized coefficients</th>
<th>Collinearity statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>SE</td>
<td>( \beta )</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.021</td>
<td>0.066</td>
<td>-0.316</td>
</tr>
<tr>
<td>ZFIRM</td>
<td>0.172</td>
<td>0.078</td>
<td>0.172</td>
</tr>
<tr>
<td>ZGOVT</td>
<td>-0.215</td>
<td>0.066</td>
<td>-0.215</td>
</tr>
<tr>
<td>ZFIRM X ZGOVT</td>
<td>0.074</td>
<td>0.086</td>
<td>0.084</td>
</tr>
</tbody>
</table>
Adoption of CTs for climate proactivity

\( (\beta = -0.161 \text{ and } p = 0.012), \text{ but negative. The combined interaction of TECH and GOVT with CTA is not significant (} \beta = -0.059 \text{ and } p = 0.383), \text{ which explains that GOVT is not acting as a moderator between TECH and CTA.}

The MR output is shown in Table VIII, which shows the standardized regression value with CTA as a dependent variable. The direct relation between STAKE and CTA is not significant (\( \beta = -0.175 \text{ and } p = 0.007 \)) although negative. The combined interaction of STAKE and GOVT with CTA is not significant (\( \beta = -0.055 \text{ and } p = 0.388 \)), which explains that GOVT is not acting as a moderator between STAKE and CTA.

The \( R^2 \) values for the above three outputs of the moderation study are 0.050, 0.049 and 0.038, respectively.

3.4.2.2 Mediating role of government. Mediation is the mechanism that underlies the relationship between an independent (initial) and a dependent (outcome) variable by the involvement of a third explanatory (intervening/mediating) variable (Baron and Kenny, 1986). The following sections discuss the moderating role of government through MR analysis.

The MR output shown in Table IX has a standardized regression value with GOVT as the dependent variable. The direct relation of FIRM (\( \beta = 0.310 \text{ and } p = 0.000 \)), TECH (\( \beta = 0.133 \text{ and } p = 0.032 \)) and STAKE (\( \beta = 0.114 \text{ and } p = 0.067 \)) with GOVT is significant and positive.

MR output is shown in Table X as having a standardized regression value with CTA as a dependent variable. The direct relation of FIRM (\( \beta = 0.057 \text{ and } p = 0.384 \)) and STAKE (\( \beta = 0.063 \text{ and } p = 0.329 \)) with CTA is insignificant. The direct relation of TECH (\( \beta = -0.135 \text{ and } p = 0.037 \)) with CTA is significant, but negative.

<table>
<thead>
<tr>
<th>Model 2</th>
<th>Unstandardized coefficients</th>
<th>Standardized coefficients</th>
<th>Collinearity statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>SE</td>
<td>( \beta )</td>
<td>t</td>
</tr>
<tr>
<td>Constant</td>
<td>0.006</td>
<td>0.063</td>
<td>0.096</td>
</tr>
<tr>
<td>ZTECH</td>
<td>-0.105</td>
<td>0.068</td>
<td>-0.105</td>
</tr>
<tr>
<td>ZGOVT</td>
<td>-0.161</td>
<td>0.064</td>
<td>-0.161</td>
</tr>
<tr>
<td>ZTECH X ZGOVT</td>
<td>-0.065</td>
<td>0.074</td>
<td>-0.059</td>
</tr>
</tbody>
</table>

Table VII. Multiple regression between technology and government

<table>
<thead>
<tr>
<th>Model 1</th>
<th>Unstandardized coefficients</th>
<th>Standardized coefficients</th>
<th>Collinearity statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>SE</td>
<td>( \beta )</td>
<td>t</td>
</tr>
<tr>
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<tr>
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<td>0.062</td>
<td>0.133</td>
</tr>
<tr>
<td>ZSTAKE</td>
<td>0.114</td>
<td>0.062</td>
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</table>

Table IX. Interaction between independent variables and mediator

<table>
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<tr>
<th>Model 1</th>
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<th>Standardized coefficients</th>
<th>Collinearity statistics</th>
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</thead>
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<td>t</td>
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<td>-0.058</td>
<td>0.067</td>
<td>-0.055</td>
</tr>
</tbody>
</table>

Table VIII. Multiple regression between stakeholder and government
The standardized MR output in Table XI shows that the direct relation of GOVT ($\beta = -0.174$ and $p = 0.007$) with CTA as a dependent variable is significant, but negative. The $R^2$ values for the above three outputs of the mediation study are 0.108, 0.027 and 0.030, respectively.

### 4. Results and discussion

The statistical outcomes of the study are discussed in this section, correlating the same with the literature study. Also, the policy implications of the research findings are discussed in this section.

As shown in Figure 1 and explained in Table VI, this study does not support the moderating role of government for CTA by the firms for climate proactivity, i.e., $H1$ is not supported. This implies that existing government mandates are only followed for compliance purposes and, with no legal compulsion, the government is not influencing the firms to go beyond compliance. The result of the mediating role of government shown in Figures 4, 7 and 8 is explained in Tables IX-XI. MR analysis shows a significant mediation effect whereas the Sobel test confirms the mediating role of the government between firm and CTA for climate proactivity. Hence, $H4$ is supported. This indicates that for CTA by firms, government policies are rather essential. The direct interaction between firm and CTA is not significant, but with the mediation of the government, it acquires significance. Empirical studies have established that regulatory pressure is a major element in firm’s environmental performance (Luken and Van Rompaey, 2008).

The mediation result shows that the interaction between government and CTA is significant, but negative. This means that government policies are not promoting CTA for climate proactivity. This result is supported by various studies carried out previously in the area of CTA. According to a survey conducted by Montalvo (2008), studies by various authors agree on the fact that the design and enforcement of the environmental policies are not favouring the adoption of CTs in industries (CSIS, 1997; PCSD, 1999; Huhtala, 2003). The negative result is also supported by Reijnders L. (2003), whose study states that present government regulation will progressively become outdated, counterproductive and incapable of motivating CTA. As per the study by the World Bank Report (2000), most of the manufacturing companies in the developing countries have complied or even overcomplied with the prescribed environmental norms. Even after complying with the environmental norms, the adoption of CTs is extremely slow in developing countries. This indicates the inadequacy of the present environmental laws in promoting CTA. This result is also supported by one recent study carried out in India. The MoEFCC (then MoEF),
Government of India (GOI), set up a high-level committee in 2014 to review all the environmental laws and ascertain the gaps in government policies. To drive a paradigm shift in technology adoption, this committee recommended a reworking of the existing standards and revising a system of financial penalties and rewards to create a market-related incentive system to encourage “green projects” (GOI, 2014). Similarly, a study by World Bank in 2014 suggested that for faster adoption of CT among the SMEs in developing countries, legal and regulatory framework is a key support area. The study states that by enabling an overall framework for clean technology, SMEs can be strengthened. This framework can be formulated by implementing a number of legal and regulatory policies, including sector-specific tax incentives, cap-and-trade emission schemes, emission reduction credits, taxation on pollution or natural resource use, import tax reductions or waivers and incentives to attract skilled labor. These can be designed to create business incentives and/or obligations that address both the supply and the demand side of clean technology markets.

The moderating role of government between technology and CTA is not supported in this study, i.e., H2 is not supported. This indicates that the government is not influencing
technology adoption beyond the policy implications. The moderating effect is shown in Figure 2 and explained in Table VII. The MR analysis and the Sobel test confirm that there is a partial mediation of government between technology and CTA, i.e., $H_5$ is supported. The mediation results are explained in Tables IX-XI. The mediating effect is shown in Figures 5, 7 and 8. The interaction of technology through government ($0.133 \times -0.174 = -0.023$) is more significant compared with the direct interaction between technology and CTA ($-0.315$). This indicates that the government has less influence on technology compared with its influence on firms for CTA.

The partial mediation implies that government policies do not have direct control over technology innovation. This is true because governments do not have direct command over CT. On the basis of the government policies, technology manufacturers carry out the required R&D, manufacture the desired product and ensure necessary marketing to convince the firms for adoption of new technology. Apart from the regulatory requirement, adoption of new technology depends on various factors such as future stringent environmental norms, capital investment, technological capabilities, organizational capabilities, awareness on new technology, environmental image, supply chain demand and commitment to go beyond compliance (Sangle, 2011; Hilliard, 2006; del Rio Gonzalez, 2005; Montalvo, 2003; Luken et al., 2008; Kemp and Volpi, 2008).

As discussed in the initial part of this section, CTA in developing countries such as India is currently perceived as beyond compliance. Hence, as the mediation result shows, CTA has a direct interaction with technology, with partial mediation by government. This result is justified because there are various firm-specific factors that influence the CTA decision along with anticipated stringent legal requirements. There are few government policies (e.g. NAPCC, National Environmental Policy) that recommend firms for various types of technology adoption, but as these are voluntary guidelines, firms barely implement them. Hence, with reference to the discussion, it can also be stated that “until there are adequate regulations for CTA, the Government role will be limited on the Technological front for the Adoption of CTs for climate proactivity.”

This study did not support the moderating role of government between stakeholders and CTA, i.e., $H_3$ is not supported. This indicates that government is not influencing the stakeholders to intervene in favor of CTA by companies. The relation is presented in Figure 3 and the moderating results are presented in Table VIII. The mediation of government between stakeholder and CTA is significant, but the Sobel test does not confirm the mediation. Hence, $H_6$ is not supported. The mediation results are explained in Tables IX-XI. The mediating effect is shown in Figures 6-8. This implies that the Indian government is neither moderating nor mediating the stakeholders for CTA for climate proactivity.

A literature study on CTA identifies the stakeholders as an important determinant of environmental performance. Local communities, consumer groups and NGOs have been sensible “watchdogs” and are all promoters of environmental protection (Dillon and Baram, 1993; Duffy et al., 1999; Hart and Ahuja, 1996; Hartman and Stafford, 1997; Luukkanen, 2003; Rondinelli and Vastag, 1996; Visser et al., 2008). However, very few studies have examined the influence of this pressure on the type of technological change brought about. As one of the few to examine the effect of stakeholder pressure on technology adoption by firms, Montalvo (2003) found that community pressure is not sufficient to foster the willingness of a firm to undertake technology change to reduce pollution. This substantiates our finding on the moderating and mediating role of government between stakeholder and CTA.

The above standardized MR output is represented in Figure 7 with all the significant and non-significant factors. In Figure 8, only the significant factor has been incorporated into the model. In both the models represented below, firm, stakeholder and technology are independent variables whereas government and CTA are dependent variables.
5. Conclusions, limitations and future research directions

The empirical findings discussed in Section 4 lead to the following conclusions. While testing the moderating role, three important points were evident. First, there is a significant direct and positive interaction between FIRM and CTA. This implies that when there is no legal obligation, it is up to the organizations to decide whether or not to go for the advanced pollution control technologies. Second, it is observed that there is no significant relation between TECH and CTA. This indicates that variables such as high capital cost, research and development and awareness are not significantly influencing CTA unless there is legal compulsion. Third, STAKEH and CTA also do not have a significant direct interaction. This indicates that the stakeholders (community, social media and industry associations) in India do not exert sufficient pressure on industries for CTA.

Government is strongly mediating between FIRM and CTA for climate proactivity. A very recent gazette notification by the GOI (Environment (Protection) Amendment Rules, 2015) helps substantiate this study finding. Currently, there are no statutory limits for the stack emissions, except for particulate matter. The gazette notification by GOI, dated December 8, 2015, introduces specific limits for stack emissions (SO2, NOx and Mercury) in thermal power plants (TPPs). Also, the notification introduces specific water consumption limits for the TPPs. TPPs have been asked to comply with this new requirement by December 2017. Industries will have to install advanced technologies such as flue gas desulfurization, low NOx burners and water recycling plants to meet the new compliance requirements. Without the statutory requirements, hardly any industry has opted for the advanced technologies, but with the new law in force, industries are bound to adopt new pollution prevention technologies. This not only enforces CTA by industries but also promotes CT innovation and engagement of stakeholders in this direction.

This helps strengthen this study’s finding that the government in India has a very influential mediating role in CTA. Government policies will have an immediate effect on the CTA strategy.

The study finding indicates that although government mediates CTA, the government policies are not adequate for faster CTA for climate proactivity. As described in the introduction section, stringent environmental norms have improved the CTA in other countries such as USA and Canada; our study findings have following policy implications for faster adoption of CTs.

The key policy implications from this research are as follows: the government needs to have in place new policies that will promote CTA by firms, the government needs to establish a continuous dialogue with technology manufacturers and incentivize new technologies to help firms in addressing hurdles such as high capital cost, technological awareness and organizational capability and the government must partner with various stakeholders (e.g. local community, media and NGOs), and make use of these valued resources to create a positive influence on the firms for adoption of new and CTs.

A few implications for the managers are discussed in this section. First, as government policies take time in terms of amendment and implementation, industries should lead the CTA process without waiting for government actions. Second, industries can collaborate among themselves to explore and adopt CT for climate proactivity. For example, Responsible Care (RC) is a chemical industry initiative that calls on companies to demonstrate their commitment to improve all aspects of performance, which relate to protection of health, safety and environment. In India, the Indian Chemical Council is at the forefront in promoting the RC initiatives. Other sectors can combine themselves to drive emission reduction programs specific for their sector through CTA. Third, large corporate houses with experience in advanced technologies can support the SMEs through knowledge sharing and help them take advantage of CTA.

A limitation of this study is that it has only tested the moderating and mediating role of the government toward CTA. Further research can be carried out to determine the
Another limitation is that the respondents did not include policymakers such as Pollution Control Boards and government institutes such as the Confederation of Indian Industry, the Federation of Indian Chambers of Commerce & Industry, The Associated Chambers of Commerce and Industry of India (ASSOCHAM), etc. Future studies can be carried out by including these stakeholders.

Global GHG Emission by economic sector shows that approximately a quarter (24 percent) of the total GHG emission is from agriculture, forestry and other land use. Specific research needs to be carried out to explore how CTs can be useful in reducing these GHG emissions. This seems to be a rather unexplored area in developing countries.

In the COP 21 held at Paris December 2015, it was evident that India is facing pressure from various international communities to adopt definite targets toward emission reduction to address the global climate change (India’s Intended Nationally Determined Contribution, 2015 agreement). Hence, more studies should include climate change or climate proactivity (as done in this study and in the study by Sangle, 2011) as a key variable for understanding CTA in the industrial as well as other areas.

This study differs from all the previous research work by introducing a new dimension into the CTA research. Instead of researching further on the government’s role as driver, this study investigates the moderating and mediating role of the government in CTA for climate proactivity. This is a major contribution of this research work and it can be applied to various researches in the area of environment and sustainability.

Note
1. Pollution abatement technologies (PATs) are added at the end of the production process to treat pollutants generated in the process. Pollution prevention or cleaner technologies (CTs) are the intermediate part of production processes and prevent the generation of pollutants from the process. The combination of PAT and CT is represented as environmentally sound technology (EST) (Luken et al., 2008).

References


Web reference

Further reading


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Using nutraceuticals in the management of major depressive disorder (MDD)

Approach to be considered for sustainable healthcare systems

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Abstract

Purpose – The purpose of this paper is to study evidence-based records on the impact of some effective nutraceuticals on major depression disorder management; and describe the antidepressant properties of nutraceuticals to achieve health policy targets and maintain a sustainable healthcare system.

Design/methodology/approach – The literature was searched using MEDLINE (PubMed), Google Scholar, PsycINFO and Quertile databases and retrieving relevant published articles in peer-reviewed journals.

Findings – The results provided evidence of a range of nutraceuticals with potential benefits in the management of depression. Studies support the anti-depressant properties of S-adenosyl methionine, folinic acid, 5-hydroxytryptophan and omega-3 fatty acids. The results might represent evidence for an innovative adjunctive neurobiological line for the management and treatment of depression.

Practical implications – Randomized-controlled trials and evaluations continue to provide evidence for the use of nutraceuticals in the treatment of depression.

Social implications – Nutraceuticals emphasize the personalized medicine, which offers a psychophysical balance to the individual.

Originality/value – Nutraceuticals have specific antidepressant properties that may be beneficial in psychiatric populations and reduce pharmacotherapeutic side effects.

Keywords 5-hydroxytryptophan (5-HTP), Complementary and alternative medicine (CAM), Major depressive disorder, Nutraceuticals, Omega-3, S-adenosyl methionine (SAMe)

Paper type General review

An overview of the problem

European public health is facing considerable challenges because of different social, political, environmental and lifestyle factors. Depression represents a major challenge for public health, affecting economic activity, social life, learning and the value of life beyond those of most physical diseases, and in particular, reported cases can lead to suicide attempts or suicide. According to the first report from the European Outcome of Depression International Network (ODIN) study carried out by Ayuso-Mateos et al. (2001), depressive disorder is a highly prevalent condition in Europe as it is reported to be 8.5 percent, for female and male the sentence will be depressive disorder is a highly prevalent condition in Europe as it is reported to be 8.5 percent for female and male with great occurrence (urban UK and urban Ireland), little occurrence (urban Spain) and average occurrence (the remaining places). According to a study carried out by Curran et al. (2007) on mental health and employment, depression was found to be the main reason for absence from work and premature retirement in many European countries. In addition, Sobocki et al. (2006) reported that depression is considered the most cost effective brain disorder in the region to manage,
Major depression disorder (MDD)

This is a psychological condition described by a general and determined low mood that is accompanied by loss of pleasure or interest in activities normally loved by a person and loss of self-esteem (Salmans, 1997).

The pathophysiology of MDD

The main physiological changes that occur in MDD are neuroendocrinological alterations, decrease in brain-derived neurotrophic factor, cytokine changes and monoamine impairment (Belmaker and Agam, 2008). There is a possibility to use a more broad therapeutic biological method to treat depression with an array of main neurobiological pathways by specific nutraceuticals (omega-3 fatty acids, S-adenosyl methionine (SAMe), folinic acid and 5-hydroxytryptophan (5-HTP)).

Nutraceuticals

According to Kaira (2003), nutraceuticals are substances arising from food with health benefits as well as essential nutritional value. It combines two words “nutrient” (a nutritious food constituent) plus “pharmaceutical” (a medical remedy), which were combined in 1989 by the Creator and Chairman of the Foundation of Innovation Medicine, Stephen L. DeFelice. Nutraceuticals include herbal products, dietary supplements, isolated nutrients and specific diets and processed foods such as soups, beverages and cereals, which supposedly offer health or medicinal benefits, and may aid the treatment and prevention of diseases. The role of nutraceuticals in human nutrition is one of the most significant areas of study, with wide implications for healthcare providers, consumers, food distributors and producers.
SAMe
SAMe is a molecule found in body fluids and tissues. It is composed of adenosine triphosphate and L-methionine (Bottiglieri et al., 1988). SAMe was initially discovered in Italy by Cantoni (1952). It was found to be an effective cofactor in biological methylation reactions by Cantoni as a to give methyl groups to a variety of molecules in the body (Kresge et al., 2005). Moreover, it is converted into homocysteine and adenosine (Baldessarini, 1987) (Figure 2). It is involved in several cellular functions including the metabolism and synthesis of neurotransmitters (Goren et al., 2004). SAMe might also improve symptoms of depression through augmented serotonin turnover, decreased prolactin secretion, re-uptake inhibition of norepinephrine, enhanced dopaminergic action and increased phosphatidylcholine conversion (Papakostas, 2009). Although SAMe has been sold in particular European countries for many years for depression and other medical conditions (Shippy et al., 2004) it is not approved legally for the treatment of depression in the UK.

L-folinic acid (the active form of folate)
Some studies in the literature propose that depression is related to folate deficiency (Coppen and Bolander-Gouaille, 2005). In addition, patients who have folate deficiency either show a slight improvement, a more severe depressive incident or greater probabilities of relapse when taking antidepressants (Fava et al., 1997). Coppen and Bailey (2000) conducted a randomized, placebo-controlled trial to study the augmentation of the fluoxetine antidepressant action by folic acid. In total, 127 patients were randomly assigned to take either 500-microgram folic acid or a similar-looking placebo plus 20 mg fluoxetine daily. There was a significantly better improvement in the depression symptoms score in the fluoxetine plus folic acid group. A good response (> 50 percent reduction in score) was observed among 93.9 percent of women who received the folic acid supplement, whereas only 61.1 percent of women who received the placebo supplement showed improvement (p < 0.005).

Folate was found to be involved in the formation and metabolism of various monoamines, especially in the formation of SAMe from homocysteine (Fava and Mischoulon, 2009).

5-HTP
5-HTP, which results from L-tryptophan, is an important monoamine precursor that is needed for the formation of serotonin (Byerley et al., 1987). A review of the literature was carried out by Shaw et al. (2002) to investigate the effect of 5-HTP or L-tryptophan in addition
to antidepressants. Trials were searched in computerized general (PsychLIT, Medline and Embase) and specialized databases (Cochrane Collaboration Depression Cochrane Controlled Clinical Trials Register, Anxiety and Neurosis Controlled Trial Register). Trials included patients with unipolar depression or dysthymia, compared preparations of 5-HTP or tryptophan with placebo and included clinical outcomes assessed by scales assessing depressive symptoms. The results showed that 5-HTP or L-tryptophan, along with antidepressants, led to improved outcomes in boosting the antidepressant response.

According to Osiecki (2006), the co-factors magnesium, calcium, B6, folic acid and iron are essential in the metabolism and conversion of tryptophan into 5-HTP and B6, zinc, magnesium and vitamin to convert 5-HTP into serotonin (Figure 3).

**Omega-3 fatty acids**

Recently, new beneficial effects of omega-3 poly unsaturated fatty acids (PUFA) were suggested, for example management for specific types of mental illness, such as depressive disorders (Grosso et al., 2014). Depression might share some pathophysiological mechanisms with cardiovascular disease, specifically endothelial dysfunction, increased manufacture of pro-inflammatory cytokines and increased levels of plasma homocysteine (Severus et al., 2001). The factors which affect omega-3 PUFA positive influence on depression might depend on their physiological content in the nervous system and their contribution toward neuroplasticity in addition to neurogenesis (Bourre, 2004). In addition, the anti-inflammatory ability of omega-3 PUFA might reduce the occurrence of inflammatory procedures in depression (Maes et al., 2009).

The antidepressant action of omega-3 fatty acids occurs through the modulation of dopamine, norepinephrine and serotonin re-uptake, synthesis, degradation and receptor binding, resulting in the improvement of cell membrane fluidity and anti-inflammatory effects (Sarris et al., 2012). A study carried out by Martins (2009) found that eicosapentaenoic acid (EPA) preparations, or those with higher EPA to docosahexaenoic acid (DHA) ratios, possibly have a greater antidepressant effect than DHA only.

**Methodology**

*Search of the literature*

*Aimed search.* The literature was searched through library databases (MEDLINE (PubMed), Google Scholar, CINAHL, PsycINFO, Cochrane Library databases and Quertile databases).

![Formation of 5-HTP and serotonin from tryptophan](source://meyers_2000)
Both conceptual and empirically published literatures on the uses of nutraceuticals in the management of depression were summarized. A review of the literature was performed to determine the mechanisms of action of these nutraceuticals.

**Search strategy.** The keywords and phrases used in the search were CAM, nutraceuticals, depression, antidepressant, SAMe, folic acid, 5-HTP omega-3, sustainability and Europe. The reference lists from published studies and reports were searched for additional sources. Several electronic journals specializing in alternative medicine were searched. The overall search method yielded discussion papers and information from consultation papers, which were examined to abstract evidence, related to the present literature review objectives.

**Selecting the articles and review resources**

**Inclusion criteria.** Articles including reviews, population, intervention of nutraceuticals in depression management and outcomes, were used in this study intervention of nutraceuticals in depression management and outcomes required.

**Topics of interest.** It were the use of Nutraceuticals in mental disorders.

**Evaluating the evidence.** The final selection of articles was performed by a comprehensive review of each article, which was assessed by two individuals to prevent errors and omissions.

**Discussion**

The high prevalence and expenses for treating and managing MDD among individual, families and community, represents a major challenge for public health in Europe prevalence and association with increased and expenses for the individual, families and community. MDD is the first reason for absence from work and premature retirement in many European countries, resulting in noticeable social and occupational impairment and reduced quality of life (Donohue and Pincus, 2007).

Sequenced treatment alternatives to relieve depression (STAR*D) have confirmed that in patients with depression, multiple treatment trials are often required as only a small proportion of patients with MDD show improvements through initial treatment with selective serotonin reuptake inhibitors (SSRIs) (Fava et al., 2003).

The huge range of abnormalities found with MDD pathophysiology such as neuroendocrinological changes, cytokine alterations and monoamine impairment may be improved with the use of adjunctive nutraceuticals by correcting the neurobiological mechanisms responsible for the disorder. Nutraceuticals such as SAMe, folic acid, 5-HTP and omega-3 fatty acids may serve as possible treatments for improving the responses of SSRIs in patients with clinical depression. The above-studied nutraceuticals have the potential to show significant benefits in improving depression in patients who are non-responsive to current antidepressants (Shaw et al., 2002; Papakostas, 2009).

Although SAMe seems more costly, considering its rapid antidepressant action and its side-effect profile, it may have a specific impact on the relations of treatment dosage and duration, inpatient and outpatient care, management of patients who discontinue therapy and having drug time off work.

L-methylfolate is very useful in depressed patients who have folate deficiency because of the administration of anticonvulsant mood stabilizers and patients whose genotype codes to an enzyme that results in ineffective L-methylfolate formation. L-methylfolate regulates the activity of different monoamine neurotransmitters through methylation. These complex mechanisms should be examined to determine the mechanisms by which natural products aid the treatment of depression (Coppen and Bailey, 2000).

5-HT has been shown to be more efficient than placebo for the treatment of depression, but the proof remains inadequate to be decisive and more and larger investigations are required to define whether 5-HTP is actually useful for the treatment of depression.
Omega-3 PUFA as a therapeutic agent was effective in MDD patients and also for depressive patients without an MDD diagnosis. Researchers found that Omega 3 PUFA had a significant positive effect on MDD patients or patients who have depressive symptoms. Many nutraceuticals control several main pathways involved in the pathogenesis and neurobiological pathways of depression; however, clinical trials usually focus on modulating just one or two neurochemicals. Nutrients usually work together; therefore, the specific effects of nutrient components may not be obvious. However, all studies confirmed the antidepressant evidence behind each component of the nutraceuticals. One probable limitation of nutraceutical research is the use of isolated nutrients as opposed to multi-component formulas.

Conclusions, implications and recommendations
- Considering the scale of the economic and social consequences and the costs of MDD, the benefits are great toward decreasing the occurrence and influence of MDD and to promote the mental health of the population as a whole.
- According to Friedli and Parsonage (2007), improvements in mental health can lead to better physical health together with reduced possibility of stroke and heart disease and reductions in alcohol and tobacco consumption and reduced obesity.
- Due to the low incidences of complete recovery of patients treated with antidepressants as a first-line treatment, in addition to the side and unknown effects of long-term use of these antidepressants, it is essential that mental experts must be focus on multiple treatment trials, consequently more interventions are essential. One of the emerging means to improve the non or low response to antidepressants is the use of nutraceuticals.
- The positive antidepressant action of nutraceuticals may represent an effective treatment option to improve the effectiveness of antidepressants and this may support the study of nutraceutical formulations for other medical disorders.
- With respect to the general safety characteristics of nutraceuticals, they must be used in a good safety profiles and therapeutic doses. However, the mechanism of action, bioavailability and absorption of nutraceuticals are still unclear; therefore, further studies are warranted.
- In Europe, an optimal public health approach is in place for mental health and CAM separately (Figure 4). However, there is a lack of CAM for mental health; therefore, useful information and significant research on complementary and traditional medicine, especially nutraceuticals, in relation to mental health are essential for an effective response, comprehensive decisions and evidence-based policy-making to achieve the European health policy targets “Investing in Health” and maintain sustainable healthcare systems.
- Complementary and traditional medicine especially nutraceuticals and its relation to mental health can be included in mainstream policies such as the National Programme for Improving Mental Health and Wellbeing in Scotland, Adolescents en Souffrance Report – France, etc.
- World Mental Health Day, usually on October 10, was organized by the World Health Organization to promote understanding and awareness of mental health issues, with different themes each year. Making (using CAM in mental health) a theme on World Mental Health Day will result in an optimal public health approach in Europe on the basis of combined knowledge, capability and expertise.
Figure 4.
Examples of mental health and complementary and alternative medicine (CAM) activity in Europe
References


Management of MDD


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Corporate governance reforms and shareholders’ confidence in emerging markets

A case of Malaysia

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Abstract

Purpose – The purpose of this paper is to investigate the relation of corporate governance (CG) attributes, such as separate leadership (SL) structure, independent chair (IC) of the board, and the proportion of independent directors on the board (Bind) recommended by the new Malaysian Code on Corporate Governance (2012), with firms’ market performance measured by share market price.

Design/methodology/approach – The paper uses a randomly selected sample of 150 non-financial Malaysian listed companies. To find the distinct impact of the code, the paper explicitly divides the sample into two-year pre-context (2010-2011) and two-year post-context (2013-2014) of the code. Besides descriptive statistics, the study also employs correlation and multiple regression estimators.

Findings – By comparing the pre-context and post-context of the code, the study found that SL and Bind have a significant positive relation while IC of the board has a significant negative relation with share market price after enactment of the code.

Research limitations/implications – The paper has a limitation of using only two years of data due to its non-availability particularly after enactment of the code. The findings show that the new code slightly improved compliance to the CG attributes investigated. Based on findings, the study also recommends further improvement in compliance to CG codes and other voluntary regulations in Malaysia.

Originality/value – Besides contributing to the limited and incongruent literature in pre-context and post-context of CG regulations, the paper also provides important insights for regulators and policy makers of the emerging markets like Malaysia.

Keywords Corporate governance, Malaysian Code on Corporate Governance 2012, Non-financial Malaysian listed companies, Shareholders’ confidence

Paper type Research paper

Introduction

Agency theory assumes a conflict of interests between management and shareholders (Jensen and Meckling, 1976). The theory assumes that management being an agent of the shareholders is liable to protect their interests. However, due to individualism and opportunism of managers as posited by agency theory, they tend to protect their own instead of shareholders’ interests. In view of this, the theory assumes that independence of the board which can be judged from its leadership structure and presence of independent directors can better protect the interests of shareholders from the expropriation of the management (Fama, 1980; Fama and Jensen, 1983; Jensen and Meckling, 1976; Jensen, 1993). Accordingly, corporate governance (CG) codes and other regulations, which are mostly based on agency theory, also have consistently been focusing on independence in structure and composition of the board (La Porta et al., 2000). Recently, the issue of boards’ independence was brought into the limelight of regulators and policy makers by the global financial crisis of 2007-2008 that badly affected shareholders’ confidence around the world. Subsequently, many countries such as the USA, the UK, Italy, and China and international forums like United Nations Conference on Trade and Development and Organization for
Economic Co-operation and Development roundtable for CG development in Asia, all stressed upon strengthening of CG regulations for the restoration of shareholders’ confidence (Dailami and Masson, 2009; OECD, 2011; United Nations, 2010).

As a result, many countries introduced and others revised their in-practice CG codes and regulations around the world. Like others, Malaysia also introduced its third CG code, i.e., Malaysian Code on Corporate Governance (Dailami and Masson, 2009; Malaysian Code on Corporate Governance (MCCG), 2012). Among others, the new code mainly focused on the independence of the Malaysian boards. The code recommended separating and establishing an independent chair (IC) of the board. Moreover, the code also recommended that firms which do not comply with the recommendation regarding IC of the board must increase the proportion of independent directors on their boards (MCCG, 2012). The establishment of an IC of the board is a new recommendation that was never addressed by the previous two CG codes (Malaysian Code on Corporate Governance (MCCG), 2007) of the country (MCCG, 2007). It was first proposed by the Securities Commission of Malaysia in July 2011 and decided to be included in the new code after receiving a positive public response in September 2011 (MCCG, 2012). Prior to this, the previous code, i.e., MCCG (2007) recommended only the separation of two influential roles of CEO and chairman of the board. Alternatively, the code also provided an escape to splitting leadership structure by suggesting an increase in the proportion of independent directors on the boards of the non-compliant firms (MCCG, 2007). As per the premise of agency theory, it is believed that the new regulatory attempt (MCCG, 2012) or tuning up of the recommendations of the previous code (MCCG, 2007) regarding independence of Malaysian boards will assist firms in ensuring good governance and improving monitoring and advising of their management. Also, it is believed that these, in turn, will improve the confidence of shareholders and firms’ market performance reflected by an increase in share market price (Baker and Anderson, 2010; Benali, 2013; Lama, 2013). However, these projections regarding the new code are mere expectations as its recommendations have rarely been empirically investigated in the past. Among others, the lack of investigation might be due to the recent introduction of the new code in March 2012.

Moreover, most of the previous empirical studies focusing on other two CG codes (MCCG, 2007) investigated their impact on accounting measures of firms’ performance as an outcome variable in pre-context and post-context (Hamid and Aziz, 2012; Hussin and Othman, 2012; Noor and Fadzil, 2011, 2013; Saad, 2010). However, it is argued that accounting measures explain firms’ actual performance based on facts and figures while market measures portray their perception in the eyes of investors, society and other stakeholders (Gentry and Shen, 2010). Based on these, there is a need of an empirical investigation that can examine the impact of the new code on compliance and perception of the shareholders. Therefore, this study investigates how specific CG attributes such as SL structure, IC of the board and proportion of independent non-executive directors on the board (Bind) recommended by the new code impacted their compliance in non-financial Malaysian listed companies. Also, the study aims to investigate the impact of these specific CG attributes on firms’ market performance measured by share market price. To find the distinct impact of the code, the study explicitly divides a sample of 150 non-financial Malaysian listed companies into two-year pre-context (2010-2011) and two-year post-context (2013-2014) of the code. The study contributes to the limited incongruent literature in pre-context and post-context of the CG regulations (Owusu et al., 2012). The study also enriches the previous literature that mostly focused on the relationship between CG codes and accounting measures of firms’ performance in the past. Besides contributing to literature, findings of the study also provide important insights for augmenting practice and policy. The findings update regulators, policy makers and other stakeholders of the emerging markets like Malaysia regarding the shareholders’ response to the regulatory
attempt of strengthening the independence of the board. The remaining of the paper is organized as follows: the following section synthesises the previous literature in pre-context and post-context of the CG regulations while the next section reports the relevant literature for developing hypotheses. These are followed by research design, results and findings and their explanation in the subsequent sections. The study also provides recommendations for further improvement of the policies and regulations before suggesting avenues for further research in the area.

Previous literature in the pre-context and post-context of CG codes
Malaysia has had three CG codes (MCCG, 2007, 2012) till date. Few empirical studies have investigated the impact of these codes on firms’ financial performance in the pre-context and post-context periods. However, these studies are specifically limited to the previous two CG codes, i.e., MCCG (2007) (Noor and Fadzil, 2013). A study in the pre-context and post-context periods of MCCG revealed that the code changed an insignificant relation of CG practices with firms’ financial performance to a significant positive (Saad, 2010). Similarly, another study found that MCCG (2007) changed the association of audit committee to significant positive in relation to financial performance of the government-linked companies (Hamid and Aziz, 2012). Noor and Fadzil (2013) found that MCCG (2007) improved the relation of boards’ characteristics with firms’ performance. It is also found that recommendations of the MCCG (2007) regarding board and audit committee improved firms’ financial performance (Noor and Fadzil, 2011). However, in contrast, it is also argued that there is no strong evidence that MCCG (2007) improved the financial performance of the listed companies in Malaysia (Hussin and Othman, 2012). Many empirical studies carried out in other countries also found that CG regulations affect firms’ in-practice structure that decreases their market value (Bello, 2016; Crina, 2016; Haniffa and Hudaib, 2006; Tariq and Abbas, 2013). Overall, the discussion in this section evidences scarcity and incongruence of empirical literature that mostly focused on the association of previous two CG codes with firms’ accounting performance in Malaysia. Based on this, there is a need for further empirical investigations in pre-context and post-context of MCCG (2012) in relation to firms’ market performance. Accordingly, the following section synthesises the previous literature for developing hypotheses and further investigation.

Literature review and hypotheses development
Separate leadership structure and firms’ market performance
The leadership structure is known to be separate when the two roles of CEO and chairman of the board are performed by different individuals (Bansal and Sharma, 2016; Rutledge et al., 2016). Agency theory assumes that CEO duality grants many powers to an individual which affects the monitoring role of the board. Moreover, the theory also assumes that excessive powers allow CEO to protect his/her own interests rather than those of the shareholders (Abdullah, 2004; Jensen, 1993; Rutledge et al., 2016). Therefore, the theory recommends separating the role of chairman of the board from CEO of the company. The theory posits that separation of the roles strengthens independence of the board which ensures effective monitoring and advising of their management. In addition, it also enriches the quality of boardrooms’ decisions, which improves firms’ performance (Fama, 1980; Fama and Jensen, 1983; Jensen, 1993). Accordingly, the Recommendation no. 3.4 of MCCG (2012) states that:

The positions of chairman and CEO should be held by different individuals and the chairman must be a non-executive member of the board.

Many empirical findings endorse these theoretical postulations and regulatory endeavours for separating the roles of CEO and chairman of the board. These studies found that there is
a significant positive relationship between SL and firms’ performance (Kajola, 2008; Tham et al., 2012). Similarly, it is also found that CEO duality has a significant negative impact on firms’ performance (Rutledge et al., 2016). However, in contrast, many studies also found that SL has no or a negative relation with firms’ performance (Dulewicz and Herbert, 2004; Ponnu, 2008; Shukeri et al., 2012; Weir and Laing, 2000; Weir et al., 2002). Contrary to agency theory, it is also found that CEO duality has no (Arora and Sharma, 2016) or a positive association with firms’ performance (Bansal and Sharma, 2016; Mehrotra, 2016). Habib (2016) found that CEO duality has a positive impact on firms’ performance (ROA). Therefore, separating chairman from the CEO negatively affects firms’ performance (Dey et al., 2011; Habib, 2016; Kajola, 2008). These findings endorse the postulations of stewardship theory that opposes separation or splitting of the leadership. The theory supports combined leadership, i.e., CEO duality on account of entrusting the powers of two influential positions to an individual committed to the betterment of shareholders and success of the firm (Arora and Sharma, 2016; Bansal and Sharma, 2016).

To sum up, contradictory theoretical postulations, incongruent findings of the previous empirical studies and the introduction of MCCG (2012) necessitate further investigation of the relationship between SL structure and firms’ market performance in the Malaysian context. Therefore, on the basis of agency theory, this paper establishes following hypotheses for further investigation:

- **H1a.** Separate leadership structure of the board has a positive association with firms’ market performance before MCCG (2012).
- **H1b.** Separate leadership structure of the board has a positive association with firms’ market performance after MCCG (2012).

**Independent chair of the board and firms’ market performance**

Board chair is independent if the chairperson of the board is an independent director. It is also considered independent if the chairperson is not an existing or ex-director of the firm (Brickley et al., 1997; MCCG, 2012). Agency theory assumes that independence of the board reduces agency conflict between the management and shareholders by ensuring effective monitoring of managers (Fama, 1980; Fama and Jensen, 1983; Jensen and Meckling, 1976). However, it is argued that independence of the board cannot be achieved in absence of its IC (Coles and Hesterly, 2000). Besides strengthening independence of the board, IC of the board is also recommended in the firms having influential CEO. It is due to the fact that being free from the influence of the CEO, IC of the board ensures strict monitoring and advising of the management by countering the pressure or influence of the CEO. These, in turn, reduce the intensity of agency conflict which enhances the confidence of shareholders (Balsam et al., 2011; O’Connell and Cramer, 2010). Accordingly, the Recommendation no. 3.4 of MCCG (2012) states that:

> The positions of chairman and CEO should be held by different individuals and the chairman must be a non-executive member of the board.

The IC of the board was first proposed by CG blueprint document of Securities Commission Malaysia in July 2011. However, before including into the MCCG (2012), the proposal floated for knowing the response of public till September 2011. After receiving a positive public response, the proposal converted into the recommendation of MCCG (2012). Many studies endorse the theoretical postulation and regulatory attempts for establishing an IC of the board. These studies support independence of the boards’ chair on account of its significant positive association with firms’ performance (Hussin and Othman, 2012; O’Connell and Cramer, 2010). It is found that IC of the board improves firms’ compliance to CG attributes which signals their positive image to public, investors and market (Delloitte, 2014). Therefore, shareholders express more confidence in the firms having IC of their boards (Balsam et al., 2011; Coles and Hesterly, 2000).
However, in contrast, it is argued that establishing an IC of the board increases firms’ costs (Coles and Hesterly, 2000). Also, it is argued that IC requires vast experience of the independent director than his/her other counterparts on the board (Spencer Stuart, 2011). Based on stewardship theory, independent directors have little knowledge and experience of the firm and industry (Davis et al., 1997; Donaldson and Davis, 1991). Therefore, IC of the board is not effective in technical firms (Balsam et al., 2011). In view of these, it is also found that the regulatory pressure for establishing IC decreased firms’ market value (Spencer Stuart, 2011). Saat and Kallamu (2014) argued that monitoring abilities of the board’s IC are tampered by the influence of the CEO and executive directors, which affect firms’ performance in Malaysia.

To sum up, the previous empirical literature is not only limited but also incongruent which necessitate further investigation of the relationship between independent board chair and firms’ performance. The theoretical contradiction and introduction of MCCG (2012) also pronounce the need for further investigation of the relationship, particularly in the Malaysian context. Therefore, on the basis of agency theory, this paper establishes following hypotheses for further investigation:

H2a. Independent chair of the board has a positive association with firms’ market performance before MCCG (2012).

H2b. Independent chair of the board has a positive association with firms’ market performance after MCCG (2012).

The proportion of independent directors on the board and firms’ market performance

Agency theory supports independence of the board that can be gauged from the proportion of independent directors on the board (Fama, 1980). The theory posits that besides augmenting independence and improving the quality of decisions of the board, independent directors also facilitate firms in unbiased, sincere, and merit-based judgments and analyses. Being neutral and free from the influence of the management, independent directors keep an eye on firms’ overall operations for protecting the interests of shareholders (Fama and Jensen, 1983; Jensen and Meckling, 1976). Accordingly, the Recommendation no. 3.5 of MCCG (2012) states that:

The board must comprise a majority of independent directors where the chairman of the board is not an independent director.

Many empirical studies also found that the proportion of independent directors on the board has a significant positive association with firms’ performance (Heenetigala, 2011; Malik, 2012). It is found that firms with a higher number of independent directors on their boards have higher market value (Zhu et al., 2015). Also, it is found that true independence of the board increases the CEO’s fear of removal on account of poor performance (Masulis and Guo, 2013). Durua et al. (2016) found that the negative effect of the CEO duality is positively moderated by the presence of independent directors on the board. They found that the interlocking of the independent directors has a positive impact on firms’ performance.

In contrast, stewardship theory posits that independent directors lack firm and industry-specific knowledge (Davis et al., 1997; Donaldson and Davis, 1991). Therefore, they are highly dependent on executive directors particularly in seeking firms’ specific information which tampers their effectiveness and quality of decisions (Davis et al., 1997; Donaldson and Davis, 1991). In addition, the stewardship theory also assumes that executives are stewards of the firm who are committed toward its success and maximization of shareholders’ wealth (Davis et al., 1997). Many empirical studies endorse these
postulations by documenting a significant negative relation between independence of the board and firms’ performance (Bhagat and Bolton, 2009; Ness et al., 2010). Regardless of positive and negative relations, many studies also concluded that independent directors have no significant relation with firms’ performance (Abdullah, 2004; Klein, 2002; Mehrotra, 2016; Orazalin et al., 2015; Ponnu, 2008; Tham et al., 2012; Wang, 2014).

Summing up, there is a theoretical contradiction regarding the presence of independent directors on the board in relation to firms’ performance. The mixed findings of previous empirical literature further highlight theoretical contradiction. In view of these and introduction of MCCG (2012) that recommended an increase in the proportion of independent directors necessitate further investigation of the relationship between independent directors and firms’ performance in the Malaysian context. Therefore, on the basis of agency theory, this paper establishes the following hypotheses for further investigation:

H3a. The proportion of independent non-executive directors on the board has a positive association with firms’ market performance before MCCG (2012).

H3b. The proportion of independent non-executive directors on the board has a positive association with firms’ market performance after MCCG (2012).

Research design
Scope and methodology of the study
Consistent with previous literature, this study controls the size of firm and board due to their possible influence on the estimation of desired investigation (Hahn and Lasfer, 2015; Randøy et al., 2006). The sample of the paper is composed of 150 listed companies randomly selected from consumer, construction and technology sectors of the Malaysian economy. The information regarding share market price and firms’ size was extracted from DataStream while the data for firms’ age and CG attributes such as SL structure, IC of the board and proportion of independent directors on the board was collected from annual reports of the sample companies. The data were collected for four years from 2010 to 2014 by excluding 2012, which being the year of introduction of the new code. The four-year time span of the study explicitly represents two-year pre-context (2010-2011) and two-year post-context (2013-2014) of the code.

Measurement of variables
(1) Separate leadership structure (SL): 1 if leadership is separate and 0 otherwise.
(2) Independent chair of the board (IC): 1 if chair of the board is independent and 0 otherwise.
(3) Independent directors on the board (Bind): the proportion of independent directors to the number of total directors on the board.
(4) Share Market Price (SP): average share market price for one year.
(5) Board size (BSiz): total number of directors on the board.
(6) Firms’ size (FSiz): market capitalization of the firm.

Results and findings
Descriptive statistics
The comparison of descriptive statistics shows a significant increase in the compliance to CG attributes and share market price after enactment of the code as reported in Table I.
The statistics indicate that the new code improved compliance to CG attributes which attracted investors. Overall, the findings which provide support for the new code achieved the first objective of the study.

**Correlation matrix**

Tables II and III show the Pearson's and Spearman's correlation matrixes in pre-context and post-context of the MCCG (2012), respectively. The simultaneous application of both the correlation matrixes has a rationale of using variables in the study having mixed nature (Gujarati, 1995; Tariq and Abbas, 2013; Wooldridge, 2002). Both Tables II and III show

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Min.</th>
<th>Max</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP (pre)</td>
<td>1.723</td>
<td>3.34</td>
<td>0.05</td>
<td>2.19</td>
<td>–</td>
</tr>
<tr>
<td>SP (post)</td>
<td>2.193</td>
<td>5.05</td>
<td>0.03</td>
<td>4.7</td>
<td>–</td>
</tr>
<tr>
<td>SL (pre)</td>
<td>–</td>
<td>0.45</td>
<td>0</td>
<td>1</td>
<td>70.6</td>
</tr>
<tr>
<td>SL (post)</td>
<td>–</td>
<td>0.38</td>
<td>0</td>
<td>1</td>
<td>82%</td>
</tr>
<tr>
<td>IC (pre)</td>
<td>–</td>
<td>0.48</td>
<td>0</td>
<td>1</td>
<td>35%</td>
</tr>
<tr>
<td>IC (post)</td>
<td>–</td>
<td>0.50</td>
<td>0</td>
<td>1</td>
<td>47%</td>
</tr>
<tr>
<td>Bind (pre)</td>
<td>0.45</td>
<td>0.13</td>
<td>0.23</td>
<td>0.83</td>
<td>–</td>
</tr>
<tr>
<td>Bind (post)</td>
<td>0.47</td>
<td>0.13</td>
<td>0.25</td>
<td>1</td>
<td>–</td>
</tr>
<tr>
<td>BSiz (pre)</td>
<td>7.22</td>
<td>1.708</td>
<td>4</td>
<td>13</td>
<td>–</td>
</tr>
<tr>
<td>BSiz (post)</td>
<td>7.11</td>
<td>1.673</td>
<td>4</td>
<td>12</td>
<td>–</td>
</tr>
<tr>
<td>FSiz (pre)</td>
<td>5.16</td>
<td>0.677</td>
<td>3.73</td>
<td>7.35</td>
<td>–</td>
</tr>
<tr>
<td>FSiz (post)</td>
<td>5.24</td>
<td>0.660</td>
<td>3.92</td>
<td>7.38</td>
<td>–</td>
</tr>
</tbody>
</table>

Notes: $T =$ 2 years, $n =$ 150, total observations = 300 (150 x 2). SP, share market price; SL, separate leadership; IC, independent chair of the board; Bind, the proportion of independent directors on the board; BSiz, board size; FSiz, firms’ size.

**Table I.** Descriptive statistics for pre-context (2010-2011) and post-context (2013-2014) of MCCG (2012)

**Table II.** Pearson’s and Spearman’s correlation matrix for pre-context (2010-2011) of MCCG (2012)

<table>
<thead>
<tr>
<th>Pre</th>
<th>SP</th>
<th>SL</th>
<th>IC</th>
<th>Bind</th>
<th>BSiz</th>
<th>FSiz</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP</td>
<td>1</td>
<td>–0.004</td>
<td>0.174**</td>
<td>–0.006***</td>
<td>0.232***</td>
<td>0.753***</td>
</tr>
<tr>
<td>SL</td>
<td>–0.007</td>
<td>1</td>
<td>0.365**</td>
<td>–0.033</td>
<td>0.161**</td>
<td>–0.01</td>
</tr>
<tr>
<td>IC</td>
<td>0.163**</td>
<td>0.354**</td>
<td>1</td>
<td>0.268***</td>
<td>0.065*</td>
<td>0.147*</td>
</tr>
<tr>
<td>Bind</td>
<td>–0.124*</td>
<td>0.034</td>
<td>0.115*</td>
<td>1</td>
<td>–0.389***</td>
<td>0.003***</td>
</tr>
<tr>
<td>BSiz</td>
<td>0.222***</td>
<td>0.114***</td>
<td>0.129*</td>
<td>–0.381***</td>
<td>1</td>
<td>0.269***</td>
</tr>
<tr>
<td>FSiz</td>
<td>0.728***</td>
<td>–0.018</td>
<td>0.112*</td>
<td>–0.153***</td>
<td>0.329**</td>
<td>1</td>
</tr>
</tbody>
</table>

Notes: $T =$ 2 years, $n =$ 150, total observations = 300 (150 x 2). SP, share market price; SL, separate leadership; IC, independent chair of the board; Bind, the proportion of independent directors on the board; BSiz, board size; FSiz, firms’ size. *,**,***Significant at 1, 5 and 10 percent levels, respectively.

**Table III.** Pearson’s and Spearman’s correlation matrix for post-context (2013-2014) of MCCG (2012)

<table>
<thead>
<tr>
<th>Post</th>
<th>SP</th>
<th>SL</th>
<th>IC</th>
<th>Bind</th>
<th>BSiz</th>
<th>FSiz</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP</td>
<td>1</td>
<td>0.007</td>
<td>0.163**</td>
<td>–0.124</td>
<td>0.222***</td>
<td>0.728**</td>
</tr>
<tr>
<td>SL</td>
<td>0.055</td>
<td>1</td>
<td>0.354**</td>
<td>0.034</td>
<td>0.114*</td>
<td>–0.018</td>
</tr>
<tr>
<td>IC</td>
<td>0.108*</td>
<td>0.354**</td>
<td>1</td>
<td>0.115*</td>
<td>0.129*</td>
<td>0.112*</td>
</tr>
<tr>
<td>Bind</td>
<td>–0.032</td>
<td>0.008</td>
<td>0.079*</td>
<td>1</td>
<td>–0.381***</td>
<td>–0.153***</td>
</tr>
<tr>
<td>BSiz</td>
<td>0.129*</td>
<td>0.008*</td>
<td>0.114*</td>
<td>–0.383***</td>
<td>1</td>
<td>0.323**</td>
</tr>
<tr>
<td>FSiz</td>
<td>0.528***</td>
<td>0.025</td>
<td>0.128*</td>
<td>–0.119*</td>
<td>0.323**</td>
<td>1</td>
</tr>
</tbody>
</table>

Notes: $T =$ 2 years, $n =$ 150, total observations = 300 (150 x 2). SP, share market price; SL, separate leadership; IC, independent chair of the board; Bind, the proportion of independent directors on the board; BSiz, board size; FSiz, firms’ size. *,**,***Significant at 1, 5 and 10 percent levels, respectively.
Pearson’s and Spearman’s statistics above and below the diagonal line, respectively. The statistics in both the tables explain the correlation between CG attributes and share market price in pre-context and post-context of the code. The findings of both the matrixes reported in Table II show that IC, BSiz and FSiz have a significant positive while Bind has a significant negative association with SP before enactment of the code. Also, the findings show an insignificant negative correlation of SL with SP in pre-context of the code.

Table III shows the Pearson’s and Spearman’s correlation matrixes for the association between CG attributes and share market price after enactment of the code. The statistics of both the matrixes show that IC, BSiz and FSiz have a significant positive while Bind has an insignificant negative association with SP. However, the correlation between SL and SP changed from insignificant negative before (Table II) to insignificant positive after enactment of the code as reported in Table III.

**Multiple regression analyses**

Before employing regression for more sophisticated estimation, the data diagnosed for the issues such as multicollinearity, heteroscedasticity and autocorrelation. The statistics of Pearson’s and Spearman’s correlation matrixes reported in Tables II and III before and after enactment of the code evidence that none of the correlation between regressors is equal or higher than 0.8 (Gujarati, 1995; Tariq and Abbas, 2013; Wooldridge, 2002). Thus, there is no issue of multicollinearity in both the data sets representing pre-context and post-context of the code. The study employed Breusch-Pagan/Cook-Weisberg test for checking homoscedasticity. The findings of the test confirm the presence of heteroscedasticity in pre-context and post-context of the code as reported in Table IV. It is found that there is no autocorrelation as Durbin-Watson (DW) statistics in pre-context and post-context of the code are close to 2 (Table IV). It is due to the fact that any DW value below 1.00 or above 3.00 indicates a serious issue of autocorrelation (Gujarati, 1995; Tariq and Abbas, 2013; Wooldridge, 2002).

The presence of heteroscedasticity implies that ordinary least square (OLS) is no more the best linear unbiased estimator. It is due to the reason that OLS strictly requires the satisfaction of all classical assumptions including homoscedasticity. The non-applicability of OLS is further confirmed by the results of Breusch and Pag n Lagrangian multiplier test for random effect (RE) as reported in Table V. The findings of the test evidenced panel effects, i.e., fixed or random in both the contexts surrounding the code (Gujarati, 1995; Wooldridge, 2002).

The study employed Hausman test to select the appropriate estimator between fixed and RE of the generalized least square (GLS). The findings of Hausman test in pre-context and post-MCCG (2012)

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>( \chi^2 )  (3)</td>
<td>86.58</td>
<td>83.87</td>
</tr>
<tr>
<td>Prob &gt; ( \chi^2 )</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>DW</td>
<td>1.87</td>
<td>1.89</td>
</tr>
</tbody>
</table>

**Table IV.** Breusch-Pagan/Cook-Weisberg test for heteroscedasticity

<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>( \chi^2 )  (01)</td>
<td>132.23</td>
<td>148.11</td>
</tr>
<tr>
<td>Prob &gt; ( \chi^2 )</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

**Table V.** Breusch and Pagan Lagrangian multiplier test for RE
post-context of the code show appropriateness of the RE over fixed effect as reported in Table VI. In other words, there is an association between regressors and unobserved heterogeneity (Gujarati, 1995; Wooldridge, 2002).

The GLS RE estimator was further robust for controlling the evident heteroscedasticity in both sets of the data (Gujarati, 1995; Wooldridge, 2002). The robust results reported in Table VII show an insignificant positive relation of both the SL and IC with share market price in the pre-context (2010-2011) of MCCG (2012). However, the findings show that the proportion of independent directors on the board (Bind) has positive but statistically weak relation with share market price before enactment of the code. Among control variables, board size (BSiz) has an insignificant negative while firms’ size (FSiz) shows a significant positive relation with share market price.

The RE robust analyses reported in Table VIII show that SL and proportion of independent directors on the board (Bind) have a significant positive relation with share market price after enactment of the code. However, the relationship between IC of the board and share market price is significantly negative in post-context of the code. Among control

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coef.</th>
<th>SE</th>
<th>z</th>
<th>P &gt; z</th>
<th>95% conf.</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>SL</td>
<td>0.1775</td>
<td>0.2493</td>
<td>0.71</td>
<td>0.239</td>
<td>−0.31111</td>
<td>0.666025</td>
</tr>
<tr>
<td>IC</td>
<td>0.0996</td>
<td>0.3110</td>
<td>0.32</td>
<td>0.375</td>
<td>−0.59995</td>
<td>0.799148</td>
</tr>
<tr>
<td>Bind</td>
<td>1.0858</td>
<td>0.8221</td>
<td>1.32</td>
<td>0.094</td>
<td>−0.52545</td>
<td>2.697141</td>
</tr>
<tr>
<td>Bsiz</td>
<td>−0.0024</td>
<td>0.0744</td>
<td>−0.03</td>
<td>0.487</td>
<td>−0.14832</td>
<td>0.143431</td>
</tr>
<tr>
<td>FSiz</td>
<td>2.9419</td>
<td>0.5765</td>
<td>5.10</td>
<td>0.000</td>
<td>1.81204</td>
<td>4.071825</td>
</tr>
<tr>
<td>Constant</td>
<td>−14.0792</td>
<td>2.8646</td>
<td>−4.91</td>
<td>0.000</td>
<td>−19.3689</td>
<td>−8.46476</td>
</tr>
</tbody>
</table>

**Notes:** $R^2 = 0.0579$, Wald $\chi^2$ (5) = 29.44, prob. $\chi^2 = 0.00$, $T = 2$ years, $n = 150$, total observations = 300 (150 × 2). SP, share market price; SL, separate leadership; IC, independent chair of the board; Bind, the proportion of independent directors on the board; BSiz, board size; FSiz, firms’ size

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coef.</th>
<th>SE</th>
<th>z</th>
<th>P &gt; z</th>
<th>95% conf.</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>SL</td>
<td>0.3537</td>
<td>0.1710</td>
<td>2.07</td>
<td>0.020</td>
<td>0.018587</td>
<td>0.688778</td>
</tr>
<tr>
<td>IC</td>
<td>−0.2312</td>
<td>0.1434</td>
<td>−1.61</td>
<td>0.054</td>
<td>−0.51227</td>
<td>0.049886</td>
</tr>
<tr>
<td>Bind</td>
<td>1.4141</td>
<td>0.5787</td>
<td>2.44</td>
<td>0.008</td>
<td>0.27991</td>
<td>2.548382</td>
</tr>
<tr>
<td>Bsiz</td>
<td>0.0331</td>
<td>0.0401</td>
<td>0.83</td>
<td>0.205</td>
<td>−0.04553</td>
<td>0.111716</td>
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<tr>
<td>FSiz</td>
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<td>0.2735</td>
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<td>0.000</td>
<td>0.714143</td>
<td>1.786525</td>
</tr>
<tr>
<td>Constant</td>
<td>−5.4477</td>
<td>1.4059</td>
<td>−3.87</td>
<td>0.000</td>
<td>−8.2032</td>
<td>−2.69219</td>
</tr>
</tbody>
</table>

**Notes:** $R^2 = 0.1680$, Wald $\chi^2$ (5) = 27.09, prob. $\chi^2 = 0.001$, $T = 2$ years, $n = 150$, total observations = 300 (150 × 2). SP, share market price; SL, separate leadership; IC, independent chair of the board; Bind, the proportion of independent directors on the board; BSiz, board size; FSiz, firms’ size

**Table VI.** Hausman specification test

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coef.</th>
<th>SE</th>
<th>z</th>
<th>P &gt; z</th>
<th>95% conf.</th>
<th>Interval</th>
</tr>
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<td>0.71</td>
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<td>1.0858</td>
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<td>0.094</td>
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<td>0.000</td>
<td>−19.3689</td>
<td>−8.46476</td>
</tr>
</tbody>
</table>

**Table VII.** GLS random effect robust results – 2010-2011 (pre)

**Table VIII.** GLS random effect robust results – 2013-2014 (post)
variables, board size (BSiz) has an insignificant while firms’ size (FSiz) has a significant positive relation with share market price as shown in Table VIII. Overall, the findings reported in Tables VII and VIII achieved the second objective of the study.

**Discussion and explanation**

The GLS RE robust analyses showed an insignificant positive relationship between SL structure and firms’ market performance measured by share market price in pre-context of the code (Table VII). The findings which reject $H1a$ of the study changed from insignificant to significant positive after enactment of the code (Table VIII). The improvement in relationship might have a plausible explanation that sample firms increased the separation of two roles from 70.60 percent in pre to 82 percent in post-context of the code (Table I). The findings in post-context of the code which accept $H1b$ of the study also endorse the postulations of agency theory (Table VIII). The theory posits that SL strengthens independence of the board which protects shareholders’ interests (Fama, 1980; Fama and Jensen, 1983; Jensen and Meckling, 1976). Therefore, shareholders express confidence in improving compliance to SL structure as evidenced by an increase in share market price. The findings are similar to Hassan (2014) who found that insignificant relationships between CG attributes and firms’ market performance are changed to significant positive by the introduction of CG codes. The findings are also consistent with many other previous empirical studies (Jackling and Johl, 2009; Kajola, 2008; Tham et al., 2012).

Table VII shows that IC of the board has an insignificant relation with share market price before enactment of the code (Table VII). However, increase in compliance to an IC of the board from 35 percent in before to 47 percent in after the enactment of the code (Table I) turned its insignificant positive relation into significant negative with share market price (Table VIII). The findings in pre-context (Table VII) and post-context of the code (Table VIII) which do not support $H2a,b$ of the study also oppose the postulations of agency theory (Fama, 1980; Fama and Jensen, 1983; Jensen and Meckling, 1976). However, both the findings show consistency with Saat and Kallamu (2014) who argued that IC of the board has no significant positive association with firms’ performance in Malaysia. The significant negative coefficient of an IC of the board after enactment of the code might be an outcome of its newness that first proposed in July 2011 and included in MCCG (2012) in March 2012. Consistent with previous literature, the significant negative findings can also be explained that regulatory pressure for establishing an IC of the board increased firms’ compliance costs after enactment of the code (Bello, 2016; Crina, 2016; Tariq and Abbas, 2013).

The statistics reported in Table VII show that the proportion of independent directors on the board (Bind) has a weakly significant and positive relation with share market price before enactment of the code. However, the improvement in compliance to the proportion of independent directors (Table I) from 45 percent in pre-context to 47 percent in post-context of the code strengthened statistical significance of its positive relation with share market price (Table VIII). The findings which support $H3a,b$ of the study also endorse the postulations of agency theory. The theory posits that increase in the proportion of independent directors improves capabilities of the board with respect to guiding and monitoring of the management (Fama, 1980; Fama and Jensen, 1983; Jensen and Meckling, 1976). Accordingly, shareholders express confidence in strengthening independence of the board. The findings are also consistent with many previous empirical studies (Heenetigala, 2011; Malik, 2012). However, the findings show inconsistency with Shukeri et al. (2012) in Malaysia. The inconsistency in findings might be due to the difference in sample, duration, statistical techniques or timing of the studies. Among control variables, board size (BSiz) has an insignificant negative association with share market price before enactment of the
code. However, the relationship changed to insignificant positive after enactment of the code. This might be due to a slight decrease in the average size of the board (Table I) in post-context of the code. Firms’ size showed a significant positive association with share market price before and after enactment of the code. Consistent with previous literature, the findings indicate that shareholders express confidence in large firms due to their potential for showing resistance to economic and financial turbulent (Hahn and Lasfer, 2015; Lama et al., 2012; Oladipupo and Okafor, 2005).

Conclusions and policy recommendations
The significant positive findings for SL and independent directors on the board (Bind) after enactment of the code (Table VIII) explain the confidence of shareholders in independence of the Malaysian boards. The findings endorse the postulations of agency theory that intensity of agency conflict between management and shareholders can be reduced by augmenting independence of the board. Besides this, the findings also provide support for MCCG (2012) that reinforced the separation of two influential roles of CEO and chairman of the board and increase in the proportion of independent directors on the board (Bind). Based on findings, this paper recommends that regulators and policy makers should further improve compliance to the recommendations of SL and proportion of independent directors (Bind). It is due to the fact that SL has an average of 82 percent whilst Bind represents 48 percent of the corporate boards (Table I). Independent directors are yet to get a majority on Malaysian boards. Regarding board IC, this study proposes that Malaysian firms should strive to nominate experienced or retired CEOs as independent chairperson (Spencer Stuart, 2011). Among control variables, the insignificant findings for board size indicate that most of the Malaysian firms have an average of fewer than eight members on their boards (Table I) as recommended by previous studies (Randøy et al., 2006). Therefore, it could not capture any statistical significance in the regression estimation (Gujarati, 1995; Tariq and Abbas, 2013). Regarding firms’ size, the findings indicate that shareholders express more confidence in large firms (Hahn and Lasfer, 2015; Lama et al., 2012; Oladipupo and Okafor, 2005). Besides contributing to the scarce and incongruent literature in pre-context and post-context of CG regulations (Owusu et al., 2012), the findings of the study also provide important insights for further improvement of the policy and practice in emerging markets like Malaysia. The findings update the regulators, policy makers, banks, Bursa Malaysia, Securities Commission of Malaysia and all other stakeholders including shareholders who were interested to know the impact of the new code.

Directions for further research
Besides considering some other recommendations of MCCG (2012) such as boardroom diversity, the study also suggests increasing the size of the sample for further verification of the derived conclusions in future. Consistent with Babones (2013), other studies might also employ the alternate methodology by using the regression estimator like OLS with panel-corrected standard errors for controlling the evident heteroscedasticity in data. Based on the market for corporate control of agency theory, the studies in future may also look into the mediating effect of firms’ financial performance measured by accounting measures in the relationship between CG attributes and shareholders’ confidence.

References


**Corresponding author**
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