

EJM&BE

Volume **27** Number **2**

ISSN 2444-8494

European Journal of Management and Business Economics

**Innovation, knowledge
absorption, judgement and
decision-making processes**

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and Giampaolo Viglia

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ISSN 2444-8494

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European Journal of Management and Business Economics

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Introduction to the special issue on innovation, knowledge absorption, judgement and decision-making processes

Introduction

The recent global financial crisis has stressed the importance to rely on long-term sources of economic growth. Prior research on business, economics and management has shown that knowledge-intensive services and innovation contribute not only to social well-being, but also to regional and national long-term economic growth (e.g. Audretsch and Keilbach, 2004; Braunerhjelm, 2011; Parellada *et al.*, 2011; Wu, 2013; Mas-Tur and Soriano, 2014; Mas-Tur and Simón-Moya, 2015; Mas-Tur and Bolufer, 2016).

Innovation may be defined as novel adoption or exploitation of processes, products or services that add economic or social value. But, to translate into economic or social improvements, innovation relies on organisational culture and knowledge absorption (Murovec and Prodan, 2009; Behrens, 2016; Pera and Viglia, 2016; Solis Vázquez *et al.*, 2017). Absorbing external knowledge and creating internal knowledge are key processes for innovation in firms. In fact, internal knowledge creation and absorptive capabilities have been shown to positively affect innovation performance (Camisón and Forés, 2010; Esterhuizen *et al.*, 2012; Forés and Camisón, 2016).

Knowledge absorption relates to the manager's judgement and the firm's decision-making processes. Social judgement theory (Sherif and Hovland, 1961) provides a framework for understanding firms' and managers' innovation-related decision processes. When managers make innovation-related decisions, they focus on four key attributes: profitability (i.e. financial returns and risk), strategic considerations (i.e. competitive advantage), uncertainty (i.e. demand and technological uncertainty) and social dimensions (e.g. management support and reputation). Judgement and decision-making processes regarding project choices are critical for achieving superior innovation performance, thus previous research has overlooked at this issue.

This special issue contributes to the literature on innovating and managing knowledge through judgement and decision making. In doing so, this special issue supports long-term economic growth complementing prior studies on innovation and knowledge management. The findings presented herein are pertinent to private and public decision makers, scholars and professionals. This special issue was initiated through the 7th Global Innovation and Knowledge Academy Conference, which took place in Lisbon, Portugal, in June 2017.

Contributions

The first contribution presents an analysis of "The effect of strategic flexibility configurations on product innovation". In this study, Behara, Bingol, Ozkan-Canbolat and Szczygiel apply fuzzy-set qualitative comparative analysis to data from semi-structured interviews with workers at electrical household appliance firms. The results reveal departmental contributions to strategic flexibility and the effect on product innovation.



In the following contribution, de Juana-Espinoso and Rakowska analyse “Public sector motivational practices and their effect on job satisfaction: country differences”. By presenting data from a sample of administrative workers at Spanish and Polish universities, the authors confirm that bureaucratic culture overrides country differences. The authors conclude that public sector organisational practices can be applied to different countries to improve performance. Mocciano Li Destri and Lo Nigro investigate “The relationship between institutions and value creation in software development models”. The authors compare different institutional settings and explore how the adoption of a hybrid model involves modification of the firms’ value appropriation strategy.

Oghazi, Rad, Karlsson and Haftor analyse “The effects of RFID and ERP systems on supply chain management”. Their findings indicate that these enterprise systems facilitate supply chain integration by improving information flow. The study has important implications for practitioners and scholars. In the subsequent contribution, Orozco, Vargas and Galindo present “The relationship between board size and financial and reputational corporate performance: the case of Colombia”. The study investigates the relationship between board size and financial and reputational corporate performance using correlations and cluster analysis. According to the analysis, large boards are associated with high performance on corporate reputation and poor financial performance, but there is no relationship that exists between financial and reputational performance.

The last contribution is “R&D and non-R&D in the innovation process among firms in ASEAN countries: based on the firm-level survey data”. In this study, Tsuji, Ueki, Shigeno, Idota and Bunno use survey data and probit analysis to identify different approaches to R&D and non-R&D innovation. The results indicate that leadership by top management drives innovation in local non-R&D firms.

Holistically, the package of articles informs on the role of knowledge management and innovation across different geographical and organisational contexts. In particular, the breadth of topics, spanning from value creation to supply chain and financial performance, offers a comprehensive view of the studied phenomena.

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The effect of strategic flexibility configurations on product innovation

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Received 29 November 2016

Revised 8 September 2017

3 November 2017

Accepted 8 November 2017

Abstract

Purpose – The purpose of this paper is to determine the contribution of company functional areas – production, marketing, and human resources – to strategic flexibility configurations. It also seeks to explore the comparative contributions of functional areas to product innovation.

Design/methodology/approach – The study uses the fuzzy-set qualitative comparative analysis to develop a better understanding of departmental contributions to strategic flexibility configuration and the effect of strategic flexibility on product innovation by functional areas.

Findings – The findings of this study indicate that marketing flexibility has a key role in product innovation.

Research limitations/implications – A limited number of cases may be one of the possible reasons for no proven contribution of HR flexibility to product innovation, and may affect results due to poor representation.

Practical implications – The required flexibility level is at least the one maintaining the company's status and certifying competitive advantage.

Social implications – A pressure for flexibility leads companies to modify their organizational structure, processes, and resources.

Originality/value – The environmental change and uncertainty provide dynamic challenges that increase the need of company flexible reactions

Keywords Product innovation, Strategic flexibility, Configuration approach,

Fuzzy-set qualitative comparative analysis

Paper type Research paper

Introduction

With the advancement of information technologies, company strategy focuses nowadays on sustainable competitive advantage, and gives importance to short-term advantages of flexibility and fast response. As a result, flexibility is accompanied by reorganization of resources and skills, strategic cooperation, and centrifugal hierarchical structure (Grant and Jordan, 2012). A company aims to absorb or exploit uncertainty through flexibility (Cannon



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European Journal of Management
and Business Economics
Vol. 27 No. 2, 2018
pp. 129-140
Emerald Publishing Limited
2444-8494
DOI 10.1108/EJMBE-02-2018-0028

and John, 2004). Flexibility is relevant to a company's ability to respond to uncertainty in both macro and micro environmental scope, while product innovation is a reaction to competitive environment.

Uncertainty has a substantial role in strategic decision-making processes. Uncertainty within the industry increases the risk and ambiguity for new-product decisions. It is a direct result of inability to forecast the direction and content of change (Thomas, 2014; Chari *et al.*, 2014). In this context, product innovation is also a key tool to cope with uncertainty and sustainable competitive advantage.

In this context, companies need innovative products for their markets. They also seek coherent structure, resources, and processes to support product innovation. In the literature, strategic flexibility mostly relates to uncertainty. Only a few research studies (Sharma and Jain, 2010; Oke, 2013) focus specifically on the effect of strategic flexibility on product innovation. Previous research has focused on either one function or the whole organization, and has not shown comparative contributions by departments to strategic flexibility. This research fills that gap by examining the effect of three functional areas together, and aims to examine the level of their individual contribution to strategic flexibility configuration. Finally, the study also differs from previous ones in the methodology it applies, as it investigates the relationship between strategic flexibility and product innovation in qualitative terms.

In the first part, we determine strategic flexibility configurations and subindicators of strategic flexibility. Production, marketing, and human resources (HR) departments hold the key indicators for analyzing strategic flexibility. In the second part, we examine whether and how strategic flexibility configurations characterize product innovation.

Literature review

Sanchez (1995, 1997) defines flexibility as an ability to respond to varying demands coming from a company's dynamic competitive environment. Hitt *et al.* (1998) define flexibility as the company's ability to immediately respond to the changing conditions of the competition, and thus to maintain or improve its competitive advantage. Strategic flexibility is considered a vital feature, particularly for industries that have highly dynamic environmental conditions (Cannon and John, 2004; Mackinnon *et al.*, 2008). Sharfman and Dean (1997), and Johnson *et al.* (2003) emphasize that a growing level of uncertainty increases the need of the company to become flexible.

From the resource-based perspective, strategic flexibility means the ability to redistribute and reorganize organizational resources, processes, and strategies of the company, based on the environmental change (Sanchez, 1995, 1997).

Strategic flexibility plays a guiding role in many organizational features such as investments, enabling rapid shifts between competitive approaches, policies, encouraging learning, and structure. Decreasing structural inelasticity and creating a horizontal and flat organizational structure are important to providing desirable flexibility (Beraha, 2014). This flexibility supports adjustment to the competitive environment by decreasing costs and reducing need for time. By means of strategic flexibility, companies find a chance to evaluate available opportunities and to minimize risks to their assets (Roca-Puig *et al.*, 2005). The success of strategic flexibility is proportional to the rate, scope, and cost of the response to uncertainty (Gerwin, 1993).

Approaches to and perspectives on flexibility differ in literature related to strategic management and organization theories. In general, these two conceptual perspectives, organizational and strategic flexibility, are interrelated and complementary. Strategic flexibility can become an organizational feature by achieving organizational flexibility at all levels. Likewise, flexibility at all levels and in functional departments of a company enriches the options of decision-making units, and thus facilitates strategic flexibility. This two-way

relationship helps a company make shifts between activities or enrich them, and turns strategic flexibility into an organizational feature. Both organizational and strategic flexibility become meaningful on the basis of organizational resources, skills, structure, processes, and the number of strategic options.

Zhang (2005) and Roca-Puig *et al.* (2005) discuss the effects of strategic flexibility on organizational performance. One of the desired organizational performance effects is product innovation.

There is vast evidence of the relationship between strategic flexibility and product innovation. In one of his early studies, Sanchez (1995) indicates a positive relationship between strategic flexibility and product innovation. Further, Zhou and Wu (2010), Fan *et al.* (2013) and Wei *et al.* (2014) show a supportive role for strategic flexibility in product innovation. The same results are presented by Kamasak *et al.* (2016).

Production flexibility

Production technology is closely relevant to process flexibility necessary to reach the required level of output flexibility (Urtasun-Alonso *et al.*, 2014). In terms of production, process flexibility means production of various products in the same plant or on the same production line. Therefore, process flexibility depends on the decisions concerning which plants and which production lines will produce the products (Beraha, 2014). When a company possesses few products and plants, decisions about flexibility will be relatively simple. As the variety of products and the number of plants increase, it becomes more difficult to assess benefits that flexibility brings (Jordan and Graves, 1995).

Sethi and Sethi (1990) report that production flexibility consists of operational and material-handling flexibility. In terms of production, flexibility aims to decrease the amount and costs of stock. On the other hand, direct and indirect connections between product and plant groups are also relevant for flexible production decisions. The interpermeability of products and plants increases due to these connections, and thus the traces of each product and plant intertwine with each other (Jordan and Graves, 1995).

In their research, Worren *et al.* (2002) argue that companies performing in particularly dynamic markets need to ensure higher product modularity. The authors stress the importance of modular product design, indicating that the production system that ensures product variety, through design based on new combinations of standard components, may promote its environmental fit. They conclude that modular product architecture has a certain effect on strategic flexibility.

Cannon and John (2004) analyze flexibility in four aspects. The first is tactical input flexibility, which indicates procurement of raw materials of desirable quality, and the abilities to minimize deficiencies arising from suppliers (such as delays or undersupply) and shift to alternative suppliers for any kind of input. Second, strategic input flexibility emphasizes the ability to use new raw materials and inputs. Third, tactical output flexibility covers the abilities to modify product properties as customers demand, accommodate changes to order due dates and amounts, and make rapid modifications in the available products mix. Finally, strategic output flexibility covers the start of production of new products, making modifications in product design and new-product decisions (for the market, the company, or both).

Marketing flexibility

Johnson *et al.* (2003) refer to the long-term strategic advantage of companies that proactively adjust themselves to change. When correlating market-based flexibility and environmental uncertainty, the authors emphasize that provision of high-level market-based strategic flexibility under conditions of high uncertainty increases organizational performance in the long run.

In his research, Sanchez (1999) discusses process flexibility in terms of the marketing function. He points out the need to impose a modular property on marketing processes, so they can gain flexibility and adaptation skills against the flexibility of the market. Common marketing-process views depend on optimization of the supply and distribution channels, so that they can support a certain production line for a certain market segment. Contrary to this view, the author indicates the need to create a supply and distribution channel that supports a system to produce various products addressing various consumer segments. He also discusses marketing processes within the framework of marketing organizations, such as market research, market development, supply chain, distribution channels, and product design, and claims that these processes will improve their flexibility and fit with the modular structure (Beraha, 2014).

Price flexibility covers discounts in prices, and benefits and services offered to customers free of charge. Distribution flexibility refers to the availability of alternative channels, performance of online sales, bargaining power of the company in agency contracts, and a company's ability to shift to alternative agencies in order to take measures against logistical problems. Promotion flexibility includes efficient use of mass-media tools, personal sales attempts, promotional activities, and frequency of participation in national and international fairs, events, and media meetings.

HR flexibility

Becker and Huselid (1998) emphasize that flexible HR systems promote procurement, encouragement, and development of intellectual assets. These systems support environmental fit and add value as a source of competitive advantage (Bhattacharya *et al.*, 2005).

One of the approaches to maintaining a flexibility-based system relies on supporting workforce flexibility in changing conditions, and investing in it (Cannon and John, 2004). HR flexibility is conceptualized by Wright and Snell (1998) within the framework of three components: worker skills flexibility, worker behaviors flexibility, and HR management practices flexibility:

- (1) Worker skills flexibility relates to the amount (variety) of skills that workers possess and can transfer to alternative uses; and rapid reassignment of workers who possess various skills.
- (2) Worker behaviors flexibility refers to the ability to routinize behaviors. In other words, workers have a wide set of behavioral codes that are adjustable to specific needs.
- (3) HR management practices flexibility means the company can adapt HR practices and apply them to various situations in various units. This type of flexibility also refers to the rate of these adjustments and practices.

Methodology

Configuration theory as a research method

The research makes use of the fuzzy-set qualitative comparative analysis (fsQCA). As a theoretical approach tool, the Qualitative Comparative Analysis (QCA) technique studies cases that include groups with qualitative properties suitable for testing configuration theories. As opposed to the regression and correlation methods matching Boolean algebra (Fiss, 2007) linearity theory, QCA may focus on equifinality and togetherness of the variables to obtain simplified statements that create certain results. QCA refers to the scenarios that enable a system to reach at the same final situation from different start points and through different or multiple ways (Katz and Kahn, 1978).

QCA offers a framework for the comparison of organizational configurations. In order to analyze the limited variety between equifinality and configurations, QCA discusses their applicability (Fiss, 2007). This paper follows the recommendations of Fiss (2007) and avoids several analytic methods, such as the cluster analysis, interaction effects, and deviation scores. When demanding complex causality and nonlinear relationships, the paper follows the theories of QCA method. Qualitative focus enables the analysis of a few cases, as it is both intense and complementary (Ragin, 2008). For this reason, this paper uses a specific type of QCA, the fsQCA program, to determine the relationships between product innovation and strategic flexibility configurations.

Methods

The first part of the research identifies the production, marketing, and HR functions affecting strategic flexibility, and their subsidiary aspects. We use a multiple case study methodology and semistructured interviews as the data-collection method. A semistructured interview method enables utilization of prearranged standard questions and additional questions that would enable acquisition of deep knowledge (Yildirim and Simsek, 2011; Buyukozturk *et al.*, 2014).

We study product innovation as an outcome, and calculate outcome with respect to companies' new innovation decisions, new market opportunities, and production mix. While determining the measures for outcome, we use the same method for conditions and take the cumulative valuation of companies' new innovation decisions, new market opportunities, and production mix values.

The industry selection process focused on the electrical household appliances industry, due to its dynamic market structure, which responds to consumer demands, and thus is in great need of flexibility. According to the data supplied by GfK Temax Turkey, more than 50 brands owned by more than 30 producers in the Turkish small electrical household appliances market dominate 98-99 percent of the market as of 2014. Nearly half are domestic producers. The authors contacted the ten largest (in terms of amount and turnover) Istanbul-located (in terms of convenience and research budget) companies, and presented the study to them. From those, four companies agreed to participate (40 percent). These four companies represent 20 percent of the Turkish retail market in terms of amount, and 12 percent of the market in terms of turnover. All interviews took place in Istanbul in May 2014.

The interview guide was prepared after the literature review, and used scales from empirical research studies in the strategic flexibility literature as a basis. Within this framework:

- Production flexibility questions use Cannon and John's (2004) scale, developed on the basis of four aspects: tactical input, tactical output, strategic input, and strategic output.
- Marketing literature does not include any flexibility-relevant scale. Consequently, marketing flexibility questions focus on the marketing-mix elements. This paper adds two more dimensions to determining marketing flexibility. The consumer and agency knowledge aspect relates to the presence or absence of a database containing consumer and agent customer information that guides marketing processes, due to market uncertainty necessitating extensive market information to cope with uncertainty (Chari *et al.*, 2014). The new markets aspect relates to capability of expanding market scope and depth. The research aims to measure marketing flexibility that includes marketing department functions and market data. As production flexibility items include questions about the product, the product aspect does not have a part in the marketing questions. The marketing

flexibility research structures the subsidiary aspects of price, distribution, and promotion factors, according to the studies of Sanchez (1999), Johnson *et al.* (2003), and Combe and Greenley (2004), and prepares the questions accordingly. Apart from the marketing-mix factors, the research also includes questions about new market opportunities, and agent, customer, and consumer information (Fan *et al.*, 2013; Combe and Greenley, 2004).

- HR flexibility questions make use of the scale that Bhattacharya *et al.* (2005) developed, which they based on three aspects: worker skills flexibility, behavioral flexibility, and HR management practices flexibility.

Average number of new products released into the market over years is accepted as an indicator for product innovation.

While collecting the measures for conditions, we take the cumulative valuation of departments' affect. Production flexibility condition includes 9 sub-affects summation (4 main affects); marketing flexibility includes 15 sub-affects summation (5 main affects) and HR flexibility includes 13 sub-affects (3 main affects). After collecting the measures for the conditions and the outcome, we calibrate the conditions so that they are computable in a fsQCA (Schneider and Wagemann, 2012). For the conditions, we set the maximum value for outcome at 100, the threshold for the crossover value for outcome at 60, and the minimum value at 0. We set the threshold for the crossover value higher. Intense competition, home fashion trends, and economic developments influence the electrical household appliances industry. The industry requires medium-level flexibility as a configurative feature. Electrical household appliances industry actors must achieve flexibility that can meet medium-level uncertainty, to obtain sustainability. Consequently, the industry must renew its products and/or production, and offer innovative products to present and/or new markets. We appoint the threshold for the crossover value at 80, due to both the industry features and the need for objective and robust results to show the effect of strategic flexibility configuration on product innovation. For the causes/conditions, we set the maximum value at 100, threshold for the crossover value at 80, and minimum value at 50. In doing so, we ensure that they calibrate the entire strategic flexibility configuration with respect to all cases.

This research processes product innovation as an outcome, testing for certain combinations of strategic flexibility degrees of the companies, with respect to product, marketing, and HR departments' affects. The study then uses each of the negations separately.

The process of analyzing findings primarily makes use of descriptive analysis. Then the process rates the findings using the hundred-point system intended for analysis through the fsQCA program, utilized to assess the relationship between product innovation and strategic flexibility, which makes up the second part of the research. A quantitative scale shows the flexibility of the company by department, to enable the program to process them. Table I summarizes the main and subsidiary dimensions of flexibility.

Conditions and outcomes

This research determines strategic flexibility configurations – that is, production flexibility, marketing flexibility, and HR inventory – and HR management practices flexibility acquaintance links as causes/conditions. It uses product innovations as outcomes that relate to hypotheses. The outcome shows average number of product innovations over years.

Study propositions

The principal objectives of this paper are as follows: to analyze the relationship between strategic flexibility configurations and product innovation; to analyze contribution of

Strategic flexibility			Effect of strategic flexibility configurations
<i>Production</i>	Tactical input Tactical output Strategic input Strategic output		
<i>Marketing</i>	New market opportunities Price Distribution Promotion		135
<i>Human Resources</i>	Agent customer, supplier and consumer information Knowledge-skills Behavior HR management practices		

Table I.
Main and subsidiary dimensions of strategic flexibility

flexibility configurations of functional areas (production, marketing, and HR) to product innovation using the fuzzy logic model; to analyze the functions of strategic performance in terms of production, marketing, and HR.

Propositions:

- P1.* Strategic flexibility configurations have a significant role in product innovation.
- P2.* The flexibility configurations of functional areas (production, marketing, and HR) contribute to product innovation at different levels.
- P3.* Functional areas (production, marketing, and HR of companies) have significant effect on strategic performance.

Results

Data collection resulted in 13 interviews conducted with individuals in the role of general manager, production manager, marketing manager, and HR manager, or their respective assistants. In one company, a single manager represented all other positions. The authors assume managers present their subjective views, opinions, and perceptions.

Truth table analysis

The core of fsQCA is a truth table analysis that seeks to identify causal combinations that are sufficient for the outcome. Truth tables give an indication of identical cases and “limited diversity phenomenon.” The truth table for the interrelatedness of innovation and strategic flexibility configurations is found below (Table II).

The truth table lists every possible combination of conditions, in this case 2^3 , with 3 being the number of conditions (Schneider and Wagemann, 2012). We set the consistency threshold to 0.8, a value expected to create robust results (Fiss, 2011; Rihoux and Ragin, 2009; Schneider and Wagemann, 2012). The only solutions that belong to more than zero cases appear. The truth table for the interrelatedness of innovation and strategic flexibility configurations does satisfy the required assumptions. The numbers in the first four columns

Production flexibility	Marketing flexibility	Human resource flexibility	Product innovation	Row cons.	PRI cons.	SYM cons.
1	1	0	1	0.954	0.897	1
1	0	0	0	0.754	0	0

Table II.
Truth table for the outcome “product innovation”

represent whether causal condition exists or not – that is, 1 means causal condition exists (fully in) and 0 means causal condition does not exist (fully out) (Ragin, 2006). We also present a truth table for the negation of product innovation and strategic flexibility configurations for checking the results (see Table III).

Product innovation as outcome

According to the first procedure, we determine the following solutions (see Table IV).

Table IV shows that one solution may explain the interrelatedness of strategic flexibility configurations and product innovation in the electrical household appliances market. Ragin (2006) suggests using raw and unique coverages to assess empirical importance. Findings of Schneider and Wagemann (2012) suggest that raw coverage refers to the size of overlaps between the causal condition sets and the outcome sets. Additionally, unique coverage partitioning the raw coverage controls the overlapping explanations.

The total coverage with respect to the importance of all causal paths is 0.873, which explains that a causal path covers most of the outcome. The notable expression with a unique coverage of 0.873 is Production flx.*market flx.* ~hr. flx, which shows that product innovation interrelates with the strategic flexibility configurations of production, market, and negation of HR departments’ affects in the electrical household appliances market. Companies with production flexibility and marketing flexibility, but without HR flexibility, are prevalent. These findings align with others from the literature. Oke (2013) presents evidence on positive effects of production flexibility on product innovation performance. Sharma and Jain (2010) assert that marketing flexibility has a positive effect on product innovation. The contradiction of the results with empirical evidence is with HR flexibility. Here, for instance, Chen *et al.* (2014) found that HR management practices affect product innovation performance of the company. Preenen *et al.* (2017) focus on internal labor flexibility and confirmed the relationship between internal labor flexibility and product innovation. A possible explanation could be an early study of Arvanitis (2005), who argues that product innovation requires highly-skilled technicians and scientists, while companies sometimes hire high-skilled personnel temporarily for certain tasks, from other institutions. Thus, company employees stay focused on routine tasks. Another possible explanation is that the findings of this research refer to the homogeneity of HR flexibility for these four companies. Because of this similarity, HR flexibility does not show its contribution in product innovation. The limited number of cases may affect this result.

In sum, the outcome of this analysis determines that production and market flexibility configuration counterparts are consistent indicators of product innovation. Results show that marketing processes provide crucial information about market trends guiding new products.

Table III.
Truth table for the outcome “~product innovation”

Production flexibility	Marketing flexibility	Human resource flexibility	Product innovation	Row cons.	PRI cons.	SYM cons.
1	0	0	1	1	1	1
1	1	0	0	0.546	0	0

Table IV.
Solution terms for product innovation

Solution term	Coverage (raw)	Coverage (unique)	Consistency
Production flx.*market flx.* ~hr. flx	0.873	0.873	0.954
Overall solution	0.873		0.954

Negation of product innovation as outcome

The concept of asymmetric causality (Lieberson, 1985) is important when evaluating the potential of QCA for social science research. Unlike most statistical procedures, QCA links conditions and outcome through set theoretical relations that are asymmetric. Therefore, QCA provides both presence and absence of phenomena in two distinct analyses (Schneider and Wagemann, 2012). The analysis of the negation of outcome determines the understanding of causal logic driving the positive cases, with respect to negative ones (Ragin and Rihoux, 2004).

Table V shows that only one solution may explain the interrelatedness of strategic flexibility configurations and the absence of product innovation.

The most notable expression with a unique coverage of 0.396 is production flx.*~market flx.* ~hr. flx, which shows that a strategic flexibility configuration of production department affect and negations of market and human resource affects are consistently indicators of negation of product innovation. The solution of the negation of product innovation is a different solution from product innovation. So we accept production flx.*market flx.* ~hr. flx solution when they determine product innovation and strategic flexibility configurations relatedness.

Conclusions

The findings reveal that the strategic flexibility configurations have a significant role in product innovation, as referred to in the first proposition. The results indicate that strategic flexibility configurations related to production and marketing flexibility have a significant role in product innovation. This result proves the second proposition. Each functional area has shown different performance in product innovation. Only HR flexibility produces no result in a comparison of functional contributions to product innovation. Solution terms for product innovation show that negation of marketing flexibility creates a little more change, in comparison to production flexibility. Findings also show functional areas contribute to strategic performance by advancing innovation related to the third proposition.

Nowadays, companies can provide both productive capacity and product diversity by means of freight production. This makes a considerable contribution to meeting production flexibility requirements, enabling companies to focus more on developing new products and their sales. Consequently, the results indicate that marketing flexibility plays a distinctive role in product innovation.

The capabilities of the production department also play a decisive role in the production of innovative products. The availability of a wide range of components and raw materials in the production process also encourages companies to innovate, and makes it easier to bring innovative products to production. For this reason, production flexibility is effective in product innovation. On the other hand, if companies have facilities for freight production to meet their requirements for production flexibility, flexibility of production system within the company has limited significance for product innovation.

The findings show that multifaceted communication with the industry environment and end users is effective in marketing flexibility. Sector fairs and events, in terms of supplier and market information and the use of social media contribute significantly to tool and end-user information. Companies also increase their marketing flexibility by using distribution

Solution term	Coverage (raw)	Coverage (unique)	Consistency
Production flx.*~market flx.* ~ hr. flx	0.396	0.396	0.1
Overall solution	0.396		0.1

Table V.
Solution terms for
~product innovation

channels, such as electronic platforms, and promotional efforts. These processes not only increase sales, but also contribute to the acquisition of end-user information to guide product innovation.

Limitations

A limited number of cases may be one of the possible reasons for no proven contribution of HR flexibility to product innovation, and may affect results due to poor representation. On the other hand, four companies are enough to satisfy fsQCA requirements. More empirical studies of heterogeneous cases can contribute to determining the role of HR flexibility in product innovation. Another limitation is the subjective character of information provided. Data analysis thus occurs on the basis of perceptions and opinions. Another study in the same context is recommended, to validate the results.

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Public sector motivational practices and their effect on job satisfaction: country differences

Public sector
motivational
practices

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Received 1 December 2016
Revised 12 August 2017
10 November 2017
Accepted 15 November 2017

Abstract

Purpose – The purpose of this paper is to explore the effects of job satisfaction practices for public sector employees through a cross-national approach.

Design/methodology/approach – A multi-group analysis was carried out using SmartPLS3 among non-teaching employees of public universities in Poland and Spain.

Findings – The results show a positive relationship between motivational factors and job satisfaction; however, there is no evidence that the variable “country” introduced significant differences.

Originality/value – The research findings contribute to a better understanding of job satisfaction for public employees and provide empirical evidence on the relationship between job satisfaction and public culture.

Keywords Public sector, Job satisfaction, Multi-group analysis, Cross-country research, Public service provision

Paper type Research paper

Introduction

To meet the demands of today’s society, the strategic goals of public sector organisations (PSOs) have progressed from merely looking for efficient and effective service provision to truly providing public service, based on the theoretical framework of public service dominant logic theory (PSDL) (Osborne, 2010; Osborne *et al.*, 2012). Among the innovations developed by PSDL, one is the acknowledgement of the role of public employees as internal customers (Azêdo and Alves, 2013; Hiedemann *et al.*, 2016).

Therefore, PSOs must encourage those human resource management (HRM) practices that positively affect the motivation and satisfaction of their human capital, which in turn will lead to better performance (Hung, 2012; Vandenabeele, 2009). The term “motivation” in this paper does not refer to the public sector motivation theory (Perry and Wise, 1990; Perry, 1997) but to the concept of an “individual’s degree of willingness to exert and maintain an effort towards organizational goals” (Franco *et al.*, 2002, p. 1). Job satisfaction is considered as “a positive (or negative) evaluative judgment one makes about one’s job or job situation” (Weiss, 2002, p. 175). Subsequently, considering public employees as internal customers implies tailoring their motivation and satisfaction policies to their specific circumstances.

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The authors would like to thank the anonymous reviewers for the constructive remarks, helpful comments, and recommendations for improvement. They have contributed greatly to the quality of the paper.



European Journal of Management
and Business Economics
Vol. 27 No. 2, 2018
pp. 141-154
Emerald Publishing Limited
2444-8494
DOI 10.1108/EJMBE-02-2018-0027

A country's cultural values could influence the perceptions of job satisfaction and its determinants, so public employees from different cultures may display different levels of job satisfaction, although the literature is inconclusive on this topic. Indeed, the phenomenon of globalisation and the wave of reforms in which PSOs all over the world are currently engaged have caused a worldwide interest in how to improve public service provision by enhancing public employees' job satisfaction. Nonetheless, there is little research regarding how HRM practices affect public employees' job satisfaction in a cross-national context, which might be useful to develop a universal construct.

The following questions therefore arise: How should public managers motivate their internal customers? Does the use of specific human resource practices have a different effect on the job satisfaction of public sector employees under a cross-national perspective? Are these practices universal, implying that public sector culture is stronger than country culture and public managers can learn from other similar institutions in other countries? This study addresses these questions using a survey among the non-teaching staff of public universities in Poland and Spain. The data analysis is conducted using SmartPLS3, which fits small samples, and through a multi-group analysis. The results provide empirical information useful to policy makers interested in formulating a HR policy that caters to their employees' needs and promotes satisfaction.

Literature review and hypotheses

According to McPhee and Townsend (1992, p. 117), job satisfaction is "a positive emotional state resulting from the perception of one's job as fulfilling or allowing the fulfilment of one's important job values, providing these values are compatible with one's physical and psychological needs". Job satisfaction may also refer to the degree to which job needs are fulfilled and the extent to which the employee perceives that fulfilment (Porter, 1962; Rich *et al.*, 2010). In other words, job satisfaction is a combination of what employees feel about their job and what they think about the various aspects of their job (Locke, 1976).

Many antecedents or determinants influence job satisfaction. Herzberg *et al.* (1959) differentiate between motivators or intrinsic aspects of the job and hygiene factors or extrinsic aspects of the job. In addition, some authors add a third type of determinant regarding relationships at work (Drabe *et al.*, 2015; Pelit *et al.*, 2011) following the perspective of the social exchange theory (SET) (Blau, 1964; Emerson, 1976). Social exchange involves a series of interactions that generate obligations. These interactions are usually interdependent and contingent on the actions of another person.

Based on reciprocity, employees develop exchange relationships with their managers and the organisation. SET posits that there are certain HRM practices and cultural values such as fairness, opportunities for personal growth, enthusiasm for the job and good reputation that significantly affect public employees' motivation and attitude (Bellou, 2010; Gould-Williams, 2016). In addition, perceived organisational support (POS) and perceived managerial support (PSS) influence these interactions (Rakowska *et al.*, 2015).

Perceived support and perceived organisational justice as determinants of job satisfaction. Eisenberger *et al.* (1986) define POS as the employees' perception that the organisation values them and their welfare. POS assumes that, when employees perceive support from their organisations, they reciprocate by working hard to improve organisational effectiveness (Brunetto *et al.*, 2013). In turn, this behaviour fulfils employees' social needs (Kurtessis *et al.*, 2015), enhancing their job satisfaction (Malhan, 2006), organisational commitment (Rhoades and Eisenberger, 2002), and organisational citizenship behaviour (Tekleab and Chiaburu, 2011), as well as causing a reduction in turnover intentions also for public sector employees (Coyle-Shapiro and Kessler, 2003; Kim and Stoner, 2008).

Regarding PSS, extant research confirms that managerial support affects exchanges between managers and subordinates (Wayne *et al.*, 1997), helps employees deal with their

job requirements (Bakker *et al.*, 2004), and builds confidence in the decisions of the leader (Macey and Schneider, 2008). Trust in relationships between superiors and subordinates creates a climate that improves job engagement and satisfaction (Ellinger *et al.*, 2010; Podsakoff *et al.*, 1996), even for public sector employees from different countries (Kim, 2014):

H1. Perceived organisational and managerial support have a positive effect on the job satisfaction of public employees.

Employees' feelings and behaviour in their work environment depend also on their perception of organisational justice and fairness (Inoue *et al.*, 2010), which affect engagement, job performance, and job satisfaction (Inoue *et al.*, 2010; Rayton and Yalabik, 2014; Saks, 2006). Perceived organisational justice refers to honesty and fairness perceived in the job environment (Greenberg, 1990; 2011; Price and Mueller, 1986; Moorman, 1991). The feelings of fairness and distributive justice have their roots in Adams' equity theory regarding employees' concerns regarding the distribution of outcomes and resources (Adams, 1965). As Cohen-Chara's (2011) meta-analysis confirms, both dimensions are quite intertwined. Chen *et al.* (2015) studied the role of perception of organisational justice in PSOs, evidencing its relation to administrative performance appraisal and organisational commitment.

Many authors emphasise that it is not the HR practices themselves but the way they are perceived what significantly influences employee behaviour (Ostroff and Bowen, 2016). In this context, perception of support from the organisation and managers, as well perception of organisational justice and fairness should influence public employees' job satisfaction:

H2. Perceived organisational justice and fairness positively influence public employees' job satisfaction.

Rewards as determinants of job satisfaction. As it was mentioned before, Herzberg's two-factor theory (Herzberg *et al.*, 1959) affirms that job satisfaction's determinants may involve extrinsic rewards (e.g. monetary compensations, job security, or promotions), and intrinsic rewards (e.g. respect from colleagues, training and development opportunities, or challenging work assignments) (Coomber and Barriball, 2007; King, 1970; Saks, 2006). Specifically, Jun *et al.* (2006) state that participation in training programs had a positive effect on the employees' level of self-confidence, being happier with their organisation, and report that rewards and recognition are key in enhancing employees' job satisfaction.

Although previous research states that studies on job satisfaction among private sector employees cannot be applicable to public employees due to their different reward systems (DeSantis and Durst, 1996), public managers should not neglect extrinsic and intrinsic factors' influence on job satisfaction (Gerhart and Fang, 2014; Mottaz, 1985; Maidani, 1991; Sousa-Poza and Sousa-Poza, 2000; Sanjeev and Surya, 2016). In any case, intrinsic rewards are more effective in PSOs (Bullock *et al.*, 2015; Crewson, 1997; Cowley and Smith, 2014). In the same vein, Judge *et al.* (2010) state that the level of compensation has only a slight effect on the level of employee satisfaction, becoming even a detriment in some cases (Deci, 1975):

H3. Intrinsic rewards will affect the job satisfaction of public employees.

H4. Extrinsic rewards will affect the job satisfaction of public employees.

Effects of country culture on job satisfaction. Considering public employees as internal customers implies tailoring motivation and satisfaction policies to their specific circumstances to improve effectiveness. National culture has been deemed a significant influence on the behaviour of private sector employees (Drabe *et al.*, 2015; Hofstede, 1984; Hofstede *et al.*, 2010; Sousa-Poza and Sousa-Poza, 2000) and public sector employees

(Bouckaert, 2007; Gerhart and Fang, 2014; Rufin *et al.*, 2014). Therefore, the effect of the same HRM policies should be different for the public employees from different countries (Brunetto *et al.*, 2013; Chordiya *et al.*, 2017; Hu, 2014; Huang and Van de Vliert, 2003; Liden *et al.*, 2014; Matheson and Kwon, 2003).

Although studies confirm national culture's role on employee behaviour, a number of researchers (Christensen and Lægheid, 2007; Milne, 2007; Vandenabeele and Van de Walle, 2008) argue that the bureaucratic nature of PSOs influences the attitudes and interests of public employees. Podger (2017) posits that the drivers of a strategic approach to public HRM are similar across countries. For that reason, specific motivational practices for public employees could have similar effects on job satisfaction regardless of the country of application. Still, Franco *et al.*'s (2002) theoretical research on motivation for public employees shows that while organisational factors (mainly structure and culture) directly affect the results of HRM policies, the broader cultural framework will also influence said organisational culture and the way employees and clients relate in the process of public service provision. The question, then, is if national culture prevails over other factors such as a bureaucratic organisational culture:

H5. The relationship between job satisfaction and its determinants will vary across countries.

Method

Administration personnel from two universities, one in Poland and one in Spain, answered a standardized quantitative survey (translated from English to the respective languages) about job satisfaction, perceived justice, perceived support and preferred rewards. The control variables were age, gender, and studies. This research was performed in two similarly sized public institutions (in number of students and personnel), with bureaucratic structures.

The data comprises 171 responses, 72 from the Spanish institution and 99 from the Polish one, from employees working in purely clerical positions belonging to the technocratic part of the organisation. The low response rate owes to the adverse feelings towards answering a questionnaire for somebody in their working place, especially considering previous situations that led to negative repercussions as a result of climate surveys, and despite the strong assurances for anonymity. The data set had only three missing values, which were replaced by the mean value since they did not have a systematic pattern and any imputation method should work (Hair *et al.*, 2010). In addition, two questionnaires were invalidated. Harman's (1976) single factor test indicated that it is unlikely that the results may be affected by common method variance (Podsakoff and Organ, 1986). As we can see, both samples are quite similar, as shown in Table I. Both groups are markedly feminine staff, most of them belonging to the generation X and well educated. Therefore, no sample particularities may alter the interpretation of the results.

SmartPLS 3.0 (Ringle *et al.*, 2015) was used to compute the model and the multi-group analysis (PLS-MGA). The PLS approach is useful and convenient when dealing with small samples in terms of robustness and statistical power (Reinartz *et al.*, 2009; Hair *et al.* 2013), particularly in management research (Hair *et al.*, 2012, 2013). A composite-based method was preferred to a factor-based method for the sake of robustness (Rigdon, 2012).

All the constructs were based on reflective items (Diamantopoulos *et al.*, 2008) using Likert scales (from 1 to 5). The items for each construct were obtained and adapted from the literature, where possible, to comply with content validity (Table II). Some items had to be depurated for the model to be valid.

Results and discussion

In the end, the model resulted in five working constructs: job satisfaction, perceived justice, perceived support (encompassing POS and PSS), intrinsic rewards, and extrinsic rewards.

	Group 1: Spain		Group 2: Poland		Total	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
<i>Gender</i>						
Total	72	42.1	99	57.9	<i>n</i>	169
Male	23	31.9	20	20.2	43	25.1
Female	48	66.7	77	77.8	125	73.1
<i>Age</i>						
< 34 (Gen Y)	2	2.8	34	34.3	36	21.1
> 35- < 49 (Gen X)	44	61.1	46	46.5	90	52.6
> 50- > 65 (Gen BB)	26	36.1	18	18.2	44	25.7
<i>Education</i>						
Secondary school	15	20.8	14	14.1	29	17.0
Bachelor degree	22	30.6	7	7.1	29	17.0
MA/Msc	32	44.4	74	74.7	106	62.0
PhD	3	4.2	3	3.0	6	3.5

Table I.
Sample characteristics

	Mean	SD	Loadings	Cronbach's α	Composite reliability	AVE	References (adapted)
Job satisfaction (JS)	3.85	0.91		0.83	0.90	0.75	Saks (2006)
All in all, I am satisfied with my job	3.917	0.957	0.92				
In general, I don't like my job (Reversed)	3.714	1.171	0.74				
In general, I like working here	3.929	1.000	0.92				
Perceived Justice and fairness (PJ)	3.16	0.933		0.86	0.90	0.64	Price and Mueller (1986), Greenberg (1990), Moorman (1991)
Job decisions are made by the manager in a biased manner (Reversed)	3.375	1.213	0.81				
To make job decisions, managers collect accurate and complete information	3.266	1.085	0.82				
All job decisions are applied consistently to all affected employees	3.089	1.140	0.72				
The outcomes I receive reflect the effort I have put into my work	3.190	1.220	0.82				
My work schedule is fair	3.167	1.194	0.82				
Perceived support (PS)	3.34	0.97		0.93	0.95	0.71	Eisenberger <i>et al.</i> (1986) (short version), Eisenberger <i>et al.</i> (2002)
I feel that my organisation really cares for my personal aims and values	2.905	1.065	0.80				
I feel that my organisation creates an environment where I can perform best	3.166	1.075	0.85				
Help is available from my organisation when I have a problem	3.337	1.161	0.80				
My supervisor really cares for my personal aims and values	3.320	1.179	0.84				
My supervisor creates an environment where I can perform best	3.420	1.164	0.87				
I can trust my boss to back me up on decisions I make at work	3.589	1.156	0.86				
My manager is supportive of my ideas and ways of getting things done	3.613	1.195	0.89				
Extrinsic rewards (ER)	2.65	1.08		0.73	0.84	0.64	Saks (2006)
A pay raise	2.238	1.390	0.74				
A promotion	2.290	1.247	0.84				
More freedom and opportunities	2.864	1.120	0.83				

Table II.
Constructs/indicators

(continued)

	Mean	SD	Loadings	Cronbach's α	Composite reliability	AVE	References (adapted)
Intrinsic rewards (IR)	3.25	0.95		0.80	0.87	0.62	Saks (2006)
Respect from the people you work with	3.805	1.163	0.78				
Praise from your supervisor	3.268	1.399	0.83				
Training and development opportunities	3.290	1.228	0.76				
More challenging work assignments	3.036	1.305	0.78				

Table II.

According to Coomber and Barriball (2007), job satisfaction can be studied as a whole concept (global approach) or focussing on specific areas (facet approach). This study uses the global approach and a multi-item construct (Saks, 2006) because of the many positions under analysis.

Table II describes the final constructs. Although PSS and POS were to be considered separately, the model showed a better fit when combining all the support-related items in one construct, even though all PSS items present higher mean values than the POS items. This concurs because POS influences the quality of the supervisor-subordinate relationship, and therefore the PSS (Eisenberger *et al.*, 2002; Wayne *et al.*, 1997). Regarding the items of the perceived justice and fairness construct, Table II shows that unbiased job decisions have the highest mean value, whereas the lowest mean value belongs to having all job decisions consistently applied to all affected employees. Among the intrinsic rewards, public employees seem to prefer the perception of respect from their colleagues, whereas having more challenging work assignments comes in last place. As for the extrinsic rewards, Table II also confirms that pay rises are less valued than other rewards and compensations.

All constructs comply with the reliability indicator (outer loadings > 0.7), internal consistency reliability (Cronbach's $\alpha > 0.7$; composite reliability > 0.8), and convergent validity (AVE > 0.5) (Table II). Discriminant validity was tested using the Fornell-Larker criterion (Fornell and Larcker, 1981) as shown in Table III.

The PLS algorithm computed a model, after 300 iterations, which was later used as a basis for the multi-group analysis. This model fit criteria are $R^2 = 0.50$ (acceptable), adjusted $R^2 = 0.49$ (acceptable), SRMR = 0.08 (valid), and NFI = 0.78. The path coefficients and their significance are shown in Table IV.

The assessment of the results states that perceived support, perceived justice, and intrinsic rewards have significant positive effects over public employees in general. Most of the

	JS	PJ	PS	ERW	IRW
JS	0.86				
PJ	0.63	0.80			
PS	0.66	0.82	0.84		
ERW	0.44	0.41	0.44	0.80	
IRW	0.60	0.58	0.68	0.54	0.79

Table III.
Discriminant validity

Table IV.
Path coefficients and
PLS-MGA results:
Country effect
(Bootstrapping 5000
iterations)

Original sample	M	SD	<i>t</i> -statistics	Path coefficients		<i>t</i> -values (Poland)	<i>t</i> -values (Spain)	Path coefficients abs. difference	Interval coefficients				
				(Poland)	(Spain)				25% (Poland)	75% (Poland)	25% (Spain)	97.5% (Spain)	
PJ → JS	0.24	0.24	0.09	2.81**	0.15	0.29	1.22	1.85	0.14	-0.11	0.37	-0.03	0.58
PS → JS	0.27	0.27	0.10	2.60**	0.35	0.10	2.79**	0.53	0.25	0.09	0.59	-0.26	0.45
ERW → JS	0.11	0.05	0.11	0.93	0.19	-0.16	1.45	0.84	0.35	-0.06	0.44	-0.43	0.21
IRW → JS	0.22	0.22	0.08	2.78**	0.15	0.29	1.25	2.34*	0.14	-0.10	0.36	0.06	0.54

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

parameters have similar weights, except for the path coefficient of extrinsic rewards, which is not significant. Therefore, *H1*, *H2*, and *H4* are accepted. The rejection of *H3* concurs with the literature stating that intrinsic rewards prevail over extrinsic rewards in PSOs (Bullock *et al.*, 2015; Crewson, 1997; Cowley and Smith, 2014).

The next step is the multi-group analysis. Table IV also presents the results of the non-parametric test for the multi-group analysis, following Hair *et al.*'s (2017) recommendations to overcome the limitations of the parametric test. None of the differences of the coefficients is significant. Therefore, there are no country effects on job satisfaction according to this model, thus failing to support *H5*.

Keeping these findings in mind, we can describe the country models to understand the characteristics of each group's samples. The R^2 for the Polish group model is 0.55, and for the Spanish group it is 0.43 (*t*-value of the difference: 1.19, *p*-value: 0.23, confirming the lack of country effect). The results in Table IV suggest that, as with the general model, extrinsic rewards do not have a significant direct effect over the job satisfaction of the respondents of both countries. However, the rest of the parameters display different behaviours: Polish respondents only show a direct, positive effect of perceived support on their job satisfaction, whereas Spanish respondents express a significant, direct effect of intrinsic rewards. The depth of the public budget cuts in Spain might explain this result.

To analyse if other variables could be affecting this relationship, we use socio-demographic control variables (gender, age, and educational level) for moderating effects, using PLS-MGA. Table V indicates that gender, age, and educational level do not make a difference either. These results do not concur with Bellou (2010), Drabe *et al.* (2015), or Sanjeev and Surya (2016), respectively. This is a matter for further investigation.

Conclusions, limitations, and future lines of research

Considering public employees as actors of the value determination process is still an innovative concept in the public sector research. The nature of PSDL implicates the involvement in the provision of public services of professionals and users. However, while the latter are often subject of research, the role of public employees as internal customers has received little attention. Its relevance increases if we take into account the current hostile environment for PSOs, which in turn may affect their performance because of unsatisfied employees not contributing to the creation of public value.

When looking at the determinants of job satisfaction for public employees, few studies provide cross-country analysis, and no consensus exists on the effect of those determinants, as with monetary rewards. The results of this study show that public managers should be aware of the motivating force of intrinsic rewards and of the lack of significant drive of extrinsic rewards, particularly money-related ones. Furthermore, the surveyed employees do not perceive a significant difference between the effects of managerial and institutional support. Bureaucracy, norms, and rules limit the behaviour of managers, who must behave "following

	Gender Male- Female	Secondary- Bachelor	Education Bachelor- Master	Secondary- Master	Gen Y- Gen X	Age Gen Y-Gen BB	Gen X-Gen BB
PJ → JS	0.06	0.33	0.03	0.30	0.43	0.47	0.04
PS → JS	0.04	0.61	0.30	0.31	0.01	0.10	0.11
ERW → JS	0.31	0.36	0.16	0.52	0.22	0.13	0.09
IRW → JS	0.20	0.01	0.04	0.05	0.44	0.31	0.13

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

Table V.
PLS-MGA results:
Path coefficients
differences (in
absolute value);
gender, education,
and age effect
(Bootstrapping
5000 iterations)

the letter of the law” and have limited decision power. Finally, public HRM could introduce innovative practices to increase the perception of justice and fairness of procedures as a way to increase employees’ satisfaction.

The results show no overall significant country differences. Public service identity seemingly weights more in determining public employees’ job satisfaction than country specifics, endorsing the universal aspect of the bureaucratic culture overriding country effects (Podger, 2017). The socio-demographic elements have also proved insignificant sources of change, reaffirming the strength of the bureaucratic culture over other parameters. Likewise, the joint construct “perceived support” reinforces the lack of country effects in favour of the bureaucratic culture effect. Therefore, public managers could learn and adapt other PSOs’ practices to increase their own performance. To evaluate the consistency of these findings, future research could replicate this study in significantly culturally different countries and using a broader assortment of PSOs. A qualitative study could also enrich these quantitative findings.

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The relationship between institutions and value creation in software development models

Software
development
models

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Received 22 November 2016

Revised 8 September 2017

3 November 2017

Accepted 8 November 2017

Abstract

Purpose – The purpose of this paper is to analyse the possibility for firms to consider institutional settings to systematically direct dispersed individual efforts of discovery and invention towards objects (products or processes) of their interest in order to enhance their value creation capacity.

Design/methodology/approach – The authors conduct a comparative analysis of the different institutional settings within which software products are invented and produced – closed producer-centred model, open user-centred model, and hybrid interactive producer-user model.

Findings – The authors draw indications regarding the possibility to design institutional settings for value creation and the potential pitfalls tied to these strategic tools.

Originality/value – A theoretical framework is elaborated in order to understand the different ways in which institutional contexts influence and direct value creation processes. The model analysed shows the firms' deliberate attempt to stimulate a dynamic process of social interaction and communication which may foster higher levels of creativity and innovation. In order to guarantee the necessary accessibility and to sufficiently motivate external programmers towards the perception of a new code, the firm has to surrender the traditional source through which it appropriates value: barriers to the accessibility of the code developed through IPRs. The adoption of an institutional setting which facilitates dynamic value creation processes suggests, therefore, the need to turn to dynamic mechanisms for value appropriation in parallel.

Keywords Institution, Value creation, Software development model

Paper type Research paper

1. Introduction

Strategy literature distinguishes value creation from value appropriation processes (Mocciaro Li Destri and Dagnino, 2005; Lepak *et al.*, 2007). The former process entails the creation of new sources of competitive advantage through innovation: it consists on the intuition and implementation of new resource combinations or the development of new competences or knowledge able to elevate the level of efficiency within the economic system considered. Value appropriation, on the other hand, regards the issues of exploiting and maintaining specific sources of competitive advantages and entails the capacity to obtain rents from transactions, given a specific set of resources and of capabilities and the way these are combined.

In the strategic literature, apart from a few exceptions, institutions have sometimes been overlooked completely, alternatively they have been considered exogenously determined by



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European Journal of Management
and Business Economics
Vol. 27 No. 2, 2018
pp. 155-170
Emerald Publishing Limited
2444-8494
DOI 10.1108/EJMBE-09-2017-0016

governments or evolutionary paths. In the latter case, institutions represent a set of given variables that must be considered (explicit or implicit) during decision-making processes. More seldom, however, is the analysis of firms' active influence on institutional contexts, while we find some notable examples in unorthodox economics (North, 1994; Nelson, 1998).

This paper contends that firms can design and manage institutional mechanisms strategically, not only to appropriate value, but also to enhance their capacity to create value.

Institutions have been the focus of studies in areas of intellectual endeavour which range from politics to sociology; they have been discussed from the very different perspective and this is the reason they have found multiple definitions (Hodgson, 1998a). In the present paper, the notion of institutional contexts derives from the neo-institutional approach in economic studies (Polanyi, 1957; North and Thomas, 1973; North, 1990, 1994, 1998; Heiner, 1983, 1986; Langlois, 1984, 1986a, b, c, 1992a, b, 1995; Loasby, 1983, 1986, 1994, 1998; Hodgson, 1998a, b). As such, they include all rules and norms which lead to behavioural regularities as well as their enforcement mechanisms. In this perspective, the rules, the norms and the enforcement mechanisms considered may have a formal or an informal nature; therefore, institutions range from commercial and tax laws, property rights and contracts, to social habits, cultures and ideologies. In brief, institutions may be considered as "the rules of the game in a society or [...] the constraints men have defined in order to discipline their relationships" (North, 1990, p. 23). The institutional context is, therefore, the structure within which economic and social interactions take place. These social interaction mechanisms are based on processes which involve feedback from the cumulative results of individual actions, and thereby are capable of achieving substantial coordination and coherence in the collective performance of the ensemble of distributed agents.

The economic historian and Nobel laureate Douglass North (1990, 1991, 1994, 1998) has shown that institutions are relevant in economic analyses because they create inefficiencies within the system that distort the final outcomes obtained by economic agents operating within the system itself. Institutions, for example, define the incentives that guide economic endeavour and create partial rigidities to the flow of tangible and intangible resources within economic systems. Consequently, in the present analysis regarding value creation processes, this approach points to the potential role of such institutions as a source of systematic influence directing individual efforts of discovery and invention.

Throughout history, government agents have continuously designed institutions which aim to create incentives towards goals considered coherent with the nation's interest. Amongst the typical institutional mechanisms used in capitalistic economic systems to motivate entrepreneurs and firms towards the intuition and execution of new resource combinations (or, in other terms, to create value), the most notable are the various forms of intellectual property rights (IPRs) – which include patents, copyrights and industrial secrets. Essentially, these mechanisms are aimed to motivate economic agents to create value for the society they belong to, by consenting that the success or failure of their endeavours influences them more than proportionately.

Consistently, the efficacy of typical IPRs to consent the protection of rent flows from new resource combinations once they have been created (i.e. value appropriation) has often been analysed. Furthermore, typical IPRs are designed to enhance producer-centred innovation processes, while they were not designed to enable user-centred innovation processes which leverage the creativity dispersed in various levels of the external environment. As a consequence, while the efficacy of typical IPRs to enhance producer-centred innovation is often debated, their capacity to spur user-centred innovation processes is far less debated.

Both the focus on the capacity to guarantee value appropriation from innovations and the central role accorded to producer-centred innovation, are (implicit) consequences of having viewed the innovation process in Schumpeterian linear terms. However, following North's studies regarding the economic role of institutions, the way in which IPRs are designed also

influences the social dynamics underlying value creation processes. Furthermore, numerous authors have underscored the importance of communication, learning and social interaction both within the single organisation and between the firm and its environment for innovation to take place (Chatterji and Fabrizio, 2014; Von Hippel, 1976, 1988, 1994; Allen, 1983; Nonaka, 1988; Heller and Eisenberg, 1998; Merges and Nelson (1994); Brown and Eisenhardt, 1995; Jeppesen and Lakhani, 2010; Afua and Tucci, 2012; Meynhardt *et al.*, 2016).

Departing from different logical bases, Hayek (1945, 1948a, 1948b, 1960, 1978), Von Hippel (1976, 1988, 1994) and Von Hippel and Von Krogh (2003) argued that due to the fact that the knowledge on which they rest is tacit, private and empirical, the sources of creativity underlying value creation processes are inevitably dispersed throughout the economic system as market mechanisms fail to consent their transfer. These studies, along with those mentioned above regarding the role of social interaction and communication for innovation processes, have been conducted to recognise that, within firm development, a fundamental part of the knowledge and creative effort underlying the process of value creation is often dispersed both within the organisation (and not necessarily restricted to the R&D lab) and in the external context. Thus, the interest matured lately in the formulation of open innovation models is not surprising (Chesborough, 2003; Chesborough and Appleyard 2007; Tuomi, 2002; Baldwin and Von Hippel 2011; Piller and West, 2014).

In this vein, the present study is focussed on the analysis of the possibility for firms to actively create and strategically manage (both formal and informal) institutional mechanisms to access and leverage knowledge and creativity which are dispersed in their external environment.

In other terms, the question posed is: “Can firms consider institutional settings as a tool to systematically direct dispersed individual efforts of discovery and invention towards objects (products or processes) of their interest in order to enhance their value creation capacity?”.

In order to conduct the proposed analysis and attempt to answer the question posed, the study contained in the rest of the paper is twofold. In the following section, a theoretical framework is elaborated in order to understand the different ways in which institutional contexts influence and direct value creation processes. The framework is aimed to both: describe how institutions may play a role in directing creative efforts towards different objects and goals; and identify a limited number of fundamental dimensions to take in consideration when describing distinct institutional contexts and their effect on value creation processes.

If, on the one hand, the theoretical model proposed illustrates that institutions influence value creation processes, on the other, it does not allow to answer the question: “can firms actively manage fine-grained instruments like institutions or are the latter developed solely through slow social evolution processes?” and “if so, what are the potential advantages and the possible pitfalls entailed by the use of these ‘strategic tools?’”.

Aimed towards shedding light on the possibility for firms to consider institutional context management as a viable strategic tool to enhance their value creation capabilities, and drawing on case studies from the software industry, the third section uses the dimensions identified in the theoretical framework to conduct a comparative analysis of the different institutional settings within which software products are invented and produced. The analysis of the software industry is particularly interesting for this study as: similar competing software products are contemporarily being invented and produced within notably different institutional settings; it is the theatre of some of the most interesting experiments firms are conducting in institutional context management.

2. A conceptual framework for the determinants of the value creation process

The present section sketches out a theoretical framework which renders explicitly the role played by the institutional context in directing individual efforts of discovery and invention.

Furthermore, it enables to pin point the main dimensions to take into consideration when describing and evaluating distinct institutional settings and their effect on the value creation processes which take place within them.

The theoretical representation proposed is strongly influenced by the Austrian process and subjective view, whilst the notions of value creation processes and institutional contexts are based on conceptual categories elaborated:

- (1) within studies regarding the sources of creativity and entrepreneurial behaviour;
- (2) with Penrose's (1959) theory of firm growth and, in particular, the distinction she introduced between productive possibilities and productive opportunities; and
- (3) as mentioned earlier, with the neo-institutional approach in economics.

The conceptual representation that follows is aimed to identify the multiple layers of reality which tie individual creativity to the value creation performances of the system analysed. In particular, the three levels of analysis considered are:

- (1) A micro-level which is composed of the agents that operate within the system analysed and their values, beliefs, knowledge and motivations. This level is focused on agent creativity and the entrepreneurial behaviours which lead to the intuition and implementation of new resource combinations within the system they belong to.
- (2) A meso-level which is composed of the social interaction mechanisms which define the nature and characteristics of the institutional context within which specific spheres of economic endeavour take place. These institutional contexts represent the structure within which micro-level agent behaviours occur.
- (3) A macro-level which is composed of economic organisations and their outcomes, in terms of value creation performances. The organisations considered are typically firms but, as will be the case in the software industry, may take on other forms such as organised communities of individuals or non-profit foundations.

The firm's capacity to create value crucially rests on the creativity expressed by individual agents regarding products or processes that the firm may commercialise and/or adopt. It is at the subjective level, in fact, that the kind of creativity that leads to the process of finding new solutions to old problems or posing and resolving new problems for the first time takes place. The kind of rationality which distinguishes the entrepreneurial behaviours on which value creation rests presents the following distinctive characteristics: it has an intuitive nature and cannot be represented in Cartesian logical-deductive terms; it implies the capacity to bring a variety of information and knowledge fragments to a new synthesis; and it rests on the ability to foresee the potential value of the new combinations perceived.

In order to comprehend the role institutions play within value creation processes, it is necessary to abandon treating subjective creativity independently from the context in which individuals operate. Given the non-cartesian nature of the intuition at the basis of entrepreneurial behaviours, micro-level analyses regarding value creation are not susceptible of deterministic theorisation. However, following the "general equilibrium" implications of the micro-behaviours of the agents analysed provides a tool for identifying critical structural relationships and parameters that consent to link micro-level studies regarding individual creativity and entrepreneurial behaviours, to the emergent properties of the macro-system.

In strategy research, it is generally accepted that the possibilities to create new resource combinations are determined by the set of opportunities and threats present in the environment in which firms operate. However, Penrose (1959) underscored that these productive possibilities lead to the realisation of new resource combinations only as long as they are perceived, the resources and the capabilities on which they rest are accessible and

there is a motivation to grasp such opportunities. The combined presence of all three of these conditions is necessary for innovations to take place; if any one of these conditions comes less, new resource combinations remain mere abstract potential developments and do not give way to concrete innovations.

On the basis of this theoretical representation, in order to assess the capacity of different institutional arrangements to enhance innovation, the scrutiny of their effect on the three dimensions underlying value creation opportunities identified by Penrose (1959) – i.e. perception, accessibility and motivation – allows a systematic consideration of both the subjective and the objective aspects necessary to give a balanced evaluation of the distinctive traits of each institutional arrangement. The following section is dedicated to the comparative analysis of the different institutional settings in which software development occurs and their influence on the determinants underlying value creation processes is assessed and discussed.

3. The strategic management of institutional settings for value creation in the software industry

The software industry is particularly turbulent and the rhythm at which innovations and re-adjustments of the sources of competitive advantage occur is notable. It is perhaps because of these characteristics, that the economic endeavour of software development has been for several years the theatre of some of the more interesting experiments firms are carrying out regarding the strategic management of institutional settings aimed to enhance their value creation performances. The observation of these experiments allows to infer the influence institutions exert on the determinants of firm development identified in the section above and, also, to underscore the possible advantages and pitfalls firms face while managing institutional settings strategically.

The software industry, shows the presence of different models of innovation and production which coexist and compete against one another. Each one of these models is characterised by a specific institutional setting that influences the way in which the innovation and production of software occur.

In particular, it is possible to identify the following two software development models which are considered “pure” as they do not share commonalities:

- (1) closed producer-oriented innovation processes, which occur within commercial software (or soft and hardware) firms and rest on the definition of institutional mechanisms that consent high levels of value appropriation; and
- (2) open user-centred innovation processes, which occur within open-source communities of programmers or non-profit foundations and rest on institutional mechanisms which facilitate value creation processes, but which, on the other hand, do not allow high levels of value appropriation from innovations.

These different institutional contexts have increasingly proven to be able to elicit successful software programming processes within firms or between networks of independent individuals that share a common interest in the development of specific software projects. In fact, open source software (OSS) has proven to be able to perform as well or better than proprietary software in a number of cases[1]. Wang *et al.* (2012) argued that OSS and free software (FS) projects have a better chance of success if they possess a desirable social network capital and adopt effective strategies. The institutions that characterize each one of these models systematically influence the main determinants underlying the software development processes which occur within them and also affect the nature of the software elaborated. The two “pure” models are described in brief, highlighting the institutional differences between them and the consequences these produce on the development process and on the software obtained.

The closed producer-centred model

This model is typically adopted by commercial software firms. It is defined “closed” because the development process takes place entirely within the firm and is conducted solely by the latter’s employees. Software is developed according to engineering principles experimented in manufacturing industries in “a deliberate attempt to transform software from an unstructured service to a product with a guaranteed level of cost and quality” (Cusumano, 1992, p. 467; Cusumano and Smith, 1997).

Amongst the institutions that distinguish this model, the most obvious are the legal protections applied to the software produced. In particular, the software developed belongs to the firm within which the code is written and not to the single programmers. The specific form of IPRs applied to software has varied in time and space, typically they are protected by copyrights or patents. The aim pursued by the definition of such IPRs is to impede free-riding, imitation or replication of the code to which they are applied by external agents. Such protection is also obtained through the distribution of the object code only.

Single programmers are tied to the firm they work for by carefully designed legal contracts. Generally, these contracts clarify that any right they may have on the code they write automatically passes to the firm, that they are tied to secrecy regarding the contents of their work and that they must not create disloyal competition. At times, these contracts may contain mechanisms to stimulate virtuous behaviours – like the re-use of pieces of code. Though it is not possible to generalise regarding the way software production is organised, it tends to adopt principles similar to those found in manufacturing firms. Thus, software production is guided by strong and layered managerial processes, activities and responsibilities that are allocated to a top-down logic and work is conducted within teams. Though this model is characterised by institutional settings similar to those of manufacturing firms, managers often try to stimulate programmer creativity by mimicking various aspects of the hacker culture. This may, for example, entail encouraging a strong tension towards technical excellence and competitive spirit.

The brief description of the main traits of the formal and informal institutions that distinguish the closed model allows to identify a number of ways in which they influence the main determinants of the development processes that take place within this model. It is possible to summarise them as follows:

- (1) The perception of productive possibilities:
 - is a top-down process – the objectives guiding software development and the main characteristics of the software are defined at the management level (in part this is due to the necessity to coordinate numerous teams working on different pieces of a programme);
 - software development is aimed to obtain market success – marketing departments play a crucial role in defining characteristics that a new software must possess based on analyses regarding competing products and consumer behaviour in target market segments; and
 - target markets chosen to orient software development are often those segments which are larger and present higher growth rates or that represent protected niches.
- (2) The accessibility of the resources and competences necessary for the implementation of creative intuitions:
 - barriers to accessibility are high due to the extended use of IPRs on software produced according to this model;
 - new intuitions often infringe on existing IPRs, rendering difficult the implementation of new programmes;

- strong IPRs force firms to dedicate resources to research the contents of other firm's IPRs before undertaking new development paths; and
 - given the interdependence between perception and accessibility, the closed model leads to a division of knowledge within society which, in turn, hinders not only the implementation but also the perception of new development paths.
- (3) The motivation driving software development:
- at the single programmer level – is strictly economic and is stimulated through the use of tangible rewards like salary levels, prizes and career advancements; and
 - at the firm level – it is strictly economic. Firms aim to obtain rents from the software they develop internally.

The open user-centred model

This model describes the process underlying the development of OSS and FS[2] in the community and foundation-based projects (O'Mahony and Ferraro, 2007). We refer to it as “open” because it identifies a transparent and open software development process that involves all programmers who are interested and technically able to contribute to the elaboration of a specific programme. Contributing programmers are software users and not employees of the project they participate on a voluntary basis, and do not receive any direct economic reward for their personal efforts towards revealing creative contributions to the OSS project.

This model is, in many ways, opposite to the closed one: it leads to a significant increase in market adoption of OSS, but contemporarily it sacrifices the possibility to obtain rents from the software produced.

The most prominent formal institutions that distinguish this model are the IPRs applied to the software elaborated. Their aim is: to maintain OS/FS open and transparent to all those interested to analyse, use or modify it; to maximise its circulation on the web; and to protect the identity and the reputation of the OS community or foundation which is governing its development (cf. Lerner and Tirole, 2002b; O'Mahoney, 2003; West, 2003; Bogers and West, 2012). Though in reality there are hundreds of specific licenses, there are two archetypes of licences that show the main difference between OSS and FS. In particular, the Berkley Software Distribution (BSD) licence which is typical of the OS adepts and the GNU General Public Licence (GPL) which is typically used for FS (Free Software Foundation, 1989/1991). Both licences allow the free distribution, use and modification of the source code of the software programmes, and they both allow that support, consultancy and training services tied to the software may be sold without restrictions. They differ regarding the possibility for third parties (typically commercial vendors) to add proprietary code to the community's work and privatise it in the attempt to make a profit (offered by the BSD license).

According to the norms of the internal organisation of the OS communities, single programmers maintain the IPRs on the pieces of software they write. Responsibility over the project is allocated according to the contributions made by programmers to the software officially released on the net (cf. Dahlander and O'Mahony, 2011) – and project leaders often tend to be also founders.

The formal institutions of this model reinforce and rest on the hacker culture that pervades the OS programmer community (Raymond, 1999).

The brief description of the main traits of the formal and informal institutions that distinguish the open model is sufficient to identify the ways in which they influence the

main determinants of the development processes that take place within this model. It is possible to summarise them as follows:

- (1) The perception of productive possibilities:
 - The programmers whose creative intuitions lead to the development of a new software are geographically dispersed and are not a pre-defined group of individuals. This aspect consents to leverage the knowledge which is disseminated throughout very different socio-economic contexts.
 - The knowledge underlying the creative intuitions is not solely technical, programmers are essentially also users of the software they write and, often, pour effort into these projects because they need the programmes.
 - The transparency of the development process implies that individuals may contribute to parts of the programme that best fit their skills.
 - Given the possibility to download OSS whilst it is being developed and the variety of time-space contexts in which single programmers-users operate, the programmes are run and experimented in a variety of different settings. This facilitates bug individuation and leads to high-quality software.
- (2) The accessibility of the resources and competences necessary for the implementation of creative intuitions:
 - Barriers to accessibility are deliberately eliminated through the formulation of licences that guarantee the transparency of both the development process and the programmes obtained. The aim is to maximise the accessibility of the code not only to whoever is interested in using it, but also to who is interested to modify it and, therefore, to develop it further.
 - The licences used to create interfaces for the interaction between communities, eliminating the risk that existing IPRs of other O/FS communities or foundations may hinder the implementation of new programmes, and thus fostering a climate of trust between communities.
 - Often the licences used contribute to the institutionalisation of the relationship between different communities, e.g. through the use of the GPL licence, the GNU community guarantees the fruits of their work to the Linux community.
 - The high accessibility of OS/FS, the trust it encourages and the role of meritocracy it supports give way to an “ecology of productive communities”.
- (3) The motivation driving software development:
 - At the single programmer level (cf. Raymond, 1998a, b, 1999; Lakhani and Von Hippel, 2000; Lakhani and Wolf, 2001; Moody, 2001; Torvalds, 2001; Lakhani *et al.*, 2002; Bonaccorsi and Rossi, 2006; Franke *et al.*, 2013) – internal motivations include: the need for the software programme they are developing; the impression that it may be a fun or interesting; the opportunity to learn by working on stimulating programmes and interacting with other top programmers.
 - External motivations include: signalling one’s technical abilities and increasing one’s reputation in the programmer community; the reputation effects of contributing to OS/FS to obtain higher economic compensations on the labour market (cf. Von Krogh *et al.*, 2012; Raymond, 1999; Weber, 2000; Lerner and Tirole, 2002a, b; Hann *et al.*, 2002).
 - At the community/foundation level – to protect the identity and the reputation of the community that is developing the software.

The hybrid – interactive producer-user – model

This model describes the context in which firms actively collaborate with the external open-source community on the development of specific software programmes. It is initiated by commercial firms through the definition of new institutional arrangements – i.e., new licenses and other new formal and informal institutions – with the objective of enhancing the firms' innovative capacity by leveraging the creativity dispersed within the external environment, whilst maintaining the capacity to appropriate sufficient value from the firms' activities.

In the attempt to begin to answer the questions: “can firms actively manage fine-grained instruments like institutions or are the latter developed solely through slow social evolution processes?” and “if so, what are the potential advantages and the possible pitfalls entailed by the use of these strategic tools?”, we consider the common traits of the experiences matured by some of the most well-known software (or soft and hardware) firms. What follows draws on a re-elaboration of archival data relative to case studies of three software and hardware firms and three pure software firms which have in various ways set up and managed hybrid development models (Stuermer *et al.*, 2009; Cusumano and Yoffie, 1998; Yoffie and Cusumano, 1999; West, 2003; Gabriel and Goldman, 2002; Moody, 2001; Long, 2003), and is supported by several personal interviews conducted with academic and industry representatives. In particular, case studies related to the former firms are: IBM and its successful interaction with the Apache OS community aimed at the development of the WebSphere products; Apple's Darwin project; and Sun Microsystems' management of its Solaris operating system, its OpenOffice suite and its Java programming language. Case studies related to the latter firms include: Netscape and its unsuccessful Mozilla project; and the successful experiences of Oracle and SAP.

The creation of a context within which to collaborate with external programmers on specific development projects implies the careful elaboration of both formal and informal institutions on behalf of the sponsoring firm. The donation of code on the web must be accompanied by carefully designed licenses. Whilst OS/FS licenses are aimed to keep the code transparent, to maintain the reputation and identity of the sponsoring community and to avoid its hijack from third parties, in firm-based OS projects the aim pursued is to manage the contradicting necessities of transparency and control over the code expressed, respectively, by the external community and by the firm. In order to attract external programmers to contribute to the development project, they must feel sufficiently reassured that the firm will not hijack the fruits of their work once they reach a sufficient value. On the other hand, sponsoring firms wish to maintain the possibility to reap at least a part of the economic rents that the software produced could generate. West (2003) (cf. also Balka *et al.*, 2014; Deodhar *et al.*, 2012) underscored that there are basically two fundamental choices firms have to manage these contradicting issues:

- (1) open partly – to divide the programmes into layers and to adopt a different license for each layer; rendering some layers completely open, whilst maintaining other layers closed (e.g. the cases of IBM and Apple);
- (2) partly open – rendering the whole programme transparent, but applying terms which concede more liberties to the sponsoring firm than is usually the case in OS/FS licenses (Sun Microsystems' SISSL license, and Netscape's Mozilla Public License and its Netscape Public License, for example). The choice of licensing terms is rendered more difficult in the hybrid model due to the asymmetry with which programmers judge OS licenses proposed by firms rather than by communities or foundations[3].

The institutions a firm must manage in order to set up a successful hybrid development model go well beyond licenses. Not only the firm must make sure technical aspects tied to the quality and the modularity of the code released consents programmers to fruitfully feed

a virtuous internal-external development process, but it must also be able to create a community interested in the project it sponsors. This last necessity involves aspects relative to agent incentives, authority structures and communication mechanisms. Technically, this implies the creation of mailing lists, web sites and newsgroups dedicated to the projects in order to facilitate communication and coordination between internal and external programmers. To obtain sufficient support from external programmers, firms must manage to overcome the mistrust which is generally felt when they show a sincere affinity to the OS initiative and to the hacker culture.

The efficacy with which hybrid models are implemented depends, also, on the firms' capacity to modify their internal organisational culture. There is the necessity to mature a corporate culture that consents to embrace and appreciate external creativity avoiding to fall into a "not invented here" syndrome.

4. Discussion and conclusion

The brief description of the building blocks underlying the creation of hybrid development models in the software industry shows that firms are beginning (inevitably) to consider institutional setting definition as a strategic tool which needs to be intentionally managed in order to re-align the social structure in which software development occurs to the contradicting necessities of value appropriation and value creation. The results that firms have obtained through the adoption of this model have not always been positive. The analysis of unsuccessful projects (e.g. Netscape and in many ways also Apple), shows that the creation of valid hybrid models depends both on technical issues (e.g. the valid modular design of the code released, or the frequency of the official updated releases) and, even more crucially, on a deep comprehension of the systemic nature of institutional settings. This last issue implies that it is insufficient to release precious internally developed code with an adequately defined license applied to it. In order to stimulate the creation of a lively community of interacting internal and external programmers, firms must support formal institution management with the creation of a complex network of coherent informal institutions. "Soft" aspects like modifications in the firm's internal culture and the embrace of the "hacker spirit" are proving to be crucial and need to be managed intentionally.

Successful hybrid models consent firms to obtain a number of benefits. In particular: first, the extension of the user base of the firm's products – which is due to the complex of benefits that follows, plus the low cost of the software released and its attractiveness for those users who value being able to control the main traits of their software autonomously; second, an increase in the quality, reliability and stability of the software obtained – thanks to the efficacy of bug identification given by the variety of contexts in which the software is tested during development and the efficiency with which cognitive resources are allocated through transparent development processes; third, the possibility that entirely new directions for the development of software are perceived and implemented – in fact, the high degree of accessibility given by the transparency of the development process, consents to leverage the creativity dispersed in the external context and in some cases this has lead firms to undertake new development paths they had not imagined ex-ante; fourth, an increased integration of the firm's code with other existing complementary or connected software programmes and a boosted portability of the firm's software on various types of hardware; fifth, increased independence from leading software houses on behalf of firms that produce and offer both soft and hardware – thus, tipping the power balance between actors within technological platforms to the advantage of those who have adopted hybrid models; and finally, the creation of a credible communication channel with the external programmer community – this enables the firm to communicate its vision and propose future development paths that play to its strengths, in the attempt to push the market, external programmers and the firm itself to co-evolve harmoniously.

Though the focus of this paper is limited to the value creation process, it cannot conclude without discussing the effects that institutional setting management has on the firm's capacity to reap rents from its development activities. In fact, the adoption of the hybrid model analysed above influences not only the firm's value creation process, but also inevitably implies the necessity to re-adjust the way the firm appropriates value too. These two aspects underlying the firms' capacity to produce rents and survive are inevitably linked in a trade-off relationship which imposes to mutually adjust their management. The model analysed, shows the firms' deliberate attempt to stimulate a dynamic process of social interaction and communication which may foster higher levels of creativity and innovation. In order to guarantee the necessary accessibility and to sufficiently motivate external programmers towards the perception of a new code, the firm has to surrender the traditional source through which it appropriates value: barriers to the accessibility of the code developed through IPRs.

The adoption of an institutional setting which facilitates dynamic value creation processes suggests, therefore, the need to turn to dynamic mechanisms for value appropriation in parallel. Strategy studies have suggested that IPRs are not the only tool firms possess, and have singled out a number of mechanisms or routes through which firms may appropriate value from their innovations (Von Hippel, 1988; Moser, 2004; Lieberman and Montgomery, 1988; Lippman and Rumelt, 1982; Teece, 1986, 2006; Pacheco-De-Almeida and Zemsky, 2012). In particular, these include: the possession and the protection from imitation or replication of specialized complementary assets from which to draw Ricardian rents; taking advantage of first mover advantages during the lead time which separates the innovating firm from its imitators; relying on the causal ambiguity tied to the tacit dimension of the knowledge underlying the innovation and the complexity of the resource combinations implemented. Of these mechanisms, in the case of the hybrid models discussed above only the first seems effective. Given the transparency of the programmes released in the hybrid models discussed above, the first source of value appropriation seems the most promising.

In the software industry, firms that have successfully adopted hybrid models have had to tackle the value appropriation issue and show the empirical soundness of these considerations. In fact, not only have they tried to maintain at least a part of their capacity to reap rents from choosing "partly open" or "open partly" licensing strategies, but they have also tended to modify their business model in a search for alternative sources from which to appropriate value. Firms have tried to compensate the distinctive elements they lose through their donation on the web both in the phases before and after the code development. In particular, firms have competed on the general architecture of the software (or soft and hardware) offered – by modifying the basic design of the complex information systems they offer – and/or they have focussed on offering turn-key solutions for clients who express complex and sophisticated needs (like IBM has done). Also, firms have been investing in marketing resources, in high brand reputation, in distinctive client services and in application design. Though the solidity of these alternative sources of value appropriation remains to be assessed in the long run, they do illustrate initial attempts that firms are making to compensate the adoption of dynamic value creation processes.

Though this paper focuses on value creation, it cannot conclude without considering that the adoption of the hybrid model analysed inevitably implies the necessity to re-adjust the way the firm appropriates value too. In fact, firms that have successfully adopted hybrid models have tackled the value appropriation not only by choosing "partly open" or "open partly" licensing strategies, but they have also tended to modify their business model in a search for alternative sources from which to appropriate value. In particular, firms have competed on the general architecture of the software (or soft and hardware) offered, and/or they have shifted value appropriation towards service-centred business models (Cusumano *et al.*, 2014).

Notes

1. Specific examples include the following software programmes: the Linux operating system; the Apache web server; Sendmail; BIND; and the programming language PERL.
2. The distinction between OSS and FS is both ideological and tied to IPRs. In particular, FS adepts (the most prominent of whom is Richard Stallman) are completely closed to interactions with the commercial world, whereas OSS adepts are open to the commercial world. Parallel to these different aptitudes, IPRs applied to FS have a “viral” nature which assures that any derived programmes will continue to be distributed and used according to the same rules, whilst IPRs applied to OSS do not have this “viral” nature.
3. General mistrust in commercial vendor’s underlying motivations may explain, for example, the criticisms faced by SunMicrosystem’s SISSL license though it is analogous to the license used by the Apache foundation.

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RFID and ERP systems in supply chain management

RFID and ERP
systems in
SCM

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Received 30 November 2016
Revised 22 August 2017
7 November 2017
Accepted 10 November 2017

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Abstract

Purpose – The purpose of this paper is to identify the impact of enterprise systems (ESs), in particular radio frequency identification (RFID) and enterprise resource planning (ERP) systems, on supply chain management (SCM). The results of this conceptual paper demonstrate that ERP and RFID systems contribute to SCM by improving supply chain integration. Supply chain integration occurs to facilitate the flow of financing, products, and information throughout the chain. In this regard, ERP and RFID contribute to integration by enhancing the information flow across the supply chain.

Design/methodology/approach – This paper proposes a conceptual model developed from the findings of literature review within the research domains of SCM, ESs, and supply chain integration.

Findings – This conceptual study contributes to the existing theory by linking the concept of information technology, ESs to SCM. The conceptual model in this paper may provide insights for executives who wish to implement ERP or RFID systems in their businesses in order to achieve higher integration, both within internal sectors and also with supply chain partners.

Originality/value – The findings in this study contribute to the theory base by linking the concept of information technologies, ESs to SCM. The conceptual model presented in this paper can provide insights for executives who wish to implement ERP or RFID systems in their businesses in order to achieve higher integration within internal sectors and with supply chain partners. This study offers new understandings by investigating the impact of ERP and RFID together on SCM.

Keywords Enterprise resource planning (ERP), Supply chain management, Information technology, Supply chain integration, Enterprise systems, Radio frequency identification (RFID)

Paper type Conceptual paper

1. Introduction

Since the early 1990s, global market competition has dramatically intensified (Oghazi, 2009). Globalization, continuous changes in customer demand, and technological breakthroughs have brought about calls for more comprehensive and updated business models and practices (Oghazi, 2009). In this regard, the application of information technology (IT) in business processes has the potential to offer new business opportunities for firms to move forward in the increasingly competitive global market (Oghazi, 2009). IT infrastructure enables organizations to exploit their competencies, contributing positively to their performance (Santhanam and Hartono, 2003; Bardhan *et al.*, 2006).



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European Journal of Management
and Business Economics
Vol. 27 No. 2, 2018
pp. 171-182
Emerald Publishing Limited
2444-8494
DOI 10.1108/EJMBE-02-2018-0031

In this context, enterprise systems (ESs) are considered to be one of the most significant subsets of IT to have arisen over the last two decades (Cotteleer and Bendoly, 2006). ESs are comprised of hardware and software that are aimed at standardization as well as integration of business processes and data being used across an organization (Davenport, 1998; Dorantes *et al.*, 2013). Companies implement ESs in order to achieve higher efficiency (Oghazi, 2009). They may also adopt ESs because of external pressure in favor of adoption (Oghazi, 2009). In this regard, since the mid-1990s, US firms have increasingly invested in efforts to implement ESs into their organizational structure (Oghazi, 2009).

On the other hand, the nature of business competition has switched from rivalries among individual firms to the competition of supply chains. In other words, to achieve success in today's market, supply chains are competing against one another rather than individual organizations (Lee, 2005). Christopher (1998) asserts that supply chain management (SCM) includes the linkage of value-creating activities that occur downstream with upstream supply chain organizations in order to deliver higher product value to end customers. In this regard, breakthroughs within IT can potentially enable supply chains to develop stronger competitive advantages (Oghazi, 2009).

In line with this, Li (2012) argues that research pertaining to ESs as a subset of IT within the dimensions of SCM has been fragmented and is limited in scope. Research in this area is also incompatible, because the results often provide paradoxical answers in which some research supports the implementation of such systems, while other research opposes it (Oghazi, 2009). Based on this finding, the research question, which is designed to address this fragmentation in the literature, is as follows:

RQ1. How can ESs, in particular radio frequency identification (RFID) and enterprise resource planning (ERP), enhance supply chain performance?

This paper strives to contribute to existing literature by presenting conceptual research that encompasses a comprehensive review which links the extant literature pertaining to SCM and ESs to supply chain performance.

To do so, according to the relevant logic of a conceptual paper, the definition of SCM and ESs will be presented in depth in Section 2. In the third section, the subsets of ESs and supply chain integration as a practice of SCM will be examined in detail. Also in Section 3, findings from the literature review regarding the impact of ESs on supply chain performance will also be identified. In Section 4, the conceptual model that links the results of the literature review will be discussed in detail. Finally, the research conclusions will be presented in Section 5.

2. Definitions of concepts

This section includes the definitions of SCM and ESs, which represent the primary concepts that form the basis of this research.

2.1 ESs

In the 1970s, scholars realized that some businesses had begun to attain a competitive advantage through the exploitation of IT systems by reducing their costs and increasing revenues (Oghazi, 2009). Following these findings, day-to-day development of the internet has gradually inserted IT into almost every aspect of our daily lives. In this context, businesses were no exception (Oghazi, 2009).

After 1995, when the internet had reached the requisite maturity to represent a trustworthy communications environment, various companies applied and utilized the internet protocol networking standard to homogenize and unify their heterogeneous, separated networks. These newly emerged IT infrastructures are called ESs (Mostaghel *et al.*, 2012). These systems

connect different hardware elements in computers as well as smaller networks, and as a result, a company-wide network is created that allows for the free movement of information across the organization (Davenport, 1998; Chandrashekar and Scharj, 1999). ESs can also be designed in a manner that allows for inter-firm information flow (Davenport, 1998; Chandrashekar and Scharj, 1999).

However, despite the overall positive view regarding the impact of ESs on businesses performance, implementation of such systems is often associated with high costs. Therefore, the strategic use of such systems plays an important role in maximizing the benefits of their usage (Oghazi, 2009). In this context, decision makers should make strategic decisions about different factors involved in the implementation of ESs. For instance, the deployment of advanced tracking systems enables a transportation firm to provide its customers with precise data. However, the managerial question is to what extent are customers willing to pay for highly accurate information, considering the fact that the deployment of such an advanced system is expensive (Levi *et al.*, 2003; Oghazi, 2009).

There is no official index regarding those systems that are considered to be ESs (Oghazi, 2009). Nevertheless, a number of systems are often included within the division of ESs, including ERP, electronic data interchange, customer relationship management (CRM), product data interchange, and RFID (Vickery *et al.*, 2003; Ramasubbu *et al.*, 2008; Oghazi, 2009). For the purposes of this research, due to the research limitations, only RFID and ERP systems will be studied to investigate their impacts on supply chain performance.

2.2 SCM

Reductions in the life cycle of products, increases in the complexity of companies' joint ventures, and incremental needs for stronger customer service call for a comprehensive understanding of the exhaustive scope of SCM from the suppliers of very raw material to the final customers of the created product (Davis, 1993).

Since the early 1980s, various researchers (Oliver and Webber, 1982; Stevens, 1989; Handfield and Nichols, 2002) have studied the concept of SCM and its subdivisions. As part of this research effort, Bechtel and Jayaram (1997) divided the definition of SCM into four school of thoughts, which are as follows (Oghazi, 2009).

The functional chain awareness school. This perspective emphasizes the presence of functional areas that are joined together in order to facilitate the flow of material from the initial upstream supplier to the final customer (Oghazi, 2009). The major theme of this school is the physical flow of materials (Oghazi, 2009). In this school, definitions include all of the factors within the value-adding process, from the crude material to the utilization of the final product (Oghazi, 2009).

The linkage school. Definitions within this school focus primarily on the organizational boundaries that exist within a supply chain (Oghazi, 2009). This school emphasizes the legitimate linkage that exists between various chain actors (Turner, 1993; Lee and Larry, 2002). It seeks to explore how these linkages should be used to pave the way for the flow of materials across the supply chain with the purpose of balancing inventories and achieving a competitive advantage (Turner, 1993; Lee and Larry, 2002).

The information school. This school highlights the importance of the information flow throughout the chain (Oghazi, 2009). It emphasizes the unidirectional flow of information from customers to suppliers and the bidirectional flow from suppliers to customers (Oghazi, 2009). This school asserts that the information flow is the milestone of SCM (Oghazi, 2009). According to this perspective, information is not transferred from one chain actor to another, but rather, flows in the shape of feedback from customers regarding the performance of the supplier (Harrington, 1995; Towill, 1997).

The integration/process school. The integration/process school encompasses the latest and most progressive definitions of SCM. It posits that SCM represents the integration of systems, including a set of processes that can deliver value to products for internal/external customers (Oghazi, 2009). In other words, this perspective emphasizes the integration of value-creating processes across the chain. Customer satisfaction is the central concept of this school, which distinguishes this perspective from previous points of view (Oghazi, 2009). Followers of this school of thought are not limited to the specific network of the supply chain and are empowered to examine alternatives to the supply chain configuration (Oghazi, 2009). Such empowerment encourages the deletion of redundancies by allowing a set of activities to be performed simultaneously (Oghazi, 2009).

3. Theories used in SCM and ESs

This section will explain supply chain integration as a significant concept in the practice of SCM. It will also describe RFID and ERP systems as two scopes of ESs that are the focus of this paper, as previously discussed. Ultimately, this section will link the two aforementioned areas of concentration by investigating the impact of RFID and ERP on supply chain integration.

3.1 Supply chain integration

In today's global marketplace, firms should operate in a well-adjusted and integrated manner in order to sustain their competitive advantage, with the ultimate purpose of successfully marketing their goods and services (Oghazi, 2009). In this regard, firms that are working together within a supply chain strive to enhance their competitive performance through the integration of their internal processes as well as their internal functions, and, following this, through integration with upstream and downstream supply chain partners (i.e. suppliers, suppliers' suppliers, customers, etc.) (Wook Kim, 2006; Flynn *et al.*, 2010; Wiengarten *et al.*, 2016).

In order to understand how competitive capability and performance are sustained through supply chain integration, supply chain network structure is explained as follows. A supply chain network is comprised of a focal firm, which is usually the manufacturing company, its suppliers and suppliers' suppliers on the upstream tiers of the chain, as well as its customers and customers' customers on the downstream tiers of the chain (Oghazi *et al.*, 2016). The number of downstream and upstream members of the chain varies depending on the specificities of the industry and the specific supply chain. A supply chain network illustrates the path that raw materials provided by suppliers follow in order to be transformed into the final product by manufacturers (Oghazi, 2009). This path continues with the storage and distribution of the final product by the distributor and the delivery to retailers before ultimately reaching final customers (Oghazi, 2009). The aforementioned path illustrates the flow of materials from upstream to downstream members of the network (Oghazi, 2009). In this context, if the final product that reaches the customer is returned, the product will follow the path from the downstream side of the network to the upstream side (Oghazi, 2009). For these reasons, the movement of products, information, and finances among the supply chain members takes place along both paths (Oghazi, 2009).

The flow of products, information, and finances among supply chain members requires strong integration between the chain actors to coordinate their activities and ensure the accurate flow of different loads. However, optimization of the supply chain configuration is a difficult task because of the very dynamic nature of supply chains and the inconsistent objectives of different partners in the chain (Oghazi *et al.*, 2016). Nevertheless, prosperous companies (e.g. ABB and Tetra Pak) have proven the feasibility of optimal

supply chain integration, as well as the potential benefits derived from such an integration, including enhancements in market share as well as overall financial performance (Levi *et al.*, 2003).

Following the statements above, the focal companies in supply chains employ various integration strategies according to their integration level (Oghazi, 2009). Companies' integration levels are divided into four groups (Oghazi, 2009): internal integration; integration with suppliers to ensure the coordination of upstream activities and the accurate flow of loads (product, information, and finance flows) among upstream members; integration with customers to coordinate downstream activities to ensure the proper flow of loads among downstream members; and full integration to ensure the effective flow of products, information, and finances across the entire supply chain (Oghazi, 2009). These four integration levels will be discussed in more detail in Section 3.4.

3.2 ERP

When various enterprises encounter a number of independent information systems across organizations, they usually face large quantities of accumulated, non-standard information in different departments, functions, and business processes throughout the company that are not able to be transferred due to their heterogeneous formats (Oghazi, 2009). The inability to transfer various data across the organization often causes difficulties for managers in terms of monitoring and decision making due to the unavailability of sufficient valuable data (Oghazi, 2009). For this reason, various companies employ ERP systems to link information from different segments of the organization to one another, with the purposes of facilitating exact and on-time delivery, improving customer satisfaction, and reducing costs (Tsai *et al.*, 2007; Häkkinen and Hilmola, 2008; Oghazi, 2009).

An ERP system consists of multiple modules that link information from different segments of the organization to one another. Each module (e.g. finance, logistic, order fulfillment, manufacturing) refers to a specific organizational function. Hence, by linking these modules to one another, data from different functions are interconnected and consequently provide managers with the required information in order to capture a bigger picture of the firm's operations and make more informed real-time decisions (Oghazi, 2009).

Moreover, an ERP system allows for the automation of business processes, which in turn can result in higher efficiency and lower costs for the firm (Oghazi, 2009). Nonetheless, it is important that firms review their processes before employing ERP systems, because automation of an ineffective and inefficient process means that the process will be consolidated and performed persistently, and it will be difficult to modify or replace after it has been automated (Oghazi, 2009).

3.3 RFID

RFID is a technology and physical infrastructure that is used as a tool to identify and label the objects (Oghazi, 2009). This technology encompasses a particular identifier that is transmitted from one device to the reader through radio waves within a preordained code definition (Oghazi, 2009). Characteristically, RFID includes a microprocessor that possesses informational memory space (Oghazi, 2009). Such a feature makes the RFID an important and functional tool for different means and purposes (Oghazi, 2009), One of which is SCM (Oghazi, 2009).

RFID allows for warehouse inventory management, ensuring that the shipped product conforms to the actual shipping order, preventing the stock-outs at the sales level, updating managers with the current phase of production, decreasing paperwork, enhancing the level

of productivity, increasing the clarity of the product development process throughout the supply chain, decreasing the cost of labor, and rendering inventory forecasting more accurate (Srivastava, 2004; Shepard, 2005; Attaran, 2006; Markelevich and Bell, 2006; Lee *et al.*, 2008; Oghazi, 2009). This technology allows for the tracking of every item that is tagged across the supply chain (Oghazi, 2009).

Despite the benefits of RFID, there are certain disadvantages correlated with this technology that must be tackled by firms. RFID tags include significant amounts of data that in some cases raise privacy concerns (Wu *et al.*, 2006). In this context, an empirical study conducted by Günther and Spiekermann (2005) illustrates that 73 percent of 129 German customers would like RFID tags on purchased product to be removed at the checkout level due to customers' concerns regarding the data stored on the tags (Oghazi, 2009). In addition to privacy concerns, data stored on the tags do not follow a standard format that can be understood by different firms across the supply chain, which can lead to false data storage on the databases of partner firms (Wu *et al.*, 2006; Oghazi, 2009).

3.4 ERP and RFID in supply chain integration

As briefly explained in Section 3.1, supply chain integration is divided into four levels that can be facilitated through ESs such as RFID and ERP.

First level of integration: internal integration. An organization that lacks any integration is often associated with separate departments that have little or no coordination with one another (Beheshti *et al.*, 2014). In this regard, information is one of the necessary tools for successful transfer and movement throughout an organization in order to achieve higher coordination. Following this line of thought, Levi *et al.* (2003) assert that standard and accessible information within an organization contributes to a firm's ability to communicate and perform business in a timely manner, and at a lower cost.

In this context, the purpose of the internal integration of information throughout an organization is to connect separate systems that exist within various departments of an organization into one central information system and standardize the format of this shared information in order to make it understandable for all divisions within the organization (Oghazi, 2009). For this purpose, ERP systems provide the organization such an integration opportunity through bundles that are located in different departments (Beheshti *et al.*, 2014). These bundles collect the domestic data of every department and link them to the main database, which is accessible for use by all units within the organization. ERP systems also allow for the standardization of information, which enables the data to be used in different departments of the company.

Moreover, usage of RFID allows for the monitoring of materials/products as they move among different organizational divisions (Oghazi, 2009). Because RFID tags are capable of carrying information, the tagged product/material can be tracked at different locations. Through the ERP system, the data regarding these tagged products/materials can be transferred to other parts of the organization in order to provide various divisions with real-time information for better planning and control.

Second level of integration: integration with suppliers. Integration with suppliers includes the creation of win-win relationships with suppliers, which are associated with a strong commitment and trust. These are achieved gradually, in conjunction with attendant risks, data sharing, rewards, and long-term contracts (Vickery *et al.*, 2003). In this regard, to achieve integration with suppliers through information sharing, ERP, and RFID systems can play vital roles. Possession of an ERP system by both manufacturing and supply companies, as well as the interconnection of these two ERP systems between these two supply chain partners, allow for a seamless informational infrastructure to exchange data between the two aforementioned chain partners. Through an ERP system, information

regarding inventory level, number of orders, production rate, etc., can be accurately shared between the manufacturer and its supplier, at the right time, and at a low cost (Levi *et al.*, 2003; Oghazi, 2009). This facilitation of information flow can lead to higher efficiency in the performance of business activities, higher customer satisfaction, and superior planning. In addition, RFID can be used to monitor the movement of supplies that are transferred to the manufacturer; it provides necessary information regarding what was being shipped and when it will be delivered.

Third level of integration: integration with customers. Relationships with customers are often characterized by asymmetrical power (Oghazi, 2009). Customers are aware that they are the ones who inject money into the chain, and their role in the entire supply chain is inevitable (Oghazi, 2009). This fact provides the customer with leverage to ask for more customized services (Oghazi, 2009). For this reason, integration with customers to increase their benefits is an important subject that must be comprehensively considered.

To accomplish this, many companies strive to enhance the quality of their relationships with customers (Oghazi, 2009). For this purpose, one of the main practices is CRM. CRM refers to the strategic capability and commitment of the company to meet its customers' demands (Lee and Billington, 1992; Powell, 1995). Firms can achieve stronger customer relationships by being more responsive to their customers' demands; following the creation of closer customer relationships, firms can be proactive in collecting data regarding customers' specific requirements and behaviors (Stroeken, 2001). Such closeness with customers makes it more difficult for competitors to truly compete (Vickery *et al.*, 2003). In this regard, IT, including ERP systems, can facilitate better relationships with customers because it brings them closer to the firm through the provision of an effective mechanism that allows for information sharing between the customer and the supplier. Therefore, the inclusion of a module that addresses those factors involved with CRM in the main body of the ERP system can strengthen integration between the firm and its customers (Levi *et al.*, 2003; Hatzithomas *et al.*, 2007; Oghazi, 2009).

Furthermore, in B2B relationships, a customer that encompasses an RFID system can potentially obtain comprehensive product information from the tagged product delivered to them through the usage of RFID, which can also contribute to the integration between the supplying company and the customer.

Fourth level of integration: fully integrated supply chain. As previously discussed, finances, products, and information represent the loads that flow from upstream tiers of suppliers toward downstream tiers and vice versa (Oghazi, 2009). Therefore, supply chain integration occurs within the context of the three aforementioned load flows. For this purpose, Rai *et al.* (2006, p. 235) define information flow integration as "the extent to which operational, tactical, and strategic information is shared between a focal firm and its supply chain partners" (Oghazi, 2009). Operational information includes data such as inventory holdings, deliveries, and production schedules (Oghazi, 2009). Tactical information includes performance metrics, task implementation, and respective outcomes (Rai *et al.*, 2006). Strategic information includes sales data (Rai *et al.*, 2006; Stratman, 2007; Oghazi, 2009).

Based on the above statements, the integration of a supply chain's tactical, strategic, and operational information is vital in order to maximize the profitability for the entire chain of actors, as it is the general objective of SCM (Rai *et al.*, 2006). For this purpose, IT, including RFID and ERP systems, can play a key role. Regarding the integration of operational information, RFID tags allow for the produced and delivered inventories to be tracked across the chain, and ERP allows this inventory-related information to be transmitted throughout the chain. Furthermore, strategic information that includes sales data can be accessed by all

actors in the supply chain at different tiers through the use of the ERP system to avoid demand information falsification and to prevent the resulting bullwhip effect from occurring. Effective sharing of information among the supply chain actors allows for production and delivery synchronization, better forecasting, coordination of inventory-related decisions, and the facilitation of a mutual understanding of performance bottlenecks (Rai *et al.*, 2006). In this regard, IT, including RFID and ERP systems, can facilitate effective information sharing among supply chain members.

4. Proposed conceptual model

Based on the findings from the literature review, the conceptual model is proposed as in Figure 1. Following the proposed conceptual model, it can be noted that ESs bridge the concept of SCM through the facilitation of supply chain integration. In this regard, supply chain integration takes place within the domain of four levels. Each level represents certain scope of integration that can be facilitated and enhanced through the use of IT, more specifically, through RFID and ERP systems.

At the first level, the ERP system and its bundles enhance the integration of information within an organization through the junction of independent information systems located in different divisions and departments into one central database. Through this system, various functions and activities can be implemented with proper coordination and harmony among different sectors in order to ensure effective and efficient performance. Such an integrated internal information system allows for top and divisional managers to make more informed and real-time decisions with respect to the overall condition that exists within the organization. An ERP system also homogenizes the data format throughout the organization to render the information more understandable and readable for every department. Following the facilitation of an intra-organizational information flow through an ERP system, RFID tags can also be a useful means to provide product-related data and to monitor product movement within the organization. Based on the declarations above, it can be said that RFID can potentially create the informational input for product status, and ERP can transmit this input across the organization.

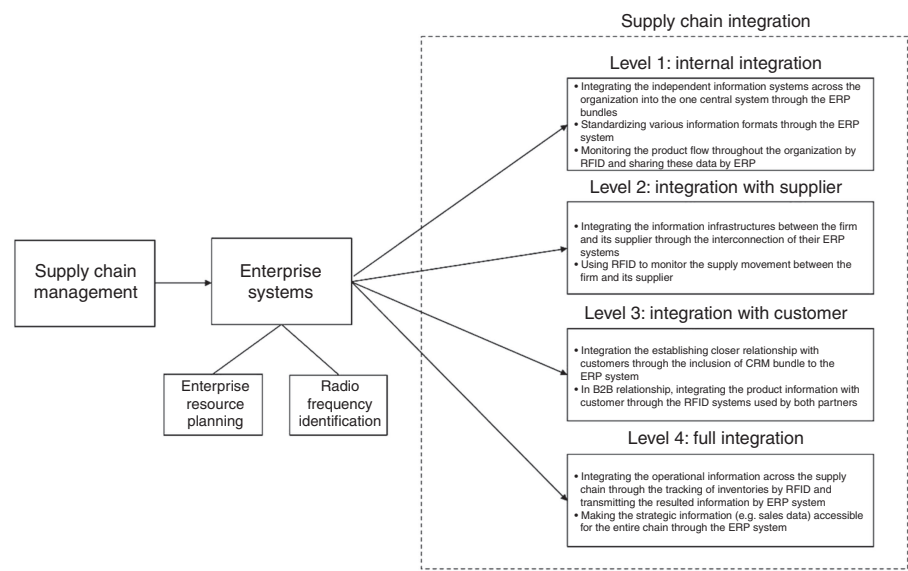


Figure 1.
Proposed conceptual
model

At the second level, RFID and ERP systems can facilitate the information flow in a manner that is similar to the first level, but within the context of the inter-organizational relationship between the firm (buyer) and its supplier. On one hand, RFID tags can inform companies regarding supply status (e.g. what is being shipping, its current location, where and when it will be delivered, etc.). On the other hand, these inputs provided by RFID can be transferred through the interconnection of the ERP system from the supply company to the buyer.

At the third level, an ERP system can enhance integration and relationships with customers through the CRM bundle, which provides the firm with access to comprehensive customer information to facilitate better understand and consequently offer customers products and services that match their requests and demands. In addition, within B2B relationships, RFID can improve integration with customers by enabling product information to be stored in microprocessors and delivered to customers in conjunction with the product to ensure the compatibility of delivered products with actual orders.

At the fourth level, the integration of operational information, such as inventory holding, delivery, and production schedules, can be enhanced among the entire supply chain of actors through the exploitation of ERP and RFID. As previously discussed, RFID can provide necessary information regarding inventory status, and supply chain members can have access to this information through seamlessly interconnected ERP systems. This allows for superior planning and the performance of tasks and activities more efficiently, and on time. ERP's ability to transmit information across the supply chain also allows for sales information to be precisely distributed among the chain's actors and, as a result, provide the opportunity for more accurate demand forecasting, which ultimately help to prevent the bullwhip effect from occurring.

5. Concluding remarks

Based on the findings above, it can be concluded that supply chain integration, which represents one of the major practices of SCM, can be enhanced through the use of ESs such as RFID and ERP. To be more specific, integration among the supply chain actors occurs in order to facilitate the effective and efficient flow of products, finances, and information across the supply chain for the purpose of maximizing profit for the entire network, which consists of suppliers, manufacturers, distributors, and customers. Accordingly, RFID and ERP, which represent the two ESs that are the focus of this study, can contribute to supply chain integration in terms of the flow of information. The two aforementioned forms of IT allow for the creation of an exchange mechanism that facilitates the accurate, on-time, and safe movement of information between members of the supply chain. This capability allows supply chain managers to have access to comprehensive information that gives them the ability to understand what is going on at different tiers of the supply chain. In summary, this capability provides them with a bigger picture of the activities taking place throughout the chain. Such an opportunity aids managers in making more informed decisions, with enhanced planning and control of processes and activities.

Moreover, despite the benefits of ESs, their implementation is often associated with high costs. Therefore, it is critically important that prior to system implementation, firms conduct deep analyses regarding their internal processes as well as their overall situation with respect to the external environment in order to prevent the waste that can result from ES implementation failure.

Furthermore, due to the limitations of this study, its explicit focus is on ERP and RFID systems in particular. In view of this limitation, it is recommended that other scholars should perform future to identify the impact of other ESs on SCM to provide further clarification in this fragmented field of study.

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Trends on the relationship between board size and financial and reputational corporate performance

Reputational
corporate
performance

The Colombian case

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Received 5 December 2016
Revised 17 August 2017
3 November 2017
Accepted 7 November 2017

Abstract

Purpose – The purpose of this paper is to investigate the relationship between board size (B-SIZE) and financial and reputational corporate performance in top companies ranked by the Business Monitor of Corporate Reputation – MERCO in Colombia.

Design/methodology/approach – This paper conducts correlations and cluster analysis in order to classify firms based on performance and control variables, using a sectional sample of 84 large companies in Colombia over the period 2008-2012.

Findings – This research finds that large boards are associated with high performance on corporate reputation, as stated by the resource dependence theory, and a low-financial performance, as predicted by the agency theory. However, the results indicate that there is no relation between financial and reputational performance.

Research limitations/implications – This research considered only large companies listed by MERCO. Therefore, the results can only be generalized for top firms in Colombia according to this list. However, results add empirical evidence to theoretical debate between B-SIZE and firm performance considering financial and reputational indicators.

Practical implications – According to the OECD manual of good corporate governance practices, the optimal B-SIZE has between five to nine core members. The board structure has a direct impact over the firm's financial and reputational performance and must be carefully analyzed by shareholders to balance the size according to expected results and firm's features like family ownership, exportation activities and norms of stock markets.

Originality/value – This paper contributes to the existing literature on the relationship between B-SIZE and corporate performance with the evaluation of financial and reputational results for the case of an emerging economy. In Latin America, this analysis must go beyond OECD recommendations, and shall consider the context of an emerging country based on empirical evidence.

Keywords Corporate reputation, Organizational theory, Colombia, Financial performance, Board size

Paper type Research paper

Introduction

The relationship between the size of the board of directors and corporate performance is a fundamental issue in corporate governance (Cheng, 2008). There are two main opposite theoretical approaches to the relationship between board size (B-SIZE) and corporate performance. Agency theory, from an economic perspective, determines that fewer



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European Journal of Management
and Business Economics
Vol. 27 No. 2, 2018
pp. 183-197
Emerald Publishing Limited
2444-8494
DOI 10.1108/EJMBE-02-2018-0029

board members improve monitoring, control and corporate financial performance (FP) (Jensen, 1993). On the other hand, Resource dependence theory, based on a more sociological approach, states that large boards improve advisory capacity, counseling, deliberation and external relations, and thus FP of firms (Pfeffer, 1972). However, research about B-SIZE and financial indicators has not produced conclusive results (Dalton *et al.*, 1999; Cheng, 2008; Belkhir, 2009; Guest, 2009; Palaniappan, 2017; Yasser *et al.*, 2017).

Corporate performance has incorporated new measures that go beyond financial indicators (Said *et al.*, 2003), especially those within the scope of the Global Reporting Initiative (Skouloudis *et al.*, 2010). Several studies have found that there is a positive relationship between B-SIZE and non-FP. This positive relationship has a substantial impact on the sustainability of the firm (Chaganti *et al.*, 1985; Platt and Platt, 2012), including firm' environmental indicators (de Villiers *et al.*, 2011) and its operational performance and social welfare (Kao and Kao, 2013). However, little progress has been made on assessing the relationship between B-SIZE and corporate reputation (Musteen *et al.*, 2010).

The relationship between financial and reputational results tends to be positive as indicated in several studies using *Fortune's* information (Fuente and Quevedo, 2003; Hammond and Slocum, 1996). However, the study from Flanagan *et al.* (2011) about companies listed in *Fortune's* 2006 rank found that the relationship between reputation and financial indicators is not as strong as Brown and Perry (1994) reported in *Fortune* (1991), and the virtuous cycle between reputation and financial results is not as clear as Dunbar and Schwalbach (2000) found for the German firms. Also, to our knowledge, there are no empirical studies evaluating this relationship regarding the effect of B-SIZE. Then, the purpose of this research is to expand the knowledge on this relationship to contribute to the theoretical development of corporate governance using empirical evidence from an emerging economy such as Colombia.

The development of corporate governance in Colombia is still incipient. Based on the OCDE and the Andean Development Corporation guidelines, the corporate governance Country Code was introduced in 2007. Although the adoption of these standards is not legally mandatory, different entities such as the Financial Superintendence and the Superintendence of Corporations, together with the Colombian Confederation of Chambers of Commerce – Confecamaras[1], have been encouraging companies to implement corporate governance practices. Additionally, contingency factors and institutional lobbying exerted by the stock market, as well as the internationalization process and growth of family businesses (FBs), among other variables, have led companies to adopt governance structures using the Colombia Country Code guidelines. However, best-practice guidelines on corporate governance do not support their recommendations on empirical evidence; thus, the relationship between B-SIZE and corporate performance is just a normative recommendation. In fact, the empirical research upon corporate governance in Latin America is limited and focused on FP without considering B-SIZE as the main variable to achieve results (Garay *et al.*, 2006; Lefort and Urzúa, 2008; Castro *et al.*, 2009; Fernández *et al.*, 2015).

This paper contributes to fill a gap in the literature, evaluating the association between B-SIZE and financial and reputational performance, using a sample of the 84 largest companies in Colombia as listed by MERCO over the term 2008-2012. Moreover, it will provide additional insight on both the agency theory and the resource dependence theory on B-SIZE, corporate performance, and best practices in corporate governance.

This paper is structured as follows: the first section develops the theoretical debate, the second presents the literature review and research hypotheses. The third part presents the methodology and results. The paper ends with conclusions and issues to be considered for future research.

Theoretical approach

Agency theory (Jensen and Meckling, 1996) states that small boards have more managerial control. Jensen (1993, p. 865) stated that “keeping boards small can help improve their performance”, and stressed that boards with more than seven members are prone to inefficient operations, lack of commitment, moral hazard problems, and greater control by the CEO. Resource dependency theory (Pfeffer and Salancik, 1978) has found evidence that an increase in B-SIZE provides access to external relationships which brings further information and access to financial and inter-organizational coordination (Pfeffer, 1972), especially upon interlocking directorates (Mizruchi, 2004). Large boards can improve the richness of perspectives, access to information and resources, and the quality of opinions and deliberation upon decision making, as well as the strategic spectrum of the company (Belkhir, 2009; de Villiers *et al.*, 2011). However, as stated by Pfeffer (1972, p. 226) “B-SIZE and composition are not random or independent factors, but are, rather, rational organizational responses to the conditions of the external endowment.”

Theoretical proposals integrating agency theory and resource dependence theory have been developed to understand the relationship between board of directors and corporate performance. The integrative model proposed by Zahra and Pearce (1989) highlights the importance of contingency factors proposed by agency theory, such as ownership concentration and stock markets, and type of business and external relationships as resource dependence theory proposed. Hillman and Dalziel's (2003) integrative model suggests that human capital (experience, expertise and reputation) and social capital (networks with other organizations and the environment) of the boards affect monitoring and advisory activities, while incentives to directors moderate the relationship between board characteristics and firm performance. However, these integrative models do not consider the possible dichotomy between financial and reputational performance, as financial results are more associated to agency theory while reputation is more related to resource dependence theory.

Regarding the relationship between financial and reputational performance, Quevedo *et al.* (2005) proposed a cyclical model based on organizational legitimacy defined by the general perception that organizations comply with a number of legal rules to produce, exchange goods and services and perform property activities, as suggested by the economic model, as well as a transparency upon information and results delivered which favor the expectations among stakeholders that are directly or indirectly involved with the organization as documented by the sociological approach. The model understands the board “as intermediary from the contractual relations that take place in the company, which exerts as a mediator to safeguard the legitimacy” (Quevedo *et al.*, 2005, p. 89). The nexus of explicit and implicit contracts creates a commitment upon directors to generate reputation and FP for the organization, which in turn fosters trust and reduces transaction costs by increasing organizational efficiency and stakeholder's satisfaction (Quevedo *et al.*, 2005).

According to integrative models, there are many contingencies that can affect the relationship between B-SIZE and corporate performance. One of the key variables described in agency theory is the concentration of property in specific families (Carney, 2005; Delgado-García *et al.*, 2010). Incentives, such as family ties within the firm may increase the monitoring and advisory efforts to outperform corporate results (Hillman and Dalziel, 2003). Given the nature of family-controlled firms, boards tend to be small (Neubauer and Lank, 1998; Corbetta and Salvato, 2004; Casillas and Vásquez, 2005). However, large companies require large boards, with people from diverse backgrounds and experiences to improve decision making (Zahra and Pearce, 1989). Similarly, commitments with stock markets and the internationalization of activities of companies could also incentivize boards toward achieving better financial and reputational performance. These contingencies require both control and advisory skills that have an impact on the size of the boards.

On the one hand, according to legislation and requirements on information transparency, stock market listed companies may have smaller boards. This is supported by empirical evidence and as suggested by the agency theory (Yermack, 1996; Tonello, 2010). On the other hand, activities like exportation increases risks, thus companies need greater number of members in their board as suggested by the resource dependence theory in order to improve their counseling capacity and inter-organizational relationships across national borders (Schwaiger, 2004; Calabrò and Mussolino, 2011; Barroso *et al.*, 2011). These contingencies will be the basis for empirical research in this paper.

Literature review and research hypotheses

According to the previous section, B-SIZE has implications for the achievement of corporate performance, including financial and non-financial results like corporate reputation. The following literature review presents the main theoretical approaches developed to explain the relationship between B-SIZE and corporate performance.

B-SIZE and FP

FP reflects the ability to create economic value. The most commonly used indicators in the literature are the firm's value (Tobin's *Q*), return on equity (ROE), return on assets (ROA), and net sales, which represent the ability of corporations to use resources efficiently and their market share. Several empirical studies found a negative relationship between B-SIZE and financial outcomes, in developed countries such as the USA (Yermack, 1996; Lehn *et al.*, 2009), Finland (Eisenberg *et al.*, 1998), the UK, France, Holland, and Italy (Conyon and Peck, 1998), Denmark (Bennedsen *et al.*, 2008), and in emerging Asian economies such as Singapore and Malaysia (Mak and Kusnadi, 2005), Thailand (Yamneesri and Herath, 2010) and India (Chatterjee, 2011; Kumar and Singh, 2013). These findings support the explanations from agency theory (Harris and Raviv, 2006), about highlighting the importance of small boards to monitoring and controlling corporate management.

However, the results obtained in the analysis of data from the Investor Responsibility Research Center –IRRC– show a negative relationship between B-SIZE and Tobin's *Q* and ROA (Cheng, 2008). Studies like Belkhir's (2009) for the US banks have found that an increase in B-SIZE delivers better FP. Also, Guest (2009) found for the UK listed firms that larger boards have a negative impact on profitability. This relationship was also found in Asian economies like Japan (Xie and Fukumoto, 2013; Bonn *et al.*, 2004), India (Jackling and Johl, 2009; Sarpal and Singh, 2013; Palaniappan, 2017), Malaysia (Shukeri *et al.*, 2012), Thailand (Glaewketgarn, 2013), China (Liang *et al.*, 2013) and Pakistan (Yasser *et al.*, 2017), as well as in emerging economies in Africa like the case for banks in Kenya (Chepkosgei, 2013), and firms in Nigeria (Ehikioya, 2009; Uadiale, 2010; Ugwoke *et al.*, 2013).

According to Pfeffer (1972), B-SIZE depends on the conditions of the environment. Specifically, the conditions of economic volatility and uncertainty experienced in developing countries may lead to boards with a greater number of members to establish more and better relationships with other organizations and the environment, and to provide valuable resources for better FP. In Latin America, the case of Chile showed a positive relationship between B-SIZE and Tobin's *Q* in a sample of 160 firms (Lefort and Urzúa, 2008). Therefore, it is possible to think that in emerging economies larger boards are needed to face the challenges of economic value creation. Based on this this paper propose that:

H1. In Colombia, B-SIZE is associated to FP.

Size of the board and corporate reputation

Reputation is a collective perception built in a process of social construction and validation. Corporate reputation refers to a common opinion about past actions and future expectations

that people have of an organization, which generates esteem and prestige when compared to other organizations (Fombrun, 1996). The configuration and structure of boards is one of the key corporate reputation factors (Gabbioneta *et al.*, 2007; Iwu-Egwuonwu, 2011). Including more members brings greater opportunities to manage corporate reputation and to establish relationships with external environments (Hillman *et al.*, 2000; Musteen *et al.*, 2010). Large boards tend to have directors with diverse backgrounds and relationships that enable organizations to project their image (Hillman *et al.*, 2000). Likewise, directors have their own reputation that helps extend a positive esteem of the corporation (Zahra and Pearce, 1989; de Villiers *et al.*, 2011).

Chaganti *et al.* (1985) found that successful companies had larger boards than those firms that did not survive. This result is confirmed by Platt and Platt (2012) in a comparative study between bankrupt companies and those remaining afloat according to RiskMetrics database. B-SIZE is positively associated to non-FP in hospitals in Taiwan (Kao and Kao, 2013) and environmental performance in the US companies (de Villiers *et al.*, 2011). Other studies show also that a B-SIZE increase with independent directors is related to additional reputational benefits for the organization (Hillman *et al.*, 2000; Raheja, 2005).

Finally, Musteen *et al.* (2010) conducted a study of *Fortune* listed corporations in which they show that companies with large boards and a high presence of external directors have better reputation than companies with small and homogeneous boards. In fact, “B-SIZE has been widely used as a metric by governance rating agencies in evaluating corporate boards [...], with firms that have relatively smaller boards often being viewed unfavorably by such agencies. [...] In other words, having more, rather than fewer, directors, firms ensure that they are in compliance with institutional expectations” (Musteen *et al.*, 2010, p. 502).

According to the evidence above and the sample used, this paper proposes that:

H2. In Colombia, B-SIZE is associated to corporate reputation.

Corporate performance: the relationship between financial and reputational indicators

During the process, whereby a corporation increases its contribution to the wealth of nations through their financial results (new jobs, taxes, products that meets needs, sustainability), an image emerges, and its name is associated with what is considered good and legitimate, thus creating corporate reputation (Fombrun and Shanley, 1990; Deephouse, 1997; Roberts and Dowling, 2002). Firms can emerge with the reputation of the entrepreneur, as William Durant and Steve Jobs demonstrated in the case of Chevrolet and Pixar respectively. However, firms need to sustain their FP to gain recognition in the long term. Then, the creation of tradition and credibility among generations, which is called sustainability (Rivera, 2012), is more valuable to stakeholders than financial analysis (Walsh and Wiedmann, 2004), and this credibility implies the improvement of financial indicators as a study on corporations in China revealed (Zhang and Rezaee, 2009).

Reputation becomes a competitive advantage and an asset that allows corporations to invest, expand, and increase their financial results in a virtuous circle of recognition and economic value creation (Roberts and Dowling, 2002; Quevedo *et al.*, 2005; Iwu-Egwuonwu, 2011) leading to customer loyalty (Eberl and Schwaiger, 2005). Theoretical propositions in the frame of marketing research highlights the importance of corporate reputation to steer better FP due to the social performance achieved in the light of stakeholder's satisfaction (Neville *et al.*, 2005). A review of literature performed by Fuente and Quevedo (2003, p. 176) “shows empirical support for both directions of the relationship between corporate reputation and FP: corporate reputation influences FP and vice versa.” With this evidence, Quevedo *et al.* (2005) proposed a cyclical model for financial and reputational corporate

performance to explain how economic value creation implies duties for managers to perform socially trying to meet the several interests of stakeholders to gain legitimacy.

However, Walsh and Wiedmann (2004, p. 310) proposed that “corporate reputation is a multi-dimensional construct that has an impact on stakeholder behavior and that it can differ across countries.” There are national cases that do not reveal a relationship between reputational and FP, like Denmark (Rose and Thomsen, 2004); Australia (Inglis *et al.*, 2006) and Turkey (Caliskan *et al.*, 2011). For German firms, Dunbar and Schwalbach (2000) found that prior FP has a positive impact on reputation. It has to be noted that reputation does not present the same impact in subsequent FP. Also, as Lee and Jungbae-Roh (2012) pointed out, the effect of corporate reputation on FP is contingent on firm characteristics.

Despite these findings, a special issue from the most renowned business magazine in Colombia, based on information from the Reputation Institute, stated that: “a point of growth in a company’s reputation is correlated to one point increase upon profitability and just below one point in relationship to the financial assessment” (Dinero, 2013, p. 74). This assertion implies that better financial indicators lead to better corporate reputation. Then, in accordance with *H1* and *H2*, and in order to test Quevedo *et al.* (2005) proposal, this paper proposes that:

H3. In Colombia, FP is associated to corporate reputation.

Methodology

Sample

MERCO provides valuable information for empirical research in Ibero-America (Delgado-García *et al.*, 2010)[2]. A sample of 84 large companies was obtained using the Colombian’ MERCO ranking for the period 2008-2012. In 2007, the Country Code of corporate governance was launched and in 2008 Colombia was included as a potential member of the OECD, and then, good practices of corporate governance have been increasing with the support of Confecamaras, the Financial Superintendence and the Superintendence of Corporations in the period selected. These companies are the most representative corporations in Colombia and include FBs, multinational organizations, and Colombian traditional enterprises in several industries including manufacturing, services and trade.

Method

To test the hypotheses, we propose to use Spearman rank correlation and the *K*-mean cluster analysis approach. Spearman correlation measures the degree of association between two variables that are ordinal data. Cluster analysis allows the creation of groups of firms that share similar characteristics in a sectional sample and identify the trend of association of variables. Using this approach, the study can reveal if a group of firms with many or few members in the boards of directors also present high or low financial and reputation results. We used a χ^2 and *F*-test for variable independence among clusters of firms, and cluster differences to ensure results reliability.

Variables

B-SIZE, the authors used the BPR Benchmark’s database[3] to obtain the number of board members. According to B-SIZE classification used in empirical studies like Bennedsen *et al.* (2008), the authors classified the B-SIZE in three categories. Low (between 0 to 5 members) coded as 1; medium (boards with at least 7 members), coded as 2; and high: boards with more than 7 members, coded as 3.

FP, the BPR Benchmark was used to obtain the ROE, ROA and the net sales average for the years covered by this study. The authors then conducted a factorial analysis among

these three FP dimensions to create a variable synthesizing the creation of wealth in terms of access to markets and efficiency of the use of resources. The values of the factorial analysis are presented in Table I. The first 28 companies with the lowest factorial value were identified as 1; the following 28 firms as 2, and the remaining 28 as 3. This variable will be used in the cluster analysis.

Corporate reputation – CR, the MERCO ranking was used by the authors to calculate the average position on the scale of corporate reputation for each company over the term 2008-2012. As the first positions of the ranking were held by the most reputed companies, the order of the firms was inverted to ensure consistency with the order of the values (high, medium, or low). Subsequently, the first 28 companies with the lowest rank were identified as 1, the next 28 as 2 and the remaining as 3.

Control variables. FB, the authors used information from the Colombian Stock Exchange[4] and corporate web pages to identify ownership concentration. Firms controlled by a single family, namely, with over 50 percent shareholding ownership were given a value of 1, while a value of 0 was given otherwise.

Export activities – Exp., export firms were given a value of 1 while a value of 0 was given to non-exporting firms. The BPR Benchmark was used to establish these values.

Colombian stock market – CSM, listed companies were given a value of 1 whereas non-listed companies were given a value of 0. The authors used information from the Colombian Stock Exchange to establish these values.

Results

As reported in Table I, 38 boards have seven members, which account for 45 percent of the companies in the sample. Likewise, 87 percent of the firm's boards have between five and nine members, while in the USA most companies have 9-12 board members (Tonello, 2010). It is worth noting that 18 out of 21 FBs of the sample presented in Table I have boards of 5-7. B-SIZE in companies with high Exp. range from 9 to 11 members, just as the companies listed in the Colombian Stock Exchange. This indicates that internationalization of activities and participation in stock markets are led by boards with a larger number of members. This result is confirmed by Herrera-Echeverri *et al.* (2015) who compiled a large sample of family firms in Colombia.

The relationship between the size of the board and corporate performance

According to the OECD, the optimal B-SIZE in Latin America ranges from five to nine core members (Garay *et al.*, 2006), and empirical evidence in the region shows that the average B-SIZE is nine members (Castro *et al.*, 2009). According to agency theory, smaller boards are expected to be formed to ensure control functions, while resource dependency theory

B-SIZE	Firms	CR average	FP average	FB average	Exp. average	CSM average
0	1	70.00	0.04	1.00	1.00	0.00
3	1	40.00	0.37	0.00	1.00	0.00
5	22	43.68	-0.08	0.36	0.55	0.45
7	38	39.13	-0.09	0.26	0.71	0.42
9	13	47.38	-0.13	0.15	0.77	0.54
11	5	51.40	-0.32	0.00	0.80	0.60
12	2	31.50	0.68	0.00	0.50	1.00
13	1	30.00	6.57	0.00	1.00	0.00
19	1	62.00	0.36	0.00	1.00	0.00
Total	84	42.69	1.19E-07	0.25	0.69	0.45

Table I.
Frequencies

maintains that large boards are aimed at promoting counseling functions (Hillman and Dalziel, 2003). Table I shows that average corporate reputation (CR) – until five board members – is lower than the average reputation of companies with nine members in their boards. Nevertheless, boards of 7 have a lower average reputation than both five and nine member boards. Moreover, the average FP is higher for boards of five than for nine-member boards. This could indicate that boards of five members tend, on average, to have a better FP than larger boards, and, on the other hand, the CR tends to be higher for nine member boards, which are possibly designed more to address counseling than control functions. These results are consistent with Musteen *et al.* (2010) findings which show that large boards are positively related to corporate reputation, and with Cheng’s (2008) finding that small boards are positively related to FP.

As reported in Table II, there is no correlation between B-SIZE and CR-FP. Thus, performance could be independent from board structure. Likewise, there is no correlation between CR and FP, indicating that both types of performance do not show a virtuous cycle as suggested by the integrative model and empirical evidence revealed in *Fortune 500*’s study (Quevedo *et al.*, 2005).

The integrative model (Quevedo *et al.*, 2005) emphasizes the importance of firm’s characteristics. It is important to highlight some of the relationships found in control variables (FB, Exp. and CSM). CR has a positive relationship with CSM and a negative relationship with FB. The Colombian sample indicates that companies with the best reputation are usually stock market listed firms rather than family-run businesses. FB has a significantly negative correlation with B-SIZE and CSM. In Colombia, the percentage of FB in CSM is low (Gómez-Betancourt *et al.*, 2012). This indicates that FBs tend to have fewer members on their boards and less participation in the stock market. Finally, export companies are not included in the CSM. This is partly explained by the fact that such companies are listed in other international stock exchange markets. It is therefore possible to conclude that the most reputable companies are those listed in the stock market. Also, family-run firms are not generally listed in the stock market and do not perform Exp., as could be expected considering Herrera-Echeverri *et al.* (2015) findings. Finally, export companies are negatively correlated to those listed in the stock market, a fact which can be explained by the performance of multinational companies with high level of activity in foreign trade but that are not necessarily listed in the Colombian stock exchange market.

A cluster analysis was performed in order to test our research hypotheses, the results of which are presented in Table III. To this end, two groups were set up: the first was comprised by 47 companies and the second by 37, showing a proper separation of the sample. Cluster 1 included companies with larger boards. Cluster 1’s CR centroid is greater than that of Cluster 2. Also, the FP centroid in Cluster 1 is smaller than the centroid in Cluster 2. This result indicates that firms with larger boards have better performance on CR and lower FP. To prove the reliability of this conclusion, Table IV presents an ANOVA analysis to assess whether there is a statistical difference between clusters means. The null

Table II.
Descriptive statistics
and Spearman
correlations

	<i>n</i>	Min.	Max.	Mean	SD	B-Size	CR	FP	Exp.	FB	CSM
B-SIZE	84	1.00	3.00	1.9643	0.75165	1	0.039	0.137	0.140	−0.267**	0.107
CR	84	1.00	3.00	2.0000	0.82140		1	−0.018	−0.000	−0.269**	0.322*
FP	84	1.00	3.00	2.0000	0.82140			1	0.126	0.067	−0.088
Exp.	84	0.00	1.00	0.6905	0.46507				1	0.030	−0.323*
FB	84	0	1	0.25	0.436					1	−0.525*
CSM	84	0	1	0.45	0.501						1

Notes: **p* = 0.01; ***p* = 0.05

hypothesis of the F -test is that the means are equal. This hypothesis is rejected for all three variables of interest (B-SIZE, CR and FP). Therefore, there are statistical differences between both groups. Thus, $H1$, which suggests that B-SIZE is associated to FP can be rejected, and $H2$, wherein B-SIZE is associated to CR cannot be rejected.

We also used a χ^2 test of independence to test $H3$, which suggests that FP is related to CR. Table V shows the χ^2 test results, the null hypothesis of which is the independence between variables. Given that p -value significance is greater than 0.05, the null hypothesis is not rejected. Therefore, it is possible to argue in line with the lack of correlation established in Table II, that FP and CP are statistically independent, so we reject $H3$. Consequently, this finding does not support the virtuous cycle theoretical approach, as proposed by Quevedo *et al.* (2005) in the case of Colombian top companies.

Conclusion and implications

This research found that companies with large boards tend to show higher corporate reputation and lower FP than companies with smaller boards. The evidence presented in this research reveals that the association between financial and reputational performance is not found in the Colombian case. Furthermore, this research shows that firms with smaller boards tend to be listed in the stock market, assume less risk related to Exp. and deliver the highest financial results. In contrast, firms with large boards tend not to be listed in the

	Cluster	
	1	2
B-SIZE	2.30	1.54
CR	2.40	1.49
FP	1.72	2.35
FB	0	0
CSM	0	1
Exp.	0.79	0.57
n	47	37

Table III.
Centroid of the
Cluster K -means

	ANOVA					
	Cluster Quadratic media	df	Error Quadratic media	df	F	Sig.
B-SIZE	11.874	1	0.427	82	27.804	0.000
CR	17.438	1	0.470	82	37.080	0.000
FP	8.163	1	0.583	82	13.993	0.000
FB	0.075	1	0.191	82	0.395	0.532
CSM	1.337	1	0.237	82	5.632	0.020
Exp.	0.999	1	0.207	82	4.832	0.031

Table IV.
Anova and F -test

	Value	df	Sig.
Pearson's χ^2	0.857	4	0.931
Likelihood ratio	0.858	4	0.931
Linear-by-linear association	0.026	1	0.871

Table V.
 χ^2 test

stock market, carry out Exp. and show higher reputational results. Finally, FBs do not tend to have large boards, are not listed in stock markets and are not at the top of reputed firms in Colombia.

With regards to the literature reviewed for this paper, large boards support synergies among financial and reputational performance, and are more appropriate for the endowments and conditions of an emerging economy. The case of Colombian top companies does not provide evidence of a virtuous cycle between financial and reputational performance. The results of Cluster 1 (47 firms) partially support the arguments of resource dependence theory, which hold that increasing the size of the board can improve the ability of firms to interact with their environment, acting as boundary spanners, thus leading to a better corporate reputation. Furthermore, the results obtained for Cluster 2 (37 companies) partially support the statement from agency theory that a smaller B-SIZE allows an improvement on management, monitoring and control functions, and thus allow better financial results.

The main theoretical implication of this research is that contingency approach, which integrates resource dependence and agency theory (Zahra and Pearce, 1989; Hillman and Dalziel, 2003), need to include not only FP, but also corporate reputation as a result of board structure to introduce the discussion about the virtuous cycle between financial and reputational corporate performance (Quevedo *et al.*, 2005).

For practical implications, shareholders must consider that B-SIZE is correlated to different performance results and variables of the company. All firms want to achieve better financial and reputational performance and the evidence provided by developed economies support the idea that this goal is possible to accomplish. However, the Colombian case involves both companies with large sales volumes that are not the most admired by society, and cases in which highly appreciated and well-ranked companies in terms of corporate reputation are not the most profitable. This research raises several questions that shareholders could take into account, such as:

- RQ1. Are companies using financial resources to invest in activities that enhance their reputation but curtail performance in terms of financial indicators?
- RQ2. Are top companies with greater market power and good financial results using their dominant position to sustain their economic value creation, instead of reducing the negative perception of the firm?

Limitations and further research

This research has several limitations that could be overcoming with future research. Further research is needed to advance towards a comprehensive theory explaining the complexity of boards and their characteristics in relationship to firm performance. Such research needs to include features and rules of board members in terms of expertise, training, competences, skills, diversity, independence, enrollment in different boards and other variables assessing organizational diversity. Moreover, it is important to use larger samples to assess the relationship between reputation and FP based on the board's structural characteristics as mediating and moderating variables. Future research using larger data and other countries could test the hypothesis proposed by Zahra and Pearce (1989) which suggests an inverted U-shaped relationship between size and performance using contingency theory to include mediator and moderator variables, i.e. the mediation of corporate social responsibility and its effects on board diversity in the relationship between B-SIZE and corporate performance (Bear *et al.*, 2010).

In summary, this research contributed empirical evidence on the analysis of the relationship between B-SIZE and financial and reputational performance. The results help

to question normative definitions of best practices in corporate governance, particularly related to emerging economies. Moreover, this research proposed that integrative models that use the framework of contingency theory could be developed further beyond the inclusion of ownership concentration, international activities, and compliance with stock market rules. Variables such as the inclusion of reputation as a corporate performance measure need to be included and more national cases are required in order to build better propositions for theory development.

We expect that this work will motivate and encourage researchers from Latin American countries and other emerging economies to build further knowledge and present local cases to shed more light on the relationship between board features and firm performance, and to promote theoretical discussions, improve practices, and enhance regional codes of corporate governance.

Acknowledgments

The authors would like to thank the contribution of Andrés Galeano, former student in Business Administration at the School of Management of Externado University, for his valuable data construction. Also, the authors are thankful for the support of Carlos Restrepo, Research Director of the School and the collaboration of Diego Andrés Chavarro PhD Advisor at Colciencias for his review. Finally, the authors express the gratitude for anonymous reviewers for the useful comments and remark and the Global Innovation and Knowledge Academy (GIKA) for allow us to share this research.

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R&D and non-R&D in the innovation process among firms in ASEAN countries

Based on firm-level survey data

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Abstract

Purpose – The purpose of this paper is to identify factors promoting innovation in the framework of R&D based on surveys conducted on firms in five ASEAN countries, Indonesia, Laos, Thailand, the Philippines, and Vietnam.

Design/methodology/approach – The analytical method divided sample firms into two categories, namely, “the R&D group” and “non-R&D group.” The analysis attempts to identify which of the internal capabilities, consisting of technology, human factors and organization factors, promote innovation. Ordered probit analysis is employed.

Findings – Findings from the estimations indicate that the two groups pursue product innovation differently. The R&D group promotes innovation by cross-functional teams of production, engineering, and marketing and IT use, whereas the non-R&D group promote product innovation by HRD programs for workers, group awards for suggestions or QC, and ISO9000 series.

Research limitations/implications – The number of samples related to the non-R&D group is too small to conduct statistical analysis. External linkages played an important role in the authors’ previous studies. The introduction of external linkages into the model may yield different results, though the analysis would become more complex.

Practical implications – The results of this paper provide the solid basis of policy to promote innovation and upgrading SMEs in the region.

Social implications – Many ASEAN SMEs successfully achieve innovation without owning specified in-house departments or sections to conduct R&D.

Originality/value – The features of this paper lie in the original firm-level survey data and rigorous estimation method using ordered probit analysis, which are new to this literature.

Keywords MNCs, HRD, Learning process, Cross-functional team, Ordered probit analysis, QC

Paper type Research paper



1. Introduction

For further economic development in ASEAN economies, transformation from simple production bases, known by terms such as the “factory of the world,” to “knowledge economies” is mandatory. In addition to so-called national innovation initiatives for this transformation, sector-specific or firm-specific policy is also required for industry or firms to upgrade their production and management. Particularly, the transformation of SMEs in these regions is an urgent prerequisite for overall macroeconomic development. In the innovation process, there is another important basis, which is R&D. Some SMEs in Europe and the USA take on the role of inducing such transformation by R&D themselves. Venture companies in the IT and biotech industries, which are strongly oriented toward R&D, are representative of these SMEs. These companies are deconstructing existing industrial structures and creating new products, services, and business models, a phenomenon aptly called creative destruction. SMEs in ASEAN economies, on the other hand, can be said to be victims of this process rather than innovators. In the midst of such rapid and turbulent change, it goes without saying that sustained R&D and the resulting innovation are required to regain vitality and, furthermore, to grow.

In this regard, in order to postulate the basic behavior of firms in these regions toward innovation, the innovation process and internal capability for innovation inside the firm must be clarified. In doing so, this paper studies innovation by focusing on R&D. R&D is thought to be the other side of the coin, and the above innovation process can be viewed from the standpoint of R&D. Similar to the above four sub-processes, the R&D process can be decomposed into the following sub-processes: idea generation; screening business analysis; development; testing; and commercialization (Booz *et al.*, 1982). In this R&D process, the internal innovation capability of firms plays an essential role in achieving innovation. Internal capability includes the technological level, such as the number of patents, production facilities, human resources, such as the number of engineers with higher degrees or skills, the level of craftsmanship and work ethics, and organizational aspects, such as communication between workers and top management, speed of decision making, and top management leadership. To achieve innovation, firms are required to nurture and strengthen their internal innovation capability. The innovation and R&D processes are considered to be the processes by which firms organize their internal innovation capability to achieve objectives. This paper categorizes R&D into two types: traditional R&D and non-R&D. The former is R&D conducted by specific R&D sections or units, whereas the latter is implemented without explicit or formal units. Jensen *et al.* (2007) defines the former as the science, technology and innovation (STI) mode and the latter as the doing, using, and interacting (DUI) mode. The authors' previous paper terms these as formal and informal R&D (Tsuji *et al.*, 2017). This paper aims to examine the innovation and R&D processes of SMEs in the ASEAN countries, which are less STI-type due to the current level of technology and size of firms in terms of employees and assets. That is, they are too small to own specific sections or units for R&D. Accordingly, the research questions in this paper are whether there are differences in the performance and conduct of innovation between two types of R&D, and if so, what they are. To solve these questions, this paper employs rigorous statistical analysis, ordered probit analysis, which examines the process by which firms come to achieve innovation under different R&D processes.

The remainder of this paper is organized as follows. The next section presents a brief survey of R&D and HRD followed by a summary of the data obtained in the five ASEAN countries. The methodology and models to be estimated are then discussed, after which the estimation results and their implications are presented. Brief conclusions and directions for further research are provided in the final section.

2. Literature review

The innovation process was defined and studied by Cohen and Levinthal (1990), Zahra and George (2002), and Christensen and Kaufman (2009), for example. Cohen and Levinthal (1990) also recognize the innovation process as a learning process consisting of four dimensions; acquisition, assimilation, transformation, and exploitation. Firms must elevate their abilities in all four dimensions to promote innovation, which is referred to as an internal capability for innovation. This internal capability includes the integrated ability of a firm to create innovation, consisting of the integration of all resources, core competences, and competitiveness, as noted by Lawson and Samson (2001), Mariano and Pilar (2005), and Perdomo-Ortiz *et al.* (2008). R&D is, on the other hand, thought to be the other side of the coin, and the above innovation process can be viewed from the standpoint of R&D. Similar to the above four sub-processes, the R&D process can be decomposed into the following sub-processes, idea generation; screening business analysis; development; testing; commercialization (Booz *et al.*, 1982). In this R&D process, the internal innovation capability of firms plays an essential role in achieving innovation.

R&D is one of the riskiest elements for businesses (Booz *et al.*, 1982; Crawford, 1987/1997; Cooper, 2001; Nadia, 2011). This nature of R&D has motivated the publication of numerous textbooks and handbooks for firms, including Crawford (1987/1997), Smith and Reinertsen (1998), Cooper (2001), and Kahn (2013). Similarly, various papers analyze R&D from the viewpoints of autonomy (Argyres and Silverman, 2004; Lerner and Wulf, 2007), of managing R&D teams (Leven and Cross, 2004; Colquitt and Rodell, 2011), of leadership (Hirst and Mann, 2004; Berson and Linton, 2005; Zheng *et al.*, 2010; Wong and Tong, 2012), of reward and incentive schemes (Lerner and Wulf, 2007), and so on. On the other hand, there also various studies of innovation through non-R&D, hidden innovation, or informal R&D, which characterize a different pattern or mode of innovation and R&D. The difference between the two is well summarized by Jensen *et al.* (2007) as the STI mode and the DUI mode. The former is dominated by scientific and technical knowledge, which is related to the formal process of R&D, whereas the latter is characterized as the informal process of learning and experienced-based skills and know-how (Thomä, 2017). The two notions are not dichotomous, but rather ambiguous. Even high-technology firms, which are perfect examples of STI, conduct non-R&D-type R&D (Barge-Gil *et al.*, 2011; Hervas-Oliver *et al.*, 2015).

3. Nature of R&D and non-R&D in ASEAN firms

3.1 Factors promoting innovation under non-R&D

3.1.1 R&D structure. R&D does not simply create something new in terms of technology or engineering, but is related to various aspects of manufacturing. R&D therefore also has related sections or functions attached to it, such as production technology, manufacturing technology, quality assurance, design, and so on. These sections are well organized so as to conduct R&D in a coherent manner.

On the other hand, in SMEs which do not own an R&D section, each engineer is trained to fulfill customer needs. Since the firms manufacture simple parts such as gears, they receive all kinds of requests regarding gears, and are required to satisfy customer needs by cultivating their skills and technologies. In firms that do not own an R&D center, each craftsman plays this role and other workers are assigned to roles that perform the functions that are similar to sections in R&D centers. In this sense, whether the R&D is formal or informal, a certain number of related functions require the conduct of R&D. The role of the ISO9000 series is important, since some SMEs (nearly 50 percent of our sample) obtained ISO9001 certification, which forms the basis of their standardized structure and R&D function.

3.1.2 R&D execution. R&D practice differs in R&D and non-R&D groups. The first step is to find ideas or a seed for innovation. An R&D group discovers these seeds by themselves or

by collaborating with business partners, mainly multi-national corporations (MNCs). Once they find a research theme, they conduct R&D either on their own or by collaborating with business partners. Most of the seeds of innovation come from buyers or suppliers in the form of either claims for better products or changes in the models or specs of final products.

Some SMEs have been invited to joint research consortia organized by MNCs and university laboratories. The reason why small SMEs are invited to participate in high-tech projects is that they have superior technology in specific parts. Without these parts, the final products would never be realized. Superior technology in a niche area is a source of further enhancement and widening of technology for these firms. Enhancing and maintaining their own high-technology level attracts innovation seeds.

ISO9001 postulates a standardized process regarding how R&D is to be conducted once an idea has been identified. One feature of SMEs is the speed of decision making. This is another reason why they are selected to be partners of MNCs.

3.1.3 HRD. HRD takes different forms in SMEs according to the technology, product, size of the firm, and other factors. The similarity in HRD is that OJT is the main practice. New employees are assigned to specific sections and receive OJT to achieve required skills from senior colleagues. Even smaller SMEs have their skill-raising process. Workers are required to achieve certain skills; failure to do so will mean that they are not promoted to higher positions. They also have skill assessment systems, which evaluate employee ability according to a scale. After attaining a passing level, employees can be registered as trainee designers and participate in design as assistants, for example. One example of more intensive OJT is observed as follows. Since most of their new employees are graduates of regular high schools, not technical high schools, they are trained thoroughly on a man-to-man basis and are required to master CAD/CAM as the first step. The employees are then required to master each machine in order, and their performance with each machine is marked up on a skill map. A glance at this map makes it apparent who is able to operate a particular machine and perform a particular function. These skills are reflected in the employees' salaries, providing them with an incentive to work seriously.

3.2 Research questions

Based on the above discussion on the ways of conducting R&D activities, the research questions of this paper are summarized as follows:

RQ1. Do informal and formal R&D groups have different innovation processes?

RQ2. What are the factors of production innovation in formal and informal R&D groups: Are there any differences between them?

3.3 Summary of data and estimation model

In this section, the sources of data, the procedure of estimation, and the construction of variables are presented.

This study is based on mail surveys and phone interviews conducted with firms in four ASEAN economies, such as Vietnam, Indonesia, Laos, the Philippines, and Thailand from 2013 to 2014, amounting to 152 in the Hanoi area and 161 in the Ho Chi Minh City area, Vietnam; 200 in the Batangas and other areas in the Philippines; 181 in the Jabodetbek area, Indonesia; and 160 in Greater Bangkok, Thailand. The surveys were conducted from November 2013 to January 2014. The total number of valid responses from these areas was 1,061.

As explained earlier, this study categorizes R&D activities into two types, R&D and non-R&D, the firms also being divided into these two groups. The firms that replied "no" to the two questions about whether they have an R&D budget (Q19.1. What is the ratio between R&D expenditure and sales at present?) and whether they have specific personnel

who are engaged only in R&D activities (Q19.3. Does your establishment develop personnel in charge of R&D at present?) were classified as non-R&D. The rationale of this lies in (i) the difficulty of devising questions to ask regarding SME R&D and (ii) the ambiguity of the definition of R&D and non-R&D. As stated in the introduction, regarding (i), questions have to be simple enough for the CEO or person in charge of R&D or innovation to understand and reply properly. Due to (ii), the concept of non-R&D activity may inseparable from those of R&D. Thus questions to identify the type of R&D are limited to the above two only. Thomä (2017) and Lee and Walsh (2016) utilize official data from the EU and USA, respectively. The former categorizes R&D expenditures into R&D and non-R&D, whereas the latter employs questions that ask “one (question) about the creative process that led to their invention and one about the type of unit to which they belonged at the time of the invention (p. 350, word in brackets added by authors).” Although our definition appears to be rough, it is convenient for the questionnaire survey. Accurate but complicated questions are hard for respondents to understand. Since the areas and firms targeted by this study are less developed countries and SMEs, simplified definitions are useful in practice.

The number of firms analyzed in this study sample was 608 in the R&D group and 441 in the non-R&D group to give 1,049 in total, as shown in Table I. 58.0 percent of the respondent firms belong to the formal R&D group. Vietnam had the largest number of firms in the R&D group, amounting to 83.7 percent of the total, followed by Indonesia at 61.9 percent. The percentage of firms in the R&D group was the lowest in the Philippines at 37.3 percent. These figures imply that the number of firms with informal R&D was larger than that with formal R&D.

Regarding the size of the firms, 50 percent of formal R&D firms have smaller than 200 employees, while that of informal R&D has smaller than 50 employees. In terms of assets, two thirds of Formal R&D are larger than 1 million-5 million USD, whereas two thirds of Formal R&D own less than those amounts. The informal R&D firms have much smaller than the formal group.

3.4 Construction of variables: product innovation as outcome variable

The construction of variables related to product innovation is based on the following four categories of innovation:

- (1) Product innovation Type I: introduction of a new product, redesigning packaging or significantly changing the appearance design of your existing products (Nascia and Perani, 2002).
- (2) Product innovation Type II: introduction of a new product, significantly improving your existing products with respect to their capabilities, user friendliness, components, subsystems, etc.
- (3) Product innovation Type III: development of a totally new product based on the existing technologies at your establishment.
- (4) Product innovation Type IV: development of a totally new product based on new technologies at your establishment.

Type of R&D	Vietnam		Indonesia		Thailand		Philippines		Laos		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
R&D	262	83.7	112	61.9	83	53.5	72	37.3	79	38.2	608	58.0
Non-R&D	51	16.3	69	38.1	72	46.5	121	62.7	128	61.8	441	42.0
Total	313	100.0	181	100.0	155	100.0	193	100.0	207	100.0	1,049	100.0

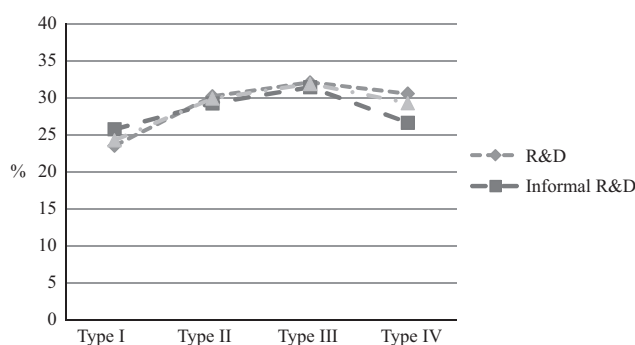
Table I.
Types of R&D group
by countries

Source: Authors

These are based on “Q13. Have you tried to introduce a new product in the last two years (2013-2014)?” This categorization is based on the OECD Oslo Manual. For each category, the respondents were asked whether they had achieved, attempted, or not attempted the innovation. If respondents had achieved the innovation, two points are given; if they had attempted the innovation, one point is given; and those who had not yet attempted the innovation are indicated by zero. Figure 1 shows the distributions of product innovation by two groups for whole regions, while Figure 2 indicates product innovation by countries without making difference between two groups. The vertical axis of both figures indicates the percent of forms responded to achieved. As shown in Figure 1, in the pooled data, no difference is found in the three groups of firms, but innovation by countries shows that Thailand has the largest percentages of the four types, whereas Indonesia shows the smallest in all types. The other three countries have almost similar figures, except for Type I (Figure 2).

3.5 Selection of explanatory variables

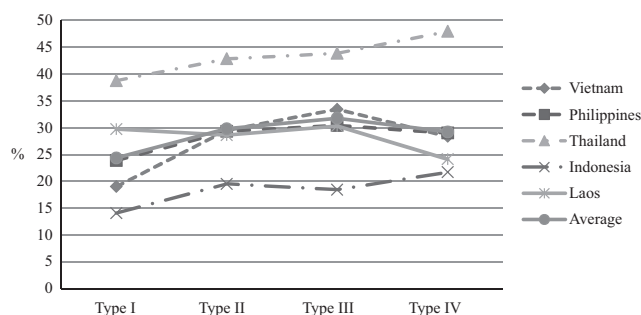
This paper employs ordered probit model and the explanatory variables used in the estimation are discussed. All variables play important roles in the promotion of innovation. The most of the previous papers were concerned with the specific research question and did



Notes: Type I, redesigning packaging or significantly changing appearance design. Type II, significantly improving existing products. Type III, new product based on the existing technologies. Type IV, new product based on new technologies

Source: Authors

Figure 1.
Product innovation:
whole regions



Source: Authors

Figure 2.
Product innovation
by countries

not cover the all related variables which might affect R&D. The authors' previous study which employed Structural equation modeling used the categories of explanatory variables such as cross-functional team, QC, human factors such working experience's for MNCs, and so on (Tsuji *et al.*, 2016). This paper also basically follows those variables.

3.5.1 ISO9000 series. ISO9000 series cover wide activities related to quality management, training, R&D structure and implementation, and so on. The technological level of a firm can be indexed by the number of patents obtained, the amount of R&D investment made, or the quality of equipment used in the manufacturing process. This study focuses only on the ISO9000 series and ISO14000 series, since the number of explanatory variables is large and there are other variables which we wish to highlight in this paper. In the actual estimation, only ISO9000 series were employed, since variables related to technology are not significant. This will be discussed in more detail in what follows.

3.5.2 Human factors. In the previous papers, human factors are discussed from the various aspects which include labor mobility (Kesidou and Szirmai, 2008), spillovers (Görg and Strobl, 2005; Balsvik, 2011; Poole, 2013) or leadership of R&D team (Sarin and McDermott 2003; Wong and Tong, 2012) in the high-tech industries. The questions related to human factors in this paper confine to those related manager classes and aim obtain the abilities of employees, but these are not in general observable. The questions thus asked subjects to focus on their career backgrounds, or current positions. The variables employed for estimation are based on the following questions: Q30.1. Does your establishment have a factory manager?

3.5.3 Organizational factors. Since innovation or R&D are conducted with various teams, groups, or units, conflicts among them are easily occurred, and to avoid such conflicts managerial arrangements or organizations are required for conducting R&D coherently. Daniel (1961) and Rockart (1979), for example, asserted that related organizations need to clarify factors that are critical to the success of the R&D process, since failure to achieve coherency would result in organizational failure. The questions related to organizational factors in this paper thus aim to obtain information on whether firms as a whole are systematically and coherently conducting R&D or innovation activities. This factor contains activities which are summarized as follows.

3.6 Top management leadership

This is an important factor particularly for the informal R&D group, as already mentioned. Innovation in SMEs is mainly led by the owners of firms, particularly SMEs with top-down type. The top management leadership contains ability to establish D&R strategy, to encourage related teams or personnel, to avoid conflicts among related groups, to evaluate their performance, etc. Greenleaf (1977) referred their ability to avoid conflicts and coordination failure to as Servant Leadership. Since the top management leadership is unobservable, it is obtained from the following questions, which are also related to top management backgrounds, such as education or past experience: Q29.8. Does the top manager have experience of working for MNCs?

3.7 Cross-functional team

This is an organizational arrangement for the exchange, dissimulation and sharing of different views or opinions from different sections of a firm that are related to innovation and which become a basis for creating new ideas. The heterogeneity of ideas or thought tends to create something new through communication. The role of cross-functional teams has been recognized not only in the context of innovation but also solving problems in general. Besides previous studies discussed the conditions on which cross-functional teams work. There were empirical studies; Blindenbach-Driessen (2015) demonstrated the positive relationship between the cross-functional team and innovation by saying that

the existence of cross-functional team is not sufficient for successful innovation. Hirunyawipada *et al.* (2010) identified the conditions for teams to work such as task cohesion, interpersonal cohesion, and transformational leadership and the qualification of team members such as common knowledge, functional expertise, and their positions in the network. Again, this factor is unobservable, and the following question is used as a proxy: Q21.5. Production Engineering, Q21.6. Manufacturing, and Q21.11. sales and marketing. From the survey data, the percentages of firms which practice following three cross-functional teams are shown in Table II.

The above questions investigate whether the firm has this characteristic. In the estimation, “no team” and “cross-functional team (production engineers, manufacturing, and sales and marketing)” are used, and the latter consists of personnel who are “production engineers, manufacturing, and sales and marketing.” The role of marketing section was emphasized by De Luca, Atuahene-Gima (2007) which obtained the conclusion such that market knowledge and cross-functional collaboration are two fundamental resources for successful product innovation. They identified the mechanisms which combine these two.

3.8 Quality control (QC)

Although QC does not directly contribute to innovation, new ideas related to innovation, particularly related to process innovation, can be obtained through small group activities. Since the improvement of product quality is a part of process innovation, the outcome of QC is equal to innovation itself. The questions used for this factor are as follows: Q22.2. Does your establishment operate a QC circle? Q22.7. Group rewards for suggestions or QC. From the data, actual practices are shown in Table III.

3.9 Learning process

This role of the learning process is to share the success experiences among related personnel engaged in R&D activities, and consists of the following questions: Q33. HRD program for blue-collar workers, such as cross-training or job rotation.

3.10 IT use

IT use is now popular and necessary among SMEs in these areas, and it is important to examine whether or not IT promotes R&D activities, since IT supports employees in disseminating their experiences and sharing them with others (Idota *et al.*, 2015a, b, c). IT use was asked in Q28.2. Has your establishment introduced the following IT systems?, which consists of the following two IT use.

	Non-R&D(%)	R&D(%)
Research	2.7	26.0
Development	6.3	38.8
Sales and marketing	25.4	40.3

Source: Authors

Table II.
Cross-functional teams

	Non-R&D (%)	R&D (%)
QC	53.7	73.4
Group rewards for QC	42.5	56.5

Source: Authors

Table III.
QC

3.10.1 *Internal use of IT.* This variable consists of the number of items of questions which are true to the firm: 5. Enterprise Resources Planning (ERP), 6. Customer Relationship Management (CRM), 7. CAD/CAM, 8. Groupware, 9. Intra-Social Networking Services (SNS).

3.10.2 *External use of IT.* This variable consists of the number of items of questions which are true to the firm: 1. Business-to-Business e-commerce (B2B), 2. Business to Consumer e-commerce, 3. Electronic Data Interchange (EDI), 4. Supply Chain Management (SCM), 10. Public SNS.

3.10.3 *IT all.* The variable “IT all” includes all of the internal and external uses of IT. In estimation, we use IT all as a variable.

The summary statistics of the above variables are shown in Table IV.

R&D/non-R&D	Variable	Obs. 951	Mean 0.40	SD 0.49	Min. 0	Max. 1
<i>Dependent variables</i>						
Product innovation	Type I: introduced a new product, redesigning packaging or significantly changing appear	951	0.98	0.92	0	2
	Type II: introduced a new product, significantly improving your existing products	951	0.93	0.89	0	2
	Type III: development of a totally new product based on the existing technologies	951	0.77	0.86	0	2
	Type IV: development of a totally new product based on new technologies	951	0.55	0.78	0	2
<i>Indedendent variables</i>						
Technology factor	ISO9000 series	951	0.43	0.50	0	1
Human factor	Appointing factory manager	951	0.69	0.46	0	1
Leadership of top management	CEO has experiences working for MNCs	951	0.41	0.49	0	1
Cross-functional team	Cross-functional team (engineering, manufacturing, sale and marketing)	951	0.93	0.97	0	3
Quality control	Practicing QC	951	0.65	0.48	0	1
	Statistical QC	951	0.54	0.50	0	1
Learning process	Group rewards for suggestion or QC	951	0.50	0.50	0	1
	HRD program for blue-collar workers such as cross-training or job rotation	951	0.59	0.49	0	1
IT	IT all	951	1.99	1.90	0	10
<i>Control variables</i>						
Firm characteristics	ln (operation years)	951	4.68	0.11	4.50	5.35
	Total Assets	951	7.26	2.26	1	10
	100% locally owned	951	0.67	0.47	0	1
	Food	951	0.11	0.31	0	1
	Wear	951	0.15	0.36	0	1
	Wood and paper	951	0.11	0.31	0	1
	Chemical & plastic	951	0.17	0.37	0	1
	Iron and metal	951	0.12	0.32	0	1
	Parts and machine	951	0.21	0.40	0	1
	Other industries	951	0.66	0.48	0	1
	Philippines dummy	951	0.18	0.38	0	1
	Indonesia dummy	951	0.19	0.39	0	1
	Laos dummy	951	0.22	0.41	0	1
	Thailand dummy	951	0.09	0.29	0	1
	Vietnam dummy	951	0.32	0.47	0	1

Table IV.
Summary statistics

Source: Authors

3.11 Result of estimation

By using the questions explained previously, ordered probit analysis is employed to identify factors promoting innovation. The results are presented through two models, product and process innovation, in what follows. For the sake of simple and clear discussion, summaries of the estimation results shown in Table V are utilized and detailed estimation results are shown in the Table AI.

First, ordered probit estimation on product innovation is conducted for each type of innovation to identify factors to achieve particular type innovation, and second estimation is conducted through four type innovations which aim to identify factors which elevate firms to higher degree of innovation. For both estimation, explained variables are relies such as 2 for “achieved,” 1 for “attempted,” and 0 for “not attempted.” The rationale of this methodology lies in the category of innovation. We assume that upgrading innovation from Types I to II, from Types II to III, and so on are so drastic changes for local firms in ASEAN countries that ordered probit analysis might not capture essential factors for innovation. Actually the estimation in this way did not bring reasonable results. Thus upgrading from “not attempted” to “attempted,” or from “attempted” to “achieved” seems not difficult for SMEs and can capture the desired results. Accordingly, this method is adopted. Estimation result for each type of innovation.

3.12 Common factors of two groups

The results of the estimation are summarized in Table V, in which firm characteristics are omitted for simplicity (for detailed estimation results, see Table AI). The significant variables differ according to the types of innovation and groups, and it is therefore difficult to obtain a clear and unified explanation. It can be said, however, that the R&D and non-R&D groups have different innovation patterns, since the only significant variables common to both groups are: “Q22.2. Does your establishment operate a QC circle?” for Type III and IV and “IT all” for Type I.

Variables	Type I		Type II		Type III		Type IV	
	Non-R&D	R&D	Non-R&D	R&D	Non-R&D	R&D	Non-R&D	R&D
ISO9000 series	**		**			**	*	
Factory manager CEO has experiences working for MNCs or JVs								**
CFT (engineering manufacturing sale and marketing)		***		***		***		***
QC					*	*	**	**
Statistical QC						**		
Group rewards for suggestion or QC	***		**		*			
HRD program for blue- collar workers such as cross-training or job rotation	**		**		***		***	
IT all	**	***		***		***		***
Observations	383	568	383	568	383	568	383	568
Pseudo R^2	0.091	0.080	0.070	0.065	0.094	0.070	0.113	0.104
Log likelihood	-305.3	-525.5	-316.6	-561.2	-292.5	-570.8	-251.6	-510.7

Note: *, **, ***Indicate levels of significance of 10, 5 and 1 percent, respectively

Source: Authors

Table V.
Estimation result of
product innovation

Both groups enhance innovation by practicing QC for higher innovation, but the difference is not a matter of measurement. Thus the first conclusion obtained from the estimation is that the R&D and non-R&D groups operate under almost totally different processes for product innovation, which answers *RQ1* for product innovation.

3.13 R&D group

Next, let us focus on the R&D group in more detail. This group has the following significant variables:

- (1) cross-functional team consisting of “production engineering, manufacturing, and sales and marketing” for all types of innovation; and
- (2) IT all for all types.

From these observations, factors such as cross-functional team and IT all are the same variables that were identified as promoting innovation obtained in the authors’ previous studies (Machikita *et al.*, 2016; Tsuji *et al.*, 2016, for example), implying that the previous studies appeared to be focused on firms conducting formal R&D activities. Moreover, since there are no significant variables related to top management, innovation in this group is mainly enhanced by employee participation. This is different from the conclusion obtained in our previous studies. As discussed in the previous sections, the R&D group consists of larger SMEs and has active QC and R&D (improvement activities, more precisely) conducted by cross-functional teams covering different sections. These results tend to coincide with the results of in-depth interviews.

3.14 Non-R&D group

What then are the results for the non-R&D group? The only common factor in this group for different types of innovation is:

- (1) ISO9000 series for Types I, II, and IV;
- (2) group awards for suggestions or QC for Types I, II, and, III;
- (3) HRD program for workers for all Types; and
- (4) IT all for Type I.

HRD is the most important factor in this group since HRD is positively significant for all types. This is different from the R&D group. This group achieves innovation through the skills and know-how of workers, as seen from the in-depth interviews. Group awards for suggestions, which provide incentives for suggestions or QC practice, is significant for Types I, II, and III. The ISO9000 series also contributes to innovation in all types except IV. Since the ISO9000 series covers a wide range of activities related to quality management, training and education, and R&D structure and implementation, further study will be required to identify the exact factors.

3.14.1 Comparison with the results of field surveys. Let us compare the above results with what we learned from field surveys. In our past studies, we did not stress the STI-type of innovation for ASEAN SMEs. These SMEs obtain new information on innovation mainly from MNCs, and concentrate on producing parts and components for MNCs. In the case of manufacturing final products, SMEs supply to local markets. Thus, in the same innovation type, firms in the two R&D groups are not so different from each other, and therefore factors of innovation identified are either cross-functional teams or HRD, which belong to the category of DUI (Jensen *et al.*, 2007). Even if their innovation is of the DUI type, there must be some reasons for the difference, these deriving from innovation or knowledge environment (Thomä, 2017), or from the types of products, e.g. simple parts and material, or complete parts

and final products. Innovation for the former requires the skills of workers accumulated by the learning process at the workplace or job shop. In case of the latter, products are more complex due to the number of parts or the need for higher quality. In addition, customer requests for quality tend to be higher. Not only do SMEs have to cope with these issues, they must also engage in marketing to sell their products. Accordingly, the number of employees participating in these activities increases. The success of these activities depends on the coordinators or supporting sections that manage these activities. In this sense, firms in the R&D group in ASEAN countries are more advanced than those in the non-R&D group.

4. Discussion

The estimation results identify the factors of innovation in R&D and non-R&D groups, which have received less discussion in the literature thus far. Here, let us compare our results with those of other studies.

The merit of this paper is in the analysis of R&D and innovation in firms in ASEAN economies. Previous empirical studies employed large public data from the EU and the USA, whereas this paper uses original data collected by each of the country teams. The US data, such as NSF's Business R&D and Innovation Survey (BRDIS) 2011, shows that "out of all US firms only 5 percent conduct R&D. Furthermore, out of all US product innovating firms, about 72 percent are non-R&D innovators. At the same time, R&D-active firms do have a higher probability of generating a product innovation than non-R&D-active firms (58 vs 7 percent) (NSF, 2014)" The data in this study show that the ratio between R&D and non-R&D is 52 vs 48 percent (Table I), but the performance in terms of product innovation appears not to be large (Figure 1).

Another merit of this research is that an original questionnaire was devised. As a result, concrete factors such as cross-functional teams and HRD have been obtained. Thomä (2017) used data from the 2011 survey wave of the Mannheim Innovation Panel (MIP), which covers the period 2008 to 2010. He emphasizes vocational education and training (VET) in Germany as an innovative factor in the DUI mode of learning. The higher ability of German workers is based on VET. In ASEAN economies, there is a severe shortage of such workers and engineers, making it necessary for firms to nurture these human resources through HRD.

5. Conclusion

The objectives of this study are to examine whether two groups of ASEAN firms have different R&D activities for achieving innovation. The firms are categorized into two groups depending on whether or not they own specific R&D sections or units. The underlying hypotheses are that the R&D group is characterized by the same process as obtained in the authors' previous studies, namely innovations are promoted by technology, human factors, and organizational arrangements. On the other hand, the non-R&D group has a different innovation process due to shortages in human resources, investment funds, or a low level of technology. Based on field research, these firms conduct innovation through the leadership of owners who dominate the firm in terms of technology, ideas, experience, and so on. In addition to this, a cross-functional team of employees discussing, disseminating, and sharing their ideas, experiences and skills among the members is another factor promoting innovation. Since the firm size is small, top management can participate in the team and the joint effort of employer and employees in the whole firm promotes innovation.

To examine the above hypotheses, this study employs a model using the same variables for both groups. This examines whether the two groups have the same innovation processes or not. The results of the first estimation procedure indicate that the two groups pursue product innovation differently. The formal R&D group promotes innovation by

cross-functional teams consisting of marketing personnel as well as technological and manufacturing engineers, QC, a learning process such as HRD and worker training. These factors coincide with those obtained in the authors' previous studies. The informal R&D group, on the other hand, does not yield clear results. An estimation model only applicable to this group is therefore employed. As a result, top management leadership, reflecting top management experience and study abroad, is identified. Accordingly, the RQs related to product innovation are partly demonstrated.

Although the roles of top management in the innovation process were recognized, they were not emphasized in the authors' previous studies. The study on connectivity conducted last year identified these roles in the context of the information transmission channel, that is, the route of information flow between MNCs and top management who formerly worked at MNCs. On the other hand, the role of top management in the innovation process in small SMEs is extracted for the first time in this study. The cross-functional team, training of workers, and QC practices were found to be three major factors prompting innovation in the authors' previous studies. These are also confirmed by this study.

This paper successfully identifies concrete factors promoting innovation for R&D and non-R&D groups in ASEAN economies, a region that has received less analytical attention in comparison with the EU and the USA. The limitations of this study that require solution in further studies are as follows: number of samples, estimation method; concrete channels as to how factors affect innovation; and external linkages. The number of samples related to the non-R&D group is too small to conduct statistical analysis. Further efforts regarding the survey method for focusing on small SMEs are required. The estimation method also requires improvement. The estimation method in this study aims rather to find factors which make a difference in the innovation process, but more suitable methods are required to test the hypotheses. The identification of how different factors affect innovation is also important. For example, how a cross-functional team disseminating ideas and experiences affects innovation is yet to be solved. Can the group reward system, for example, stimulate cross-functional activities? This can be examined by the cross term of two variables. What kind of organizational arrangements can elevate employee ability for innovation is a similar kind of problem that needs to be analyzed. This study focuses on the internal innovation process and is less concerned with external linkages, which played an important role in the authors' previous studies. The introduction of external linkages into the model may yield different results, though the analysis would become much more difficult and complex.

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Variables	(1) Type I		(2)		(3)		(4) Type II		(5)		(6) Type III		(7) Type IV		(8)	
	Non-R&D	R&D	Non-R&D	R&D	Non-R&D	R&D	Non-R&D	R&D	Non-R&D	R&D	Non-R&D	R&D	Non-R&D	R&D	Non-R&D	R&D
ISO9000 series	0.370**	(0.182)	-0.045	(0.123)	0.437**	(0.178)	-0.032	(0.118)	0.249	(0.181)	0.271**	(0.116)	0.355*	(0.190)	0.043	(0.121)
Factory manager	0.066	(0.164)	-0.017	(0.129)	0.168	(0.162)	0.010	(0.125)	0.044	(0.167)	-0.067	(0.125)	0.026	(0.181)	-0.280**	(0.133)
CEO has experiences working for MNCs or JVs	-0.119	(0.164)	-0.018	(0.116)	-0.017	(0.160)	-0.083	(0.112)	0.198	(0.163)	0.023	(0.111)	0.244	(0.172)	0.107	(0.115)
Cross-functional team (engineering and manufacturing sale and marketing)	0.014	(0.091)	0.275***	(0.059)	0.004	(0.090)	0.285***	(0.057)	-0.045	(0.093)	0.195***	(0.057)	0.037	(0.096)	0.159***	(0.059)
QC	-0.049	(0.163)	0.015	(0.130)	0.171	(0.161)	-0.076	(0.127)	0.315*	(0.167)	0.246*	(0.127)	0.440**	(0.181)	0.294**	(0.136)
Statistical QC	-0.270	(0.181)	0.195	(0.136)	-0.245	(0.178)	0.118	(0.131)	-0.178	(0.183)	0.259**	(0.129)	-0.206	(0.199)	0.053	(0.135)
Group rewards for suggestion or QC	0.549***	(0.176)	0.071	(0.127)	0.353**	(0.172)	0.165	(0.123)	0.300*	(0.176)	-0.013	(0.122)	0.284	(0.188)	0.127	(0.126)
HRD program for blue-collar workers such as cross-training or job rotation	0.313**	(0.153)	-0.084	(0.118)	0.331**	(0.150)	-0.024	(0.114)	0.413***	(0.155)	-0.034	(0.113)	0.614***	(0.169)	0.106	(0.119)
IT all	0.110**	(0.050)	0.104***	(0.028)	0.043	(0.050)	0.120***	(0.028)	0.044	(0.051)	0.081***	(0.027)	-0.043	(0.054)	0.076***	(0.028)
Observations	383	568	383	568	383	568	383	568	383	568	383	568	383	568	383	568
Pseudo R^2	0.091	0.080	0.070	0.065	0.070	0.065	0.070	0.065	0.094	0.094	0.070	0.070	0.113	0.113	0.104	0.104
Log likelihood	-305.3	-525.5	-316.6	-561.2	-316.6	-561.2	-316.6	-561.2	-292.5	-292.5	-570.8	-570.8	-251.6	-251.6	-510.7	-510.7

Note: *, **, *** Indicate levels of significance of 10, 5 and 1 percent, respectively

Source: Authors

Table AI.
Detailed
estimation result of
product innovation

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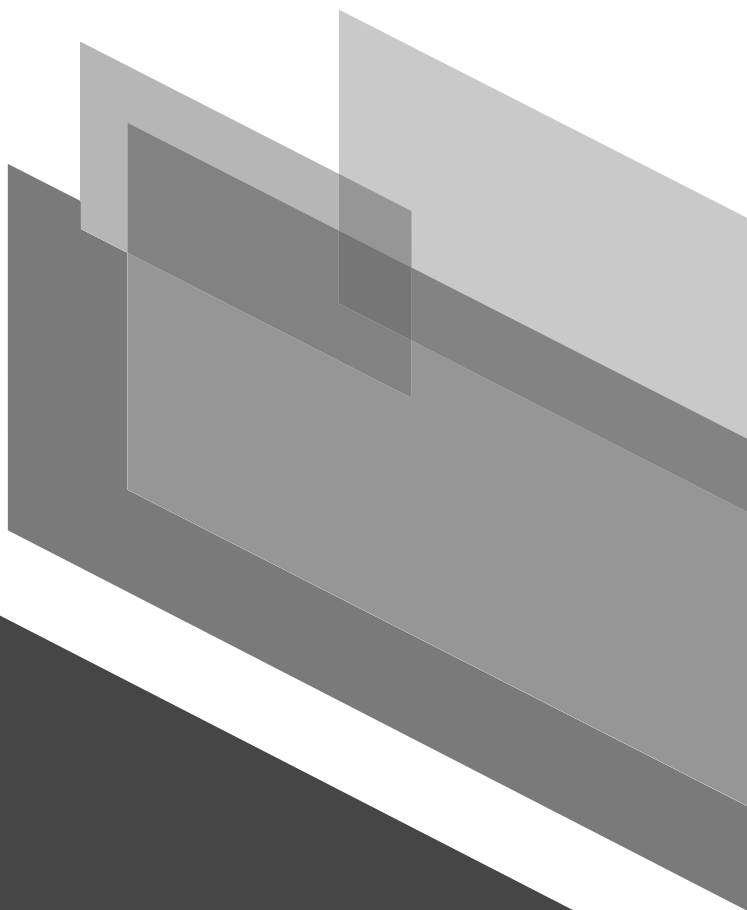


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Volume **27** Number **2**

European Journal of Management and Business Economics

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