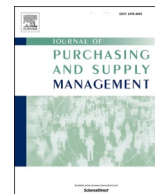


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How supply chain strategies moderate the relationship between innovation capabilities and business performance

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ABSTRACT

The purpose of this paper is to study how the fit between innovation capabilities and supply chain (SC) strategies affects business performance. An empirical study based on a sample of 329 companies from Portugal and Brazil was performed to test a theoretical model based on the resource-based view. Linear and hierarchical regression analyses are conducted to test the hypotheses. The different combinations of core and supplementary innovation capabilities and lean and agile SC strategies are empirically tested and discussed. Data reveal that core and supplementary innovation capabilities positively impact on business performance and that SC strategies moderate the relationship between innovation capabilities and business performance. The analysis also shows that the combination of an agile SC strategy and supplementary innovation capabilities offers the greatest opportunities to improve business performance. The results of this study could help managers to choose the most appropriate SC strategy, thus contributing to increasing the impact of innovation capabilities on business performance. This study contributes to the knowledge concerning the consequences of adopting different innovation capabilities and SC strategies on business performance.

1. Introduction

Innovation is recognized as a fundamental source of competitive advantage (Porter, 1996; Teece, 2018) and its potential to generate improvements in performance depends on a set of factors known as innovation capabilities (ICs), which result from the abilities to explore the available resources to develop new ideas successfully (Adler and Shenhar, 1990; Francis and Bessant, 2005; Guan and Ma, 2003; Teece, 1986). Many authors argue that ICs impact positively on business performance (Borjesson and Elmquist, 2011; Calantone et al., 2002; Mir et al., 2016; Saunila et al., 2014), but the factors and circumstances that favor or undermine this relationship are not well known (Saunila et al., 2014).

This study looks at the relationship between ICs and supply chain management (SCM), which plays an important role in companies' competitiveness as well as innovation and considers the complexity and variety of factors that influence the impact of ICs on business performance. The link between innovation and supply chain (SC) has been attracting more attention from academics in the last few years (Arlbjorn

and Paulraj, 2013; Sjoerdsma and van Weele, 2015; Zimmermann et al., 2016; Moreira et al., 2018). An important part of SCM is the SC strategy, which is related to the way that a company manages the issues concerning the sourcing of products, the ability to plan, the conversion of raw materials, the managing of demand, the communication with SC actors, and the delivery of products and services (Arora et al., 2016).

The relationship between two or more areas, functions, processes, units, strategies or capacities can be studied through the lens of the concept of fit (Porter, 1996; Venkatraman and Camillus, 1984), which expresses the adjustment of one or more variables in relation to another. A good fit is believed to have a positive impact on performance (Peng et al., 2011; Venkatraman and Camillus, 1984; Wu et al., 2014). Venkatraman (1989) presents six types of fit: fit as moderation, fit as mediation, fit as matching, fit as gestalts, fit as profile deviation and fit as covariation. Fit as moderation, which is used in this study, is related to the impact of a moderator variable on the link between a predictor variable and a criterion variable (Venkatraman, 1989).

In light of this scenario, the aim of this paper is to study how the fit (as moderation) between ICs and SC strategies affects business

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performance, using the resource-based view (RBV) as a basis. The following research question is addressed: how do SC strategies moderate the relationship between ICs and business performance?

By trying to understand the relationship between innovation and SCM better, this study contributes to the literature in several ways. The empirical test of the relationship between ICs and SC strategies and its effects on business performance represents a contribution to both theory and practice, bringing a new perspective to the topic. By focusing on the strategic view of SC strategies and ICs, the paper enhances the understanding of the importance of the two areas, and their relationship, for business performance and adds to the prior literature on the relationship between innovation and SCM. It also contributes to purchasing and supply management (PSM) literature by presenting a set of commendations concerning purchasing and combines topics from operations management and strategy. As such, it also contributes to PSM by its multidisciplinary approach, which is part of the nature of this field (Wynstra et al., 2019). This paper also offers practical implications for companies seeking to improve their overall performance by discussing the importance of aligning SC strategies and ICs.

2. Literature review and theoretical development

The concept of fit has gained ground in the literature over the last few years (Acur et al., 2012; Wu et al., 2014) and implies consistency and harmony between two or more variables. It is believed that the better the fit, the greater the impact on performance (Peng et al., 2011; Venkatraman, 1989). Peng et al. (2011, p. 486) state that “researchers adopting a fit perspective investigate consistency among subsystems (areas, processes, strategies) within a firm (internal fit) or fit among the organizational structure, strategy and the external environment (external fit).”

Fit as moderation refers to the impact of a moderator variable on the relationship between a predictor variable and a criterion variable (Venkatraman, 1989). This perspective is adopted when the theory indicates that the impact of the predictor on the criterion varies depending on the level of the moderator, which can be understood categorically (types of environment, stages of a product’s life cycle, organizational types) or characteristically (degree of business-relatedness, degree of competitive intensity). The type of moderation can affect the direction or the strength of the relations between a predictor and dependent variable (Venkatraman, 1989).

The RBV constitutes the theoretical foundation of this paper as it is widely used in strategic management literature and has been applied to operations management, and more specifically to SCM and PSM, in recent years (Zimmermann and Foerstl, 2014; Sjoerdsma and van Weele, 2015; Spina et al., 2016; Yan and Azadegan, 2017; Fawcett et al., 2012). According to Barney (1991, p. 101), resources are “all assets, capabilities, organizational processes, firm attributes, information, knowledge, etc. controlled by a firm that enable the firm to conceive of and implement strategies that improve its efficiency and effectiveness”. To the RBV, the resources and capabilities of companies are the key sources of sustained competitive advantage (Barney, 1991; McIvor, 2009; Menguc et al., 2014). Teece et al. (1997) highlight that from the resource-based perspective the capabilities and assets of a company are the fundamental determinants of performance. The RBV has been increasingly used to explain how strategically managed interactions with suppliers contribute to gaining competitive advantage. Previous studies have argued that “firms augment their resource endowments by co-developing capabilities with suppliers, as well as engaging in sourcing” (Day et al., 2015, p.1). Complementarily, according to Zimmermann and Foerstl (2014), the RBV suggests that PSM practices can help companies to improve performance.

Although criticized by authors such as Priem and Butler (2001) and Lockett et al. (2009) in terms of its theoretical relevance, method, empirical evidence and practical insights, the RBV is considered an important contribution to this paper as it offers a systematic approach to a company-level analysis, as it characterizes a company as a collection of

resources and capabilities. “RBV assumes that performance differences across firms are due to differences arising from valuable, rent-generating, firm specific resources and capabilities that cannot be easily imitated or substituted” (Lawson and Samson, 2001, p. 379). Thus, the focus of the RBV is on the internal characteristics of companies which affect performance (Craighead et al., 2009) and, in this sense, the RBV supports the idea that ICs and SC strategies are strategic attributes that influence key outcomes, such as business performance. Moreover, according to the concept of dynamic capabilities, companies must adapt, integrate and reconfigure their organizational skills, resources and competences in order to match the requirements of changing environments and to be able to obtain a sustainable competitive advantage (Teece et al., 1997; Eisenhardt and Martin, 2000; Gutierrez-Gutierrez et al., 2018).

2.1. Innovation capabilities

A company’s capabilities are usually described as what it is able (or unable) to do (Borjesson and Elmquist, 2011) and are often seen as the ability to apply the available specific resources to achieve the expected results (Yang, 2012). ICs, which have received increasing attention from researchers in the last few years (Calantone et al., 2002; Guan and Ma, 2003; Mir et al., 2016; Ngo and O’Cass, 2012; Oura et al., 2016), result from the ability to apply the available resources in order to develop and explore new ideas successfully and are determinant factors in generating competitive advantages (Guan and Ma, 2003; Menguc et al., 2014).

The concept of IC originated from the need to understand why firms that innovate commonly fail to obtain significant economic benefits (Teece, 1986). Previous research has indicated that, due to the complexity and broad nature of innovation, establishing product development processes does not necessarily result in innovative products or in economic benefits (Borjesson and Elmquist, 2011; Lisboa et al., 2011; Mir et al., 2016). In order to achieve this (the effectiveness of innovation), companies must have a set of characteristics that positively influence the continuous development of innovative activities. Teece (1986) discussed the importance of having different resources, including assets and competencies, to take advantage of any innovation undertaken and argued that innovators will fail if they do not have the capabilities that allow them not only to develop new products, but also to implement them successfully. Moreover, ICs must be defined or developed according to the specificities and needs of each company, accommodating the special conditions and characteristics of each competitive environment (Guan and Ma, 2003; Lisboa et al., 2011).

The pursuit of innovation brings a certain degree of uncertainty to firms, as it requires the coexistence of different and often contrasting interests. Lawson and Samson (2001, p. 381) discuss the paradox of managing daily operations while also cultivating innovation, stating that “the need to manage mainstream competencies efficiently is often seen as hampering the development of successful innovation”. Mainstream activities, such as manufacturing and marketing, are commonly viewed as the key to a company’s success; and the related organizational processes are developed around stability, efficiency and profitability. On the other hand, innovation requires long-term vision and flexibility (Lawson and Samson, 2001), which makes this balance a real challenge to managers. The development of a set of capabilities suitable for a company’s needs helps to minimize this instability.

Guan and Ma (2003) identified seven dimensions of ICs based on companies’ needs to transform knowledge and ideas into new products, processes and systems and to succeed in their implementation (Lin, 2007) while balancing the different needs and interests: (1) research and development (R&D) capability; (2) manufacturing capability; (3) marketing capability; (4) learning capability; (5) organizational capability; (6) resource exploiting capability; and (7) strategic capability.

R&D capability is more related to companies that have a formal R&D process (represented by an area or department), but is not exclusive to this group. Companies without a formal R&D process can present this capability if they are able to embrace novel approaches when

developing new products or processes (Guan and Ma, 2003). This capability presupposes the existence of a routine (more or less organized or formalized) that leads to the regular development of new products or processes. When it comes to innovation, manufacturing capability concerns the capacity to transform R&D results into products, which meet the needs of the market, in terms of design and can also be manufactured in batches. Guan and Ma (2003) and Yam et al. (2014) conclude that this capability does not hold a significant influence over performance. Marketing capability refers to the ability to publicize and sell the products from the understanding of the customers' current and future needs and competitors' knowledge (Guan and Ma, 2003).

Learning capability refers to the ability to identify, assimilate, and exploit new knowledge (Guan and Ma, 2003). Research on innovation commonly considers learning as a crucial capability for innovative firms (Borjesson and Elmquist, 2011). Learning encompasses the sharing and transfer of knowledge internally, learning from previous experiences and collaborating with external companies. Companies with organizational capabilities, as an IC dimension, have a well-established organizational structure that allows the coordination of the work of all activities influencing the speed of the innovative processes (Guan and Ma, 2003). Resource exploiting capability refers to the company's ability to mobilize and expand its technological, human and financial resources. Organizational and resource exploiting capabilities play an important role in balancing the contrasting interests related to mainstream activities and innovation (Lawson and Samson, 2001). Strategic capability, in the context of innovation, is related to the ability of a company to adopt different types of strategies according to the needs of a competitive environment (Guan and Ma, 2003). On the one hand, this capability represents the long-term view needed to develop and invest in innovation and, on the other hand, the flexibility to change directions whenever necessary.

According to Guan and Ma (2003) and following the conclusions of Teece (1986), the seven dimensions can be divided into two groups: core ICs, composed by R&D (viewed as a process or routine), manufacturing and marketing capabilities; and supplementary ICs, composed by learning, organizational, resource-exploiting and strategic capabilities. This division is similar to Lawson and Samson's (2001), who classified capabilities as mainstream and newstream. According to Lawson and Samson (2001), a balance between mainstream and newstream capabilities is needed to build the basis where innovation is developed. Newstream capabilities, are defined as the resources within the organization that allow the identification and creation of new value for customers, while mainstream capabilities, such as manufacturing and marketing, are often viewed as "the key to current success with organizational processes built around stability, efficiency and profitability in generating cashflow" (Lawson and Samson, 2001, p.384). Thus, the model proposed by these authors views innovation capabilities as "a higher-order integration capability, that is, the ability to mould and manage multiple capabilities" (Lawson and Samson, 2001, p.380).

Core ICs are more related to intellectual property (Teece, 1986) and knowledge management (Swink, 2006) and are understood as the ability to transform innovative ideas originating from R&D into the manufacturing and marketing process (Guan and Ma, 2003). On the other hand, supplementary ICs are defined as "the ability of a firm to support and harmonize core innovation capability to play the role effectively" (Guan and Ma, 2003, p.743). Supplementary ICs are key determinants of a company's performance in markets where barriers to imitation and entrance of new competitors are smaller (Teece, 1986). According to Teece (1986, p. 285), "when imitation is easy, markets don't work well, and the profits from innovation may accrue to the owners of certain complementary assets, rather than to the developers of the intellectual property".

In this sense, even though core ICs include R&D, manufacturing and marketing, their existence *per se* is no guarantee of successful innovation nor financial return (Mir et al., 2016; Teece, 1986). Supplementary capabilities for innovation are important determinants to balance and

integrate different interests within the company and allow the sustainability of innovation over time. Thus, core and supplementary ICs, although independent, are complementary dimensions. Organizations possessing a balanced set of these capabilities are able to integrate key capacities, assets and resources to successfully stimulate innovation (Lawson and Samson, 2001).

The significance of ICs concerning the intensity and depth of innovation (Lisboa et al., 2011) can be understood through the concepts of exploration and exploitation. Exploration refers to a company's ability to find completely new knowledge, competences, and opportunities. It is closely connected to creativity and innovation and includes characteristics such as search, variation, risk taking, experimentation, flexibility and discovery (March, 1991; Uotila, 2017). On the other hand, exploitation is the ability to refine and utilize the company's existing knowledge, competences and opportunities. It is linked to efficiency and productivity and encompasses refinement, choice, selection, implementation, and execution (March, 1991; Uotila, 2017).

2.2. SC strategies

SC environments have become increasingly more dynamic and unpredictable and are influenced by characteristics such as: product demand, product variety and product life cycle (Hallavo, 2015). As such, companies need to deploy their SC strategies to overcome volatile environments, in order to enhance their competitiveness in the market (Abdollahi et al., 2015; Stentoft and Rajkumar, 2018).

Although SCM is a recurring topic in strategic plans, companies often do not define their strategies clearly (Qi et al., 2009; Qrunfleh and Tarafdar, 2014; Sharifi et al., 2013). How companies achieve and maintain competitive advantage is one of the main questions in the field of strategic management (Pisano, 2015; Porter, 1996; Teece et al., 1997). Strategic positioning refers to the development and adoption of different activities compared with the competitors, or using similar activities, but differently (Porter, 1996). In this sense, a strategy is a commitment to a set of resources, activities, policies and behaviors, which are coherent and mutually supportive, seeking to achieve objectives that contribute to the competitiveness of the companies. For Pisano (2015), good strategies encourage alignment between the different functional/business areas of the organization, clarify objectives and help maintain the focus on the priorities stated.

SC strategies reflect the nature of the SCs and lay down their objectives and goals (Lee, 2002; Qrunfleh and Tarafdar, 2014). Moreover, they should be aligned with the product's characteristics, the competitive strategy adopted and the environment where the firms compete (Zimmermann et al., 2020). For Arora et al. (2016, p. 206), "SC strategy describes a pattern of decisions related to sourcing products, capacity planning, conversion of raw materials, demand management, communication across the SC, and delivery of products and services and thereby links SCM strategy to business and corporate-level strategy." In this sense, SC strategy is often understood as an extension of the operational strategy and represents a set of choices that companies need to make to match the environmental contingencies they confront (Lo and Power, 2010).

Through the lens of SCM, there are essentially two ways to achieve and sustain a competitive position in the market: increase efficiency or respond quickly to the market's needs. The model presented by Marshall Fisher in his seminal article published in the Harvard Business Review in 1997 (Fisher, 1997) proposed the adoption of two types of SC strategy: the efficient SC strategy and the market-responsive SC strategy. Fisher (1997) discussed the issue of adopting an SC strategy from the point of view of a company's products, especially considering the characteristics of the demand. According to Fisher (1997), products can be categorized as primarily functional – they do not change much over time, have a stable and predictable demand and present long life cycles; or are primarily innovative, with unpredictable demand and short life cycles. Each type of product requires different kinds of SC strategy. The model proposed by Fisher (1997) indicates that functional products match with

efficient SCs and innovative products match with responsive SCs.

Starting from the operational perspective of SC strategies proposed by Fisher (1997), and including a broader view of SCM (Narayanamurthy and Gurumurthy, 2016), Christopher and Towill (2002), adopted the typology of a lean SC strategy, related to Fisher’s efficient strategy, and an agile SC strategy, related to Fisher’s market-responsive strategy (Abdollahi et al., 2015; Christopher and Towill, 2002; Qi et al., 2009; Qrunfleh and Tarafdar, 2014). This typology is the most commonly used in the current literature on SC strategies (Zimmermann et al., 2019). Companies that adopt a “lean” perspective seek to improve the efficiency of their business processes (Mason-Jones et al., 2000). This kind of strategy is linked to the elimination of waste, cost efficiency and lead-time reduction. The agile SC strategy, on the other hand, seeks to have the capacity to be responsive and flexible to changing and unpredictable demands (Abdollahi et al., 2015; Lee, 2002). While a lean SC strategy tends to perform better in high volume, low variety and predictable environments, an agile SC strategy is more adaptable to less predictable environments where the demand varies considerably (Christopher, 2000). Some authors have adopted other terminologies in their studies, especially lean/agile, or leagile (Bruce et al., 2004; Mason-Jones et al., 2000; Naylor et al., 1999), which is a combination of the lean and agile approaches.

Fisher’s model, as well as the models derived from it, considers that it is the characteristics of products that determine the SC strategy. In these models, a lean or efficient SC matches with functional products, while an agile or responsive SC matches with innovative products (Fisher, 1997; Lo and Power, 2010; Qrunfleh and Tarafdar, 2014). However, as SC management is a process that goes through constant changes, the choice of SC strategy is also a dynamic process that has to be adapted whenever it is needed. As Christopher and Towill (2002) state, lean and agile are not opposing philosophies, they are just better suited to different contexts. As Lee (2002, p. 106) states, “strategies that are based on a one-size-fits-all or try-everything mentality, will fail.”

2.3. Theoretical model and development of hypotheses

This paper has been prepared according to the model presented in Fig. 1, which represents the relationship between ICs, SC strategies and business performance, complemented by the influence of a company’s size and environmental uncertainty (environmental munificence, environmental dynamism and environmental complexity) as control variables. The model reflects the concept of fit as moderation, where ICs are the predictor variables, business performance is the criterion variable and SC strategies are the moderator variables.

The relationship between ICs and business performance is not new, as many authors have argued that ICs positively affect business performance (Borjesson and Elmquist, 2011; Calantone et al., 2002; Mir et al., 2016; Saunila et al., 2014). However, the characteristics of this relation and the circumstances that influence it have not been studied

extensively yet. In this sense, testing the effect of the ICs separately, in this case core and supplementary, is a new approach and is central to an understanding of the overall approach of this paper. In other words, besides knowing the impact of ICs as a whole, it is important to know if the different characteristics of core and supplementary ICs lead to different results in terms of business performance. Thus, hypotheses H1 and H2 are as follows:

H1. Core ICs positively affect business performance.

H2. Supplementary ICs positively affect business performance.

As discussed earlier, due to the complexity of the innovation process, the growing importance of SCM and the intrinsic relation between innovation and SC, it is natural to expect that SC strategies affect the relationship between ICs and business performance. Considering the characteristics of each type of IC and SC strategies, the different combinations between them are discussed below.

2.3.1. ICs and lean SC strategies

This section discusses how lean SC strategies moderate the relationship between ICs (core and supplementary) and business performance. Core ICs and a lean SC strategy share a set of common characteristics and principles, as both represent a certain degree of stability and continuity of the status quo within companies. The main goal of lean strategies is to generate efficient supply chains, in terms of costs, allowing improvements in efficiency and the elimination of waste. This strategy fits well with a stable and predictable demand with products and processes streamlined to enable the organization to satisfy the current customers’ needs (Christopher and Towill, 2002; Qi et al., 2009; Qrunfleh and Tarafdar, 2014).

Core ICs are represented by marketing, manufacturing and R&D capabilities. Manufacturing capabilities are related to the consistency of the manufactured product’s quality and the employment of advanced technologies compared to competitors (Guan and Ma, 2003). The fit between manufacturing capabilities and a lean SC strategy can favor exploiting innovation activities, as both can focus on incremental improvements for existing products and processes, which also generates a positive effect on business performance.

Marketing capabilities represent the capacity of companies to segment and target specific markets and to distinguish their products from competitors. Companies with marketing capabilities strive to understand consumers’ needs, how to access customers, and competitors’ knowledge. Recognizing marketing as a core capability means that this capability helps firms attract and maintain clients with their current portfolio of products, rather than implementing new products or identifying new opportunities. Companies tuned to exploiting innovation activities for the needs of the market tend to favor lean SC strategies as they can lead to incremental improvements in products and processes.

Although R&D capability is related to innovation, it also works as a

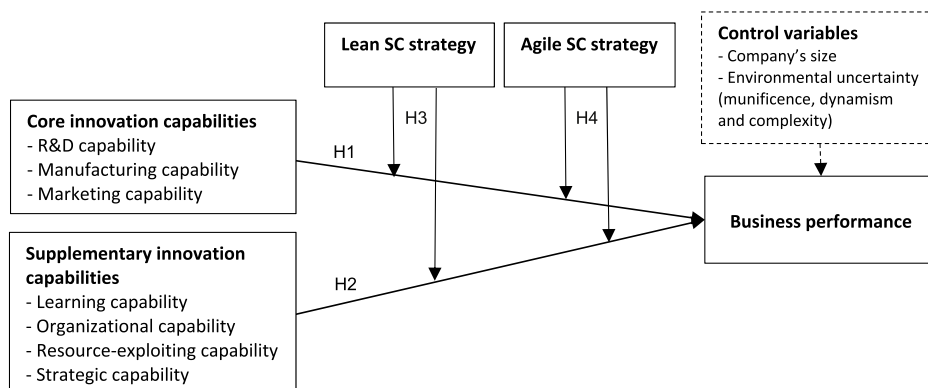


Fig. 1. Theoretical model.

process that requires stability and, in this sense, represents mainstream activities. It is expected that R&D capabilities are tuned to a lean SC strategy when companies favor the development of products and processes that need to be adapted to constant changes in demand. As such, a company's exploitation of innovative activities is more appropriate for companies deploying lean SC strategies. On the other hand, the presence of supplementary capabilities (learning, organizational, resource-exploiting and strategic capabilities) also increases the impact of R&D capability in the development of exploration and more radical innovation activities. Thus, R&D capability is understood in this study as a core capability, following previous studies (Teece, 1986; Guan and Ma, 2003), but is closely related to exploration activities when combined with supplementary innovation capabilities. In this sense, it is expected that a lean SC strategy *positively* moderates the relationship between core ICs and business performance.

Completion, supplementary ICs are composed by learning, resource-exploiting, organizational and strategic capabilities. Learning capabilities are related to the promotion of a culture that stimulates learning and that allows the identification and assimilation of knowledge important to the company's success, which is reflected in the identification of new trends within the industry and the development and acquisition of the new and necessary skills or technologies to develop new products (Guan and Ma, 2003). Thus, learning capability and a lean SC strategy share some characteristics, as lean presupposes the ability to learn in order to improve processes and increase efficiency continuously.

Companies with high resource exploiting capabilities are able to mobilize and enlarge their technological, human and financial resources by combining internally and externally developed technologies while maintaining an uninterrupted flow of financial resources for the introduction of new products. These companies also have the capacity to allocate personnel when necessary and try to improve products and processes continuously (Guan and Ma, 2003). Organizational capability refers to the ability to develop and maintain a well-established organizational structure that coordinates the different activities within companies, searches for shared objectives and affects the speed of the innovation processes. It includes the implementation of management practices that help to improve routines and activities, facilitating the use and exchange of information, knowledge and skills within the companies. Those that have this ability can also implement new organizational methods to distribute responsibilities and support decision-making tasks better.

Strategic capability refers to the ability to implement different types of strategies that help to adjust to changes in the business environment in order to excel in today's highly competitive environments. Companies with these capabilities shape their strategy using a strong entrepreneurial vision and senior managers are highly capable of understanding external factors that may affect business operations and can anticipate the movements of outstanding competitors quickly and adjust their strategies to these changes. In this sense, supplementary ICs and a lean SC strategy represent, in most cases (the main exception is learning capability), contrasting interests within companies and it is believed that the fit between them does not affect business performance. Thus, considering the characteristics of lean SC strategies and the different ICs, the following hypothesis is proposed:

H3. *Lean SC strategies (a) positively moderate the relationship between core ICs and business performance, (b) but do not moderate the relationship between supplementary ICs and business performance.*

2.3.2. ICs and agile SC strategies

The main goal of agile SC strategies is to ensure the adaptability and flexibility of the SC considering the ever-changing customers' needs (Christopher and Towill, 2002; Qi et al., 2009; Qrunfleh and Tarafdar, 2014). This type of strategy seeks to adapt the organization to unique market characteristics, in order to generate and retain new competitive

advantages based on continuously changing environments. The reduction of products' life cycles leads to the need to supply products and services faster and in a more responsive way (Qi et al., 2009).

Core ICs are represented by marketing, manufacturing and R&D capabilities. Manufacturing capabilities, as a core dimension of the ICs, are related to a certain level of stability and uniformity, which (in a sense) contradicts the idea of the flexibility required by an agile SC strategy. Due to their characteristics, manufacturing capabilities represent those capabilities that seem to be less related to innovation and performance. Previous studies have highlighted the lack of communication between manufacturing and R&D departments, as well as the inability of the manufacturing department to match the process capabilities with the market requirements in a timely manner as possible reasons for this disconnection (Wheelwright and Clark, 1992; Guan and Ma, 2003).

As a core capability, marketing IC also demands a certain degree of consistency and continuity, while, as mentioned before, R&D capability requires the combined presence of supplementary capabilities to favor exploration activities. Thus, core ICs require (or at least fit better with) stability and short-term vision. Contrary to an agile SC strategy, which is prone to adapt better to the exploration of innovation activities, the adoption of core ICs favor the exploitation of innovation activities.

On the other hand, supplementary ICs and agile SC strategies share similar characteristics and principles as they represent the "newstream" and require flexibility and adaptability. Innovation exploration activities are more tuned to developing unique products and processes based on constantly changing environments, which require companies to have an outward, opportunity-based perspective in order to keep abreast of future market perspectives.

It is expected that learning capabilities have a good fit with agile SC strategies, as they presuppose understanding and adapting to customer requirements and need a certain degree of flexibility. Resource exploiting capabilities refer to the capacity to mobilize and expand the technological, human and financial resources of firms, continually striving to improve products and processes. Exploration innovation activities are riskier than exploitation innovation activities as the former are tuned to the company's ability to generate new competitive advantages for the future market needs, which involve long-term, riskier partnerships and technologies.

Companies with higher organizational capabilities use flexible structures that permit the adjustment to new projects regarding product or process innovation; these companies also assure the autonomy of managers in the innovation process and encourage close coordination and cooperation between the technical, sales and manufacturing areas. Organizational capabilities also influence the speed of the innovation process, allowing companies to identify and tackle market needs and expectations in a timely fashion. In this sense, flexibility and adaptability tend to be key organizational capabilities among successful companies that adopt agile SC strategies.

Strategic capabilities allow companies to shape their strategy by a strong entrepreneurial vision and senior managers can understand the external factors that affect business operations and may readily anticipate the movements of competitors and adjust strategies to these changes. That is, strategic capabilities allow a firm to adopt different types of strategies according to the needs of a competitive environment. Outwardly, innovation-seeking companies have a strong connection between innovation and the customers' recognition of value. Thus, it is expected that strategic capabilities fit well with an agile SC strategy, as both presuppose a solid understanding of customers' evolving requirements and the ability to adapt to external environmental changes. Taking into account the characteristics of agile SC strategies and their expected relationship with the different ICs, the following hypothesis is proposed:

H4. *Agile SC strategies (a) positively moderate the relationship between supplementary ICs and business performance, (b) but do not moderate the*

relationship between core ICs and business performance.

3. Research methodology

3.1. Questionnaire

A survey instrument was developed to test the research model. Krause et al. (2018) highlight the use of survey research when testing theory as the primary goal of researchers examining the management of SCM operations. To ensure its reliability, the first version of the questionnaire was developed and reviewed by experienced researchers of operations management and SCM. Two potential respondents were also interviewed to ground the research and provide appropriate focus for the development of the questionnaire. This version, designed in English, was translated into Portuguese, and then translated back into English. The new English version was then checked against the original English version.

The questionnaire was then pilot-tested in five companies in Portugal and five companies in Brazil – although the items and questions in the questionnaire were adapted from previously published studies, the pilot-test is considered an important part of the process. The participants were asked to answer the questionnaire and to give their opinion about the clarity of the items. Some of the minor modifications suggested by the respondents were implemented based on this pilot study. After these changes, the final version was reviewed by two academic experts and was ready to be sent to a large sample for data collection.

The combination of the two interviews, the specialists' review, the translation to Portuguese and English, as well as the pilot tests, support the reliability and the validity of the measurement method applied in the research (Zhao et al., 2007).

Several items, divided into dependent, independent, moderator and control variables, were identified and selected from the literature as a way to measure the constructs that are part of the research model.

3.1.1. Dependent variable

Business performance was measured following Gonzalez-Benito (2007). Five items were included to measure the commercial success of the firm and three items refer to ratios based on accounting data and relate to the company's economic benefits and productivity. The respondents were asked to value company performance in comparison with their competitors for each of the aspects on a seven-point Likert scale (1 = lower, 4 = equal, 7 = higher).

3.1.2. Independent and moderator variables

ICs were based on the seven capabilities proposed by Guan and Ma (2003) and the questions were based on the items proposed by the same authors. The respondents were asked to classify each of the statements on a seven-point Likert scale with 1 = strongly disagree and 7 = strongly agree.

SC strategies (moderator variable) were measured by adapting the items used by Qi et al. (2009), which in turn are based on a variety of sources, including Katayama and Bennett (1996), Yusuf et al. (1999), Naylor et al. (1999), Christopher (2000), Mason-Jones et al. (2000), and Heikkial (2002). A set of statements describing the characteristics of lean and agile SCs were presented and the respondents were asked to answer the following question: "to what extent do you agree that the supply chain of your company's major product/product mix has the following characteristics?" A seven-point Likert scale with 1 = strongly disagree and 7 = strongly agree is used.

3.1.3. Control variables

A set of potentially relevant control variables was identified following the recommendations of Bernerth and Aguinis (2016). Company size (represented by the logarithm of the number of employees) and environmental uncertainty were considered as control variables. Company size can be related to the availability of resources that

companies have to carry out their initiatives and may affect their profitability (Gligor, 2016). Previous research has also found that innovation performance and business performance can benefit from economies of scale (Fosfuri and Tribo, 2008).

Environmental uncertainty was measured as proposed by Dess and Beard (1984). Environmental uncertainty helps us understand the impact of the business environment in the context of SC and innovation – and consequently the fit between them. It is expected that the greater the uncertainty of the environment (reflected in environmental munificence, environmental dynamism, and environmental complexity), the greater the influence of SC strategies on the relationship. Aldrich (1979) and Dess and Beard (1984) classify environmental uncertainty in three dimensions: environmental munificence, environmental dynamism, and environmental complexity. Environmental munificence is related to the capacity of the environment to support sustained growth. Environmental dynamism refers to the extent that the environment in which the firm competes is characterized by changes that are hard to predict and that heighten uncertainty for key organizational members. Environmental complexity refers to the complexity of the environment, measured by the extent that the environment in which the firm competes is characterized by great uncertainty and a great requirement for information-processing (Dess and Beard, 1984). The respondents were asked to indicate their opinion on the statements concerning the business condition of the company on a seven-point Likert scale with 1 = strongly disagree and 7 = strongly agree. Table 1 presents the constructs used in the study.

3.2. Universe of the research - target sample

The sample is composed by companies operating in Portugal and Brazil. The aim of choosing these two countries was to enrich the analysis based on the distinct characteristics of these economies. By exploring the realities of Portuguese and Brazilian companies, the paper contributes to deepening the knowledge regarding the characteristics of companies located in countries that are not part of the most highly industrialized countries in the world and that have not yet received significant attention from researchers when it comes to ICs and SC strategies. The same approach was used by Mani and Gunasekaran (2018) and Gimenez et al. (2012). The Brazilian companies were selected from two of the most industrialized states – São Paulo and Santa Catarina.

The databases provided by Neoway in Brazil and Bureau Van Dijk in Portugal (both big data companies which collect and provide information about companies) were used to randomly select the final sample (to whom the questionnaire was sent), composed by 1000 companies in Portugal and 1000 companies in Brazil. Only industrial companies were included, and the final sample includes companies from various sectors, including automotive, construction and materials, electronic and electrical equipment, food and beverages, machinery and plant construction, pharmaceuticals and biotechnology and textiles and apparel.

3.3. Data collection

The questionnaire was put on the online Lime Survey platform. To determine the most appropriate respondents, the researchers identified (by e-mail and/or phone calls) the managers who would be most knowledgeable about the company's SC strategies and ICs. Following the guidelines proposed by Boyer and Verma (2000) and Craighead et al. (2011) and the principles discussed by Krause et al. (2018) and Flynn et al. (2018), the questionnaire was designed to be answered by two respondents from each company. The first part (related to SC strategies) by an SC manager, the second and third parts (related to innovation capabilities and environmental uncertainty) by an innovation manager and the fourth part (related to business performance) by both. The answers relating to business performance were compared, ensuring the reliability of the information. When significant differences between the

Table 1
Constructs used in the study.

Construct		Source	
Supply chain strategies			
Lean	AL1. Our SC supplies predictable products AL3. Our SC reduces costs through mass production AL4. Our SC provides customers with standardized products AL6. Our SC selects the suppliers based on their performance concerning cost and quality ^a AL7. Our SC structure seldom changes ^a	Qi et al. (2009)	
Agile	AA9. Our SC responds to the changing market environment quickly AA11. Our SC provides customers with personalized products ^a AA12. Our SC selects the suppliers based on their performance concerning flexibility and responsiveness AA13. Our SC needs to maintain a short and flexible relationship with a large number of suppliers AA14. Our SC structure often changes in order to cope with the volatile market	Qi et al. (2009)	
Innovation capabilities			
Core ICs	R&D	BR1. Our company develops technologies by investing in R&D BR2. Our company acquires new technologies BR3. Our company is recognized for products that are technologically superior BR4. Our company, in product development, employs some of the most qualified experts in the industry and in the country	Guan and Ma (2003); Oura et al. (2016)
	Marketing	BMK1. Our company can segment and target specific markets ^a BMK2. Our company can utilize marketing tools (product design, pricing, advertising) to differentiate our products ^a BMK3. Our company implements new pricing methods for the export of goods and services BMK4. Our company utilizes new sales channels abroad BMK5. Our company applies new techniques to promote products abroad	
	Manufacturing ^a	BM1. Our company is consistent in the quality of product manufacturing/production BM2. Our company manufactures products designed through R&D (Research and Development) efforts that meet customer needs BM3. Our company complies with delivery times in the manufacturing/production of our products BM4. Our company employs advanced technologies in manufacturing/production compared to our international competitors	
Supplementary ICs	Learning	BL1. Our company identifies and applies technological trends in our industry ^a BL2. Our company promotes a learning culture that allows for the identification, assimilation and exploitation of new knowledge essential to the competitive success of the company BL3. Whenever we have needed to develop new skills or technologies to offer new products, we have been able to do so efficiently BL4. Learning new skills and acquiring new capabilities that enable the introduction of new products is easily achieved BL5. We effectively bridge the gap between what we know or have and what we need to know or have to develop new desired products and to introduce them on the market	
	Organizational	BO1. When necessary, our company adopts a flexible organizational structure to adjust to new projects focused on product or process innovation ^a BO2. Our company offers managers considerable autonomy in the innovation process ^a BO3. In our company, there is strong coordination between the technical (e.g., engineering, projects), sales and manufacturing departments BO4. Our company implements new management techniques to improve routines and work practices and to facilitate the use and exchange of information, knowledge and skills within the company BO5. Our company implements new work organization methods to better distribute responsibilities and decision-making tasks, e.g., the establishment of teamwork, the decentralization or integration of departments, etc.	
	Resource Exploiting	BRE1. Our company combines internally and externally developed technologies (e.g., technologies developed by business partners) ^a BRE2. Our company maintains a continuous flow of financial resources for the introduction of new products on the market ^a BRE3. Our company is skilled in the allocation of personnel BRE4. Our personnel continually strive to improve our products and processes BRE5. Our employees believe that they are responsible for improving our products and processes	
	Strategic	BS1. In our company, strategy formulation is guided by a strong entrepreneurial vision BS2. In our company, senior management is highly capable of understanding external factors that may affect business operations BS3. In our company, senior management quickly anticipates the movement of foreign competitors and adjusts strategies to this movement BS4. In our company, there is a strong connection between innovation and value recognition by customers	
Business performance			
Commercial performance	DC1. Sales growth DC2. Reputation and image DC3. Customer satisfaction DC4. Market share (of the main product) DC5. Success of new product launches ^a	González-Benito (2007)	
Economic and productivity performance	DF6. Return on investment – ROI DF7. Profits as percent of sales DF8. Labor productivity	González-Benito (2007)	
Environmental uncertainty			

(continued on next page)

Table 1 (continued)

Construct		Source
Env. Munificence	CM1. The environment in which the firm competes can support sustained growth and sustainability	Dess and Beard (1984)
Env. Dynamism	CD2. The environment in which the firm competes is characterized by changes that are hard to predict and that heighten uncertainty for key organizational members	
Env. Complexity ^a	CC3. The environment in which the firm competes is characterized by great uncertainty and great information-processing requirement	

^a Dropped in subsequent validation stage.

answers were found, the respondents were contacted again. Any incomplete answers provided were discarded. The respondents' most common functional responsibilities included: operations director/manager; purchasing director/manager; supply-chain director/manager; and innovation and new product development director/manager.

An email inviting the selected respondents (one email for each respondent – two for each company) was sent with a cover letter explaining the purpose and intention of the survey and promising anonymity to increase participation. Follow-up emails and phone calls took place to improve the response rate. The data collection took five months, from September 2017 to January 2018 and totaled 329 responses – 179 from Portugal and 150 from Brazil. The return rate was 16.5% (17.9% in Portugal and 15.0% in Brazil). Specifics of the composition of the sample are presented in Table 2.

3.4. Non-response and common-method bias

Following Mentzer and Flint (1997), the non-response bias was assessed by contacting a sample of 30 non-respondents randomly selected (15 in Portugal and 15 in Brazil) and asking them to respond to a set of non-demographic questions. No statistically significant differences were detected between the answers of respondents and non-respondents. Non-response bias was also tested by examining the differences between early ($n = 198$) and late respondents ($n = 131$), considering that, as late respondents took the longest time to answer the questionnaire, there are some similarities when compared to non-respondents. The differences in the means in the metrics were compared and there were no statistically significant differences between early and late respondents. These results indicate that the non-response bias does not appear to be a concern in the present study.

To minimize potential common-method bias, some procedural and statistical methods were implemented. The questionnaire was answered by two respondents from each company. Afterwards, the answers of part 3 were compared, ensuring the reliability of the information. When relevant differences between the answers were found, the respondents were contacted again. Secondary data were used to triangulate survey data, this approach limits the risk of common method bias and enhances causal inference by reducing the likelihood of rival method-based explanations (Montabon et al., 2017). Bureau Van Dijk and Neoway databases (in Portugal and Brazil respectively), as well as sectorial and the companies' websites (when available) were consulted as a way to identify their archival data. Mainly secondary data on demographic and performance (when available) were used.

4. Results and discussion

4.1. Measurement properties

Structural equation modeling, applying the software AMOS 24, was used to examine the measurement models (Hair et al., 2010; Byrne, 2001). Confirmatory factor analysis (CFA) was applied to assess two measurement models (Hair et al., 2010; Byrne, 2001): model 1 includes all the constructs in a first order structure and model 2 considered ICs and performance as second order constructs.

4.1.1. Measurement model 1 – all first order constructs

The goodness of fit for the measurement model with all first order constructs was assessed by analyzing the: χ^2 , IFI, TLI, CFI and RMSEA.¹ Two aspects of validity were examined: convergent validity, assessed by the average variance extracted (AVE), and discriminant validity, assessed by comparing the AVE of each construct with the shared variance between constructs. Moreover, the items cross-loadings were analyzed to support the discriminant validity assessment. Based on the analysis of this model, a set of items were excluded following Byrne's recommendations (2001).

This analysis led to the exclusion of all items that were intended to measure manufacturing ICs. Besides their reduced contribution to the model according to the statistical tests carried out, the exclusion of the manufacturing ICs can also be justified in theoretical terms. As discussed before, previous studies have highlighted the insignificance of this capability to performance (Guan and Ma, 2003) and its misalignment with the innovation process (Wheelwright and Clark, 1992). Moreover, the items proposed by Guan and Ma (2003) to measure these ICs (BM1, BM2, BM3 and BM4) are only weakly linked to innovation practices, as they are more connected to practices related to the manufacturing process *per se* (e.g. BM1 - Our company is consistent in the quality of product manufacturing/production). Previous studies using Guan and Ma's (2003) model have also excluded different capabilities according to the objectives of the investigation (e.g. Guan and Ma, 2006). The control variable environmental complexity was also excluded at this stage due to its high correlation with the other control variable environmental dynamism.

The goodness of fit of the resulting model ($\chi^2 = 964.454$, Degrees of freedom = 515, $p < 0.001$) is presented in Table 3. All indexes analyzed exceed the recommended values (Hu and Bentler, 1995), which supports the validity of the structural model hypothesized.

Next, the reliability and validity of the measurement model were analyzed. Table 4 shows that most of the items' loadings were higher than 0.7 ($p < 0.001$), apart from five items where loadings were greater than 0.6, which were also accepted (Hair et al., 2010).

Table 5 presents the analysis of convergent and discriminant validity for the first order constructs. For all constructs, convergent validity, assessed by the AVE (presented in the diagonal), meets the minimum threshold value of 0.5 set by Hair et al. (2010). Thus, each latent variable explains, on average, more than 50% of the variance of its indicators. All constructs present composite reliability (CR) greater than 0.7, indicating the internal consistency of the items.

Discriminant validity was assessed by comparing the AVE of each construct with the shared variance between constructs, represented by the square of the correlation between the variables (presented above the diagonal). In this case, to support discriminant validity, the AVE for each construct should be greater than its shared variance with any other construct (Fornell and Larcker, 1981; Farrel, 2010). As shown in Table 5, the AVEs of all constructs are larger than their shared variance with all other constructs, supporting their discriminant validity. An analysis of the items cross-loadings was also performed.

¹ Chi-square, Incremental Fit Index, Tucker-Lewis Index, Comparative Fit Index (good models ≥ 0.90); Root Mean Square Error of Approximation (good models ≤ 0.06) (Hu & Bentler, 1995).

Table 2
Sample composition.

Variable	Portugal		Brazil		Total	
	Number	%	Number	%	Number	%
Number of responses	179	54.2%	150	45.5%	329	100.0%
Response rate	17.9%		15.0%		16.5%	
Number of employees	Number	%	Number	%	Number	%
<50	10	5.6%	10	6.7%	20	6.1%
50–100	19	10.6%	27	18.0%	46	14.0%
101–500	69	38.5%	68	45.3%	137	41.6%
501–1000	43	24.0%	19	12.7%	62	18.8%
>1000	38	21.2%	26	17.3%	64	19.5%
Total	179	100.0%	150	100.0%	329	100.0%
Industrial Sector	Number	%	Number	%	Number	%
Food and beverages	42	23.5%	26	17.3%	68	20.7%
Automotive and parts	40	22.3%	15	10.0%	55	16.7%
Construction and materials	17	9.5%	14	9.3%	31	9.4%
Machinery and plant construction	8	4.5%	15	10.0%	23	7.0%
Industrial metals	9	5.0%	13	8.7%	22	6.7%
Textiles and apparel	10	5.6%	11	7.3%	21	6.4%
Household goods and personal care	9	5.0%	11	7.3%	20	6.1%
Chemical	9	5.0%	10	6.7%	19	5.8%
Electronic and electrical equipment	7	3.9%	8	5.3%	15	4.6%
Forestry and paper	6	3.4%	5	3.3%	11	3.3%
Pharmaceuticals and biotechnology	6	3.4%	5	3.3%	11	3.3%
Electricity	5	2.8%	5	3.3%	10	3.0%
Oil and gas	4	2.2%	4	2.7%	8	2.4%
Medical equipment	1	0.6%	3	2.0%	4	1.2%
Mining	2	1.1%	2	1.3%	4	1.2%
Technology hardware and equipment	2	1.1%	2	1.3%	4	1.2%
Aerospace	2	1.1%	1	0.7%	3	0.9%
Total	179	100.0%	150	100.0%	329	100.0%

Moreover, as two different samples were collected, one from Portugal and another from Brazil, Schuirmann’s two one-sided tests (TOST) for equivalence (Schuirmann, 1987) was applied and showed that there was no significant difference in their means.

4.1.2. Measurement model 2 – second order constructs

The theoretical reason to consider ICs and performance as second order constructs was presented in section 2. The high correlation between the items of each group of ICs (core and supplementary) and between the two different measures of performance (commercial and economic and productivity) of the first order model, presented in Table 5, also supports the analysis of a second order model.

The goodness of fit was assessed using the same indices presented in the first order model and is presented in Table 6 ($\chi^2 = 1015.97$, $df = 542$, $p < 0.001$). Once again, all indices analyzed exceed the recommended values, providing support for the validity of the hypothesized structural model.

Moreover, the regression weights of ICs on the dimensions (core and supplementary) and performance on the dimensions (commercial and economic and productivity) are significant at $p < 0.001$, and the loadings of the other dimensions on their items are significant at $p < 0.001$ (Table 7).

Finally, in order to validate the existence of the higher order structure statistically, the target-coefficient (T) was calculated, following the recommendations of Marsh and Hocevar (1985) and Day et al. (2015). T is a ratio of the χ^2 for the first order measurement model in relation to the χ^2 for the second order measurement model [$T = \chi^2_{1st\ Order} / \chi^2_{2nd\ Order} = 964.454 / 1015.971 = 0.949$]. The result exceeds the recommended value of 0.7 (Segars and Grover, 1998), justifying the use of the second order model.

4.2. Hypotheses testing

Linear regression analysis was used to test hypothesis H1 and H2 and hierarchical regression analysis (Aguinis and Gottfredson, 2010; Arnold, 1982; Gonzalez-Benito et al., 2016; Sharma et al., 1981) was used to test

hypotheses H3 and H4. As presented in Table 8, the control variables company size and environmental uncertainty (environmental munificence and environmental dynamism) were placed as independent variables in model 1. Core and supplementary IC were included in model 2 as the direct effects. In model 3 the effects of the adoption of a lean SC strategy are examined with the inclusion of the two relationships to be tested – core IC x lean SC and supplementary IC x lean SC. Finally, model 4 tests the effects of the adoption of an agile SC strategy – including core x agile and supplementary x agile.

According to the findings, ICs have a positive effect on business performance. The results obtained support hypothesis H1 ($\beta = 0.19$; $p < 0.001$), that core ICs positively affect business performance, and H2 ($\beta = 0.31$; $p < 0.001$), that supplementary ICs positively affect business performance.

Model 3 tested the effect of a lean SC strategy on the relationship between core ICs and business performance and between supplementary ICs and business performance. The data do not confirm the hypothesis that lean SC strategies positively moderate the relationship between core ICs and business performance ($\beta = 0.162$; $p > 0.05$), although confirm that the relationship between supplementary ICs and business performance is not moderated by lean SC strategies ($\beta = 0.011$; $p > 0.05$).

The results supported the assumption of H4 that agile SC strategies positively moderate the relationship between supplementary ICs and business performance ($\beta = 0.185$; $p < 0.001$), as well as confirmed that the relationship between core ICs and business performance is not moderated by the adoption of agile SC strategies ($\beta = 0.031$; $p > 0.05$).

Table 3
Goodness of fit for the first order measurement model.

Goodness of fit measures	Recommended values	Results
χ^2/df	≤ 3.00	1.873
IFI	≥ 0.90	0.934
TLI	≥ 0.90	0.923
CFI	≥ 0.90	0.933
RMSEA	≤ 0.060	0.052

Table 8 presents a summary of the results.

Among the control variables, environmental munificence has proven to be the most significant, while company size and environmental dynamism do not influence the relationships tested. Among the items that measure environmental uncertainty, environment munificence presents the highest mean (5.58; environmental dynamism = 4.56). These results suggest that the environments where the companies compete can support sustained growth and present relatively low levels of dynamism. In other words, the environments are relatively stable and do not require high levels of flexibility from the companies, especially in terms of manufacturing capabilities.

4.3. Discussion

H1 and H2 were supported through regression analysis. The findings confirm previous studies on the impact of ICs on business performance (Borjesson and Elmquist, 2011; Calantone et al., 2002; Mir et al., 2016; Saunila et al., 2014), and contribute to the knowledge in this field by testing the impact of core and supplementary ICs separately. According to the results, supplementary ICs have a higher impact on business performance than core ICs ($\beta = 0.19$ and 0.31 respectively), although the findings are robust in both cases.

As discussed before, core ICs are understood to be more related to exploitation and supplementary ICs are more related to exploration. The difference in the impact of supplementary ICs on business performance compared to core ICs can be explained by the often greater potential of exploration activities to positively impact on business performance (Kavin and Narasimhan, 2018; Wang et al., 2017); and by a greater contribution of supplementary ICs to exploitation, compared to the contribution of core ICs to exploration. As exploitation refers to incremental improvement made to existing products or processes using

Table 4
First order measurement model – standardized loadings.

Constructs		Mean	Standard deviation	Loading*
AL1	<← Lean	4.980	1.680	0.742
AL3	<← Lean	4.840	1.643	0.770
AL4	<← Lean	5.120	1.733	0.790
AA2	<← Agile	4.770	1.337	0.731
AA5	<← Agile	4.860	1.336	0.759
AA6	<← Agile	4.640	1.546	0.679
AA7	<← Agile	4.060	1.572	0.706
BR1	<← R&D	4.960	1.756	0.731
BR2	<← R&D	5.380	1.325	0.697
BR3	<← R&D	5.060	1.502	0.789
BR4	<← R&D	4.630	1.683	0.748
BMK3	<← MKT	4.280	1.670	0.749
BMK4	<← MKT	4.080	1.805	0.880
BMK5	<← MKT	3.820	1.784	0.939
BL2	<← LEA	5.200	1.404	0.804
BL3	<← LEA	4.990	1.294	0.865
BL4	<← LEA	5.030	1.274	0.860
BL5	<← LEA	4.910	1.277	0.852
BO3	<← ORG	4.990	1.450	0.746
BO4	<← ORG	5.120	1.345	0.905
BO5	<← ORG	5.090	1.325	0.835
BRE3	<← REx	4.990	1.391	0.720
BRE4	<← REx	5.570	1.025	0.887
BRE5	<← REx	5.460	1.173	0.837
BS1	<← STRAT	5.350	1.337	0.816
BS2	<← STRAT	5.530	1.302	0.807
BS3	<← STRAT	5.140	1.360	0.822
BS4	<← STRAT	5.150	1.310	0.764
DC1	<← Commercial	4.820	1.118	0.610
DC2	<← Commercial	5.500	1.228	0.884
DC3	<← Commercial	5.400	1.124	0.747
DC4	<← Commercial	4.900	1.457	0.604
DF1	<← EconProd	4.650	1.289	0.870
DF2	<← EconProd	4.580	1.259	0.860
DF3	<← EconProd	4.770	1.221	0.601

Note: n = 329; *p < 0.001.

currently available technologies or competencies (March, 1991; Uotila, 2017), the existence of some of the supplementary ICs may help to achieve this aim, especially learning capabilities (Guan and Ma, 2003), which contribute to refining existing business activities. On the other hand, exploration concerns the capacity to create completely new knowledge and opportunities (March, 1991; Uotila, 2017), which requires flexibility and adaptability, characteristics that are only weakly related to core ICs (Swink, 2006).

These results can also be explained through the lens of the RBV, where different resources generate different results. According to the RBV, companies must develop a set of characteristics that are valuable, rare, inimitable and not substitutable (Barney, 1991; Hong et al., 2011; Laosirihongthong et al., 2014), which are characteristics more easily related to supplementary ICs than core ICs.

When it comes to the moderator effect of SC strategies on the relationship between ICs and business performance, H3 and H4 were tested. As discussed in the literature review section, the relationship between core ICs and lean SC strategies was expected to affect business performance as they share some characteristics and principles. Both require stability and consistency and match with stable and predictable environments (Guan and Ma, 2003; Qrunfleh and Tarafdar, 2014) and are much more suitable for exploitation than exploration activities. However, H3 (part a) was not supported by the data. The results show that an improvement in the level of a lean SC strategy does not significantly strengthen the positive relationship between core ICs and business performance. This can be explained by the different degrees of stability of markets and technologies they need. While core ICs, especially R&D, admit, and even can be favored by, some degree of “novelty”, lean SC strategies adapt to turbulence with difficulty (Christopher and Towill, 2002). Moreover, although the overall results of the core x lean relationship are not statistically significant, the results seem to indicate that lower levels of core ICs combined with the presence of a lean SC strategy might have a positive impact on performance.

H3 also deals with the impact of a lean SC strategy on the relationship between supplementary ICs and business performance (part b). Supplementary ICs and a lean SC strategy represent conflicting interests within companies. On the one hand, supplementary ICs require flexibility and adaptability (Guan and Ma, 2003) and, on the other, a lean SC strategy requires stability and predictability (Qi et al., 2009). The data confirm that a lower or higher degree of a lean SC strategy does not generate significantly different results in the relationship between supplementary ICs and business performance.

Companies implementing agile SC strategies value flexibility and adaptability in order to develop new products and processes by adapting to unique market characteristics, to generate and retain new competitive advantages based on constantly changing environments (Qi et al., 2009; Qrunfleh and Tarafdar, 2014). Based on the literature review, it was expected that the relationship between core ICs and business performance would not be strengthened by agile SC strategies, as their characteristics represent contrasting interests and priorities, which was supported by the data. It can also be argued that core ICs are the costliest capacities to create and develop as they are strongly related to important functions and areas within firms. Similarly, the adoption of an agile SC strategy requires a high level of commitment from the different areas and functions within a company. Thus, in a sense, core ICs and an agile SC strategy compete for the same resources, which are finite, within a company.

Finally, as expected and discussed in the literature review, the tests supported the assumption that agile SC strategies strengthen the positive relationship between supplementary ICs and business performance. It can be said that supplementary ICs and agile SC strategies require the same kind of organizational culture, what makes the relationship between them natural. Both are related to newstream activities or processes, favoring flexibility, adaptability and innovation (Guan and Ma, 2003; Qi et al., 2009; Qrunfleh and Tarafdar, 2014).

Table 5
Validity analysis for first order constructs.

	CR	1	2	3	4	5	6	7	8	9	10	11	12	13
R&D (1)	0.830	0.551	0.285	0.466	0.319	0.237	0.381	0.069	0.084	0.001	0.081	0.001	0.028	0.028
MKT (2)	0.894	0.534	0.739	0.208	0.191	0.098	0.219	0.066	0.010	0.010	0.053	0.001	0.006	0.023
LEARN (3)	0.909	0.683	0.456	0.715	0.575	0.457	0.632	0.097	0.130	0.010	0.125	0.000	0.068	0.016
ORG (4)	0.870	0.565	0.437	0.758	0.691	0.520	0.555	0.062	0.080	0.004	0.100	0.002	0.030	0.022
Rex (5)	0.857	0.487	0.313	0.676	0.721	0.669	0.430	0.094	0.102	0.003	0.062	0.003	0.051	0.014
STRAT (6)	0.879	0.617	0.468	0.795	0.745	0.656	0.633	0.122	0.159	0.017	0.071	0.003	0.104	0.008
Econ/P. P (7)	0.822	0.262	0.256	0.312	0.248	0.306	0.349	0.613	0.407	0.046	0.040	0.000	0.043	0.002
Com. P. (8)	0.807	0.289	0.102	0.360	0.282	0.320	0.399	0.638	0.518	0.027	0.035	0.000	0.019	0.003
Lean SC (9)	0.811	-0.028	0.098	0.101	0.063	0.051	0.129	0.214	0.164	0.589	0.106	0.006	0.019	0.020
Agile SC (10)	0.811	0.284	0.231	0.354	0.317	0.248	0.267	0.200	0.186	-0.326	0.517	0.002	0.002	0.044
Size (11) ^a	-	-0.025	0.023	0.008	0.043	-0.053	-0.053	0.011	-0.003	0.080	-0.047	-	0.000	0.004
Env. Mun (12) ^a	-	0.168	0.076	0.260	0.174	0.225	0.322	0.207	0.139	0.137	0.040	-0.014	-	0.000
Env. Dyn (13) ^a	-	0.168	0.153	0.126	0.147	0.117	0.090	-0.041	0.059	-0.140	0.210	-0.067	0.003	-

Note: n = 329.

^a Single-item constructs; AVEs are presented along the diagonal; Correlations are presented below the diagonal; Shared variance (squared correlations) are presented above the diagonal.

Table 6
Goodness of fit for the second order measurement model.

Goodness of fit measures	Recommended values	Results
χ^2/df	≤3.00	1.874
IFI	≥0.90	0.930
TLI	≥0.90	0.922
CFI	≥0.90	0.929
RMSEA	≤0.060	0.052

5. Post-hoc analysis

This section presents a post-hoc analysis where the hypotheses are tested considering only commercial and economic and productivity performance as the dependent variables (Table 9). This analysis was developed in order to derive additional insights concerning the impact of the different combinations of ICs and SC strategies on different types of performance. The separation of business performance into commercial performance and economic and productivity performance is based on Vickery et al. (1993) and González-Benito (2007). For these authors, these two perspectives of the business performance are complementary and reflect different aspects of companies' performance, in this sense, they may also be influenced by different aspects.

The results suggest weaker effects of the core ICs on commercial performance ($\beta = 0.16$; $p < 0.001$) when compared to business performance in the original model ($\beta = 0.19$; $p < 0.001$) as well as a slightly weaker effect of supplementary ICs ($\beta = 0.30$; $p < 0.001$), also compared to the original model ($\beta = 0.31$; $p < 0.001$). When analyzing the same models, but considering only commercial performance as the dependent variable, H3 and H4 present similar behavior to the original models. The results do not support that lean SC strategies positively moderate the relationship between core ICs and commercial performance, but confirm the assumption that the relationship between supplementary ICs and commercial performance is not moderated by the adoption of lean SC strategies. On the other hand, the results provide evidences that the adoption of agile SC strategies has positive effects on the relationship between supplementary ICs and commercial performance ($\beta = 0.16$; $p < 0.001$).

When considering only economic and productivity performance as the dependent variables, the overall results also remain similar to the original model. H1 and H2 are confirmed, although, in this case, supplementary ICs presents a slightly stronger effect on economic and productivity performance ($\beta = 0.32$; $p < 0.001$) comparing to the original model with business performance ($\beta = 0.31$; $p < 0.001$). Like the original model, H3 (part a) was not supported by the data when analyzing the effects of the adoption of lean SC strategies on the relationship between core ICs and economic and productivity performance.

Table 7
Second order model- standardized weights and loadings.

Constructs		Weights*	Loadings*
R&D	<←	Core	0.872
MKT	<←	Core	0.612
LEA	<←	Sup	0.907
ORG	<←	Sup	0.851
REx	<←	Sup	0.761
STRAT	<←	Sup	0.878
Commercial	<←	Performance	0.797
EconProd	<←	Performance	0.798
AL1	<←	Lean	0.737
AL3	<←	Lean	0.773
AL4	<←	Lean	0.791
AA2	<←	Agile	0.734
AA5	<←	Agile	0.759
AA6	<←	Agile	0.680
AA7	<←	Agile	0.701
BR1	<←	ICRD	0.732
BR2	<←	ICRD	0.698
BR3	<←	ICRD	0.784
BR4	<←	ICRD	0.750
BMK3	<←	ICMKT	0.748
BMK4	<←	ICMKT	0.880
BMK5	<←	ICMKT	0.938
BL2	<←	ICLEA	0.803
BL3	<←	ICLEA	0.864
BL4	<←	ICLEA	0.860
BL5	<←	ICLEA	0.853
BO3	<←	ICORG	0.748
BO4	<←	ICORG	0.902
BO5	<←	ICORG	0.837
BRE3	<←	ICREx	0.711
BRE4	<←	ICREx	0.884
BRE5	<←	ICREx	0.846
BS1	<←	ICSTRAT	0.816
BS2	<←	ICSTRAT	0.807
BS3	<←	ICSTRAT	0.821
BS4	<←	ICSTRAT	0.765
DC1	<←	Commercial	0.611
DC2	<←	Commercial	0.886
DC3	<←	Commercial	0.745
DC4	<←	Commercial	0.600
DF1	<←	EconProd	0.873
DF2	<←	EconProd	0.857
DF3	<←	EconProd	0.584

Note: n = 329; *p < 0.001.

The results also confirm that the relationship between supplementary ICs and economic and productivity performance is not moderated by the adoption of lean SC strategies.

H4 (part a) is supported ($\beta = 0.20$; $p < 0.001$), meaning that agile SC strategies strengthen the positive relationship between supplementary

Table 8
Summary of the regression analyses.

Variables	Model 1	Model 2	Model 3	Model 4
Company size	0.012	0.010	0.003	0.012
Env. munificence	0.184**	0.083	0.074	0.082
Env. dynamism	0.016	0.038	0.023	0.050
Core	-	0.192*	0.135	0.047
Supplementary	-	0.311*	0.069	0.229
Core x Lean	-	-	0.162	-
Core x Agile	-	-	-	0.031
Supp. x Lean	-	-	0.011	-
Supp. x Agile	-	-	-	0.185*
R ²	0.034	0.160	0.174	0.201
Adjusted R ²	0.025	0.147	0.156	0.190
Change in R ²	-	-	0.014	0.008
Sig. change in R ²	-	-	0.063	0.048

Notes: n = 329; Unstandardized regression coefficients are reported; *p < 0.001; **p < 0.01; ***p < 0.05.

ICs and economic and productivity performance. The results of this scenario show a stronger impact of the supplementary ICs on performance – as well as a stronger moderation effect of agile SC strategies on performance – than the original model and the model where only commercial performance is tested. Thus, the results suggest that the impact of the relationship between ICs and SC strategies is more directly observed in economic and productivity performance than in commercial performance. Furthermore, innovation, whether in products or processes, tends to have a faster impact on economic and productivity aspects (i.e. ROI, profits as percent of sales and labor productivity) than on commercial aspects (i.e. sales growth, reputation and image, customer satisfaction and market share).

6. Implication and conclusions

Grounded on the RBV, the main goal of this study was to discuss and understand how SC strategies impact on the relationship between ICs and business performance. The RBV supports the discussion due to its potential to: (1) understand the characteristics that lead to better business performance; (2) compare business performance based on observable characteristics; and (3) explain the antecedents of innovation (Prajogo, 2016). ICs and SC strategies were understood to be strategic resources that must match specific requirements (internal and external) and that help to explain a company’s performance.

The paper provides several theoretical and managerial contributions. The study adds to knowledge concerning the impact of ICs on business performance, previously dealt with by several authors (Borjesson and Elmquist, 2011; Calantone et al., 2002; Mir et al., 2016; Saunila et al., 2014), by analyzing the effects of core and supplementary ICs separately. The data analyzed supported the hypotheses that both types of

ICs have positive effects on business performance, even though supplementary capabilities presented a slightly greater impact. The post-hoc analysis showed that the aforementioned effects are stronger when observing only economic and productivity performance rather than commercial performance. The circumstances and consequences of having different types of ICs capabilities have not been studied before.

The relationship between the different types of ICs and SC strategies and the effects of their interactions on business performance was assessed and discussed using data from an empirical study based on a sample of 329 companies from Portugal and Brazil. As hypothesized, the relations between the most contrasting ICs and SC strategies – namely core x agile; and supplementary x lean – do not affect business performance, as they represent conflicting characteristics, interests and priorities. In these cases, SC strategies practically do not affect the relationship between ICs and business performance. Contrary to previous expectations, the moderator effect of a lean SC strategy on the relationship between core ICs and business performance was not supported by the data. One possible explanation for this is the different degree of market stability and technologies needed and by the relative low priority of innovation activities among companies with lean SC strategies (Christopher and Towill, 2002). Finally, the results show that the relationship between supplementary ICs and an agile SC strategy produces the main positive effect on business performance (as well as in commercial performance and economic and productivity performance separately).

SC strategy is related to the way that a firm manages a variety of issues, including the sourcing of products, the planning capacity, the conversion of raw materials, the management of demand, the communication with SC actors and the delivery of products and services. Thus, besides the contributions to SCM, the results also contribute to PSM. As highlighted by Servajean-Hilst and Calvi (2018), the purchasing function not only contributes to innovation performance through its effects on cost, quality and time issues, but also by linking innovation strategies and external resource management. Previous studies have argued that companies should not only manage their own capabilities, but also strategically manage their interactions, especially with suppliers, in order to boost their inter-firm capabilities (Day et al., 2015). Thus, companies must be able to develop routines to create value through the interactions with suppliers, whose selection and evaluation processes can benefit from the analysis of the SC strategies and ICs. In practice, companies should consider: (1) their own strategies and capabilities; (2) the strategies and capabilities they need to improve/develop; and (3) the strategies and capabilities of the potential supplier when carrying out their selection and evaluation. As suggested by Pihlajamaa et al. (2019), companies benefit when they stimulate their suppliers’ innovation in three ways: enhancing suppliers’ innovativeness, guiding their innovation process and encouraging suppliers to share their innovations. These activities are favored by the development of knowledge-sharing routines

Table 9
Summary of the regression analyses for commercial and economic and productivity performance.

Variables	Commercial performance				Economic and productivity performance			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Company size	0.010	0.009	0.003	0.010	0.011	0.009	0.003	0.011
Env. munificence	0.133***	0.039	0.031	0.038	0.201***	0.117	0.107	0.115
Env. dynamism	0.040	0.008	0.007	0.015	0.038	-0.066	-0.053	-0.080
Core	-	0.162*	0.230	0.011	-	0.187*	0.142	0.079
Supplementary	-	0.304*	0.113	0.282	-	0.319*	0.090	0.283
Core x Lean	-	-	0.116	-	-	-	0.201	-
Core x Agile	-	-	-	0.046	-	-	-	0.078
Supp. x Lean	-	-	0.043	-	-	-	0.085	-
Supp. x Agile	-	-	-	0.161*	-	-	-	0.205*
R ²	0.019	0.146	0.187	0.198	0.041	0.196	0.183	0.206
Adjusted R ²	0.010	0.132	0.169	0.179	0.032	0.183	0.164	0.187
Change in R ²	-	-	0.012	0.004	-	-	0.017	0.009
Sig. change in R ²	-	-	0.113	0.077	-	-	0.053	0.049

Notes: n = 329; Unstandardized regression coefficients are reported; *p < 0.001; **p < 0.01; ***p < 0.05.

between buyer and supplier (Pihlajamaa et al., 2019). The adoption of PSM practices that are involved in complex resource interactions with suppliers, such as knowledge sharing and joint product development, contributes to the development of sustained competitive advantage (Zimmermann and Foerstl, 2014). In this sense, PSM professionals must develop the set of competencies that allow for the creation of these types of practices/routines, such as interpersonal communication, strategic thinking and competencies related to innovation (Bals et al., 2019).

While making significant contributions to research and practice, this study has limitations and future research directions that are worth mentioning. The study has some limitations related to the method used. The results are based on survey research with a limited sample size of 329 respondents and geographic coverage (Portugal and Brazil), which may limit the interpretation and generalization of the results and conclusions. This could be extended to other countries in future studies. The authors adopted a set of rigorous methods to minimize the limitations related to the development and validity of the measurement procedures and to nonresponse and common-method bias.

The scope of this investigation is limited to researching the influence of SC strategies on the relationship between ICs and business performance, leaving opportunities for further research adding new features such as innovation strategies (as independent variables), product characteristics, supply chain fit (as moderators) and innovation performance (as dependent variables). The importance of cultural characteristics and the role of ambidexterity are two other topics that should also be studied in the future, helping to improve the understanding of the circumstances that lead to a better or worse fit between ICs and SC strategies.

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CRediT authorship contribution statement

Ricardo Zimmermann: Conceptualization, Methodology, Investigation, Formal analysis, Writing - original draft. **Luís Miguel D.F. Ferreira:** Conceptualization, Methodology, Formal analysis, Writing - review & editing. **António Carrizo Moreira:** Conceptualization, Methodology, Formal analysis, Writing - review & editing.

Declaration of competing interest

The authors whose names are listed immediately below certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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