An empirical analysis of the relationship between supply chain strategies, product characteristics, environmental uncertainty and performance

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Abstract

Purpose – This paper aims to investigate supply chain (SC) strategies, analyzing the adoption of lean, agile, leagile and traditional SC strategies with respect to product characteristics, environmental uncertainty, business performance and innovation performance.

Design/methodology/approach – The paper presents an empirical analysis carried out on a sample of 329 companies. Cluster analysis was applied, based on lean and agile SC characteristics, to identify patterns among different SC strategies. One-way analysis of variance of different constructs by types of SC clusters was conducted to test the research hypotheses.

Findings – Cluster analysis indicates that the companies studied adopt four types of SC strategies – lean, agile, leagile and traditional. The differences between the clusters are identified and discussed, highlighting that companies adopting a leagile SC strategy present the highest performance, while those that adopt a traditional SC present the lowest; companies adopting an agile SC compete in the most complex and dynamic environments, while companies with a lean SC present a clear predominance of functional rather than innovative products.

Research limitations/implications – This paper provides empirical evidence of the antecedents and consequences of the adoption of different SC strategies. As a limitation, the results are based on a survey research with a limited sample size.

Originality/value – Based on the analysis of the relationship between constructs that have not been addressed previously, the paper adds to the knowledge regarding the role of SC strategies, as well as the antecedents and consequences of their adoption. The results may support managers in the difficult task of choosing the "right" SC strategy.

Keywords Innovation, Company performance, Supply chain management, Environmental uncertainty, Product information, Product characteristics, Business performance, Innovation performance, Supply chain strategies

Paper type Research paper

1. Introduction

Supply chain (SC) strategy has attracted attention from academics due to its potential to help companies to improve performance and obtain competitive advantage (Naylor *et al.*, 1999; Roh *et al.*, 2014; Perez-Franco and Phadnis, 2018; Zimmermann *et al.*, 2018). The choice of the most appropriate SC strategy is a challenge to managers, as they need to consider the various features of companies and their environments (Fisher, 1997; Lee, 2002; Nakandala and Lau, 2019).

Previous studies have discussed and tested, theoretically and empirically, different patterns of the adoption of SC strategies, whether using lean and agile (Lee, 2002; Qi *et al.*, 2009; Wagner *et al.*, 2012; Qrunfleh and Tarafdar, 2014) or efficient and responsive SC strategies (Fisher, 1997; Gunasekaran *et al.*, 2008; Nakano, 2015), and the importance of their alignment with a variety of aspects (Lo and Power, 2010; Wagner *et al.*, 2012; Qrunfleh and Tarafdar, 2014; Prajogo *et al.*, 2018). It is widely discussed in the literature that companies adopting a lean (or efficient) SC strategy prioritize efficiency in terms of costs and seek to reduce waste, while those with an agile (or responsive) SC strategy seek to improve their capacity to respond to a constantly changing demand (Fisher, 1997; Tarafdar and Qrunfleh, 2017).

Hence, each type of SC strategy requires different conditions and produces different results. Additionally, product and environmental characteristics are also viewed as antecedents to SC strategies, as they help to understand the choice of a

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particular strategy, while performance can be understood as a consequence of the chosen strategy (Arora *et al.*, 2016; Prajogo *et al.*, 2018). However, the relationship between SC strategies, the nature of the products and performance is not consensual (Lo and Power, 2010; Nakano, 2015). Phadnis and Fine (2017) and Nakandala and Lau (2019) discuss the complementarity of company and environmental characteristics in the definition of SC activities and strategies, highlighting the need to understand aspects related to an SC strategy, as it "governs the managerial choices organizations make in response to the diverse requirements of SC entities and the dynamics of the business environment" (Nakandala and Lau, 2019, p. 241).

In this sense, the aim of this paper is to add new knowledge about the antecedents and consequences of the adoption of SC strategies by means of an empirical analysis of their relationships with product characteristics, environmental uncertainty, business performance and innovation performance. Part of the paper is developed as a complement to previous studies that assessed the fit of product characteristics with SC strategies (Qi *et al.*, 2009; Lo and Power, 2010; Wagner *et al.*, 2012; Nakano, 2015) as well as their impact on financial and operational performance, contributing to the generalizability of the previous findings, while assessing the same subjects under different conditions (Goldsby and Autry, 2011). As stated by Goldsby and Autry (2011) and van Weele and van Raaij (2014), the replication and extension of previous studies should be more frequent in SCM research, as it helps to increase the validity, credibility and relevance of theory developed in the field. Sobh and Perry (2006, p. 1206) also discuss the issue of replication logic, highlighting that "replication logic should be used to explore the effects of context upon the underlying structures and mechanisms that are the core of the frameworks".

Additionally, this paper further contributes to extending the knowledge regarding the role of SC strategies by including an assessment of the adoption of the different strategies with respect to environmental uncertainty – munificence, complexity and dynamism – and innovation performance. The following question will be addressed: what differentiates the companies that adopt each type of SC strategy in terms of product characteristics, environmental uncertainty and performance? Thus, the objectives of this paper are to assess:

- the taxonomy of SC strategies adopted by companies in Portugal and Brazil;
- the link between product characteristics and the different SC strategies;
- the link between environmental uncertainty and the different SC strategies;
- the impact of SC strategies on business performance; and
- the impact of SC strategies on innovation performance.

This paper contributes to theory, as it analyzes a set of characteristics related to the adoption of the different SC strategies that have not been tested together previously, in logic of extension of previous studies. It also contributes to practice, as the results may help managers in the challenging task of choosing the most appropriate SC strategy. By using data from Portuguese and Brazilian companies, the paper also contributes to extending the knowledge regarding the characteristics of firms located in countries that are not part of the group of the most highly industrialized countries in the world and that have not yet received significant attention from researchers when it comes to SC strategies.

The resource-based view (RBV) constitutes the theoretical foundation for this paper as it is widely used in strategic management literature and has been applied to operations management, and more specifically to supply chain management (SCM) in recent years (Fawcett *et al.*, 2012; Sjoerdsma and van Weele, 2015; Yan and Azadegan, 2017; Yang *et al.*, 2019). According to the RBV, the resources and capabilities of companies are the key sources of sustained competitive advantage (Barney, 1991; Menguc *et al.*, 2014) and SC strategy can be understood as the adoption and development of capabilities that cannot be easily imitated or acquired by competitors.

The rest of the paper is organized as follows: Section 2 provides the theoretical background of the paper and presents a literature review about the topics under analysis and provides the research hypotheses. Section 3 presents the methodology used in the study, including data collection and measurement scales. In Section 4, the results of the analysis are presented, followed by the discussion, where a comparison between the different groups of companies adopting each one of the SC strategies is provided. Finally, the conclusions and implications of the study are presented in Section 5.

2. Theoretical background and literature review

Increasingly recognized as an important source of competitive advantage for firms (Qrunfleh and Tarafdar, 2014), SCM is understood as the management of SC activities with the aim of maximizing customer value and achieving a sustainable competitive advantage (Lee *et al.*, 1997; Lambert and Cooper, 2000; Chen and Paulraj, 2004; Arantes *et al.*, 2015). SC refers to the flow of goods, money, information and knowledge between individuals, organizations, resources and activities (linked directly or indirectly) with the goal of delivering value to the end consumer (Chen and Paulraj, 2004).

In this sense, SC strategies refer to a pattern of decisions related to sourcing products, capacity planning, conversion of raw materials, demand management, communication with SC actors, and delivery of products and services (Qi *et al.*, 2009; Arora *et al.*, 2016). For Christopher (2000), Lee (2002) and Qrunfleh and Tarafdar (2014), SC strategies reflect the nature of the SC and lay down its objectives and goals. Moreover, they should be aligned with the product's characteristics, with the adopted competitive strategy and with the environment where the firm competes (Qi *et al.*, 2009; Lo and Power, 2010; Nakano, 2015).

2.1 Adopting the right supply chain strategy

Today's business environments lead companies to incorporate SC strategies in their quests for competitive advantage (Narasimhan and Narayanan, 2013; Arora *et al.*, 2016; Zimmermann *et al.*, 2016). It is clear in the literature on strategic management that the alignment between strategy and other management elements is key to the success of the adopted strategy (Miles and Snow, 1984) and it is broadly recognized that SC strategies must be aligned with a company's set of

internal and external characteristics to achieve the best results (Lee, 2002; Qi *et al.*, 2009; Prajogo *et al.*, 2018).

The choice of an SC strategy is a complex and dynamic process, as the main elements that constitute the nature of the SC, such as product life-cycle, product demand and product variety, can be dynamic as well (Christopher, 2000; Abdollahi *et al.*, 2015; Zimmermann *et al.*, 2019). SC strategies have their specific requirements and it is essential that they are properly managed/adopted by companies (Galankashi and Helmi, 2016), to maintain the fit with changing contextual aspects and achieve higher performance (Perez-Franco and Phadnis, 2018; Prajogo *et al.*, 2018). Thus, the SC strategy adopted must help to overcome the (more or less) volatile environment and enhance the competitiveness of companies. As stated by Birhanu *et al.* (2014, p. 2289), "setting the right SC strategy is compulsory for companies competing in the market".

To respond to the different requirements of the business environments, two main approaches are presented and discussed in the literature (Fisher, 1997; Selldin and Olhager, 2007; Qi *et al.*, 2009; Qasar and Hall, 2018; Stratton, 2018): increasing efficiency (usually described as a lean or efficient SC) and/or responding quickly to market demands (usually described as an agile or responsive SC). The lean paradigm, similar to an efficient SC, as proposed by Fisher (1997), focuses on the improvement of the efficiency of the business processes and on the elimination of waste (Naylor *et al.*, 1999; Christopher and Towill, 2002; Cigolini *et al.*, 2004; Qi *et al.*, 2011; Qrunfleh and Tarafdar, 2014). Companies that adopt this strategy are often characterized by mass production, preserve long-term relationships with suppliers and implement practices such as just-in-time systems (Cigolini *et al.*, 2004; Nakandala and Lau, 2019). On the other hand, companies adopting an agile SC strategy, similar to a responsive SC, seek not just to respond quickly to demand, but also to improve flexibility; therefore becoming able to exploit opportunities in volatile markets (Goldman *et al.*, 1995; Christopher, 2000; Mason-Jones *et al.*, 2000). Thus, the aim of both agile and lean SC strategies is to respond to the customers' requirements; however, while lean SC strategies focus on efficiency and cost reduction by eliminating waste in operational processes, agile SC strategies target the trade-offs between time, information and knowledge in more dynamic and innovative environments (Bruce *et al.*, 2004; Zacharia *et al.*, 2009; Nakandala and Lau, 2019).

Although each SC strategy demands different and specific requirements, the complexity of the business environment makes the existence of conditions that require either purely lean or agile SC strategies unique. Companies adopt different levels of leanness and agility to meet the specific needs of their business conditions (Naylor *et al.*, 1999; Mason-Jones *et al.*, 2000). As highlighted by Christopher and Towill (2002, p. 1), "lean and agile are not mutually exclusive paradigms and may be married to advantage in a number of different ways." When a relative balance between lean and agile is found, this combination is often called leagile (or lean/agile) (Bruce *et al.*, 2004; Qi *et al.*, 2009). Selldin and Olhager (2007) and Nakandala and Lau (2019) highlight the advantages and difficulties inherent to the adoption of a leagile SC strategy, as it requires different and even conflicting managerial styles. Although the concept of leagility has received attention from researchers, a major limitation has been the lack of research addressing "how" leagility has been applied. On the other hand, when companies do not emphasize either lean or agile principles, they adopt what is known as a traditional SC strategy (Qi *et al.*, 2009).

Among the most relevant aspects that guide companies to choose the "right" SC strategy, which can be called antecedents or drivers, it is possible to point out a set of characteristics that influence a company's conditions to compete and perform its business, such as: product characteristics (Fisher, 1997; Christopher and Towill, 2002; Huang *et al.*, 2002; Wright, 2013; Nakano, 2015), supply and demand uncertainty (Lee, 2002; Sun *et al.*, 2009; Birhanu *et al.*, 2014), the dynamism and competitiveness of the business environment (Prajogo *et al.*, 2018), technological and marketing turbulence (Arora *et al.*, 2016), supplier management practices (Prajogo *et al.*, 2018), suppliers' tactics (Jajja *et al.*, 2016), among others.

Fisher (1997) discussed the issue of adopting the right 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; and each type of product requires different kinds of SC strategies. The model proposed by Fisher (1997) indicates that functional products match with efficient SCs and innovative products match with responsive SCs.

Lee (2002) added the concept of uncertainty to the model presented by Fisher, theoretically discussing strategies that help to reduce uncertainty in supply and demand. According to Lee (2002), companies with functional products and stable SC processes must develop efficient SCs; companies with functional products and evolving SC processes should have a risk-hedging SC (when the risks are shared among the SC partners); companies with innovative products and stable SC processes should pursue responsive SC strategies; and companies with innovative products and evolving and unstable SC processes have to utilize agile SCs (which, according to Lee, is the combination of risk-hedging and responsive strategies).

More recently, Prajogo *et al.* (2018) address the external links between the business environment and SC strategies and the internal links between SC strategies and supplier management practices. The authors discuss the fit between the dynamism and competitiveness of the business environment with the characteristics of the SC strategies namely, the focus on cost reduction or flexibility and the fit between supplier practices – such as: the strategic relationship with suppliers, suppliers' assessment, logistics integration and SC strategies. They conclude that dynamic environments present a better fit with flexibility and that competitive environments do not present a stronger fit to a "low-cost strategy", contrary to the authors' expectations (Prajogo *et al.*, 2018).

2.2 Product characteristics and environmental uncertainty as antecedents of supply chain strategies

To extend the knowledge on the topic, this study evaluates the impact of product characteristics and environmental uncertainty on the choice of the SC strategy. Product characteristics is a concept traditionally linked to SC strategies

(Fisher, 1997; Huang *et al.*, 2002; Qi *et al.*, 2009) as it is one of the main features that has to be considered when defining a strategy. To choose the most suitable SC strategy, companies must consider characteristics such as the length of a product's life-cycle, predictability of demand, product variety and market standards for lead times and services (Fisher, 1997; Huang *et al.*, 2002; Qi *et al.*, 2009).

Previous studies have analyzed the relationship between SC strategies and product characteristics and a relative consensus has been achieved: companies with functional products deploy a lean SC strategy and companies with innovative products need an agile SC strategy (Childerhouse *et al.*, 2002; Qi *et al.*, 2009; Nakano, 2015). Functional products normally address basic needs that do not change over time and are characterized by stable and predictable demand and long life cycles (Fisher, 1997). This stability attracts competition, which leads to low margins, demanding cost-efficient SC strategies (Nakandala and Lau, 2019). On the other hand, due to their high degree of novelty, innovative products are characterized by unpredictable demand and short life cycles (Fisher, 1997). To cope with this context of constant changes, companies tend to adopt a market-responsive, or agile, SC strategy. As highlighted by Nakandala and Lau (2019, p. 243):

> SC strategies for functional products which are static, have a low-margin, stable demand and long life cycles should be quite different from those that cater for primarily innovative products that are dynamic and highly profitable with high demand unpredictability and short life cycles.

Thus, the first hypothesis of this study is:

H1. Different product characteristics demand/necessitate different SC strategies.

The second aspect assessed as an antecedent of SC strategies is environmental uncertainty. Uncertainty has been considered a phenomenon intrinsically linked to the most diverse activities of companies and with great relevance in operations and business research for the last decades (Wernerfelt and Karnani, 1987; Buchko, 1994; Courtney *et al.*, 1997; Miller and Shamsie, 1999; Lopez-Gamero *et al.*, 2011) and has been widely used in SCM literature (Wong *et al.*, 2013; Azadegan *et al.*, 2013). The definition of environmental uncertainty encompasses the inability, at different levels, to establish the probability of future events and to predict the consequences of the decisions accurately (Miller and Shamsie, 1999; Sia *et al.*, 2004).

Environmental uncertainty is adopted in this study according to the model proposed by Aldrich (1979) and Dess and Beard (1984), who classify the concept in three dimensions: environmental munificence, environmental dynamism and environmental complexity. Environmental munificence refers to the extent to which the environment where companies compete can support sustained growth (Aldrich, 1979). The concept is linked to the availability of resources in the environment (Pan *et al.*, 2018), it is defined by Castrogiovanni (1991, p. 542) as "the scarcity or abundance of critical resources needed by (one or more) firms operating within an environment". Environmental dynamism is related to the extent that the environment in which the company competes is characterized by changes that are hard to predict and that heighten uncertainty for key organizational members (Aldrich, 1979; Dess and Beard, 1984). Environmental dynamism is closely linked to aspects such as unpredictability and the absence of a pattern. 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 information-processing requirement (Dess and Beard, 1984).

Considering the characteristics of each one of the three dimensions, it is expected that companies that compete in environments with high degrees of dynamism and complexity tend to adopt agile SC characteristics, while companies in environments with low degrees of dynamism and complexity tend to adopt lean SC characteristics. These assertions are supported by the relevant theory, as agile is related to uncertainty and flexibility and lean is characterized by predictability (Azadegan *et al.*, 2013; Tarafdar and Qrunfleh, 2017). Environmental munificence, on the other hand, is expected to have a lower level of correlation with the choice of the SC strategy, as munificence can be found in different types of environments, both more or less dynamic and complex (Pan *et al.*, 2018).

Thus, the second hypothesis of the study is:

H2. Different degrees of environmental uncertainty demand/necessitate different SC strategies.

To assess the different aspects of environmental uncertainty, *H2* is divided into the following three sub-hypotheses:

H2.1. Companies competing in environments with high degrees of dynamism tend to adopt agile SC strategies, while companies competing in environments with low degrees of dynamism tend to adopt lean SC strategies.

H2.2. Companies competing in environments with high degrees of complexity tend to adopt agile SC strategies, while companies competing in environments with low degrees of complexity tend to adopt lean SC strategies.

H2.3. Environmental munificence does not impact on the choice of the SC strategy.

2.3 Performance as a consequence of supply chain strategies

The relationship between strategies and performance has been extensively discussed by authors such as: Carroll (1982), Porter (1996), Mintzberg (1994), Kaplan and Norton (1996), Markins and Steele (2005), among others. Although it is a complex and vast subject, there is a consensus among scholars that the adoption of the most appropriate strategy favors a better performance and allows companies to achieve a sustainable competitive advantage. On the other hand, the lack of a clear strategic positioning tends to have a negative impact on performance. The same idea can be extended to the reality of SC strategies (Qi *et al.*, 2009; Nakano, 2015). In this study, apart from business performance, which has been linked to SC strategies in previous studies, the impact of the adoption of SC strategies on innovation performance is also analyzed.

Business performance has been used in a great variety of ways (Gonzalez-Benito, 2007; Rauch *et al.*, 2009; Richard *et al.*, 2009). There are several possible dimensions to measure performance, which may differ for business managers and for researchers and a consensual model does not exist (Franco-

Santos *et al.*, 2007). A measure of business performance can be understood as a set of metrics used to quantify both the efficiency and effectiveness of companies' actions (Neely *et al.*, 1995; McAdam and Bailie, 2002; Franco-Santos *et al.*, 2007).

Contemporary knowledge suggests that financial and economic issues need to be combined with market-based assets to generate a more composite assessment of business performance attributes (Morgan and Strong, 2003). Thus, a common distinction in the literature regarding business performance is between financial and non-financial measures (Rauch *et al.*, 2009). Non-financial measures include satisfaction and global success ratings, while financial measures include factors such as sales growth and return on investments.

Previous studies have shown that SC strategies impact on business performance (Prasad *et al.*, 2012; Kim, 2013; Nakano, 2015). As lean and agile SC strategies present different characteristics, which are more suitable for each company depending on product and environmental features (as discussed before), it is expected that those strategies support companies differently, according to the specific environments in which they compete. That is, both efficiency and responsiveness, when needed, are expected to lead to good results (Qasar and Hall, 2018). According to previous studies, the lack of a clear strategy can be detrimental to performance, while the combination of lean and agile can support companies in achieving better performance. In this sense, as a way to analyze the impact of the different SC strategies on business performance, the third hypothesis of the study is:

H3. SC strategies influence business performance.

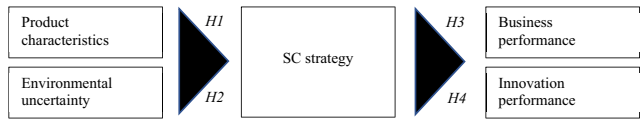
As a complex process, innovation is becoming more important for businesses to face stiff competition (Jean *et al.*, 2012). Innovation is also recognized as one of the most important features for firms to achieve a competitive advantage (Ribau *et al.*, 2019). As innovation performance is a complex and non-consensual issue, the concepts of product and process innovation effectiveness are used in this paper, following Alegre and Chiva (2008), who based their model on the Oslo Manual (OECD & Eurostat, 2005).

The relationship between innovation and SCM has attracted attention from researchers in recent years (Primus and Stavrulaki, 2017; Mikkelsen and Johnsen, 2018; Zimmermann *et al.*, 2019). However, the impact of SC strategies on innovation performance is a subject that has not yet been explored profoundly in the literature. In this sense, the performance of innovation is included in this study to contribute to theory and practice, by evaluating whether the adoption of different SC strategies is related to the performance of innovation and complements the idea behind the relationship between SC strategies and product characteristics (functional or innovative products). In this sense, fourth hypothesis addresses the consequences of the adoption of each type of SC strategy on innovation performance:

H4. SC strategies influence a firm's innovation performance.

Figure 1 shows the research model adopted in this study, where product characteristics and environmental uncertainty act as antecedents to the adoption of an SC strategy, which, in turn, have an impact on business performance and innovation performance.

Figure 1 Research model



3. Methodology

3.1 Questionnaire development and data collection

A survey instrument was developed and applied to test the research model. The initial version of the questionnaire was reviewed by two researchers from the field of SCM, to improve its reliability. Two potential respondents were also interviewed to ground the research and to test whether the focus of the instrument was appropriate. This version, written in English, was translated into Portuguese, and then back translated into English. The new English version was then checked against the original one. Next, the questionnaire was pilot tested in five companies in Portugal and five companies in Brazil to verify the clarity of the items. Some minor modifications suggested by the respondents were made based on this pilot study. After these changes, the final version was reviewed by two academic experts and was made available on the online Lime Survey platform. The combination of these procedures, in accordance with Zhao *et al.* (2007), support the reliability and the validity of the measurement method applied in the research.

Data were collected from companies operating in Portugal and Brazil. The same approach has been used by Gimenez *et al.* (2012) and Mani and Gunasekaran (2018). The Brazilian firms were selected from two of the most industrialized states – São Paulo and Santa Catarina.

Following the guidelines proposed by 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 in each firm: the part concerning SC strategies by an SC manager; while the section on environmental uncertainty and innovation performance by an innovation manager; and the business performance section by both. The answers relating to business performance were compared, ensuring the reliability of the information. When significant differences between the answers were found, the respondents were contacted again. The responses from companies with incomplete answers were discarded. The most common functional responsibilities of the respondents included: operations director/manager; SC director/manager; and innovation and new product development director/manager.

The sample, composed by 1,000 companies in Portugal and 1,000 companies in Brazil, was selected randomly from the data bases provided by Bureau Van Dijk in Portugal and by Neoway in Brazil (companies that collect and provide information about companies), and includes companies from various sectors, such as: automotive and parts, construction and materials, electronic and electrical equipment, food and beverages, machinery and plant construction, pharmaceuticals

and biotechnology and textiles and apparel. Data were collected from September 2017 to January 2018 and totalized 329 responses – 179 from Portugal and 150 from Brazil. The return rate was 16.5 per cent (17.9 per cent in Portugal and 15.0 per cent in Brazil), which is not an unusual return rate when the unit of analysis is a company and it involves an extensive organizational-level survey. Table I presents the composition of the sample.

Non-response bias was assessed by contacting a random sample of 30 non-respondents (15 in Portugal and 15 in Brazil) and asking them to respond to a set of non-demographic questions, as suggested by Mentzer and Flint (1997) and Montabon *et al.* (2018). No statistical difference was found between the answers of respondents and non-respondents. Non-response bias was also tested by a wave analysis, examining the differences between early (n = 198) and late respondents (n = 131), considering that late respondents have some similar characteristics to non-respondents – they took more time and effort to respond to the questions. The differences in the means were not statistically significant for the constructs analyzed. These results indicate that a non-response bias does not appear to be a concern in the present study.

Procedural and statistical methods were adopted to minimize potential common-method bias. Besides the two answers from each company, secondary data were used to triangulate the survey data as a way to limit the risk of common method bias and to enhance causal inference by reducing the likelihood of rival method-based explanations (Montabon *et al.*, 2018). The databases made available by Bureau Van Dijk and Neoway, were consulted to collect archival data such as: size, age, industry sector, financial ratios and other miscellaneous data on the companies in the sample. Additionally, the respondents' anonymity was protected, the respondents were assured that there were no right or wrong answers and the ambiguity of the items was reduced during the pilot test.

3.2 Measures

The main measures used in the analysis are: SC strategies, product characteristics (functional and innovative), environmental uncertainty (munificence, dynamism and complexity), business performance and innovation performance. SC strategies are measured by adapting the items proposed 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) and Mason-Jones *et al.* (2000). Seven statements describing the characteristics of a lean SC and seven describing an agile SC were listed and the respondents were asked to answer the question: "to what extent do you agree that the SC of your company's major product/product mix has the following

Table I Composition of the sample

Variable	Portugal		Brazil		Total	
	No.	(%)	No.	(%)	No.	(%)
Number of responses	179	54.2	150	45.5	329	100.0
Response rate	17.9		15.0		16.5	
Number of employees						
<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						
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

characteristics?" A seven-point Likert scale (with 1 = strongly disagree and 7 = strongly agree) is used as the measurement scale.

Product characteristics were measured based on the principle that, when selecting an appropriate SC strategy, the first step for manufacturers is to consider the characteristics of their end-products, including product life cycle length, predictability of demand, product variety, and market standards for lead times and services (Fisher, 1997; Qi *et al.*, 2009). The question asked was "to what extent are the following statements suitable descriptions of your company's end products or production process." These items use a seven-point Likert scale with 1 = most unsuitable and 7 = most suitable as the anchors. The last question (CS6) requires the respondents to provide estimates regarding the introduction interval for new products. The respondents were asked to indicate the best estimate for times ranging from 1 = <3 months to 7=≥5 years.

Environmental uncertainty was measured as proposed by Aldrich (1979) and Dess and Beard (1984), who classify environmental uncertainty in three dimensions: environmental munificence, environmental dynamism, and environmental complexity. 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. Business performance was measured based on the model used by Gonzalez-Benito (2007). Five items measure commercial success and three items are related to ratios based on accounting data and refer to the economic benefits and productivity of the company. The respondents were asked to evaluate their company's performance in comparison with their competitors for each of the aspects on a seven-point Likert scale (1 = lower, 4 = equal, 7 = higher). The items measured are: sales growth, reputation and image, customer satisfaction, market share (of the main product), success of new product launches (commercial success), return on investment (ROI), profits as a percentage of sales, and labor productivity (economic and productivity performance).

Finally, innovation performance was measured using the concepts of product and process innovation effectiveness, proposed by Alegre and Chiva (2008). The respondents were asked to compare their company's performance to that of their competitors over the last three years using a seven-point Likert scale (1 = much worse, 4 = at the same level, 7 = much better). Table II presents the constructs used in the study.

4. Results and discussion

The data collected through an online questionnaire were analyzed by means of an exploratory analysis. Cluster analysis was employed to find patterns among the SC strategies adopted by the companies. These clusters were then analyzed though one-way analysis of variance (ANOVA) to assess the differences between the four clusters of SC strategies and the characterization variables. SPSS Statistics 25 and AMOS 24 were used to perform the analyses.

4.1 Reliability and validity of the constructs

A set of methods was applied to assess the reliability and validity of the constructs. First, exploratory factor analyses (EFAs) were conducted for each construct, as proposed by Qi *et al.* (2009). The complete results of the EFA are presented in the Appendix. The first analysis was made according to lean and agile SC characteristics. All the items were maintained as they presented factor loadings greater than 0.5 in the factors they were supposed to measure (AL1 to AL7 to measure lean and AA1 to AA7 to measure agile).

A second EFA was run for product characteristics and none of the items were excluded. CS1 and CS2 measured the characteristics of innovative products and CS3 and CS4 the characteristics of functional products. Regarding business performance, DC1 to DC5 were designed to measure commercial performance while DF1 to DF3 measure economic and productivity performance. The item DC5 was excluded from the final construct, as it presented high cross loadings, following the suggestion of Hair *et al.* (2010). The next EFA assessed the constructs for innovation performance. Items DIPT1 to DIPT5 measure product innovation performance and items DIPS1 to DIPS10 measure process innovation performance. Items DIPS8, DIPS9 and DIPS10 were excluded due to the presence of high cross-loading values.

Cronbach's alpha results for SC strategy, business performance and innovation performance are also presented in the Appendix as they help to assess the internal consistency of the constructs (Hair *et al.*, 2010; Peng and Lai, 2012). All the Cronbach's alpha results presented are greater than 0.8, suggesting good reliability (Peng and Lai, 2012). Eigenvalues were also analyzed for the constructs and are presented in the Appendix. The analysis of the constructs for SC strategy showed that the factor for agile SC strategy explains 27.0 per cent of the variance (eigenvalue = 3.78/7 items) and the factor for lean SC strategy explains 25.8 per cent of the variance (eigenvalue = 3.61/7 items). The EFA for business performance also resulted in two factors – commercial performance – which explains 34.65 per cent of the variance (eigenvalue = 2.43/4 items) – and economic and productivity performance – which explains 31.98 per cent of the variance (eigenvalue = 2.24/3 items). Innovation performance also presents two factors, where product innovation performance explains 32.1 per cent of the variance (eigenvalue = 4.17/5 items) and process innovation explains 26.2 per cent (eigenvalue = 3.40/7 items). Regarding product characteristics, the factor for innovative products explains 38.1 per cent (eigenvalue = 1.52/2 items) and the factor for functional products explains 26.9 per cent (eigenvalue = 1.08/2 items).

The fit indices of the structural model were also tested, and the results ($p < 0.001$, IFI = 0.926, TLI = 0.912, CFI = 0.924 and RMSEA = 0.054)[1] provide support for the validity of the structural model. Discriminant validity was assessed by the comparison between Maximum Shared Variance (MSV) and Average Variance Extracted (AVE). AVE is higher than MSV for all the constructs. Moreover, the square root of AVE is greater than the inter-construct correlations for all the constructs.

Further, as two different samples were collected, one from Portugal and the other from Brazil, two one-sided tests (TOST) for equivalence were applied, as proposed by Schuirmann (1987), and showed that there was no significant difference in their means.

Table II Constructs used in the study

Construct	Source
Supply chain strategies	
Lean	
AL1. Our supply chain supplies predictable products	Qi, *et al.* (2009)
AL2. Our supply chain reduces any kind of waste as much as possible	
AL3. Our supply chain reduces costs through mass production	
AL4. Our supply chain provides customers with standardized products	
AL5. Our supply chain needs to maintain a long and rigid relationship with a small number of suppliers	
AL6. Our supply chain selects the suppliers based on their performance concerning cost and quality	
AL7. Our supply chain structure seldom changes	
Agile	
AA8. Our supply chain always faces the volatile customer demand	Qi, *et al.* (2009)
AA9. Our supply chain responds to the changing market environment quickly	
AA10. It is necessary for our supply chain to maintain a higher capacity buffer to respond to the volatile market	
AA11. Our supply chain provides customers with personalized products	
AA12. Our supply chain selects the suppliers based on their performance concerning flexibility and responsiveness	
AA13. Our supply chain needs to maintain a short and flexible relationship with a large number of suppliers	
AA14. Our supply chain structure often changes to cope with the volatile market	
Business conditions	
Environmental uncertainty	
CM1. The environment in which the company competes can support sustained growth and sustainability (environmental munificence)	Dess and Beard (1984)
CD2. The environment in which the company competes is characterized by changes that are hard to predict and that heighten uncertainty for key organizational members (environmental dynamism)	
CC3. The environment in which the company competes is characterized by great uncertainty and great need for information-processing (environmental complexity)	
Product characteristics	
CS4. To what extent does the demand for each type of end product vary quickly?	Qi, *et al.* (2009)
CS5. To what extent is a new product's time-to-market very short?	
CS6. To what extent is the volume of each type of end product very high?	
CS7. Indicate the best estimated time for the introduction interval of new products (1) $<$3 months (2) 3-6 months (3) 7-11 months (4) 1-2 years (5) 2-3 years (6) 3-5 years (7) $>$5 years	
Business performance	
Commercial performance	
DC1. Sales growth	Gonzalez-Benito (2007)
DC2. Reputation and image	
DC3. Customer satisfaction	
DC4. Market share (of the main product)	
DC5. Success of new product launches	
Economic and productivity performance	
DF6. Return on investment – ROI	Gonzalez-Benito (2007)
DF7. Profits as percent of sales	
DF8. Labor productivity	
Innovation performance	
Product innovation	
DIPT9. Replacement of products being phased out	Alegre and Chiva (2008)
DIPT10. Extension of the product range within the main product field through new products	
DIPT11. Extension of the product range outside the main product field	
DIPT12. Development of environment-friendly products	
DIPT13. Opening of new markets abroad	
DIPT14. Opening of new domestic target groups	

(*continued*)

Table II

Construct	Source
Process innovation	
DIPS15. Improvement of production flexibility	Alegre and Chiva (2008)
DIPS16. Reduction of production costs by cutting labor cost per unit	
DIPS17. Reduction of production costs by cutting material consumption	
DIPS18. Reduction of production costs by cutting energy consumption	
DIPS19. Reduction of production costs by cutting rejected production rate	
DIPS20. Reduction of production costs by cutting design costs	
DIPS21. Reduction of production costs by cutting production cycle	
DIPS22. Improvement of product quality	
DIPS23. Improvement of labor conditions	
DIPS24. Reduction of environmental damage	

4.2 Adoption of different supply chain strategies

Based on the constructs for lean and agile SC characteristics, a two-step clustering analysis was implemented, combining a hierarchical (Ward's method, squared Euclidean distance) and a non-hierarchical technique (K-means), to identify patterns among the respondent companies and classify them according to the different SC strategies adopted.

The analysis of the number of clusters used diagram inspection and the theoretical background, following the method proposed by Frohlich and Dixon (2001) to be precise and, at the same time, identify a number of clusters that would permit a proper analysis of the groups. Taking into consideration that the choice of the final number of clusters is subjective, the solution with four clusters was chosen as it provided a better understanding of the characteristics of each cluster and it matches with the solutions applied by Qi *et al.* (2009). The clusters were named according to this study, where the four clusters are defined as: lean, agile, leagile and traditional.

Next, ANOVA was conducted to test for differences in the means of groups. The ANOVA and the Scheffe post hoc tests of mean differences helped to analyze the specificities of each cluster and interpret the results. Table III shows the analysis of variance of the SC strategies by the SC characteristics.

The four clusters identified present very well-defined features when analyzing the constructs for SC characteristics, which can be seen from the results of Scheffe's multiple comparison test, which indicates significant differences among the clusters.

As shown in Table III, the companies which are part of the leagile cluster present high means for the characteristics of lean and agile SCs, which means that they demonstrate a balance between leanness and agility, according to the environment where they compete (Mason-Jones *et al.*, 2000). Companies in cluster 2 present the highest means for agile SC characteristics among all the groups and the lowest value for lean, meaning that this group clearly prioritizes characteristics such as: a quick response to the changing market environment, high capacity buffer, personalized products, selection of suppliers based on their performance concerning flexibility and responsiveness and a short and flexible relationship with a large number of suppliers.

On the other hand, companies in cluster 4 present the highest values for lean, and the lowest values for agile, SC characteristics. This group has a clear predominance of practices that focus on predictability and reduction of waste, reducing costs through mass production, providing customers standardized products, maintaining long and rigid relationships with a small number of suppliers and selecting suppliers based on their performance regarding cost and quality. Finally, companies in cluster 3 do not present a clear focus on leanness or agility, as they show low scores for both strategies. This group is called traditional SC in alignment with Qi *et al.* (2009).

Following this assessment, the characteristics of each cluster were analyzed with respect to the demographic characteristics of the companies that are part of each cluster. Two aspects were analyzed: company size and industrial sector. These analyses were intended to evaluate the impact of the two characteristics on the choice of the SC strategy and help to find connections and patterns for later discussion. Tables IV and V show the results of the analyses.

Regarding the size of the companies, as presented in Table IV, some interesting findings can be observed. Leagile and traditional SC strategies present the highest percentage among companies with a size of between 101 and 500 employees. On the other hand, while a lean SC strategy is the

Table III Analysis of variances of the SC strategies using hierarchical cluster analysis

	Cluster 1 – Leagile *N* = 90		Cluster 2 – Agile *N* = 40		Cluster 3 – Traditional *N* = 74		Cluster 4 – Lean *N* = 125		
	Mean*	SE	Mean*	SE	Mean*	SE	Mean*	SE	*F* Value
Lean SC	5.55 (2,3)	0.11	2.95 (1,3,4)	0.16	4.14 (1,2,4)	0.18	5.72 (2,3)	0.10	156.02**
Agile SC	5.39 (2,3,4)	0.12	5.83 (1,3,4)	0.12	4.81 (1,2,4)	0.17	3.71 (1,2,3)	0.11	308.66**

Notes: SE = standard error; *Based on a seven-point Likert scale; **$p < 0{,}001$; Numbers in parentheses indicate the cluster from which this cluster is significantly different at 0.05 level of significance based on the Scheffe pairwise comparison

Table IV Company size by SC strategy cluster

	Cluster 1 – Leagile *N* = 90		Cluster 2 – Agile *N* = 40		Cluster 3 – Traditional *N* = 74		Cluster 4 – Lean *N* = 125		Total	
Variable	**No.**	**(%)**	**No.**	**(%)**	**No.**	**(%)**	**No.**	**(%)**	**No.**	**(%)**
<50	6	6.7	3	7.5	3	4.1	6	4.8	18	5.5
50-100	8	8.9	9	22.5	7	9.5	24	19.2	48	14.6
101-500	46	51.1	14	35.0	35	47.3	42	33.6	137	41.6
501-1000	13	14.4	8	20.0	13	17.6	28	22.4	62	18.8
>1000	17	18.9	6	15.0	16	21.6	25	20.0	64	19.5
Total	90	100.0	40	100.0	74	100.0	125	100.0	329	100.0

Table V Company industry sector by SC strategy cluster

	Cluster 1 – Leagile *N* = 90		Cluster 2 – Agile *N* = 40		Cluster 3 – Traditional *N* = 74		Cluster 4 – Lean *N* = 125		Total	
	N	**(%*)**	**N**	**(%*)**	**N**	**(%*)**	**N**	**(%*)**	**N**	**(%)**
Food and beverages	25	36.8	7	10.3	12	17.6	24	35.3	68	20.7
Automotive and parts	12	22.2	5	9.3	9	16.7	28	51.9	54	16.4
Construction and materials	8	25.8	3	9.7	6	19.4	14	45.2	31	9.4
Machinery and plant construction	6	26.1	4	17.4	9	39.1	4	17.4	23	7.0
Textiles and apparel	4	17.4	7	30.4	7	30.4	5	21.7	23	7.0
Industrial metals	4	18.2	4	18.2	6	27.3	8	36.4	22	6.7
Household goods and personal care	6	30.0	2	10.0	5	25.0	7	35.0	20	6.1
Others	25	28.4	8	9.1	20	22.7	35	39.8	88	26.7
Total	90	27.4	40	12.2	74	22.5	125	38.0	329	100.0

Note: *% of companies in the industry sector which adopt the SC strategy

most commonly used by companies with more than 500 employees, an agile SC strategy has the highest percentage of companies with fewer than 100 employees. Although these results partially confirm previous studies, where no significant differences were found between the clusters (Qi *et al.*, 2009; Nakano, 2015), they also suggest that agility might be related to smaller companies, with fewer than 100 employees, in comparison with leanness.

Concerning the industrial sector, some interesting findings can also be highlighted. Companies in the food and beverage sector (the most common among the respondents) adopt lean and leagile SC strategies predominantly, which might be explained by the highly diverse and heterogeneous characteristics of this sector (Bayraktar *et al.*, 2010). Moreover, more than 50 per cent of the companies in the automotive and parts sector and 45 per cent in the construction and material sector adopt a lean SC strategy, indicating a predominance of this strategy among companies in these sectors, which could be explained by their characteristics, especially mass production, when compared with other sectors. Among the companies that adopt an agile SC strategy, it is possible to note the presence of those from the textile and apparel sector, although this sector presents a relative homogeneity regarding the choice of SC strategy. Companies in the sector of machinery and plant construction predominantly choose a traditional SC strategy. Looking at the other sectors, no substantial differences among the clusters were found.

4.3 Antecedents to the adoption of supply chain strategies

ANOVA was also conducted to analyze the differences between the clusters regarding product characteristics and environmental uncertainty (Table VI).

The results show significant differences among the clusters, especially when it comes to product characteristics (both functional and innovative products), providing support for hypotheses 1, i.e. different product characteristics require different SC strategies. *H2* is also supported, as the results show that both the environmental dynamism (*H2.1*) and complexity (*H2.2*) are related to the adoption of SC strategies: companies competing in environments with high degrees of complexity and dynamism tend to adopt agile SC strategies; and companies with lower levels of complexity and dynamism tend to adopt lean SC strategies. Additionally, environmental munificence does not present statistically different results among the clusters, thereby confirming *H2.3*.

Cluster 1, leagile, consists of the companies that adopt lean and agile principles simultaneously (Mason-Jones *et al.*, 2000; Qi *et al.*, 2017). Companies in this group have relatively high levels of functional and innovative products. Considering that leagile is a combination of lean and agile and that lean is more related to functional products and agile to innovative products (Fisher, 1997; Wagner *et al.*, 2012), the findings are aligned with previous studies. The environment is characterized by average levels of complexity, dynamism (well below agile but above lean and traditional strategies) and munificence (although it is the highest

Table VI Analysis of variance of business conditions and performance by SC strategy clusters

	Cluster 1 – Leagile $N = 90$		Cluster 2 – Agile $N = 40$		Cluster 3 – Traditional $N = 74$		Cluster 4 – Lean $N = 125$		
	Mean*	SE	Mean*	SE	Mean*	SE	Mean*	SE	*F* value
Functional product	4.03(2,4)	0.17	3.41(4)	0.23	3.76(4)	0.18	5.35(1,2,3)	0.14	4.89***
Innovative product	4.61	0.18	5.13(4)	0.25	4.29(4)	0.19	4.00(2,3)	0.14	6.29***
E. Munificence	5.70	0.11	5.40	0.18	5.49	0.13	5.62	0.08	1.11
E. Complexity	4.53(2)	0.16	5.30(1,3,4)	0.23	4.49(2)	0.17	4.38(2)	0.13	3.89***
E. Dynamism	4.51(2)	0.17	5.45(1,3,4)	0.21	4.39(2)	0.18	4.16(2)	0.13	7.36**
Commercial performance	3.71(2,3,4)	0.06	3.41(1)	0.11	3.36(1)	0.07	3.45(1)	0.06	4.92**
Economic and productivity performance	5.25(2,3,4)	0.11	4.75(1)	0.17	4.58(1)	0.12	4.67(1)	0.09	7.48**
Product innovation performance	4.88(2,3,4)	0.10	4.49(1)	0.10	4.26(1)	0.13	4.34(1)	0.09	7.49**
Process innovation performance	5.05(2,3,4)	0.08	4.58(1)	0.10	4.28(1)	0.13	4.55(1)	0.08	10.19**

Notes: SE = standard error; *Based on a five-point Likert scale; **$p < 0.001$; ***$p < 0.01$; Numbers in parentheses indicate the cluster from which this cluster is significantly different at 0.05 level of significance based on the Scheffe pairwise comparison

among the clusters, the differences between them are not significant) in this cluster. To cope with this relative uncertainty, this group needs to be able to respond quickly to changes, which explains the need for a certain degree of agility.

Cluster 2, agile, is composed of the companies that focus on flexibility and adaptability for changing market demands (Christopher and Towill, 2002). The results show a predominance of innovative, rather than functional products, among the companies in this group. This can be explained by existing theory, as an agile strategy is often linked to innovative products (Fisher, 1997; Wagner *et al.*, 2012) and product characteristics can be considered one of the main antecedents of SC strategy (Qi *et al.*, 2009). The high levels of environmental complexity and dynamism characterize the environment in this cluster, which helps to explain the companies' SC strategy.

Companies with a traditional SC strategy make up Cluster 3. This group shows a relative balance between functional and innovative products, which may help to explain their apparent lack of focus (Qi *et al.*, 2009). The environment in which this group of companies competes is characterized by average levels of environmental munificence and low levels of environmental complexity and dynamism.

Cluster 4, lean, is composed of companies that prioritize efficiency and reduction of waste (Guan and Ma, 2003; Qrunfleh and Tarafdar, 2014). There is a clear predominance of functional products among the companies in this cluster, rather than innovative products, confirming the theory that a lean strategy is related to functional products (Fisher, 1997). The environment of this group is characterized by low levels of environmental complexity and dynamism, which explains the cluster's strategic choice.

4.4 Impact of the supply chain strategies on business performance and innovation performance

The impact of the adoption of the different SC strategies on both business and innovation performance was also assessed by means of ANOVA, as presented in Table VI.

These results show that companies with a leagile SC strategy achieve the best performance among the clusters in the four parameters analyzed (commercial performance; economic and productivity performance; product innovation performance and process innovation performance). This group is the most well prepared to face different types of environments, as they are able simultaneously, and depending on different challenges, to reduce waste and improve efficiency and respond quickly to changes in demand (Mason-Jones *et al.*, 2000; Galankashi and Helmi, 2016; Qi *et al.*, 2017).

Companies with an agile SC strategy present relatively high levels of economic and productivity performance, as well as product and process innovation performance, but a relatively low level of commercial performance. Companies that follow a lean SC strategy present high levels of economic and productivity performance compared to product and process innovation performance and commercial performance. The group of companies that adopt a traditional SC strategy has the lowest levels of performance in all the parameters observed. It is important to highlight that all the clusters present lower levels of commercial performance compared to economic and productivity performance.

The results support *H3* and *H4*, as SC strategies influence both business and innovation performance. According to the results, the leagile cluster shows better performance in all parameters *vis-à-vis* all the clusters analyzed, while the traditional SC strategy presents the worst results. Simultaneously, the results show that there are no statistically significant differences between the four parameters of performance analyzed between agile and lean SC strategies. These results confirm previous studies when it comes to business performance (Qi *et al.*, 2009; Nakano, 2015) and show that innovation performance behaves in a similar way.

The results suggest that a leagile SC strategy provides the best outcomes regarding the four parameters of performance, which indicates that managers should implement it whenever possible. However, as supported by Naylor *et al.* (1999) and Nakandala and Lau (2019), the adoption of a leagile SC strategy requires a complex combination of characteristics and represents a great challenge for managers. The results also suggest that lean and agile SC strategies can lead to relatively similar outcomes when their adoption matches the requirements of the products and the environment in which companies compete. The traditional SC strategy should be avoided as it represents a lack of strategic focus and leads to the

worst results, suggesting that choosing a strategy – lean, agile or leagile – is clearly beneficial.

5. Conclusions

The aim of this paper was to discuss and test the antecedents and consequences of the adoption of different SC strategies. An exploratory approach was applied to analyze data from Portuguese and Brazilian companies. The RBV was used as the theoretical foundation for this paper, following previous studies in the field (Fawcett *et al.*, 2012; Sjoerdsma and van Weele, 2015; Yan and Azadegan, 2017). An SC strategy was understood to be a strategic resource that must match specific requirements (internal and external) and that helps to explain a company's results. 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

The RBV helped to:

- understand the characteristics that lead to a better business performance;
- compare companies' business performances, based on observable characteristics; and
- understand SCs as networks in which a set of resources influences the business performance of the chain and of each actor.

Moreover, the best performance achieved by the companies that adopt a leagile SC strategy can be explained by using the lens of the RBV. This group of companies are able to find a balance between the necessary resources to be, at the same time, efficient – by applying resources to reduce waste and minimize costs (for instance, using methods and activities such as "just in time") – and responsive – by investing in resources to improve the ability to respond quickly to market changes (for instance, by means of a higher capacity buffer). This idea is strongly related to the concept of ambidexterity, which refers to the capability of simultaneously dealing with paradoxical or conflicting factors (Gibson and Birkinshaw, 2004; He and Wong, 2004). In this context, organizational ambidexterity, applied in the form of leagility, emerges as a way to manage this dilemma better and perform best in both directions, by being both efficient and responsive.

The cluster analyses carried out in this study demonstrated that the four types of SC strategies observed by Qi *et al.* (2009) in Chinese companies were also found in the companies analyzed in the Portuguese and Brazilian context. Significant differences among the clusters were found in a variety of aspects.

Product characteristics and environmental uncertainty were analyzed as antecedents of the adoption of SC strategies. The results confirmed that companies with primarily functional products tend to adopt a lean SC strategy, while those with primarily innovative products adopt an agile SC strategy. Companies with traditional and leagile SC strategies present non-statistically different levels of functional and innovative products, although the leagile SC strategy has higher levels of innovative products. These results provide support for *H1* and confirm the model proposed by Qi *et al.* (2009), providing validity, credibility and relevance of this model in different contexts.

Environmental uncertainty was assessed to add knowledge about the factors driving the adoption of SC strategies. According to the results, companies that compete in environments characterized by high levels of complexity and dynamism tend to adopt agile SC strategies. The results also support the idea that environmental munificence is not a factor driving the adoption of SC strategies. These results support *H2* and help to explain the strategic choices regarding SC strategies.

The results showed that the companies that adopt leagile SC strategies present better commercial, and economic and productivity performance, contrary to previous studies, which did not find significant differences between the performance of lean, agile and leagile SC strategies. Moreover, the cluster adopting a leagile strategy also performs better in terms of product and process innovation, which had not been tested before. The results also show that a traditional SC strategy leads to the worst results, confirming the previously obtained results. These findings support hypotheses 3 and 4. The similarity of the performance between lean and agile confirms the idea that there is no best SC strategy, although agile SC strategy performed slightly better regarding innovation. The choice of SC strategy must fit the requirements of each company (Lee, 2002).

5.1 Theoretical implications

This paper makes a theoretical contribution to the literature concerning the choice of the "right" SC strategy. A theoretical model involving the antecedents to the adoption of an SC strategy was empirically tested within the context of Portugal and Brazil. Moreover, this study includes an analysis of the impact of SC strategies on product and process innovation performance, which has not been tested previously. The replication and extension of previous studies in a different context, especially in non-highly industrialized countries, which are not among the most common ones in the empirical research published so far, contributes to the generalizability of the previous findings. However, some of the findings of the present paper differ from those of previous studies, contributing to the discussion and showing the need for more research on the topic.

5.2 Practical implications

This paper also presents broad managerial implications. To adopt the right SC strategies, companies need to consider their product characteristics and the various features of their environment. The results could be used to guide managers in the adoption of their SC strategy as they clearly demonstrate that each strategy fits the different characteristics of companies, environments and products. Managers who identify that their companies have predominantly functional products and compete in environments characterized by relatively low levels of complexity and dynamism should consider the adoption of a lean SC strategy, as the results suggest that this combination often favors a better performance. On the other hand, companies with innovative products and competing in complex and dynamic environments should consider the adoption of an agile SC strategy. The results also suggest that in many cases –

especially when product and environmental characteristics do not clearly indicate the need of a "purely" lean or agile SC strategy – the adoption of a leagile SC strategy leads to the best performance of them all. Even though other features need to be considered, knowing the combinations of antecedents and consequences to the adoption of an SC strategy is helpful when choosing the best strategy. Regarding the size of the companies analyzed, the results suggest that agility can be found predominately among smaller companies in comparison with leanness, which is more prevalent among medium-sized and large companies. Moreover, when analyzing the industrial sectors some differences in the adoption of SC strategies can be observed, which clearly indicates the heterogeneous behavior of the companies regarding the choice of the SC strategy.

5.3 Limitations and future research

While making significant contributions to SCM literature and having important implications in terms of theory and practice, some limitations and opportunities for future research can be highlighted. The results are based on a survey research with a limited sample size (329 respondents) and geographic coverage (Portugal and Brazil). Future research using data from different countries could contribute to discussing similarities and differences among different contexts. Moreover, while it is clear what leads to the choice of a lean or an agile SC strategy, there is a need to understand how leagility has been applied, which could be done by analyzing case studies in greater depth.

Considering the lower level of commercial performance compared with economic and productivity performance in all the clusters, future research could use different scales and metrics (such as secondary data) to explore and discuss the reasons and effects of this characteristic. Moreover, besides analyzing other constructs, such as competitive strategies, future research could also analyze the antecedents and consequences of the adoption of SC strategies by means of the combination of different methods, using survey data and case studies (by means of longitudinal studies, for instance). Future research could also analyze the antecedents to the adoption of SC strategies through the lens of a different theoretical basis, such as dynamic capabilities, resource-advantage theory of competition, the SC practice view, among others. Finally, this study considers the link between SCM and innovation, a topic that has been gaining relevance recently. Therefore, future research could analyze the relationship between SC strategies, innovation strategies and innovation capabilities.

Note

1 Incremental Fit Index, Tucker-Lewis Index, Comparative Fit Index (good models > 0.90); Root Mean Square Error of Approximation (good models < 0.06) (Hu and Bentler, 1995).

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Appendix

Table AI Factor analysis for the SC strategies

	Agile Eigenvalue = 3.78 Cronbach's Alpha = 0.849	Lean Eigenvalue = 3.61 Cronbach's Alpha = 0.837
AL1	−0.177	*0.742*
AL2	0.018	*0.756*
AL3	−0.098	*0.797*
AL4	−0.153	*0.766*
AL5	−0.277	*0.541*
AL6	−0.050	*0.715*
AL7	−0.297	*0.525*
AA1	*0.615*	−0.241
AA2	*0.778*	−0.037
AA3	*0.608*	−0.177
AA4	*0.698*	−0.230
AA5	*0.777*	−0.014
AA6	*0.769*	−0.049
AA7	*0.719*	−0.205

Note: Numbers greater than 0.50 are presented in italic

Table AII Factor analysis for business performance

	Commercial Eigenvalue = 2.43 Cronbach's Alpha = 0.803	Economic and productivity Eigenvalue = 2.24 Cronbach's Alpha = 0.806
DC1	*0.617*	0.354
DC2	*0.859*	0.220
DC3	*0.762*	0.216
DC4	*0.701*	0.215
DC5	NA	NA
DF1	0.273	*0.853*
DF2	0.232	*0.869*
DF3	0.273	*0.673*

Notes: Numbers greater than 0.50 are presented in italic. *Item excluded from the final construct due to high cross-loadings (above 0.40)

Table AIII Factor analysis for innovation performance

	Process Eigenvalue = 3.40 Cronbach's Alpha = 0.833	Product Eigenvalue = 4.17 Cronbach's Alpha = 0.904
DIPT1	0.324	*0.644*
DIPT2	0.212	*0.767*
DIPT3	0.041	*0.708*
DIPT4	0.176	*0.744*
DIPT5	0.154	*0.656*
DIPT6	0.265	*0.658*
DIPS1	*0.562*	0.360
DIPS2	*0.798*	0.116
DIPS3	*0.802*	0.099
DIPS4	*0.738*	0.225
DIPS5	*0.827*	0.135
DIPS6	*0.687*	0.227
DIPS7	*0.698*	0.278
DIPS8	NA	NA
DIPS9	NA	NA
DIPS10	NA	NA

Notes: Numbers greater than 0.50 are presented in italic. *Items excluded from the final construct due to high cross-loadings (above 0.40)

Table AIV Factor analysis for product characteristics

	Innovative Eigenvalue = 1.52	Functional Eigenvalue = 1.08
CS1	*0.731*	−0.058
CS2	*0.859*	0.143
CS3	0.210	*0.869*
CS4	−0.453	*0.544*

Note: Numbers greater than 0.50 are presented in italic

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