Dynamic capabilities in the "new normal": a study of organizational flexibility, integration and agility in the Peruvian coffee supply chain

Edgar Ramos
Department of Industrial Engineering, Universidad Peruana de Ciencias Aplicadas, Lima, Peru
Andrea S. Patrucco
Department of Marketing and Logistics, College of Business Administration, Florida International University, Miami, Florida, USA, and
Melissa Chavez
Department of Industrial Engineering, Universidad Peruana de Ciencias Aplicadas, Lima, Peru

Abstract

Purpose – Considering the unprecedented supply chain disruptions due to the COVID-19 pandemic, especially in the agri-food sector, the possession of dynamic capabilities (DCs) – particularly, the need for higher agility – seems to be the key to survival in highly uncertain environments. This study aims to use the dynamic capability view (DCV) theory to analyze how three key supply chain capabilities – organizational flexibility, integration and agility – should be combined to obtain the desired supply chain performance.

Design/methodology/approach – The authors designed a conceptual model in which the relationships between these three key capabilities and supply chain performance were hypothesized. The model was first tested through partial least square regression using survey data collected from 98 members of the Peruvian coffee supply chain. A fuzzy-set qualitative comparative analysis (fsQCA) was conducted to uncover how DCs could be combined in successful supply chain configurations.

Findings – The authors show that organizational flexibility is a driver of higher agility in agri-food supply chains, together with external and internal supply chain integration, that have a direct impact on agility, which positively affects supply chain performance. Higher levels of supply chain agility are necessary but insufficient to guarantee high performance, as sufficiency is reached when both integration (internal and/or external) and agility are present.

Originality/value – This study represents a pioneering attempt to apply the DCV theory to agri-food supply chains – characterized by many sources of uncertainty. All the DCs are included within the same model and the joint use of PLS regression and fsQCA provides evidence about the relationships between DCs and how they can empower agri-food supply to obtain the desired performance.

Keywords Dynamic capabilities, Supply chain integration, Supply chain agility, Organizational flexibility, Agri-food supply chain, South America

Paper type Research paper

1. Introduction

The COVID-19 pandemic has put unprecedented pressure on several industries, particularly on supply chain networks that suddenly faced the need to reorganize themselves to ensure continuity of operations and future availability of products (Flynn *et al.*, 2021).

The agri-food supply industry was particularly affected, with bottlenecks in farm labor, processing, transport and logistics and meaningful shifts in demand that generated many challenges from a supply chain management (SCM) perspective (Cappelli and Cini, 2020; Hobbs, 2020).

The stresses COVID-19 put on the agri-food supply chain originate from many sources (Kumar *et al.*, 2021). Several farm productions experienced a shortage of inputs in raw materials (such as seeds, pesticides and fertilizers) and labor due to the global market and local transportation constraints. Limited mobility of people reduced the availability of seasonal workers and logistic services were constrained as bottlenecks in transportation limited product movement along the supply chain (Singh *et al.*, 2020), leading to disruptions for several agri-food products worsened by unpredictable customer behaviors (OECD, 2020; Vargas *et al.*, 2021).

In this scenario, local agri-food suppliers and processors worked with local and international distributors to manage the disruptions caused by COVID-19 and mitigate their effects at different points in the supply chain, partly through changes to

The current issue and full text archive of this journal is available on Emerald Insight at: **https://www.emerald.com/insight/1359-8546.htm**

Supply Chain Management: An International Journal

[DOI 10.1108/SCM-12-2020-0620]

Authors would like to thank Editor Prof Beverly Wagner and the two anonymous reviewers for their significant contributions to the improvement of this article. Authors would also like to thank Dr Giacomo Marzi for the methodological inputs provided. All the eventual errors are our sole responsibility.

Received 11 December 2020
Revised 19 March 2021
1 June 2021
12 July 2021
Accepted 17 July 2021

their organizational structures (e.g. flexible operating hours, job rotation and temporary hiring of extra staff), increasing cooperation with suppliers and customers through constant information sharing and joint planning (to prevent costly and time-consuming changes for manufacturers and simplified inventory management for retailers) and using alternate sources of inputs when facing disruptions (Sharma *et al.*, 2020).

Many agri-food supply chains are examples of networks that can survive the economic effects of the current pandemic owing to their ability to quickly adapt to dramatic environmental changes and reorganize themselves to react to unprecedented shifts in supply and demand (Lougee, 2020). This suggests that "agility" may be the critical strategic feature for supply chains during these new business times.

Agility is defined as "the capability of the firm, internally and in conjunction with its key suppliers and customers, to adapt or respond speedily to marketplace changes, as well as to potential and actual disruptions, contributing to the agility of the extended supply chain" (Braunscheidel and Suresh, 2009, p. 121). The discussion on challenges and opportunities to build agile networks has dominated the SCM literature for the past decade (Gligor *et al.*, 2015; Fayezi *et al.*, 2017).

Supply chains operating in unstable environments such as agri-food networks were challenged by several sources of uncertainty prior to the COVID-19 events (Yanes-Estévez *et al.*, 2010; Sharma *et al.*, 2020). In these contexts, the focal company and its members (i.e. suppliers and customers) must be able to quickly align their collective capabilities to respond efficiently and effectively to demand uncertainty and other supply risks (Williams *et al.*, 2013; Rojo *et al.*, 2018). This alignment increases the network's capability to mitigate variability and potential shifts, making supply chains more agile and leading to improved performance (Wong *et al.*, 2011; Gligor *et al.*, 2015).

This perspective is in line with the dynamic capabilities view (DCV) of the organization (Teece, 2007), used in several SCM studies to analyze the relationship between the source of supply chain uncertainty, organizational actions and outcomes (Li *et al.*, 2008; Williams *et al.*, 2013; Vickery *et al.*, 2013; Dubey *et al.*, 2018).

The impact of COVID-19 demonstrated that possession and growth of dynamic capabilities (DCs) and particularly, the design of more agile networks may become a key challenge for several supply chains in the future (McKinsey and Company, 2020a; Shih, 2020).

Consequently, the post-pandemic environment calls for a more in-depth understanding of how DCs are generated, interact with each other and contribute to maintaining supply chain performance in high uncertainty contexts. In agri-food networks, the "agile" capabilities seem to be partially the result of previous investments aimed at increasing the level of visibility and collaboration throughout the supply chain, so that the different actors can have a better understanding of the network's decisions and operations, thus being better prepared in case of unprecedented scenarios (Stone and Rahimifard, 2018; OECD, 2020; Ramirez *et al.*, 2020).

From an academic perspective, these new challenges provide further opportunities to advance discussions on the role of DCs in making supply chains successful in the post-COVID-19 business environment. This study explores how DCs interact with each other and can grow supply chain networks' agility and resiliency, to answer the following research question:

In agri-food supply chains, how can DCs be combined to build more responsive and agile networks, which can guarantee higher performance?

In line with the DCV, supply chain organizational flexibility (Dubey *et al.*, 2019b), integration (Zhao *et al.*, 2011) and agility (Gligor *et al.*, 2019; Dubey *et al.*, 2019b) are combined within the same research model to analyze the relationships between them and explain their impact on the performance of agri-food supply chains. That allows us to provide recommendations about the supply chain reconfiguration problem in the post-pandemic business environment.

This study focuses on the coffee supply chain. Coffee production is one of the most diffused and developed worldwide and, although not perishable as a final product, several risk factors characterize this supply chain. These include volatility of prices, perishability of raw materials, sensitivity to natural disasters, variation in the reliability of manufacturing and storage infrastructure, heterogeneous culture and technological maturity of the different actors (Sepúlveda *et al.*, 2018). This has pushed supply chain actors to build networks with high capabilities to respond to this uncertain environment (Candelo *et al.*, 2018). Owing to these features, following the spread of COVID-19, several coffee producers (particularly in Latin American countries) experienced limited interruption in their ability to access resources and satisfy market demand, as existing flexibility, integration and collaboration infrastructure were used to minimize the impact of the emergency (Guido *et al.*, 2020).

Consequently, the coffee supply chain becomes an interesting unit of analysis for the purpose of this research. It enables us to analyze how DCs have been combined in a heterogeneous network of actors, characterized by formal and informal relationships and affected by several sources of uncertainty (including COVID-19). This represents a good benchmark for designing more resilient and agile agri-food networks for other types of products.

The remainder of this paper is organized as follows. Section 2 describes the main concepts related to the theoretical development of this study. In Section 3, the research model and main hypotheses are presented. Section 4 describes the research methodology and Section 5 presents the results of the data analysis. Section 6 discusses the implications of the results. Finally, Section 7 summarizes the main theoretical and managerial implications and identifies the research limitations and scope for future research.

2. Theoretical foundation: the definition and role of dynamic capabilities in Agri-food supply chains

DCs measure "the firm's ability to integrate, build and reconfigure internal and external competencies to address rapidly changing environments" (Teece, 2007, p. 516). In line with scholars who use the DCV to explain the origin of an organization's competitive advantage in turbulent environments (Singh *et al.*, 2013; Vanpoucke *et al.*, 2014; Sandberg, 2021), this research supports the idea that organizations operating in supply chains affected by higher uncertainty need to grow stronger DCs to successfully adapt to changing environments (Teece and Leih, 2016). In this work, we combine three key DCs – supply chain organizational flexibility (OF), supply chain integration (SCI) and supply chain agility (SCA) – to explain how these capabilities relate to each other in agri-food supply chains and how they should be combined aiming to reduce the severity of disruptions such as those caused by the COVID-19 pandemic.

2.1 Supply chain organizational flexibility

Flexibility is considered an important organizational capability to adapt to highly complex tasks (Braunscheidel and Suresh, 2009; Williams *et al.*, 2013). It represents a principal weapon to achieve a competitive advantage, especially in the most competitive markets and the most significant uncertainty (Kortmann *et al.*, 2014). Initial research focused on this concept by looking at flexibility within the organization; later, the attention switched to the study of manufacturing flexibility and, more recently, supply chain OF (Prajogo and Olhager, 2012; Cheng *et al.*, 2014; Dubey *et al.*, 2019a).

In an SCM context, OF can be defined as "the ability of supply chain managers to reconfigure their internal supply chains quickly and efficiently to adapt to changing demand and supply market conditions" (Srinivasan and Swink, 2018, p. 1852).

The importance of OF results from the supply chain orientation of companies, as organizations no longer operate in isolation, but in a connection with a network of other actors (Rojo *et al.*, 2018). Relying on a flexible and reactive network is a strategic tool in several industries, especially the more unpredictable ones (Sreedevi and Saranga, 2017). In uncertain environments, companies with flexible supply chains can generate new sources of competitive advantage (Merschmann and Thonemann, 2011), as they can use the evolution of factors such as regulations, technology and customer preferences to improve their processes and products (Fayezi *et al.*, 2017).

OF has become a key aspect in agri-food supply chains (Hobbs and Young, 2000; Stone and Rahimifard, 2018), which are facing increasing pressures due to low availability of resources (such as energy and water), shortage of land availability, global food insecurity, climatic change and natural and health disasters (Despoudi *et al.*, 2020). This uncertainty makes it difficult to predict the evolution of the operating environment accurately, which can be related to globalization, changes in customer attitude, increased market competition, demand for environmental sustainability and different food regulations (Yanes-Estévez *et al.*, 2010; Ghadge *et al.*, 2020; Xu and Long, 2020). Therefore, having a responsive network, characterized by organizational structures able to reconfigure themselves quickly, is an essential feature for SCM (Beske *et al.*, 2014; Kataike *et al.*, 2019).

2.2 Supply chain integration

SCI can be defined as "the degree to which a manufacturer strategically collaborates with its supply chain partners and collaboratively manages intra- and inter-organizational processes, to achieve effective and efficient flows of products and services, information, money and decisions, to provide maximum value to the customer" (Flynn *et al.*, 2010, p. 59). In practice, the degree of integration measures the capability of the supply chain to establish collaborations between actors in the same network to produce advantages over competitors by creating superior value for the customer (Shou *et al.*, 2018; Wiengarten *et al.*, 2019). Integration capabilities are particularly important in uncertain environments (Wong *et al.*, 2011; Huang *et al.*, 2014), as they enable a fast (re)alignment between partners in response to evolving external factors (Yu *et al.*, 2019). The SCM literature distinguishes two types of integration (Braunscheidel and Suresh, 2009): internal and external.

Internal integration (II) refers to the degree to which a company can structure strategies, practices, procedures and organizational behaviors in collaborative, synchronized and manageable processes to meet customers' requirements and interact efficiently with suppliers (Lee *et al.*, 2007). It involves collaboration and alignment of various functions of an organization to achieve supply chain goals (Cheng *et al.*, 2016).

External integration (EI) refers to the degree to which a company can strategically collaborate with its suppliers and customers to structure its strategies, practices, procedures and organizational behaviors in an aligned way (Cao and Zhang, 2011). Integration with suppliers and customers allows a company to closely synchronize internal and external operations, increasing visibility, information processing capacity and relationships in a supply chain (Lockstrom *et al.*, 2011; Cao and Zhang, 2011).

II capabilities should be developed before EI, as processes within an organization must be aligned before participating in information exchange and collaboration activities with external partners in the supply chain (Flynn *et al.*, 2010; Huang *et al.*, 2014).

Although numerous studies have investigated SCI in several manufacturing sectors in recent years (Sabet *et al.*, 2017), less attention has been paid to integration in agri-food supply chains. This is surprising for two reasons. First, developing capabilities for effective coordination between members in these networks is not easy, as structured and unstructured (e.g. farmers) organizations coexist and focal companies need to manage a heterogeneous set of relationships and relationship approaches (Handayati *et al.*, 2015; Dania *et al.*, 2018; Zaridis *et al.*, 2020). Second, this is a context characterized by high environmental turbulence, where integration capabilities between members represent an effective way to react and manage these sources of uncertainty (Sharma *et al.*, 2020; Kumar *et al.*, 2021). With a lack of SCI, agri-food supply chains are more exposed to the consequences of disruptive events (Pereira *et al.*, 2020). Therefore, establishing integrated processes between farmers, food processors and distributors to deliver higher value for both customers and society represents a key contemporary challenge for these networks (Mangla *et al.*, 2018).

2.3 Supply chain agility

Companies are increasingly investing in building more agile supply chains to respond to market changes efficiently and effectively (Lee, 2004; Bottani, 2010; Whitten *et al.*, 2012; Blome *et al.*, 2013; Shih, 2020). SCA can be defined as "the result of integrating the supply chain's alertness to changes (opportunities/challenges) – both internal and environmental – with the supply chain's capability to use resources in responding (proactively/reactively) to such changes, all in a timely and flexible manner" (Li *et al.*, 2008, p. 421).

SCA enables companies to develop, produce and distribute products in a timely and sustainable manner and is a characteristic that networks must build to respond to and survive high levels of turbulence and uncertainty (Swafford *et al.*, 2006; Braunscheidel and Suresh, 2009).

SCA provides superior value downstream and is a way to overcome disruption risks and mitigate their consequences (Gligor and Holcomb, 2012; Gligor *et al.*, 2015, 2016). To reach agility, organizations should leverage factors favoring their development such as internal cross-functional integration and operational integration with key customers and suppliers (Braunscheidel and Suresh, 2009), as well as stronger communication, visibility and information sharing between the supply chain actors (Dubey *et al.*, 2018).

SCA is a desired capability as it allows a quick response to sudden changes in demand and supply and handles external disruptions smoothly (Gligor *et al.*, 2019). Furthermore, during crises, it becomes a key capability for more effective disaster response (Shekarian *et al.*, 2020).

Agile capabilities have not been explored in the agri-food context. Although some studies mentioned agility to overcome some risk factors peculiar to these contexts (Stone and Rahimifard, 2018), so far, the dynamics (i.e. drivers and consequences) of agility in agri-food supply chains are unclear. Still, the recent COVID-19 crisis has demonstrated how this represents a prime feature to minimize the consequences of global disasters, as these events amplify the sources of risks that affect these supply chains in regular times (McKinsey and Company, 2020b; Mussell *et al.*, 2020; Butt, 2021).

3. The interplay between dynamic capabilities in agri-food supply chains: conceptual model and hypotheses development

In line with the DCV of organizations, this study's main objective is to analyze how, in agri-food supply chains, DCs (i.e. OF, SCI and SCA) relate to each other and can be combined to maintain high performance in uncertain environments. Their relationships are hypothesized as in the theoretical model shown in Figure 1.

The model relies on five hypotheses that are further described as follows.

3.1 The drivers of supply chain agility

The model first positions OF and SCI as drivers of SCA.

OF represents the capability that allows organizations to operate in turbulent environments and adapt to changing demand and supply market conditions quickly and efficiently (Braunscheidel and Suresh, 2009; Srinivasan and Swink, 2018). In complex networks such as agri-food supply chains, firms characterized by higher OF possess higher capabilities to reconfigure their resources and modify their operational routines following environmental changes (Singh *et al.*, 2020; Sharma *et al.*, 2020). As the concept of SCA refers to the rapidity with which the supply chain can move the operations in turbulent and competitive environments (Whitten *et al.*, 2012), by improving their OF, actors in the supply chain can contribute to increasing the speed in moving the network configuration from the current state to a new state (Chan *et al.*, 2017).

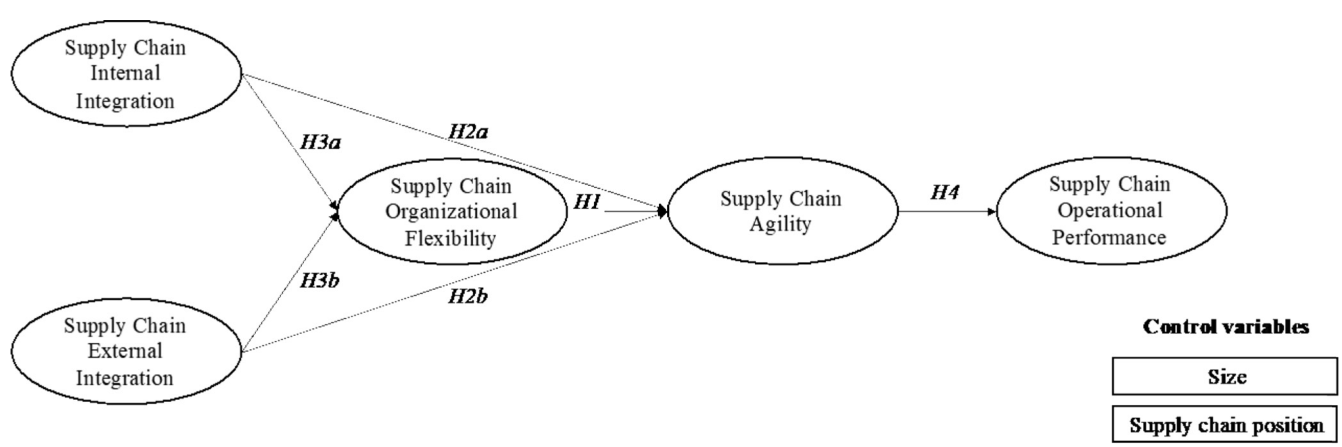
This leads to the formulation of the following hypothesis:

H1. In agri-food supply chains, higher OF of supply chain actors positively impacts the SCA.

SCI represents the capability that leads to the development of internal and external synergies among supply chain actors, to favor alignment between processes and increase visibility, which is essential to prepare for, respond to and recover from unpredictable events while reducing their impact (Schoenherr and Swink, 2012). As a DC, SCI enhances supply chain partners' understanding of each other's businesses by providing "end-to-end" visibility across the network (Droge *et al.*, 2004; Vickery *et al.*, 2013). This solves the problem of untimely and inaccurate information and communication between members, preventing the supply chain from reactively responding to environmental changes (Jajja *et al.*, 2018).

II increases communication between departments and synchronizes cross-functional processes (Lee *et al.*, 2007; Williams *et al.*, 2013). The effective involvement of internal stakeholders in supply chain processes increases knowledge about possible interdependencies, uncertainties and potential opportunities and helps to design a more robust and responsive

Figure 1 Research model–the relationship and impact of dynamic capabilities in agri-food supply chains



organization and create better awareness and understanding of supply chain operations (Koufteros *et al.*, 2005; Flynn *et al.*, 2010). This is essential in agri-food supply chains as increasing II efforts (especially in less formal companies such as farmers and cooperatives) can enhance the utilization of organizational resources to execute the supply chain processes and improve their governance, resulting in faster conflict resolution and response to customer requirements (Ramirez *et al.*, 2020; Zhao *et al.*, 2020).

Higher EI in terms of better visibility, information sharing and process integration with suppliers and customers can lead to a better understanding of mutual needs, resulting in better-focused efforts to respond to market demand and increased agility capabilities (Chaudhuri *et al.*, 2018). Coordinating operations with suppliers, for example, is key for developing quick and reliable production plans (Narayanan *et al.*, 2015), while sharing projected sales information with the customer can reduce demand uncertainty, which, in turn, makes supply chain planning more manageable and improves internal delivery reliability (Sabet *et al.*, 2017). EI, particularly for information sharing, is vital in agri-food supply chains, especially for industrial customers. It can provide a sense of final demand and its potential evolution, reducing the lag of information flow with actors positioned more upstream in the supply chain (Hobbs and Young, 2000; Taylor and Fearne, 2006).

Higher EI in terms of collaborative decision-making and process involvement with suppliers and customers can provide advantages such as faster and more effective new product development and modification (Droge *et al.*, 2004), ultimately giving the supply chain superior agility capabilities (Gligor *et al.*, 2016). For example, in agri-food supply chains, operational integration with important customers can improve the preparation and response time for specific customization requests from distributors (Sepúlveda *et al.*, 2018). In contrast, integration with suppliers can provide quick insights into the lack of raw materials, product quality and perishability risks (Ramirez *et al.*, 2020). Both suppliers and customers can also bring complementary knowledge and infrastructure that a single actor in the agri-food supply chain cannot possess (Kumar *et al.*, 2021).

In line with previous studies that argued that internal, supplier and customer integration provide the opportunity for organizations in the supply chain network to improve their agile capabilities (Braunscheidel and Suresh, 2009; Schoenherr and Swink, 2012; Fayezi *et al.*, 2017; Jajja *et al.*, 2018; Shukor *et al.*, 2020), this study perceives EI and II as instrumental to establish SCA in agri-food supply chains.

This leads to the formulation of the following hypotheses:

H2a. In agri-food supply chains, higher II of supply chain actors positively impacts SCA.

H2b. In agri-food supply chains, the higher EI of supply chain actors positively impacts SCA.

3.2 The mediating role of organizational flexibility

Our model positions OF and SCI as main drivers of SCA but also hypothesizes a relationship between them.

Previous literature suggests that companies can be stimulated to develop they are OF further to maximize their operational ability to respond to market externalities (Fayezi *et al.*, 2017; Yu *et al.*, 2018; Shukor *et al.*, 2020). Owing to higher II, which favors cross-functionality and homogenization of strategies and processes across departments, companies can increase their capability to reconfigure their organization quickly, effectively and with consensus (Yu *et al.*, 2013; Chaudhuri *et al.*, 2018). Similarly, owing to higher EI, companies develop better capabilities for collaborating and integrating processes and information with both suppliers and customers, which can increase their ability to review their organization and their organizational objectives in line with supply chain needs (Braunscheidel and Suresh, 2009; Cheng *et al.*, 2014).

Although OF can be seen as one of the strategic capabilities that companies can improve in response to higher SCI, we also discussed that OF has been noted as one of the key drivers of agility (Gligor, 2014). Particularly in agri-food supply chains, where actors are often fragmented and heterogeneous and organizational changes are not easily implemented (Beske *et al.*, 2014; Liu *et al.*, 2019; Zhao *et al.*, 2020; Kittichotsatsawat *et al.*, 2021), possessing higher SCI capabilities can become a way to stimulate organizations to develop better OF which, in turn, provides them better capabilities to improve SCA.

This leads to the formulation of the following hypotheses:

H3a. In agri-food supply chains, higher OF of the supply chain actors positively mediates the relationship between II and SCA.

H3b. In agri-food supply chains, higher OF of the supply chain actors positively mediates the relationship between EI (i.e. with suppliers and customers) and SCA.

3.3 Impact of supply chain agility on operational performance

Agility represents the fundamental DC that allows companies (in connection with their supply chain partners) to rapidly adapt and/or respond to environmental changes, including potential and actual disruptions, thus contributing to the responsiveness of the overall supply chain (Braunscheidel and Suresh, 2009; Gligor *et al.*, 2019). The turbulence generated by the intensification of global competition, the volatility of markets and unpredictable shifts in customer demand has recorded an unprecedented hike owing to the COVID-19 emergency. In response to these challenges, supply chain partners should invest in developing and improving their level of agility, as this seems to be the best lever to manage disruption risks and ensure continuity of service to customers (Ivanov, 2020). Ultimately, SCA provides the supply chain competitive advantage, as it improves overall operational performance (OP) (Swafford *et al.*, 2008; Gligor and Holcomb, 2012; Gligor *et al.*, 2015; Dubey *et al.*, 2019a, 2019b). Indeed, in supply chains characterized by strong competition and high exposure to external uncertainty (such as agri-food supply chains), the possession of these features is the foundation of competitive advantage (Stone and Rahimifard, 2018).

This leads to the formulation of the following hypothesis:

H4. In agri-food supply chains, a higher level of SCA positively impacts the supply chain operational performance.

4. Methodology

Survey data collection was selected as an appropriate methodology to test the relationships included in the conceptual model in Figure 1. This approach has been recently used to analyze issues related to DCs in the supply chain (Chan *et al.*, 2017; Srinivasan and Swink, 2018; Dubey *et al.*, 2019b).

4.1 Context of the study

Our study focused on the agri-food industry in Latin America, specifically the Peruvian coffee supply chain. Although recent SCM studies have not considered this type of supply chain, given our research objective of studying DC, we considered the choice valid for several reasons.

In recent years, coffee production has experienced severe crises and exposure to sources of complexity and uncertainty. The recent decline in world coffee prices has further squeezed coffee producers' margins, throwing several producers below the global extreme poverty line of US$1.90/day, especially in developing countries (Amrouk, 2018). At these low farm gate prices, coffee production is not economically viable for a significant number of coffee farmers. Furthermore, coffee producers begin to bear the brunt of climate change and variability. Climate change is expected to undermine the suitability of coffee across vast regions, decrease coffee bean quality and increase the risk of coffee diseases (FAO, 2017). Consequently, the coffee industry as a whole has an interest in ensuring that coffee production can adapt to climate change. This is crucial if we consider the short life that characterizes coffee production. Although the final product is characterized by low perishability, upstream in the supply chain, time is still a critical variable in the execution of manufacturing and distribution activities (Ortiz-Miranda and Moragues-Faus, 2015). Coffee crops are genetically engineered to flower for just 48 h before they are no longer capable of withering into the seeds that help the plant reproduce itself. Furthermore, the temperature window of the coffee plant is short and fragile. Coffee grows best when temperatures range from 18°C to 22°C, so a single freeze is strong enough to interrupt the life cycle of even the healthiest crop.

These factors increase the complexity, uncertainty and exposure to the vulnerability of these supply chains (Bitzer *et al.*, 2013). Consequently, the plurality of stakeholders participating in the value-creation process pushed the development and implementation of strategic actions to increase supply chain responsiveness and resiliency to a more complex environment (Candelo *et al.*, 2018), thus making possession of DC critical to surviving.

Finally, these supply chains have been particularly challenged by the COVID-19 pandemic, where shutdowns and shortages of supply affected farmers' ability to contract workers, access roads and facilities and obtain financing. The demand for coffee exports decreased by more than 15% in the second quarter of 2020 compared to 2019 (Guido *et al.*, 2020). Particularly in Latin America [1], this pushed actors at different levels to increase their level of collaboration and quickly reconfigure the network structure, leveraging existing integration, knowledge sharing and innovation (International Coffee Organization, 2020).

Among the different countries, Perú was selected for its relevance to the industry. It represents the third-largest exporter of coffee in Latin America and the 11th worldwide, with a value of US$635m in 2019 [2]. In recent years, Peruvian coffee production has demonstrated extreme dynamism, with integration and collaboration initiatives between coffee cooperatives, associations, wholesale buyers, distributors, collectors, processors and customers to obtain a flexible and responsive network (Tulet, 2010; Bitzer *et al.*, 2013). Although Latin American regions have experienced disruptive events in the past decades, the Peruvian coffee supply chain has demonstrated a strong ability to react to external sources of risks (Ramos *et al.*, 2019; Vargas *et al.*, 2021), becoming an interesting and unexplored unit of analysis from a DC perspective.

4.1 Questionnaire design and scale development

A questionnaire was designed specifically to measure the reflective constructs and test the conceptual model shown in Figure 1. It included items directly driven by or re-adapted from the literature to the context of agri-food supply chains (see Appendix 1 for details about the questions included in the survey instrument).

To measure supply chain OF, we used five items adapted from Swafford *et al.* (2008), Srinivasan and Swink (2018) and Dubey *et al.* (2019b), who questioned respondents on the extent to which their organizations were able to change the structure quickly, cost-effectively and without negatively impacting service quality in response to changing business conditions. Further, they questioned the extent to which their organizations were able to change delivery schedules to meet customer requirements and were more flexible to changes than competitors.

To measure II, we used four items adapted from Braunscheidel and Suresh (2009) and Flynn *et al.* (2010). Respondents were questioned regarding the extent to which their organizations used cross-functional teams to solve problems, identify process improvements and use periodic interdepartmental meetings among internal functions. They also asked the extent to which internal management frequently communicated about goals and priorities.

Supply chain EI was measured as a second-order construct, using two sets of four specular items measuring supplier and customer integration, adapted from Braunscheidel and Suresh (2009) and Zhang *et al.* (2018). For supplier integration, we asked the respondents to what extent their organizations jointly developed new products with suppliers, shared demand information and received production information from suppliers. We also asked the extent to which their organizations strived to establish long-term relationships with suppliers. Similarly, for customer integration, we asked the respondents to what extent their organizations involved customers in new product development projects, shared production information with them and received customer demand information. Further, we asked the extent to which their organizations strived to establish long-term relationships with customers.

To measure SCA, we used five items adapted from Chan *et al.* (2017) and Dubey *et al.* (2019a). Respondents were asked to what extent their organizations could quickly detect changes in the environment, continuously collect information from suppliers and customers, are characterized by a speed in adjusting delivery capability, improving customer service and improving and responsiveness.

Finally, to measure supply chain OP, we used five items adapted from Chan *et al.* (2017) and Dubey *et al.* (2019a, 2019b), who questioned the respondents about the extent to which their supply chain could deliver zero-defect products, minimize total product cost, respond to and solve problems, deliver products on-time to final customers, minimizing all types of waste throughout the supply chain.

Each item was measured on a five-point Likert scale ranging from "completely disagree" to "completely agree." In addition to the model's main constructs, we included two relevant control variables on supply chain performance, namely, the type of supply chain actor and company size (in terms of a number of employees), which were operationalized through dummy variables.

4.2 Data collection and sample characteristics

Data collection occurred between May and June 2020 and entailed gathering information from all actors in the coffee supply chain including local suppliers and producers (farmers), larger independent traders/providers (cooperatives) and customers (local and international wholesalers and retailers). To avoid technological constraints and maximize the response rate, data were collected through the distribution of a paper-based survey. We were able to reach all 145 actors in the Peruvian coffee supply chain, but only 98 fully completed the survey (68% response rate). Table 1 summarizes the respondents' characteristics.

Table 1 Descriptive statistics of the sample

Primary supply chain position	*n*	(%)
Supplier	39	39.8
Coffee producers or processor	18	18.4
Distributor/trader	22	22.4
Industrial customer (e.g. wholesaler and retailer)	19	19.4
Respondent function		
Production	45	45.9
Purchasing	11	11.2
Sales	16	16.3
Logistics	14	14.3
Executive (e.g. CEO)	12	12.2
Work experience (years)		
1–5	12	12.2
6–10	29	29.6
11–20	42	42.9
>20	15	15.3
Firm size (number of employees)		
Small (5–20)	37	37.8
Medium (21–100)	53	54.0
Big (>100)	8	8.2
Annual revenue (US$)		
<100,000	52	53.1
100,000–500,000	40	40.8
>500,000	6	6.1
	98	100.0

4.3 Bias control and data analysis approach

Potential biases were considered in the survey, protocol design and data analysis. Several approaches (e.g. direct contact by phone and assurance to share the results) were adopted to ensure the highest response rate and avoid a non-response bias (Frohlich, 2002). We conducted non-parametric tests to confirm that no significant differences existed in the distribution of company size (number of employees) and role in the supply chain. Social desirability was reduced through the assurance of confidentiality and questions about the organization's behavior and its members in general, rather than directly asking about personal behaviors.

Furthermore, the common latent factor technique was applied to address common method bias (Podsakoff *et al.*, 2003). Through this analysis, we determined that the standard latent variable had a linear estimate of 0.617. This value indicates a variance of 0.380, which is below the threshold of 0.50.

To test the research model and answer our research questions, we used both partial least squares structural equation modeling (PLS-SEM) and fuzzy-set qualitative comparative analysis (fsQCA). Smart PLS and the *R* software package QCA were used for the analyzes. Applying these complementary techniques served the purpose of our study in two different ways.

Through PLS-SEM, we were able to analyze the net impact of SCA on the outcome (performance) and the relationship between DCs (OF, SCI and SCA), based on the rules of linearity, unifinality and additive effects. Although it has been criticized (Rönkkö *et al.*, 2016), following the recent recommendations provided by Hair *et al.* (2019), PLS-SEM can still be considered an appropriate methodology when: the primary objective is to better understand increasing complexity by exploring theoretical extensions of established theories (exploratory research for theory development); research goals are to predict key target constructs and identify driver constructs; the small population (actors in the Peruvian coffee supply chain) restricts the sample size (and thus, the application of more robust SEM methodologies) and the plan is to use latent variable scores for further analysis. These conditions were valid for the present study.

Through fsQCA, we can study the combinatorial effects of the different DCs, thus seeking combinations (i.e. configurations) of causal conditions leading to a specific outcome, rather than purely analyzing relationships between constructs (Ciampi *et al.*, 2021).

In this way, we can provide recommendations regarding existing relationships between DCs and between DC and supply chain performance and how DCs could be combined to obtain high supply chain performance.

5. Data analysis and results

The results of the measurement (based on confirmatory factor analysis) and structural (based on bootstrapping) models and fsQCA are reported in the following sections.

5.1 Measurement model: constructs validity and reliability

The reflective constructs were validated by testing internal consistency, composite reliability, convergent and discriminant validity (Table 2). To verify the internal consistency and

Table 2 Construct consistency, reliability, convergent and discriminant validity squared value of the AVE reported on the main diagonal of the correlation matrix

Constructs	Composite reliability	Cronbach alpha	Average variance extracted (%)	OF	II	SI	CI	EI	SCA	OP
Organizational flexibility (OF)	0.899	0.862	64.2	*0.801*						
Supply chain internal integration (II)	0.846	0.841	58.0	0.549	*0.761*					
Supply chain supplier integration (SI)	0.837	0.826	56.2	0.506	0.489	*0.750*				
Supply chain customer integration (CI)	0.832	0.844	55.5	0.507	0.485	0.485	*0.745*			
Supply chain external integration (EI)	0.810	0.813	68.1	0.499	0.463	0.566	0.503	*0.825*		
Supply chain agility (SCA)	0.885	0.804	60.8	0.537	0.526	0.517	0.524	0.465	*0.779*	
Supply chain operational performance (OP)	0.900	0.863	64.4	0.545	0.525	0.506	0.553	0.601	0.536	*0.802*

composite reliability of the constructs, we verified that the value of Cronbach's alpha and composite reliability indices exceeded 0.7 (Nunnally, 1994). This condition was valid for all the constructs.

To test convergent validity, we verified that the average variance extracted (AVE) index was greater than 50%. The lowest observed value (55.5%) was substantially higher than this threshold.

The discriminant validity of the reflective constructs was tested in three ways (Fornell and Larcker, 1981). The correlation matrix proved that the AVE was greater than the square correlation between each pair of latent constructs (Fornell-Larcker criterion). Second, we verified the outer loadings for each item to be higher than the cross-loadings. Third, we checked the heterotrait-monotrait (HTMT) ratios, with all the values lower than the threshold of 0.9. Most values were lower than 0.85 (Table 3).

Overall, these results suggest the validity of the reflective constructs used in our analysis and the adequacy of the items used as construct indicators.

5.2 Structural model: hypotheses testing

Table 4 shows the results of the structural model from the PLS analysis, including standardized path coefficients with two-tailed t-tests for the hypotheses and the post-hoc tests for testing the mediation effect of OF.

The results partially confirm the hypotheses proposed by the research model (Figure 1). The path analysis confirms that OF (*H1*: $\beta = 0.267, p < 0.01$), II (*H2a*: $\beta = 0.234, p < 0.05$) and EI (*H2b*: $\beta = 0.301, p < 0.001$) all positively impact SCA. Although both II ($\beta = 0.297$, $p < 0.001$) and EI ($\beta = 0.238$, $p < 0.05$) positively impact OF, the mediation effect is present only for the case of II, as the post-hoc test for the indirect effect is statistically significant for the path II→OF→SCA ($\beta = 0.079, p < 0.05$), but not for the path EI→OF→SCA ($\beta = 0.064$, $p > 0.05$). Therefore, *H3* is only partially confirmed (through *H3a*). Finally, SCA positively influences OP (*H4*: $\beta = 0.493, p < 0.001$).

The structural model explained a variance rate of 0.774 for OF, 0.731 for SCA and 0.608 for OP. These values can be considered as the predictive accuracy of the models between moderate and strong (Hair *et al.*, 2019). The analysis of the composite-based standardized root mean square residual (SRMR) yielded a value of 0.063, below the 0.10 threshold, which confirms the robustness of the model (Henseler *et al.*, 2015).

Finally, we found that the path coefficients of both firm size and supply chain position (our two control variables) were not statistically significant for the OP construct.

5.3 Fuzzy-set qualitative comparative analysis and importance-performance map analysis

The objective of fsQCA is to find all combinations of causal conditions that potentially lead to a certain outcome. In our case, high levels of OP represented the results, while the causal conditions were the combinations of high and low levels of DC, that is, OF, II, EI and SCA. In fsQCA, dependent and independent variables must be preliminarily calibrated, that is, transformed into fuzzy sets with values ranging from 0 to 1, where 1 represents full set membership, 0.5 represents the crossover point and 0 denotes no set membership (Ragin, 2009). For our case, the following threshold values were adopted: 5 for full membership, 2 for full non-membership and

Table 3 HTMT results

	OF	II	SI	CI	EI	SCA	OP
Organizational flexibility (OF)							
Supply chain internal integration (II)	0.859						
Supply chain supplier integration (SI)	0.806	0.788					
Supply chain customer integration (CI)	0.85	0.853	0.862				
Supply chain external integration (EI)	0.822	0.801	0.788	0.797			
Supply chain agility (SCA)	0.822	0.775	0.763	0.813	0.775		
Supply chain operational performance (OP)	0.882	0.87	0.824	0.879	0.803	0.812	

Table 4 Path analysis estimates (*** = $p < 0.001$; ** = $p < 0.01$; * = $p < 0.05$; NS = $p > 0.05$)

Hypothesis	Effect	Path	Path coefficient	*t*-statistics	*p*-values
Main effects in the research model					
H1	Direct	OF → SCA	0.267	2.82	0.004**
H2a	Direct	II → SCA	0.234	2.36	0.027*
H2b	Direct	EI → SCA	0.301	3.43	0.000***
H3a	Direct	II → OF	0.297	3.21	0.000***
H3b	Direct	EI → OF	0.238	2.53	0.011*
H4	Direct	SCA → OP	0.493	6.51	0.000***
Post-hoc tests for the mediation of OF					
H3a	Indirect	II → OF → SCA	0.079	2.46	0.013*
H3b	Indirect	EI → OF → SCA	0.064	1.87	0.061NS
Control variables					
		Firm size – small → OP	0.182	1.48	0.138NS
		Firm size – medium → OP	0.118	0.88	0.378NS
		Supply chain position – supplier → OP	0.035	0.71	0.476NS
		Supply chain position – producer → OP	0.079	0.92	0.357NS
		Supply chain position – distributor → OP	0.054	1.29	0.197NS

3 for the crossover point. Calibrated constructs were obtained by averaging the corresponding calibrated indicators.

FsQCA analyzes causal conditions and configurations of causal conditions through the metrics of consistency (i.e. the statistical significance of the configuration) and coverage (i.e. the empirical relevance of the subset) (Schneider and Wagemann, 2010).

Necessity analysis represents the first desirable step for a fsQCA. It allows verification of whether any of the DCs is always present (or absent) in all cases where high levels of OP are present (or absent). To be considered as "necessary" or "almost always necessary," a condition should have consistency above 0.9 or 0.8, respectively, and coverage above 0.75 (Ciampi *et al.*, 2021).

In our data, the necessary condition analysis shows that only high levels of SCA give consistency above 0.9, specifically 0.911, making SCA the only always necessary DC for obtaining high levels of OP. All the other DCs can be classified as "almost always necessary" with levels of consistency of 0.854 for OF, 0.812 for II and 0.889 for EI. For all conditions, the coverage was 0.91 or higher. This analysis already suggests that high levels of OP can seldom be achieved without having a high DC and can never be achieved without SCA.

We then performed a sufficiency analysis using the fsQCA algorithm to produce the truth table (Ragin, 2009). To avoid including less significant configurations, a five-observation frequency threshold was adopted, which caused the exclusion of nine cases in the sample.

To identify the sufficient configurations of conditions for supply chains to achieve high levels of OP, we considered the thresholds proposed by Skarmeas *et al.* (2014) to determine sufficiency (0.74) and coverage (0.27).

The results of the fsQCA on sufficiency conditions are reported in Table 5.

Our analysis produced four possible solutions leading to a high level of OP.

Solution 1a, with high levels of II, EI and SCA, had the highest consistency (0.967) and explained the highest number of cases (coverage = 0.744). It also had the highest unique coverage (0.414), indicating that the combination of high levels of II, EI and SCA mostly contributed to high levels of OP compared to all other solutions.

Solutions 2a and 3a included high levels of OF and SCA and only one type of SCI (EI for 2a and II for 3a). Finally, solution 4a included high levels of EI and SCA, indicating that integration with suppliers and customers and agility are sufficient conditions to achieve high levels of supply chain performance. We noticed that SCA was present in all possible configurations leading to the higher OP, confirming its role as a necessary condition to achieve high OP.

Table 5 FsQCA Results on sufficient conditions (• denotes the presence of a causal condition; ∅ denotes the absence of a causal condition; – denotes irrelevance of a causal condition)

Solutions	OF	II	EI	SCA	Consistency	Raw coverage	Unique coverage
High OP							
1a	∅	•	•	•	0.967	0.744	0.414
2a	•	–	•	•	0.953	0.418	0.017
3a	•	•	–	•	0.950	0.339	0.007
4a	∅	–	•	•	0.941	0.437	0.018
	Overall consistency: 0.916						
	Overall coverage: 0.935						
Low OP							
1b	∅	∅	∅	∅	0.891	0.432	0.071
2b	•	–	∅	∅	0.765	0.267	0.029
	Overall consistency: 0.948						
	Overall coverage: 0.830						

With fsQCA, it was also possible to explore what configurations lead to the inverse of the outcome (i.e. low levels of OP) (Ragin, 2009). Our analysis of the inverse of the outcome produced two informative solutions (1b and 2b).

In solution 1b, low levels of OP were obtained where all the DCs were absent, which confirms the relevance of these capabilities for sustained supply chain performance.

In solution 2b, low levels of OP were obtained with high levels of OF, absence of EI and SCA, regardless of the presence of II, which confirms the relevance of keeping high levels of EI and SCA to obtain high OP.

This conclusion was further confirmed by the importance-performance map analysis (Ringle and Sarstedt, 2016), which shows that SCA (with a performance of 76.1 and a total effect of 0.493) and EI (with a performance of 74.2 and a total effect of 0.356) represents the most important DCs in agri-food supply chains (Appendix 2).

6. Discussion

The empirical investigation of the relationships in the research model and the combination of the variables to obtain higher performance provides important results regarding the role of DCs in the context of agri-food supply chains.

The overall results of the study are summarized in Table 6.

6.1 Organizational flexibility and supply chain integration as drivers of supply chain agility

Our results present three DCs (OF, II and EI) as drivers of another DC-SCA.

These findings confirm the evidence already included in previous studies (Swafford *et al.*, 2006; 2008; Braunscheidel and Suresh, 2009; Gligor, 2014; Chen *et al.*, 2017; Shukor *et al.*, 2020) in the context of the Peruvian coffee supply chains.

SCA represents a desired strategic capability when supply chains are affected by high environmental uncertainty, as it allows actors in the network to perceive, in a timely manner, external and internal sources of risks and react accordingly (Whitten *et al.*, 2012).

By confirming *H1*, we conclude that to implement agile practices appropriately in the supply chain, relying on actors characterized by flexible organizations is essential. A supply chain operates within a specific range of OF and its level of agility (that is, its ability to quickly adjust tactics and operations) is constrained by that range. Increasing the OF is particularly critical in the coffee industry, where supply chains are characterized by several complex operations that involve interaction between a heterogeneous group of actors (farmers, processors, distributors, retailers) from different countries (developed and developing) and so flexibility is required to manage any potential process misalignment that might occur (Beske *et al.*, 2014; Cheng *et al.*, 2014; Mandal, 2017; Stone and Rahimifard, 2018). To maintain agri-food supply chains' solvency is a priority and the successful adoption of agile practices is born out of the adaptability of organizations in the supply chain (Liu *et al.*, 2019; Zhao *et al.*, 2020). This is even more important when disruptive events (such as the COVID-19 pandemic) occur: if agri-food manufacturers, intermediaries and retailers do not have the ability to reconfigure themselves following environmental changes, the possibility of reaching the desired SCA level might be inhibited (Hobbs and Young, 2000; Sharma *et al.*, 2020). In the coffee supply chain, during COVID-19 several coffee producers were able to adjust their delivery capabilities and limit the labor shortage during the peak harvest season by promoting the organization of community labor strategies used in the past.

Similarly, by confirming *H2*, our study interprets SCI as a mechanism to drive higher agility.

In agri-food supply chains, different actors need to invest to increase the level of II and EI before disruptive events occur. Thus, they can develop and exploit different technical and relational capabilities that can be shared and combined when environmental changes occur and manage aspects such as food security, livelihoods and biodiversity (Despoudi *et al.*, 2020; Sharma *et al.*, 2020). Although heterogeneous, these supply chains are usually characterized by a relatively small number of suppliers and moderate complexity in the supply chain structure (Ramos *et al.*, 2019), which can facilitate interaction between parties and the level of collaboration (Candelo *et al.*, 2018). For example, in coffee supply chains, for many farm operations that require significant amounts of labor (mainly, production of specialty crops such as strawberries and lettuce),

Table 6 Preliminary evidence on the role of dynamic capabilities in Agri-food supply chains

Dynamic capability	Relationship with other dynamic capabilities	Role in supply chain operational performance
Organizational flexibility	• It is a driver of SCA • Mediates the relationship between II and SCA	• It is an almost always necessary DC for obtaining higher OP, but not sufficient
Supply chain internal integration	• Its impact on SCA is mediated by OF	• It is the less important DC for obtaining higher OP (although being almost always necessary)
Supply chain external integration	• It is a driver of SCA	• It is an almost always necessary DC for obtaining higher OP (but not sufficient)
Supply chain agility	• It is enabled by OF and SCI	• It is an always necessary condition for obtaining higher OP (but not sufficient) • It is the most important DC for obtaining a higher OP

the most pressing pandemic-related challenge faced was the unavailability of workers, followed by a shock in oil demand and interruption of transportation services. Owing to the efforts made during those years, to build a constructive dialog and transparency between every actor in the network, farmers' needs (i.e. why they process in a certain way, how they harvest and what difficulties they face with shipping coffees) were already known. Thus, buyers and importers could design timely corrective actions and minimize the impact of these supply disruptions. Another example of the relationship between SCI and SCA was represented by the case of the trading platform Beyco, which, during the past few years, has been connecting and integrating coffee producers and buyers using blockchain technology. The platform focuses on transparency and traceability and its detailed data recording allows stakeholders to react quickly to external events. Demand for the platform increased during COVID-19 and it helped connect supply chain actors when they were unable to travel, thus limiting process interruption [3].

Although SCI can sometimes make supply chains more "rigid" (Huang *et al.*, 2014; Wiengarten *et al.*, 2019; Cappelli and Cini, 2020), in the agri-food context, better-integrated networks can rely on the higher volume of information about the possible risk sources (and how they affect performance), thus increasing their capability to detect environmental changes, rely on better knowledge and quickly adjust supply chain tactics and operations when needed (Fayezi *et al.*, 2017; Shukor *et al.*, 2020).

These capability drivers of agility are not independent of each other. Although only partially supported, the statistical testing of *H3* first shows that SCI contributes to increasing OF, a result that is in line with previous literature (Braunscheidel and Suresh, 2009; Fayezi *et al.*, 2017; Yu *et al.*, 2018; Dubey *et al.*, 2019b; Shukor *et al.*, 2020), but now confirmed as valid also for agri-food supply chains. Higher levels of integration can stimulate actors in the supply chain to increase the level of flexibility of their organizations, to achieve the maximum benefit of internal and external (i.e. with suppliers and customers) collaboration. During COVID-19, with cafes and restaurants closing during the lockdown, demand for coffee changed. For some producers, this created uncertainty. Several coffee companies and retailers have been working in strict cooperation with coffee producers to share their forecasts and buying commitment, establishing long-term contracts and reducing payment terms whenever possible. These initiatives aimed to be an incentive for these producers to invest in building more flexible organizations, able to maintain the same level of quality and service even in uncertain conditions.

Our results show that a mediating relationship exists between II and OF, which represents a unique finding in the SCM literature. In the context of the Peruvian coffee supply chain, investing to increase internal communication and cross-functional decision-making is the starting point for improving the OF of each actor (which, in turn, increases the level of SCA). The use of big data and modern agricultural technologies (e.g. wireless sensor networks, cloud computing, internet of things) is helping even the less structured coffee producers to improve their II and rely on efficient and flexibles process organizations able to offer reliable service to customers (Kittichotsatsawat *et al.*, 2021).

6.2 Dynamic capabilities and supply chain performance in the Agri-food context

Driven by SCI and OF, in line with previous SCM literature (Gligor and Holcomb, 2012; Whitten *et al.*, 2012; Gligor *et al.*, 2015; Dubey *et al.*, 2019a, 2019b), the present study supports the idea that SCA represents a necessary DC in contexts such as agri-food supply chains characterized by high environmental uncertainty, as it allows supply chains to effectively survive disruptive events, maintain good supply chain performance and build long-term competitive advantage.

However, although strategic, agility and agile practices on their own are not sufficient capabilities for agri-food supply chains. Our empirical analysis shows that, in all the configurations leading to higher performance, SCA needs to be paired with other DCs to reach sufficient conditions.

This supports the idea that obtaining SCA is a necessary condition to maximize the potential of collaborative efforts and translate into a positive impact on OP. In the agri-food context, agility contributes to increased supply chain performance, but it must be accompanied by SCI and OF, as configurations characterized by higher outcomes always include different DCs.

Among the drivers of SCA, EI has a particularly important role (as evident from the FsQCA and the importance-performance map analysis). Supply chains characterized by higher information sharing and collaboration with suppliers and customers rely on better information about the actors and the environment and this develops an understanding of the market conditions (and thus, the possibility to react effectively). This is a primary strategic capability to be leveraged when disruptive events such as COVID-19 or coffee rust epidemic occur, which complements previous SCM literature, which has instead emphasized OF as the main driver of SCA and/or better performance (Swafford *et al.*, 2008; Merschmann and Thonemann, 2011; Gligor, 2015; Chan *et al.*, 2017; Srinivasan and Swink, 2018; Liu *et al.*, 2019).

This represents a unique result when contextualized to agri-food supply chains, although not intended to underestimate the role of OF. Our results confirm that OF is no longer a sufficient condition for competitive advantage, but it is still a strategic capability to develop to generate other desired supply chain features.

7. Conclusions

The SCM literature strongly discusses how COVID-19 affects the production and consumer end of supply chains and particularly how supply chains should reconfigure themselves to minimize the impact of such disruptive events (Shih, 2020).

More agile supply chains appeared to be the strongest networks with the ability to deal with the global pandemic (Ivanov, 2020), which questions how supply chains should invest to increase their capabilities and obtain higher agility. Starting from these motivations, we tried to answer this question by adopting the lens of the DCV of supply chains to understand how DCs relate to each other and can be combined to positively impact performance. We adopted the agri-food industry as the context of analysis (specifically, the Peruvian coffee supply chain).

By demonstrating a positive relationship between OF, SCI, SCA and SCA as a necessary (but not sufficient) condition to obtain high OP, this study provides several theoretical and managerial contributions.

7.1 Theoretical contributions

Although providing preliminary evidence, this study represents the first attempt to establish a clear relationship between three DCs (OF, SCI and SCA), usually considered separately and supply chain performance.

Previous SCM studies have only partially included these aspects, focusing either on the relationship between integration and agility (Braunscheidel and Suresh, 2009), flexibility and agility (Chan *et al.*, 2017), integration and flexibility (Chaudhuri *et al.*, 2018), integration and performance (Wiengarten *et al.*, 2019) and agility and performance (Dubey *et al.*, 2019b). However, they did not consider all these aspects within the same research model. In particular, the results can extend the typical structure-conduct-performance framework of the supply chain (Ralston *et al.*, 2015), as we conceive SCI and OF, not as a direct driver of superior performance, but as a driver of another DC (SCA). We conclude that, according to our data, EI and SCA are the most important DCs to drive superior performance.

We ground these results in a specific context – agri-food supply chains – which have not been often used as a unit of analysis in studies on supply chain collaboration and agility (Ramirez *et al.*, 2020), despite being characterized by high environmental uncertainty. This makes OF, SCI and SCA critical aspects to be considered from an SCM perspective in these contexts (Rojo *et al.*, 2018; Sharma *et al.*, 2020).

Finally, although the survey did not collect COVID-19 specific data, responses were collected during (and concerning) the pandemic, thus contributing to the current SCM discussion about how supply chains should be reconfigured in the new post-COVID-19 business environment (Shih, 2020; Butt, 2021).

7.2 Managerial implications

From a practical perspective, we provide supply chain managers with clear guidelines on the ideal profile for the configuration of a successful agri-food network. We hope that practitioners use the results from our proposed model to grow the DCs of their supply chain, facilitate the management of potential issues or reduce the impact of risky situations such as the COVID-19 pandemic.

Results in Table 6, particularly, could serve as an example for managers on the role and impact of DCs in agri-food supply chains. Managers should invest in growing all three DCs but particularly in increasing EI and SCA, as directly related and most important capabilities to obtain higher performance. However, OF still represents a key capability to be kept, so organizations should not neglect this aspect. This empirical evidence could motivate industry experts, especially in emerging economies (characterized by a scarcity of resources), to implement and deploy flexibility, integration and agile strategies to maintain competitive results in the market.

For more unstructured actors in agri-food networks such as farmers and cooperatives, this means defining more formal and adaptable procedures in managing their processes and investing in increasing the adoption of technological support. For more structured organizations such as producers and retailers, this means designing contingency plans, conducting elaborate structure analyzes of risk sources, investing in advanced technologies and implementing specific training initiatives to prepare the organization for possible changes. With these individual efforts, the different actors can achieve higher internal collaboration and integration and capabilities for collaborating with external actors, ultimately increasing the level of SCA and OP.

7.3 Limitations and future developments

This study is characterized by specific limitations that can generate further research opportunities in the context of the agri-food sector in the Latin American region and other emerging economies.

First, the study uses exploratory techniques and it considers a specific agri-food supply chain – coffee – in a specific Latin

American country – Perú. Although the findings could be generalized to other types of agri-food industries, they should be considered preliminary and the examination of the DCs of aggregate supply chains should be conducted in other contexts characterized by high environmental uncertainty (e.g. more perishable end-food products), possibly using a bigger sample (thus enabling the application of more robust data analysis methodologies), to strengthen the statistical evidence concerning the relationship between DCs. The conceptual model could then be expanded to other sectors and extended to other representations in the processing/manufacturing and retail sectors and stored in consumer countries to achieve a more longitudinal approach.

The model does not include the specific sources of uncertainty that can impact the level of OF, integration and agility in a particular environment. Future studies should consider the impact of specific sources of risks (related or unrelated to COVID-19) on the variables included in the model.

Finally, while testing the model allows us to discuss the relationship between DCs and what combination is able to lead to high performance, the study is not able to provide any evidence on how DCs can be obtained and how the different actors (suppliers, manufacturers, distributors) contribute to their creation DCs. This opens space for a more qualitative, case-based, research approach.

Notes

1 https://www.forbes.com/sites/shaynaharris/2020/05/05/how-the-pandemic-is-impacting-coffee-supply-chains-in-central-and-south-america/?sh=50ed88a177d3

2 https://www.worldatlas.com/articles/top-coffee-producing-countries.html

3 https://www.langdoncoffee.com.au/tackling-the-covid-19-coffee-crisis-can-blockchain-strengthen-the-link-between-producers-and-buyers/

References

Amrouk, E.M. (2018), "Depressed international coffee prices: insights into the nature of the price decline", *FAO Food Outlook*, pp. 25-28.

Beske, P., Land, A. and Seuring, S. (2014), "Sustainable supply chain management practices and dynamic capabilities in the food industry: a critical analysis of the literature", *International Journal of Production Economics*, Vol. 152, pp. 131-143.

Bitzer, V., Glasbergen, P. and Arts, B. (2013), "Exploring the potential of intersectoral partnerships to improve farmers' position in global Agri-food chains: findings from the coffee sector in Peru", *Agriculture and Human Values*, Vol. 30 No. 1, pp. 5-20.

Blome, C., Schoenherr, T. and Rexhausen, D. (2013), "Antecedents and enablers of supply chain agility and its effect on performance: a dynamic capabilities perspective", *International Journal of Production Research*, Vol. 51 No. 4, pp. 1295-1318.

Bottani, E. (2010), "Profile and enablers of agile companies: an empirical investigation", *International Journal of Production Economics*, Vol. 125 No. 2, pp. 251-261.

Braunscheidel, M.J. and Suresh, N.C. (2009), "The organizational antecedents of a firm's supply chain agility for risk mitigation and response", *Journal of Operations Management*, Vol. 27 No. 2, pp. 119-140.

Butt, A.S. (2021), "Strategies to mitigate the impact of COVID-19 on supply chain disruptions: a multiple case analysis of buyers and distributors", *The International Journal of Logistics Management*.

Candelo, E., Casalegno, C., Civera, C. and Mosca, F. (2018), "Turning farmers into business partners through value co-creation projects. Insights from the coffee supply chain", *Sustainability*, Vol. 10 No. 4, p. 1018.

Cao, M. and Zhang, Q. (2011), "Supply chain collaboration: impact on collaborative advantage and firm performance", *Journal of Operations Management*, Vol. 29 No. 3, pp. 163-180.

Cappelli, A. and Cini, E. (2020), "Will the COVID-19 pandemic make us reconsider the relevance of short food supply chains and local productions?", *Trends in Food Science & Technology*, Vol. 99, pp. 566-567.

Chan, A.T., Ngai, E.W. and Moon, K.K. (2017), "The effects of strategic and manufacturing flexibilities and supply chain agility on firm performance in the fashion industry", *European Journal of Operational Research*, Vol. 259 No. 2, pp. 486-499.

Chaudhuri, A., Boer, H. and Taran, Y. (2018), "Supply chain integration, risk management and manufacturing flexibility", *International Journal of Operations & Production Management*, Vol. 38 No. 3, pp. 690-712.

Cheng, L.C.V., Cantor, D.E., Grimm, C.M. and Dresner, M. E. (2014), "Supply chain drivers of organizational Flexibility-A study of US Manufacturing industries", *Journal of Supply Chain Management*, Vol. 50 No. 4, pp. 62-75.

Cheng, Y., Chaudhuri, A. and Farooq, S. (2016), "Interplant coordination, supply chain integration, and operational performance of a plant in a manufacturing network: a mediation analysis", *Supply Chain Management: An International Journal*, Vol. 21 No. 5, pp. 550-568.

Ciampi, F., Demi, S., Magrini, A., Marzi, G. and Papa, A. (2021), "Exploring the impact of big data analytics capabilities on business model innovation: the mediating role of entrepreneurial orientation", *Journal of Business Research*, Vol. 123, pp. 1-13.

Dania, W.A.P., Xing, K. and Amer, Y. (2018), "Collaboration behavioural factors for sustainable agri-food supply chains: a systematic review", *Journal of Cleaner Production*, Vol. 186, pp. 851-864.

Despoudi, S., Papaioannou, G. and Dani, S. (2020), "Matter?", *Production Planning & Control*, pp. 1-14. "Producers responding to environmental turbulence in the Greek agricultural supply chain: does buyer type

Droge, C., Jayaram, J. and Vickery, S.K. (2004), "The effects of internal versus external integration practices on time-based performance and overall firm performance", *Journal of Operations Management*, Vol. 22 No. 6, pp. 557-573.

Dubey, R., Altay, N., Gunasekaran, A., Blome, C., Papadopoulos, T. and Childe, S.J. (2018), "Supply chain agility, adaptability and alignment: empirical evidence from the indian auto components industry", *International Journal of Operations & Production Management*, Vol. 38 No. 1, pp. 129-148.

Dubey, R., Gunasekaran, A. and Childe, S.J. (2019a), "Big data analytics capability in supply chain agility", *Management Decision*, Vol. 57 No. 8, pp. 2092-2112.

Dubey, R., Gunasekaran, A., Childe, S.J., Fosso Wamba, S., Roubaud, D. and Foropon, C. (2019b), "Empirical investigation of data analytics capability and organizational flexibility as complements to supply chain resilience", *International Journal of Production Research*, Vol. 59 No. 1, pp. 1-19.

FAO (2017), "The future of food and agriculture: trends and challenges", available at: www.fao.org/3/a-i6583e.pdf

Fayezi, S., Zutshi, A. and O'Loughlin, A. (2017), "Understanding and development of supply chain agility and flexibility: a structured literature review", *International Journal of Management Reviews*, Vol. 19 No. 4, pp. 379-407.

Fornell, C. and Larcker, D.F. (1981), "Structural equation models with unobservable variables and measurement error: algebra and statistics", *Journal of Marketing Research*, Vol. 18 No. 3, pp. 382-388.

Flynn, B.B., Huo, B. and Zhao, X. (2010), "The impact of supply chain integration on performance: a contingency and configuration approach", *Journal of Operations Management*, Vol. 28 No. 1, pp. 58-71.

Flynn, B., Cantor, D., Pagell, M., Dooley, K.J. and Azadegan, A. (2021), "From the editors: introduction to managing supply chains beyond Covid-19-preparing for the next global mega-disruption", *Journal of Supply Chain Management*, Vol. 57 No. 1, pp. 3-6.

Frohlich, M.T. (2002), "Techniques for improving response rates in OM survey research", *Journal of Operations Management*, Vol. 20 No. 1, pp. 53-62.

Ghadge, A., Er Kara, M., Mogale, D.G. and Choudhary, S. and D., S. (2020), "Sustainability implementation challenges in food supply chains: a case of UK artisan cheese producers", *Production Planning & Control*, pp. 1-16.

Gligor, D.M. (2014), "The role of demand management in achieving supply chain agility", *Supply Chain Management*, Vol. 19 No. 5, pp. 577-591.

Gligor, D.M. and Holcomb, M.C. (2012), "Antecedents and consequences of supply chain agility: establishing the link to firm performance", *Journal of Business Logistics*, Vol. 33 No. 4, pp. 295-308.

Gligor, D.M., Esmark, C.L. and Holcomb, M.C. (2015), "Performance outcomes of supply chain agility: when should you be agile?", *Journal of Operations Management*, Vols 33/34 No. 1, pp. 71-82.

Gligor, D.M., Holcomb, M.C. and Feizabadi, J. (2016), "An exploration of the strategic antecedents of firm supply chain agility: the role of a firm's orientations", *International Journal of Production Economics*, Vol. 179, pp. 24-34.

Gligor, D., Gligor, N., Holcomb, M. and Bozkurt, S. (2019), "Distinguishing between the concepts of supply chain agility and resilience", *The International Journal of Logistics Management*, Vol. 30 No. 2, pp. 467-487.

Guido, Z., Knudson, C. and Rhiney, K. (2020), "Will COVID-19 be one shock too many for smallholder coffee livelihoods?", *World Development*, Vol. 136, p. 105172.

Hair, J.F., Risher, J.J., Sarstedt, M. and Ringle, C.M. (2019), "When to use and how to report the results of PLS-SEM", *European Business Review*, Vol. 31 No. 1, pp. 2-24.

Handayati, Y., Simatupang, T.M. and Perdana, T. (2015), "Agri-food supply chain coordination: the state-of-the-art and recent developments", *Logistics Research*, Vol. 8 No. 1, p. 5.

Henseler, J., Ringle, C.M. and Sarstedt, M. (2015), "A new criterion for assessing discriminant validity in variance-based structural equation modeling", *Journal of the Academy of Marketing Science*, Vol. 43 No. 1, pp. 115-135.

Hobbs, J.E. (2020), "Food supply chains during the COVID-19 pandemic", *Canadian Journal of Agricultural Economics/Revue Canadienne D'agroeconomie*, Vol. 68 No. 2, pp. 171-176.

Hobbs, J.E. and Young, L.M. (2000), "Closer vertical co-ordination in Agri-food supply chains: a conceptual framework and some preliminary evidence", *Supply Chain Management: An International Journal*, Vol. 5 No. 3, pp. 131-143.

Huang, M., Yen, G.F. and Liu, T.C. (2014), "Reexamining supply chain integration and the supplier's performance relationships under uncertainty", *Supply Chain Management: An International Journal*, Vol. 19 No. 1, pp. 64-78.

International Coffee Organization (2020), "Impact of COVID-19 on the global coffee sector: a survey of ICO coffee members", Coffee Break series n° 3, available at: www.ico.org/documents/cy2019-20/coffee-break-series-3e.pdf

Ivanov, D. (2020), "Viable supply chain model: integrating agility, resilience and sustainability perspectives – lessons from and thinking beyond the COVID-19 pandemic", *Annals of Operations Research*, pp. 1-21.

Jajja, M.S.S., Chatha, K.A. and Farooq, S. (2018), "Impact of supply chain risk on agility performance: mediating role of supply chain integration", *International Journal of Production Economics*, Vol. 205, pp. 118-138.

Kataike, J., Aramyan, L.H., Schmidt, O., Molnár, A. and Gellynck, X. (2019), "Measuring chain performance beyond supplier–buyer relationships in agri-food chains", *Supply Chain Management: An International Journal*, Vol. 24 No. 4, pp. 484-497.

Kittichotsatsawat, Y., Jangkrajarng, V. and Tippayawong, K.Y. (2021), "Enhancing coffee supply chain towards sustainable growth with big data and modern agricultural technologies", *Sustainability*, Vol. 13 No. 8, p. 4593.

Kortmann, S., Gelhard, C., Zimmermann, C. and Piller, F.T. (2014), "Linking strategic flexibility and operational efficiency: the mediating role of ambidextrous operational capabilities", *Journal of Operations Management*, Vol. 32 Nos 7/8, pp. 475-490.

Koufteros, X., Vonderembse, M. and Jayaram, J. (2005), "Internal and external integration for product development: the contingency effects of uncertainty, equivocality, and platform strategy", *Decision Sciences*, Vol. 36 No. 1, pp. 97-133.

Kumar, A., Mangla, S.K., Kumar, P. and Song, M. (2021), "Mitigate risks in perishable food supply chains: learning from COVID-19", *Technological Forecasting and Social Change*, Vol. 166, p. 120643.

Lee, H.L. (2004), "The triple-A supply chain", *Harvard Business Review*, Vol. 82 No. 10, pp. 102-113.

Lee, C.W., Kwon, I.W.G. and Severance, D. (2007), "Relationship between supply chain performance and degree of linkage among supplier, internal integration, and customer", *Supply Chain Management: An International Journal*, Vol. 12 No. 6, pp. 444-452.

Li, X., Chung, C., Goldsby, T.J. and Holsapple, C.W. (2008), "A unified model of supply chain agility: the work-design perspective", *The International Journal of Logistics Management*, Vol. 19 No. 3, pp. 408-435.

Liu, Y., Zhang, Y., Batista, L. and Rong, K. (2019), "Green operations: what's the role of supply chain flexibility?", *International Journal of Production Economics*, Vol. 214, pp. 30-43.

Lockstrom, M., Schadel, J., Moser, R. and Harrison, N. (2011), "Domestic supplier integration in the Chinese automotive industry: the buyer's perspective", *Journal of Supply Chain Management*, Vol. 47 No. 4, pp. 44-63.

Lougee, R. (2020), "Has COVID-19 broken our food supply chain?", ORMS today, available at: https://pubsonline.informs.org/do/10.1287/orms.2020.06.02/full

McKinsey and Company (2020a), "Resetting supply chains for the next normal", available at: www.mckinsey.com/~/media/McKinsey/Business%20Functions/Operations/Our%20Insights/Resetting%20supply%20chains%20for%20the%20next%20normal/Resetting-supply-chains-for-the-next-normal.pdf

McKinsey and Company (2020b), "US food supply chain: disruptions and implications from COVID-19", available at: www.mckinsey.com/industries/consumer-packaged-goods/our-insights/us-food-supply-chain-disruptions-and-implications-from-covid-19

Mandal, S. (2017), "The influence of dynamic capabilities on hospital-supplier collaboration and hospital supply chain performance", *International Journal of Operations & Production Management*, Vol. 51 No. 7, pp. 1442-1461.

Mangla, S.K., Luthra, S., Rich, N., Kumar, D., Rana, N.P. and Dwivedi, Y.K. (2018), "Enablers to implement sustainable initiatives in Agri-food supply chains", *International Journal of Production Economics*, Vol. 203, pp. 379-393.

Merschmann, U. and Thonemann, U.W. (2011), "Supply chain flexibility, uncertainty and firm performance: an empirical analysis of german manufacturing firms", *International Journal of Production Economics*, Vol. 130 No. 1, pp. 43-53.

Mussell, A., Bilyea, T. and Hedley, D. (2020), "Agri-food supply chains and COVID-19: balancing resilience and vulnerability", Independent Agri-Food Policy Note, Agri-Food Economic Systems, 1-6, available at: www.agrifoodecon.ca

Narayanan, S., Narasimhan, R. and Schoenherr, T. (2015), "Assessing the contingent effects of collaboration on agility performance in buyer-supplier relationships", *Journal of Operations Management*, Vol. 33-34 No. 1, pp. 140-154.

Nunnally, J.C. (1994), *Psychometric Theory 3E*, Tata McGraw-Hill Education.

OECD (2020), "Food supply chains and COVID-19: impacts and policy lessons", available at: www.oecd.org/coronavirus/policy-responses/food-supply-chains-and-covid-19-impacts-and-policy-lessons-71b57aea/#abstract-d1e27

Ortiz-Miranda, D. and Moragues-Faus, A.M. (2015), "Governing fair trade coffee supply: dynamics and challenges in small farmers' organizations", *Sustainable Development*, Vol. 23 No. 1, pp. 41-54.

Pereira, S.C.F., Scarpin, M.R.S. and Neto, J.F. (2020), "Agri-food risks and mitigations: a case study of the Brazilian mango", *Production Planning & Control*, pp. 1-11.

Podsakoff, P., MacKenzie, S., Lee, J. and Podsakoff, N.P. (2003), "Common method biases in behavioral research: a critical review of the literature and recommended remedies", *Journal of Applied Psychology*, Vol. 88 No. 5, pp. 879-903.

Prajogo, D. and Olhager, J. (2012), "Supply chain integration and performance: the effects of long-term relationships, information technology and sharing, and logistics integration", *International Journal of Production Economics*, Vol. 135 No. 1, pp. 514-522.

Ragin, C.C. (2009), *Redesigning Social Inquiry: Fuzzy Sets and beyond*, University of Chicago Press.

Ralston, P.M., Blackhurst, J., Cantor, D.E. and Crum, M.R. (2015), "A structure–conduct–performance perspective of how strategic supply chain integration affects firm performance", *Journal of Supply Chain Management*, Vol. 51 No. 2, pp. 47-64.

Ramirez, M.J., Roman, I.E., Ramos, E. and Patrucco, A.S. (2020), "The value of supply chain integration in the Latin American agri-food industry: trust, commitment and performance outcomes", *The International Journal of Logistics Management*, Vol. 32 No. 1, pp. 281-301.

Ramos, E., Mesia, R., Cavero, C., Vera, B. and Wu, Z. (2019), "Modeling the distribution of organic coffee supply chain from Junín region, Peru", *International Journal of Supply Chain Management*, Vol. 8 No. 2, p. 394.

Ringle, C.M. and Sarstedt, M. (2016), "Gain more insight from your PLS-SEM results: the importance-performance map analysis", *Industrial Management & Data Systems*, Vol. 116 No. 9, pp. 1865-1886.

Rojo, A., Stevenson, M., Montes, F.J.L. and Perez-Arostegui, M.N. (2018), "Supply chain flexibility in dynamic environments", *International Journal of Operations & Production Management*, Vol. 38 No. 3, pp. 636-666.

Rönkkö, M., McIntosh, C.N., Antonakis, J. and Edwards, J.R. (2016), "Partial least squares path modeling: time for some serious second thoughts", *Journal of Operations Management*, Vols 47/48 No. 1, pp. 9-27.

Sandberg, E. (2021), "Dynamic capabilities for the creation of logistics flexibility – a conceptual framework", *The International Journal of Logistics Management*, Vol. 32 No. 2, pp. 696-714.

Sabet, E., Yazdani, N. and De Leeuw, S. (2017), "Supply chain integration strategies in fast evolving industries", *The International Journal of Logistics Management*, Vol. 28 No. 1, pp. 29-46.

Schoenherr, T. and Swink, M. (2012), "Revisiting the arcs of integration: cross-validations and extensions", *Journal of Operations Management*, Vol. 30 Nos 1/2, pp. 99-115.

Schneider, C.Q. and Wagemann, C. (2010), "Standards of good practice in qualitative comparative analysis (QCA) and

fuzzy-sets", *Comparative Sociology*, Vol. 9 No. 3, pp. 397-418.
Sepúlveda, W.S., Ureta, I., Mendoza, C. and Chekmam, L. (2018), "Ecuadorian farmers facing coffee and cocoa production quality labels", *Journal of International Food & Agribusiness Marketing*, Vol. 30 No. 3, pp. 276-290.
Sharma, R., Shishodia, A., Kamble, S., Gunasekaran, A. and Belhadi, A. (2020), "Agriculture supply chain risks and COVID-19: mitigation strategies and implications for the practitioners", *International Journal of Logistics Research and Applications*, pp. 1-27.
Shekarian, M., Nooraie, S.V.R. and Parast, M.M. (2020), "An examination of the impact of flexibility and agility on mitigating supply chain disruptions", *International Journal of Production Economics*, Vol. 220, p. 107438.
Shih, W.C. (2020), "Global supply chains in a Post-Pandemic world", *Harvard Business Review*, Vol. 98 No. 5, pp. 82-89.
Shou, Y., Li, Y., Park, Y. and Kang, M. (2018), "Supply chain integration and operational performance: the contingency effects of production systems", *Journal of Purchasing and Supply Management*, Vol. 24 No. 4, pp. 352-360.
Singh, D., Oberoi, J.S. and Ahuja, I.S. (2013), "An empirical investigation of dynamic capabilities in managing strategic flexibility in manufacturing organizations", *Management Decision*, Vol. 51 No. 7, pp. 1442-1461.
Singh, S., Kumar, R., Panchal, R. and Tiwari, M.K. (2020), "Impact of COVID-19 on logistics systems and disruptions in food supply chain", *International Journal of Production Research*, pp. 1-16.
Skarmeas, D., Leonidou, C.N. and Saridakis, C. (2014), "Examining the role of CSR skepticism using fuzzy-set qualitative comparative analysis", *Journal of Business Research*, Vol. 67 No. 9, pp. 1796-1805.
Sreedevi, R. and Saranga, H. (2017), "Uncertainty and supply chain risk: the moderating role of supply chain flexibility in risk mitigation", *International Journal of Production Economics*, Vol. 193, pp. 332-342.
Srinivasan, R. and Swink, M. (2018), "An investigation of visibility and flexibility as complements to supply chain analytics: an organizational information processing theory perspective", *Production and Operations Management*, Vol. 27 No. 10, pp. 1849-1867.
Stone, J. and Rahimifard, S. (2018), "Resilience in agri-food supply chains: a critical analysis of the literature and synthesis of a novel framework", *Supply Chain Management: An International Journal*, Vol. 23 No. 3, pp. 207-238.
Shukor, A.A.A., Newaz, M.S., Rahman, M.K. and Taha, A.Z. (2020), "Supply chain integration and its impact on supply chain agility and organizational flexibility in manufacturing firms", *International Journal of Emerging Markets*, Vol. ahead-of-print No. ahead-of-print.
Swafford, P.M., Ghosh, S. and Murthy, N. (2006), "The antecedents of supply chain agility of a firm: scale development and model testing", *Journal of Operations Management*, Vol. 24 No. 2, pp. 170-188.
Swafford, P.M., Ghosh, S. and Murthy, N. (2008), "Achieving supply chain agility through IT integration and flexibility", *International Journal of Production Economics*, Vol. 116 No. 2, pp. 288-297.
Taylor, D.H. and Fearne, A. (2006), "Towards a framework for improvement in the management of demand in agri-food supply chains", *Supply Chain Management: An International Journal*, Vol. 11 No. 5, pp. 379-384.
Teece, D.J. (2007), "Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance", *Strategic Management Journal*, Vol. 28 No. 13, pp. 1319-1350.
Teece, D. and Leih, S. (2016), "Uncertainty, innovation, and dynamic capabilities: an introduction", *California Management Review*, Vol. 58 No. 4, pp. 5-12.
Tulet, J.C. (2010), "Peru as a new major actor in Latin American coffee production", *Latin American Perspectives*, Vol. 37 No. 2, pp. 133-141.
Vanpoucke, E., Vereecke, A. and Wetzels, M. (2014), "Developing supplier integration capabilities for sustainable competitive advantage: a dynamic capabilities approach", *Journal of Operations Management*, Vol. 32 Nos 7/8, pp. 446-461.
Vargas, R., Fonseca, C., Hareau, G., Ordinola, M., Pradel, W., Robiglio, V. and Suarez, V. (2021), "Health crisis and quarantine measures in Peru: effects on livelihoods of coffee and potato farmers", *Agricultural Systems*, Vol. 187, p. 103033.
Vickery, S.K., Koufteros, X. and Droge, C. (2013), "Does product platform strategy mediate the effects of supply chain integration on performance? A dynamic capabilities perspective", *IEEE Transactions on Engineering Management*, Vol. 60 No. 4, pp. 750-762.
Whitten, G.D., Green, K.W. Jr, and Zelbst, P.J. (2012), "Triple-A supply chain performance", *International Journal of Operations & Production Management*, Vol. 1, pp. 28-48.
Wiengarten, F., Li, H., Singh, P.J. and Fynes, B. (2019), "Re-evaluating supply chain integration and firm performance: linking operations strategy to supply chain strategy", *Supply Chain Management*, Vol. 18 No. 5, pp. 539-552.
Williams, B.D., Roh, J., Tokar, T. and Swink, M. (2013), "Leveraging supply chain visibility for responsiveness: the moderating role of internal integration", *Journal of Operations Management*, Vol. 31 Nos 7/8, pp. 543-554.
Wong, C.Y., Boon-Itt, S. and Wong, C.W.Y. (2011), "The contingency effects of environmental uncertainty on the relationship between supply chain integration and operational performance", *Journal of Operations Management*, Vol. 29 No. 6, pp. 604-615.
Xu, D. and Long, Y. (2020), "The role of supply chain integration in the transformation of food manufacturers: a case study from China", *International Journal of Logistics Research and Applications*, Vol. 24 No. 2.
Yanes-Estévez, V., Oreja-Rodríguez, J.R. and García-Pérez, A. M. (2010), "Perceived environmental uncertainty in the agrifood supply chain", *British Food Journal*, Vol. 112 No. 7, pp. 688-709.
Yu, W., Jacobs, M.A., Salisbury, W.D. and Enns, H. (2013), "The effects of supply chain integration on customer satisfaction and financial performance: an organizational learning perspective", *International Journal of Production Economics*, Vol. 146 No. 1, pp. 346-358.

Yu, K., Luo, B.N., Feng, X. and Liu, J. (2018), "Supply chain information integration, flexibility, and operational performance: an archival search and content analysis", *The International Journal of Logistics Management*, Vol. 29 No. 1, pp. 340-364.

Yu, W., Chavez, R., Jacobs, M., Wong, C.Y. and Yuan, C. (2019), "Environmental scanning, supply chain integration, responsiveness, and operational performance organizational information processing theory perspective", *International Journal of Operations & Production Management*, Vol. 39 No. 5, pp. 787-814.

Zaridis, A., Vlachos, I. and Bourlakis, M. (2020), "SMEs strategy and scale constraints impact on Agri-food supply chain collaboration and firm performance", *Production Planning & Control*, pp. 1-13.

Zhang, M. and Huo, B. (2013), "The impact of dependence and trust on supply chain integration", *International Journal of Physical Distribution & Logistics Management*, Vol. 43 No. 7, pp. 544-563.

Zhang, M., Lettice, F., Chan, H.K. and Nguyen, H.T. (2018), "Supplier integration and firm performance: the moderating effects of internal integration and trust", *Production Planning & Control*, Vol. 7287, pp. 1-12.

Zhao, X., Huo, B., Selen, W. and Yeung, J.H.Y. (2011), "The impact of internal integration and relationship commitment on external integration", *Journal of Operations Management*, Vol. 29 Nos 1/2, pp. 17-32.

Zhao, G., Hormazabal, J.H., Elgueta, S., Manzur, J.P., Liu, S., Chen, H. ... and Chen, X. (2020), "The impact of knowledge governance mechanisms on supply chain performance: empirical evidence from the agri-food industry", *Production Planning & Control*, Vol. ahead-of-print No. ahead-of-print, pp. 1-24.

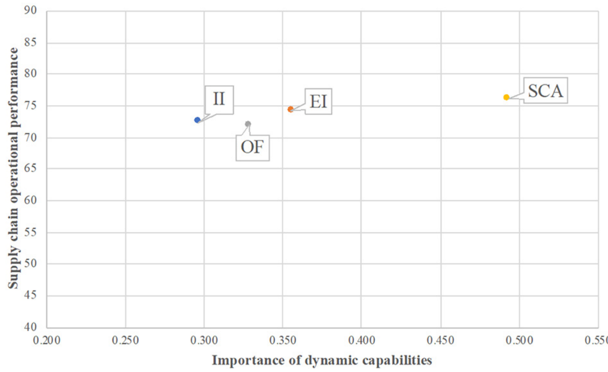
Appendix 1

Table A1 Construct measurement

Construct	Adapted from	Item label	Description
Supply chain organizational flexibility	Swafford *et al.* (2008) Srinivasan and Swink (2018) Dubey *et al.* (2019b)	OF1	We can quickly change our organizational structure to respond to changing business conditions
		OF2	We can cost-effectively change our organizational structure to respond to changing business conditions
		OF3	We can alter delivery schedules to meet customer requirements
		OF4	We can change our organizational structure without negatively impacting service quality
		OF5	Our organization is more flexible than our competitor in changing the organizational structure
Supply chain internal integration	Braunscheidel and Suresh (2009) Flynn *et al.* (2010)	II1	We use cross-functional teams to solve problems
		II2	Internal management frequently communicates about goals and priorities
		II3	Our firm encourages the use of cross-functional teams in process improvement
		II4	Our firm encourages the utilization of periodic interdepartmental meetings among internal functions
Supply chain external integration	Braunscheidel and Suresh (2009) Zhang and Huo (2013)	CI1	We actively involve customers in our new product development process
		CI2	We frequently share production information (e.g. production plan and inventory levels) with customers
		CI3	Customers frequently share demand information with our firm
		CI4	We strive to establish long term relationships with our customers
		SI1	We jointly develop new products/services with our suppliers
		SI2	We frequently share demand information with our suppliers
		SI3	Suppliers share production information (e.g. production plan and inventory levels) with us
		SI4	We strive to establish long term relationships with our suppliers
Supply chain agility	Chan *et al.* (2017) Dubey *et al.* (2019a)	AG1	Our organization can quickly detect changes in our environment
		AG2	Our organization continuously collects information from suppliers and customers
		AG3	Our organization is characterized by the speed in adjusting delivery capability
		AG4	Our organization is characterized by the speed in improving customer service
		AG5	Our organization is characterized by the speed in improving responsiveness
Supply chain operational performance	Whitten *et al.* (2012) Dubey *et al.* (2019a, 2019b)	OP1	Our supply chain has the ability to deliver zero-defect products to final customers
		OP2	Our supply chain has the ability to minimize total product cost to final customers
		OP3	Our supply chain has the ability to respond to and solve problems of the final customers quickly
		OP4	Our supply chain has the ability to deliver products on-time to final customers
		OP5	Our supply chain has the ability to minimize all types of waste throughout the supply chain

Appendix 2

Appendix 2 Importance-performance map analysis



Corresponding author

Andrea S. Patrucco can be contacted at: andreastefano.patrucco@gmail.com