Conceptualizing Supply Chain Resilience: An Alternative Dynamic Capabilities Perspective

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Despite growing attention to resilience in supply chain literature, the lack of a parsimonious conceptualization of supply chain resilience highlighting its multidimensional structure has hampered progress in empirical research. This study utilizes both the dynamic capabilities perspective in the conceptualization of supply chain resilience. The dynamic capabilities perspective is utilized to posit agility and visibility as reflective dimensions of resilience, while the SCOR perspective demonstrates that supply chain resilience as the combined effect of resilience achieved in sourcing, manufacturing and distribution processes. Thus, the resulting framework presents a comprehensive systems-based view of supply chain resilience that is very parsimonious.

INTRODUCTION

Academics and industry practitioners have become increasingly aware of the risks to firm and supply chain activities. This widespread interest comes at a time when risks to supply chains resulting from firms pursuing initiatives to respond to fiercer competition thrive. When risks are realized, they cause disruptions to firm and inter-firm operations with significant consequences. A fire in a Phillips semiconductor plant which resulted in losses of up to 400 million dollars for Ericsson, a key customer, is a quintessential example often cited in literature that demonstrates the extent to which disruptions have contagion effects throughout the supply chain (Norrman and Jansson, 2004; Tomlin, 2006; Zsidisin and Wagner, 2010). Disruptions due to natural and man-made disasters also abound. For example, Apple and Toyota were both affected by separate earthquakes that hit affected their suppliers in Taiwan and Japan respectively (Tang, 2006a; Pettit, et. al., 2010). Man-made disasters such as the terrorist attacks of September 11, 2001 impacted many supply chains including several of Ford's manufacturing plants that were delayed, resulting in idle assembly lines and failure to meet production schedules (Sheffi and Rice, 2005). Disruptions have been shown to have severe negative consequences on a firm's logistics performance, specifically, order fill capacity, delivery speed and dependability, and customer satisfaction (Wagner and Bode, 2008). For example, Ford's production of F-150 pickup trucks had to be suspended for two weeks, due to a fire at a major supplier's plant (Howard, 2018). Furthermore, announcements of disruptions have also been demonstrated to have effects on firm performance. In addition to an abnormal decrease in shareholder value, firms reporting disruptions experience significantly lower sales growth, and higher growth in costs and inventory, taking them up to two years to recover from the disruption announcement (Hendricks and Singhal, 2003, 2005).

This growing attention to disruptions and their effects has spawned research into disruption and risk mitigation. This research stream can be classified into two categories: (1) formal disruption risk

management techniques, and (2) supply chain resilience. Formal disruption management is the procedure, or series of procedures of estimating the probability and severity of the disruption event (Zsidisin, et. al., 2004). These steps typically include disruption identification, estimation of probabilities and potential losses, and evaluating and selecting appropriate countermeasures (Kleindorfer and Saad, 2005). These steps have been examined from different perspectives, including a real options perspective (Cucchiella and Gastaldi, 2006), a proactive disruption risk management approach (Knemeyer, et. al., 2009), a global supply chain risk management approach (Manuj and Mentzer, 2008) and a value-focused process engineering perspective (Neiger, et. al., 2009).

However, despite growing interest in supply chain resilience, the nature of the concept is still unclear. As indicated by Bhamra et. al. (2011), "it is essential to understand whether resilience is: a measure, a feature, a philosophy or a capability? … is being resilient a tangible capability or an intangible capability?" The lack of conceptual clarity concerning the phenomenon of resilience prevents further development and understanding of resilience from a supply chain perspective from a theoretical and empirical perspective. Without proper and adequate construct conceptualization, researchers would face difficulty in developing measures and specifying how the measures relate to the constructs with the ultimate consequence of undermining the credibility of a study that relies on these inadequate constructs (Mackenzie, 2003).

Our objectives in this paper are as follows. First, we utilize the dynamic capabilities perspective to identify agility and visibility as theoretically defensible dimensions of resilience. Second, we utilize the SCOR model to propose supply chain resilience as the combined effect of resilience capabilities developed in sourcing, manufacturing and distribution activities. This study contributes to existing literature by providing a framework of supply chain resilience utilizable in future empirical studies.

The remainder of this paper is structured as follows: The next section provides a selected literature review on risks and resilience in supply chain management literature. Following, we provide a discussion on dynamic capabilities and establish how the dynamic capabilities perspective fits into resilience. Next, we develop and discuss a framework for supply chain resilience. Finally, we conclude with a discussion of our framework, including limitations and areas for future research.

LITERATURE REVIEW

We restrict our literature review specifically to articles addressing supply chain resilience. Though research on supply chain resilience is still in its nascent phase, we are able to observe some trends. First, we find that research on supply chain resilience seeks the integration of the concept of resilience from multiple disciplines. Specifically, Ponomarov and Holcomb (2009) draw from the ecological, psychological and economic perspectives of resilience to create a definition of supply chain resilience as, "the adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function" (Ponomarov and Holcomb 2009, p. 131). Similarly, Bhamra et. al., (2011) reviewed 100 articles on resilience from ecological, individual, social, organizational and supply chain contexts and uncovered four different perspectives on resilience: resilience has been viewed from a behavior and dynamics context, a capabilities context, a strategy context, and a performance context.

A second trend in supply chain resilience literature is the aggregation of potential components of resilience in a conceptual framework. Specifically, Sheffi and Rice (2005) take a competitive advantage perspective on resilience, to identify two important variables: the competitive position of the enterprise, and the responsiveness of the supply chain. Furthermore, they also present resilience as being bolstered by building in flexibility or building redundancy. Redundancy is the concept that relates to having reserve resources in case of delays or disruptions, while flexibility relates to the development of capabilities able to sense threats and respond to them.

By contrast, Christopher and Peck (2004) take a philosophical approach to present four principles regarding supply chain resilience. First, resilience is a feature that is designed and engineered into a supply chain. Second, collaboration between supply chain partners is essential to developing inter-firm

resilience. Third, due to the need to react quickly to unpredictable events, resilience implies agility. Finally, a risk management culture in the organization is necessary for the development of resilience. Pettit et. al., (2010) also take a philosophical approach to resilience. They contrast resilience with traditional approaches to risk management in order to present resilience as a portfolio of capabilities and management controls designed to counteract external vulnerabilities that the firm faces. They present a comprehensive list of capability factors that include organizational strategic components (such as flexible sourcing and order fulfillment, visibility and adaptability), inter-firm components (collaboration), and industry related components (market position).

Two major directions for research emerge from this literature review. First, there is a lack of consensus on the nature of resilience. Bhamra et. al. (2011) pose the following question, " it is essential to understand whether resilience is: a measure, a feature, a philosophy or a capability?" (Bhamra, et. al., 2011, p. 5389). Second, while studies have aggregated potential components of resilience, we find that the relationship between these components and resilience is hardly specified. As mentioned by Ponomarov and Holcomb (2009), key elements of supply chain resilience and the relationships among them are poorly understood. Furthermore, we find that the lack of parsimonious nature of components of existing resilience frameworks inhibits advancements in empirical research into resilience.

Accordingly, our objectives in this research are as follows: First, we utilize dynamic capabilities to present resilience as a capability and identify dimensions of resilience. Second, we utilize dynamic capabilities in conjunction with the SCOR framework to develop an empirically testable model of supply chain resilience. Following is a discussion on dynamic capabilities.

THEORETICAL FRAMEWORK

Dynamic Capabilities

Teece, et. al., (1997) influentially advanced the dynamic capabilities concept in response to the inadequacy of existing theories in addressing key issues of competitive advantage in rapidly changing environments. Differential firm performance is a primary question driving management scholarship (Fawcett and Waller, 2012). Industrial economics and resource-based view are two different perspectives on why firms outperform others. The industrial economics perspective places a firm's competitive advantage in how the firm manages external competitive forces, either by taking defensive positions against competitors or by taking actions to throw rivals off balance (Shapiro, 1989; Teece, et. al., 1997). On the other hand, resource-based perspectives on competitive advantage places emphasis on leveraging firm specific resources that are rare, difficult to imitate and difficult to substitute (Wenerfelt, 1984; Barney 1991).

A key issue with the industrial economics perspective is that econometric studies have consistently demonstrated that firm-specific components, as opposed to industry-related components explain the largest percentage of variance in firm performance (Rummelt, 1991; McGahan and Porter, 1997; Hough, 2006). On the other hand, the highly dynamic business environment of the post-90s challenged the original arguments as presented by the resource-based perspective. The value of a resource is determined by exogenous factors, i.e., when they exploit opportunities or neutralize threats in a firm's environment (Barney, 1991). Therefore, if the product and customer factors vary, then resource values may vary (Priem and Butler, 2001). Consequently, in highly dynamic business environment, resource-based perspectives of the firm overemphasize the role of leveraging resources because the true locus of competitive advantage lies ability to reconfigure resources concomitant with the current business environment (Eisenhardt and Martin, 2000). Dynamic capabilities, defined as the firm's ability to integrate, build and reconfigure internal and external competences to address rapidly changing environments (Teece, et. al., 1997), are therefore essential to resources commonly linked to resilience.

Fundamental to the concept of dynamic capabilities is the distinction between operational capabilities and higher order capabilities. Operational capabilities are responsible for the firm's daily routines and directly contribute to the firm's output (Winter, 2003). Conversely, higher order capabilities do not directly contribute to the firm's output but contribute indirectly via their impact on operational

capabilities. However, they are embedded in the firm's organizational routines because as capabilities, they must have achieved some level of practiced activity (Helfat and Peteraf, 2003). Dynamic capabilities are higher order capabilities because they indirectly contribute to firm performance by aiming at changing a firm's resources and operational routines (Zollo and Winter, 2002; Zott, 2003).

Dynamic capabilities place emphasis on the firm's processes, positions and path dependencies. Processes include organizational and managerial processes that are effectively coordinated and integrated and allow for learning and ease of reconfiguration. Positions include the firm's tangible and non-tangible assets within the firm and the firm's market position. Path dependencies emphasize that a firm's current and future position are often shaped and constrained by the path it has traveled (Teece, et. al., 1997).

Dynamic Capabilities and Resilience

Through the lens of dynamic capabilities, we identify theoretically feasible dimensions of resilience to be used in our framework. The theoretical underpinnings of resilience suggest a higher order embedded capability, that is, resilience should be designed in (Christopher and Peck, 2005). Furthermore, dynamic capabilities employ two principles relevant to the development of our resilience framework. First, dynamic capabilities relates to the firm's ability to sense and shape opportunities and threats. This recognition ability relates to a firm's ability to assess and leverage information about the business environment through learning and innovation as well as capitalizing on innovation capabilities of suppliers and customers (Teece, 2007). We extend this principle to resilience as the capability enables the firm's ability to sense and manage threats. This aspect of resilience, that relates to the ability to detect disruptions and, in the event of the occurrence of a disruption, the tracing of the disruption for quick recovery (Sheffi and Rice, 2005; Blackhurst, et. al., 2005; Skilton and Robinson, 2009). Second, dynamic capabilities includes the capacity to maintain competitiveness through enhancing, combining, protecting, and, when necessary, reconfiguring the business enterprise's intangible and tangible assets (Teece, 2007). This aspect of the resilience is the mechanism by which a firm can avoid potential disruptions, and/or quickly recover from disruptions through rapid reconfiguration of resources. Through integrating these three aspects of resilience, we posit two dimensions of resilience: visibility and agility. A discussion of each follows.

Resilience and Agility

Agility references a firm's ability to respond to unexpected and unpredicted changes and events, market opportunities and customer requirements (Kidd, 2000). Agility is an often-cited necessity in a turbulent, hyper-competitive environment marked by constant change and market unpredictability. In such environments, agility can be seen as a source of competitive advantage due to the ability to efficiently change operating states (Narasimhan, et. al., 2006). Due to providing firms with the ability to respond to unforeseen events, agility has been found to be of value in risk mitigation and response. In addition to responding to marketplace changes, Braunscheidel and Suresh (2009) extend the definition of supply chain agility to include responding to potential and actual disruptions.

Flexibility is a key component of agility that is relevant to the development of our resilience framework. Flexibility is a measure of reactionary capabilities; it is the ability of a firm to implement different processes and apply different facilities to reach the same results (Lin, et. al., 2006). Agility, on the other hand, is a measure of reactionary time (Swafford, et. al., 2008). Consequently, agility is considered an externally focused capability, with flexibility as an antecedent (Swafford, et. al., 2006; Vasquez-Bustelo et. al., 2007; Tang and Tomlin, 2008), where agility involves tapping into the synergies of different forms of flexibility within a firm (Agarwal, et. al., 2006). At the inter-firm level, external integration is also identified as a component of agility. External integration is necessary for the coordination of responses across multiple firms to meet unforeseen changes (Braunscheidel and Suresh, 2009; Chiang, et. al., 2012; Gligor and Holcomb 2012).

Through the lens of dynamic capabilities, we identify agility as a dimension of resilience. We posit that the flexibility component of agility is the dynamic capability that enables the reconfiguration of a business's assets in response to potential or actual disruptions. Furthermore, the external integration

component of agility enables coordinated reconfiguration of inter-firm processes in response to unforeseen changes in order to respond to potential or actual disruptions. Consequently, we posit agility as a reflective dimension of resilience.

Resilience and Visibility

Visibility is defined as "the extent to which actors within a supply chain have access to or share information which they consider as key or useful to their operations, and which they consider will be of mutual benefit" (Barratt and Oke, 2007). Consequently, information sharing is an activity that enables visibility, as the recipient must determine whether the information is of their benefit (Barratt and Oke, 2007). Properties of information that enable visibility include timeliness, quality, trustworthiness and accuracy (Klein, 2007; Zhou and Benton, 2007).

Information sharing provides benefits in terms of the resolution of the bullwhip effect (Lee, et. al., 1997) and reduction in inventory due to the ability to replace inventory with information (Bourland, et. al., 1996; Gavirneni, et. al., 1999; Cachon and Fisher, 2000; Chu and Lee, 2006). Additionally, information sharing enables improvements in customer service through the reduction in lost sales as there is increased confidence in managing the supply chain (Martin and Hau, 2004; Delen, et. al., 2007).

Through the lens of dynamic capabilities, we also identify visibility as a dimension of resilience. Visibility is the dynamic capability that enables the sensing of potential and actual threats (Brandon-Jones, et. al., 2014). The ability to trace the causes of adverse events is critically dependent on timely, accurate and reliable information about process chains (Skilton and Robinson, 2009). In addition to tracing actual disruptions, visibility may also serve as a warning capability. Visibility enables the conveyance of pertinent information about potential or actual disruptions to relevant members of the supply chain who would be affected by the disruption, thereby enabling members to proactively plan for disruption avoidance and/or recovery (Blackhurst, et. al., 2005; Craighead, et. al., 2007). Consequently, we posit visibility as a reflective dimension of resilience.

The SCOR Framework

Having identified agility and visibility as foundational dimensions of resilience, we further develop our resilience framework utilizing the SCOR model. We utilize the SCOR model to establish resilience in the source, make and deliver processes. The SCOR model is utilized for the following reasons. First, supply chain agility is a largely multidimensional construct, and we seek to emphasize different aspects of agility depending on its context. We emphasize the flexibility aspect of agility and the firm level, and we emphasize the integrative aspect of agility at the inter-firm level. Second, in line with Pettit et. al., (2010), we seek to develop a resilience framework that covers a wide range of vulnerability factors. Our literature review on potential disruptions classifies threats according to the sourcing, manufacturing and delivering processes. Following is a discussion on supply chain threats.

Supply side risks are typically associated with inadequate supplier performance. This may result either from the nature of the product, i.e., high demand uncertainty, or from the suppliers' incapability (Tang, 2006a). The supplier's incapability to fulfill the focal firm's demand may result from inadequate capacity (Zsidisin and Ellram, 2003; Chopra and Sodhi, 2004), the supplier's inability to handle volume demand changes (Noordewier, et. al., 1990; Lee, et. al., 1997) with the ultimate consequence of being unable to fill order demands (Ellis, et. al., 2011). In addition to the inability to fulfill order quantities, the supplier's inability to meet quality requirements may also result in supplier delays (Lee and Billington, 1993). Therefore, resilience on the supply side needs to reflect the ability to withstand disruptions and/or maintain continuity of operations result from supplier incapabilities or volatile demand.

Operational risks, i.e. risks arising from within the firm, result in the focal firm's inability to meet its own production goals in the scheduled time. These risks are typically linked to inadequate capacity, infrastructure breakdowns. Inadequate capacity occurs when the firm's process capabilities are lower than their customer's demand resulting in production delays (Simons, 1999). Additionally, inadequate capacity may also result from high variability in the production process (Manuj and Mentzer, 2008). This may result in inconsistent production outputs that may not meet customer demand. Furthermore, frequent

breakdowns of infrastructure and equipment downtimes that a firm utilizes for its production operations may also result in the inability to meet scheduled production targets (Wagner and Bode, 2008; Rao and Goldsby, 2009). Consequently, resilience on the operational side needs to reflect the ability to withstand these threats.

Demand side risks, which are risks linked to the inability to fill customer demand in a timely manner, are typically linked to the nature of product demand and distorted information on demand between supply chain partners. These are commonly linked to the level of demand uncertainty. High variations in demand present higher opportunities for unfilled orders than lower demand volatility (Johnson, 2001). Furthermore, distorted information on demand is considered a major contributor to the amplification of demand volatility between inter-firm partners (Lee, et. al., 2004). Consequently, resilience on the demand side involves being able to withstand severe demand volatilities, as well as inaccurate demand forecasts.

Procurement Resilience

Procurement resilience refers to the extent to which sourcing activities are able to withstand and/or quickly recover from disruptions that threat these sourcing activities. Sourcing activities, a key link between manufacturers and their suppliers, involve all activities related to the purchasing and delivery of quality material. Consequently, these activities are contingent on both the supplier's capabilities as well as the manufacturer's internal capabilities (Swafford, et. al., 2006).

Procurement agility refers to the structural and procedural aspects of sourcing that enable ease of reconfiguration of sourcing activities. Since procurement activities necessarily involve both the capabilities of the manufacturer and supplier, we conceptualize procurement agility through their collaborative activities that enable ease and rapid reconfiguration. Improved responsiveness in procurement activities is achieved through effective supplier relationship management (Narasimhan, et. al., 2001). Maintaining relationships requires a high level of managerial effort and therefore, a reduction in supply chase is required in order to achieve close relationships (Langley and Holcomb, 1992). However, in addition to reduction in inventory management costs, improved quality and benefits related to increased economies of scale based on order volume (Shin, et. al., 2000; Chen and Paulraj, 2004), increased collaborative activities with suppliers enables firms to reduce lead times due to dedicated capacity and WIP inventory from their suppliers (Chen, et. al., 2004). Consequently, reduction in supply base reflects the resilience capability of rapid reconfiguration in response to potential threats.

It is worth mentioning that extant research identifies a reduction in supplier base as a strategy that contributes to increased supply chain vulnerability. Fewer supply chain partners results in a more critical role that each partner plays. Therefore, the effect of a disruption on one firm in this supply chain would have an increased ripple effect throughout the supply chain (Christopher and Peck, 2004; Craighead, et. al., 2007). However, for the purpose of this research, we take the perspective that having multiple suppliers increases the complexity of the supply chain, making it difficult to manage (Manuj and Mentzer, 2008), thereby making the traceability of potential disruptions increasingly difficult (Skilton and Robinson, 2009). We take this perspective because our consideration of resilience is restricted to network-related sources of risk, which are mitigated by increased co-ordination that is only enabled by having fewer partners.

Procurement visibility refers to the extent to which the manufacturer and supplier have access to or share information that they consider as key or useful to their operations and which they consider to be of mutual benefit (Barratt and Oke, 2007). With more accurate information flows, production efficiency is improved due to the direct impact that this information has on production scheduling, inventory and shipment control (Heikkila, 2002; Wilding and Humphries, 2006). In addition to these benefits, we posit that this increased visibility improves the ability of the manufacturers and suppliers to trace potential threats to the sourcing activities. Increased information visibility allows partnering firms to be more responsive to volatile demand (Rosenzweig, et. al., 2003).

Procurement resilience is a capability reflected by the ability to trace potential threats to sourcing activities, as well as adapt and reconfigure to either avoid these threats, or recover from the detrimental consequences of these threats. This capability is reflected in the agility and visibility dimensions of

procurement activities. Therefore, we posit that procurement agility and procurement visibility are dimensions of procurement resilience. Thus:

P1a: Procurement agility is a dimension of procurement resilience.

P1b: Procurement visibility is a dimension of procurement resilience.

Manufacturing Resilience

Manufacturing resilience refers to the extent to which manufacturing activities are able to withstand and/or quickly recover from disruptions that pose as a threat to manufacturing operations. For the purpose of this study, we treat manufacturing activities as contingent solely on the manufacturer's internal capabilities.

Manufacturing agility refers to the structural and procedural aspects of sourcing that enable ease of reconfiguration of sourcing activities. Within the manufacturing context, manufacturing flexibility is a major component of manufacturing agility. While these concepts may be similar, it is recognized in research that flexibility and agility are different concepts, with flexibility being an antecedent to agility (Braunscheidel and Suresh, 2009; Chiang, et. al., 2012). Swafford et. al., (2006), define manufacturing flexibility as the coalignment of its range and adaptability dimensions. Manufacturing range refers to the capacity to manufacture multiple products and multiple production volumes in a cost effective manner Manufacturing adaptability refers to the ability to accommodate changes in volume and production mix requirements. The difference between these two closely related dimensions is that manufacturing range relates to capacity, while manufacturing adaptability relates to process reconfiguration. Manufacturing agility reflects the resilience capability that is able to reconfigure manufacturing processes in order to withstand and/or recover from threats to manufacturing activities such as breakdowns in manufacturing infrastructure, inadequate capacity, and undesired variability in the production process (Simons, 1999; Manuj and Mentzer, 2008; Jiang, et. al., 2009).

Manufacturing visibility refers to the extent of information sharing between the organizational functions directly or indirectly involved in manufacturing activities. These organizational functions include purchasing, manufacturing, logistics, and marketing. While reference is made to many different organizational functions, we refer to this construct as manufacturing visibility in order to remain consistent with our SCOR perspective of the supply chain, which in this case refers to the 'make' process. Barratt and Barratt (2011) provide many potential benefits of manufacturing visibility including acting as a conduit for extending visibility across multiple firms, and positively impacting operational performance if utilized efficiently and/or effectively.

Manufacturing resilience is a capability reflected by the ability to trace potential threats to manufacturing activities, as well as adapt and reconfigure to either avoid these threats, or recover from the detrimental consequences of these threats. This capability is reflected in the agility and visibility dimensions of manufacturing activities. Therefore, we posit that manufacturing agility and manufacturing visibility are dimensions of manufacturing resilience. Thus:

P2a: Manufacturing agility is a dimension of manufacturing resilience.

P2b: Manufacturing visibility is a dimension of manufacturing resilience.

Distribution Resilience

Distribution resilience refers to the extent to which sourcing activities are able to withstand and/or quickly recover from disruptions that pose as a threat to distribution activities. Threats to distribution activities include any untoward events that disrupt the accurate and timely fulfillment of customer demand, such as transportation disruptions, high demand volatility, and inaccurate forecasting (Johnson, 2001; Harland, et. al., 2003).

Distribution agility refers to the structural and procedural aspects of sourcing that enable ease of reconfiguration of distribution activities. Distribution agility is a capability involving both the manufacturers and their downstream partners. As a result, in similar fashion with procurement agility, we posit distribution agility as the collaborative activities shared by a manufacturer and its customers that allow for rapid reconfiguration. Distribution agility can be achieved via postponement. Postponement

allows for the minimization of uncertainty costs that are tied to differentiation of goods occurring during manufacturing and logistics, by delaying differentiation of form and identity of products until the latest possible point (Pagh and Cooper, 1998). By minimizing uncertainty costs due to differentiation, postponement can also be seen as resilience capability. Delaying changes in different product configurations and inventory locations until the final market changes reduces risks inherent with major changes in customer needs, technologies and competitor's actions (Yang and Yang, 2010).

Distribution visibility refers to the extent to which the manufacturer and customer have access to or share information that they consider as key or useful to their operations and which they consider to be of mutual benefit. Distribution visibility has efficiency related benefits in terms of inventory reduction, due to the manufacturer receiving demand information that allows for the reduction in demand uncertainty, and therefore, safety stocks (Wilding and Humphries, 2006). Therefore, we posit that distribution visibility reflects a resilience capability due to the improved ability to trace potential threats to distribution activities.

Distribution resilience is a capability reflected by the ability to trace potential threats to distribution activities, as well as adapt and reconfigure to either avoid these threats, or recover from the detrimental consequences of these threats. This capability is reflected in the agility and visibility dimensions of distribution activities. Therefore, we posit that distribution agility and distribution are dimensions of distribution resilience. Thus:

P3a: Distribution agility is a dimension of distribution resilience.

P3b: Distribution visibility is a dimension of distribution resilience.

Supply Chain Resilience

We posit supply chain resilience as the combined effect of resilience in procurement, manufacturing and distribution resilience. From the SCOR model perspective, supply chain resilience is achieved through the development of resilience capabilities in sourcing, manufacturing and distribution. Accordingly, we make the following hypotheses:

P4: A positive relationship exists between sourcing resilience and supply chain resilience

P5: A positive relationship exists between manufacturing resilience and supply chain resilience

P6: A positive relationship exists between distribution resilience and supply chain resilience

Resilience and Performance

The dynamic capabilities perspective of resilience led us to classify resilience as a higher order capability. Dynamic capabilities do not directly contribute to a firm's output but contribute indirectly via their impact on operational capabilities (Helfat and Peteraf, 2003; Zott, 2003). They are the firm's systematic methods for reconfiguring operational capabilities (Zollo and Winter, 2000). Consequently, we posit that resilience has an indirect link to firm performance. Resilience positively contributes to performance in environments where the firm has to reconfigure its operational capabilities on a frequent basis.

This can occur in two closely related situations. First, frequent reconfiguration of operational capabilities can occur in environments where the firm is highly susceptible to disruptions. This constant exposure to vulnerability factors necessitates the need for firms to utilize dynamic capabilities to reconfigure resources for the purposes of managing potential and actual disruptions in order to maintain the continuity of the firm's operations. Second, in line with the development of dynamic capabilities, frequent reconfiguration of operational capabilities can occur in environments where constant adaptation can be used as a source of competitive advantage. Specifically, in environments that exhibit a high degree of market and environmental turbulence. Factors such as radical technological innovation, regulatory change, economic cycle and changing competitive nature of the industry increase the drive for firms to exhibit dynamic capabilities (Zollo and Winter, 2000; Wang and Ahmed, 2007). In these contexts, fast-responding firms can gain market share and solidify leadership positions against firms that are slow responders to marketplace changes (Sheffi and Rice, 2005). Conversely, within the context of static environments and low vulnerabilities, the need for frequent reconfiguration of operational capabilities

may be unnecessary. Consequently, the development of dynamic capabilities may prove to be too costly to maintain (Zollo and Winter, 2000). Thus, if resilience capabilities are developed and under-utilized, they can have a negative effect on profitability (Pettit, et. al., 2010; Blackhurst, et. al., 2011). Thus, synthesizing these two perspectives leads us to make the following proposition.

> P7: Resilience positively contributes to performance in contexts of high environmental turbulence. In contexts of stable environments, the development of resilience capabilities negatively affects performance.

CONCLUSION

Organizational and supply chain strategies need to consider the environmental conditions in which they operate. For instance, lean and agile supply chain strategies are based on the nature of the product being produced, with functional products requiring cost efficient supply chains, while innovative products requiring responsive supply chains (Fisher, 1997). Those strategies can also be characterized based on how they address their entrepreneurial, managerial, and operational processes. Firms can be characterized either as those who seek to constantly exploit new market opportunities, or those who seek to dominate a stable segment of the market, or those who do both simultaneously (Miles, et. al., 1978). Our resilience framework extends these strategic implications to how firms address their resilience capabilities. Since disruptions have significant detrimental consequences on firm performance (Wagner and Bode, 2008, Hendricks and Singhal, 2005), it is imperative that firms include resilience as part of their operations and supply chain strategy (Peck, 2006, Williams et al., 2008).

This study examines the antecedents and consequences of resilience. Drawing from the dynamic capabilities perspective, we posited agility and visibility as key components of resilience. To align with the SCOR perspective of the supply chain, we examined resilience from the perspective of procurement, manufacturing and distribution activities, and posited that supply chain resilience is the combined effect of resilience from achieved in each of these three activities. To synthesize multiple perspectives, we posited the relationship between resilience and performance to be positive or negative contingent on the level of environmental turbulence in which the firm operates.

By providing clearly defined constructs and theoretically defensible dimensions of resilience, our framework sets the groundwork for future empirical studies on resilience. Moving forward, the empirical validation of our developed framework, including scale development, and the examination of the relationship between resilience and performance will facilitate a greater understanding on supply chain resilience.

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