Strategic Agility in Supply Chains: A Conceptual Research Review

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Whether and how organizations should enhance their agility depends greatly on the nature, scope, and time frames of the challenges involved. We review the literature on strategic and operational agility in supply chains, focusing primarily on better integrations of Strategy Theory and Operations Management. We interpretively review relevant literature in these two fields, each with its own journals, theoretical approaches, and professional organizations, to discern key concepts and approaches. We then develop conceptual syntheses of the main agility factors for supply chains and examine eight prototypical cases, followed by additional contextual insights. We conclude with unsettled research issues for supply chain agility and extend this further to the field of strategic management, including promising topics – some canonical - for further research.

Keywords: Agility, Supply chains, Leadership, Scenarios, Systemic Risk

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1 Introduction

Supply chains are critical shared systems of modern society, linking firms across and within national borders into production-distribution networks. In 2022, cross-border merchandise exports alone were $24.3 trillion, a quarter of the global GDP. Supply chain management is important at multiple industry levels, according to a meta-analysis that showed a positive association between supply chain integration and firm performance (Leuschner et al., 2013). At the *firm* level, collaborative supplier partnerships (versus transactionally competing short-term for profit) assure the long-term availability of critical materials (Kraljic, 1983). Long-term perspectives and trust stimulate product and process innovation (Anderson et al., 2019; Appleyard, 2003; Schoenherr & Swink, 2014). Interfirm collaborations can spur supplier diversification through closer customer connections (Mawdsley & Somaya, 2018). *Buyer-supplier dyads* can likewise create value through

complementary assets, knowledge transfer, and governance mechanisms (Dyer & Singh, 1998; Kogut & Zander, 1992) or by building superior products that use integrated architectures (Ülkü & Schmidt, 2011). In *broader supply ecosystems*, frequent coordination with customers and suppliers fosters superior operational performance (Frohlich & Westbrook, 2001; Hult et al., 2002, 2007).

Interfirm coordination in supply chains enables value creation when product demand and supply change rapidly and unpredictably. An example from the COVID-19 pandemic is the Get Us PPE shortage index, which used a simple hashtag to promote national movement about the need for personal protective equipment (PPE) in different parts of the U.S. This movement encouraged firms to donate PPEs wherever needed and later to retrofit factories to produce PPEs (and other equipment like ventilators) under the auspices of the Defense Production Act of 1950 which helped meet skyrocketing demand (He et al., 2021). Such agile coordination is a hallmark of the critical role of supply chains in humanitarian logistics when food, medicine, and equipment supplies must be mobilized swiftly in natural or manmade disasters (Van Wassenhove, 2006). The coordination of critical decisions made by diverse organizations in advance of and during emergencies can make agility in supply chains "strategic" (Leiblein et al., 2018).

Despite its importance in our increasingly uncertain and interconnected world, the role of strategic agility in supply chains remains poorly understood. In a seminal supply chain article, Lee (2004) identified two types of strategic agility based on the nature of the external changes that firms encounter: *supply chain agility* was defined as the ability to respond to short-term changes in demand or supply, and *supply chain adaptability* as the ability to reinvent itself to handle structural market shifts better. Still, the *strategic agility* construct lacks a broadly shared unified definition when viewed across key disciplines. Some management scholars defined it as "the capacity of making knowledgeable, nimble, rapid strategic moves with a high level of precision" (Brueller et al., 2014). Others defined it as the ability "to constantly and rapidly sense and respond to a changing environment by intentionally making strategic moves and consequently adapting the necessary organizational configuration for successful implementation" (Weber & Tarba, 2014). The former highlights nimbleness and precision, whereas the latter emphasizes systemic adaptation via organizational reconfigurations. These strategic changes could be planned top-down as part of unified strategic planning efforts or might result from bottom-up responses via local

incrementalism (Lindblom, 1959; Quinn, 1978; Heracleous et al., 2023). These definitional incongruities point to conceptual confusion or differences about scopes, purposes, and methods.

Since agility is typically associated with speed, pursuing rapid strategic moves runs the risk of backfiring badly in dynamically linked supply chains. Prange (2021) suggests, therefore, that "active waiting" is often more important than "moving at a fast pace without in-depth reflection" (p. 28) when responding to fast-changing environments. A telling case is Peloton, the New York-based producer of internet-connected stationary exercise bikes, which caught on big early in the COVID-19 pandemic. The need for indoor fitness activity grew as outdoor options dwindled, which, combined with the U.S. government's large fiscal stimulus, boosted the sale of home exercise equipment. The distinctive internet connectivity of Peloton bikes made them especially appealing for home use, as this allowed for some remote social contact or virtual group training. However, Peloton's supply of this ingenious, timely product ran into serious trouble when port congestions in Los Angeles and elsewhere caused major supply delays in bikes from its Asian suppliers.

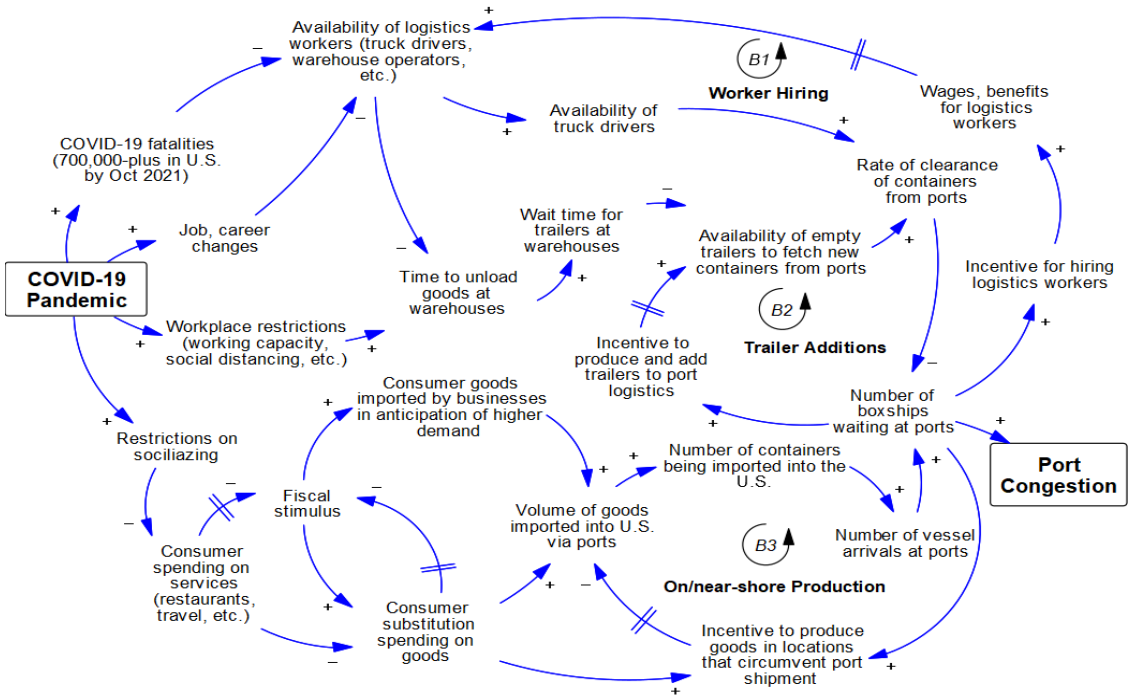
Figure 1 diagrams some of the main forces that caused major shipping congestions at U.S. West Coast seaports in 2021, highlighting primary and secondary causes with their feedback loops (Phadnis & Schoemaker, 2022). Well-intentioned actions by individuals, businesses, and governments during the COVID-19 pandemic caused unprecedented global collective port congestion. At its peak in January 2022, 109 container ships were waiting several days to dock at the California ports of Los Angeles and Long Beach, carrying over $25 billion of cargo.

To circumvent this mega global traffic jam, Peloton moved quickly to explore on-shore US production of its bikes with improved quality and cost performance as an added benefit (Grappi, 2018; Pedroletti & Ciabuschi, 2023). So, Peloton swiftly invested $400M in its first U.S. factory, based in Ohio, and also acquired fitness equipment maker Precor for $420 million. Nine months later, however, Peloton abruptly canceled all further plans for its Ohio factory and laid off 2,800 workers. The reason was a sudden sharp drop in indoor bike demand in the U.S. due to the easing of COVID lockdowns in the U.S. This, in turn, was due to the broadscale availability of highly effective vaccines, produced in an unprecedented nine months after the World Health Organization officially declared Covid-19 a global pandemic. All these moving parts raise whether Peloton's

rapid decision to build its factory in Ohio was a smart but unlucky mistake or an ill-conceived hasty plan (which it seems in hindsight).

To appreciate the complexities of such decisions and assess the role of strategic agility in supply chain management, we shall first synthesize relevant literature segments from the fields of Strategic Management (SM) and Operations and Supply Chain Management (OSCM) to answer the following question: "What is strategic agility in supply chains essentially about?" We begin with a critical literature review highlighting the key lessons about managing uncertainty in supply chains. We further synthesize various literatures and organize their findings along two dimensions central to strategic agility in supply chains. We then cross these two dimensions to create a basic typology of six distinct agility prototypes for supply chains and illustrate each with a real-world case. Our typology's conceptual and practical diversity underscores the need for further research about strategic agility, which we shall return to near the end by outlining a rich set of opportunities for future research.

Figure 1: Causal Loop Diagram of COVID-19's Impact on Port Closures



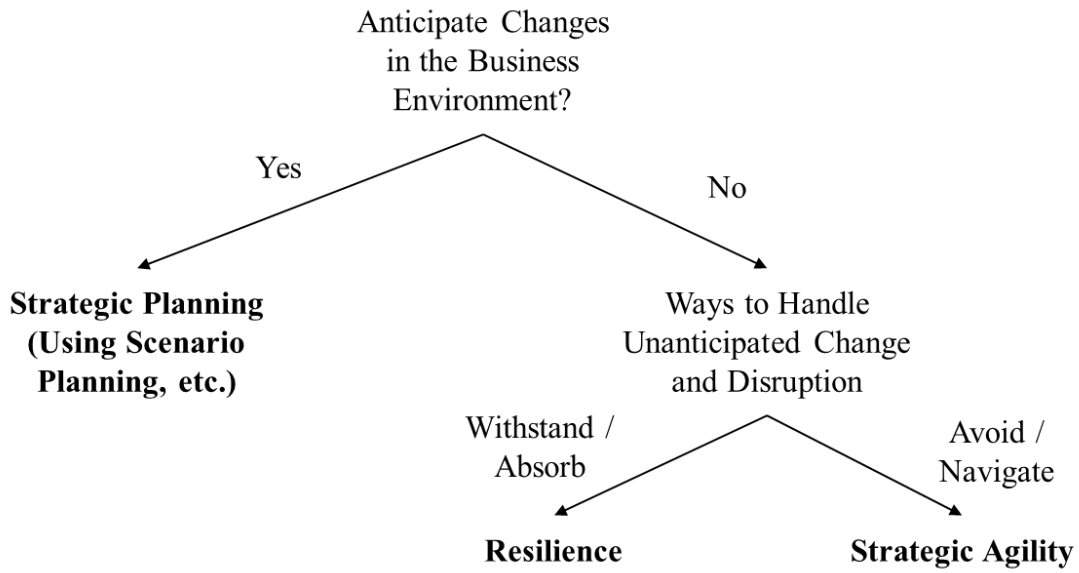
Note: B1, B2, B3 are balancing feedback loops, where a change in the level of a variable is counterbalanced elsewhere in the causal chain.

Source: Phadnis and Schoemaker (2022)

2 Uncertainty and Complexity in Supply Chains

The risk of making strong strategic commitments and then being wrong-footed when markets change drastically is why strategic agility matters to business leaders (Doz & Kosonen, 2008). It is important, however, to distinguish the concept of strategic agility from two related notions: strategic planning and resilience (Schoemaker, 2024), as depicted in Figure 2.

Figure 2: Strategic Planning, Resilience, and Strategic Agility



Source: Adapted from Schoemaker (2024)

Strategic planning is an umbrella term for "systematic, formal approaches to strategy formulation" (Grant, 2003, p. 491), traditionally administered as a "periodic process that provides a structured approach to strategy formulation, implementation, and control" (Wolf & Floyd, 2017, p. 1758). The process starts with anticipating possible futures and then exploring strategies to handle them flexibly with adjustments as necessary. This discipline, usually top-down, helps business leaders partly accommodate bounded rationality when exploring futures and assessing their strengths and weaknesses (Mintzberg, 1991, 1994). This type of strategic planning does indeed correlate with higher firm performance (Grant, 2003; Miller & Cardinal, 1994), faster organizational learning (de Geus, 1988; Kaplan & Beinhocker, 2003), and managing in changing environments (Wolf & Floyd, 2017). In contrast, the notions of agility and resilience relate more to how organizations can cope with and navigate *unanticipated* disruptions. Resilience pertains to the amount of disturbance

an organization and its broader supply chain (Sheffi, 2005; Wieland & Durach, 2021) can absorb and recover from in time (Schoemaker, 2024). In contrast to this more defensive capability, agility enhances a supply chain's ability to maneuver around negative changes handily as well as seize positive opportunities that may be fleeting.

In many industries, building supply chain infrastructures can take several years of planning, with heavy capital investments whose economic lives span decades, such as equipment, factories, ships, and infrastructure. The traditional approach for handling these long-term risks has been strategic planning, partnerships, and financing, while stress testing plans against multiple external scenarios (Wack, 1985a,b; Schoemaker, 1995, 2022). Once implemented, effective use of supply chain assets often requires sophisticated tactical planning for acquiring raw materials with long lead times, allocating sufficient production capacity to different product lines, reserving storage and transportation capacity, and more. For capital-intensive industries such as chemicals, steel mills, oil refineries, etc., the tactical plans for managing sunk assets may stretch to 18 months or more. And for new assets that still need to be built, like plants or specialized machinery, the time frames may even be more extended.

Table 1: Definitions of Agility in Different Disciplines

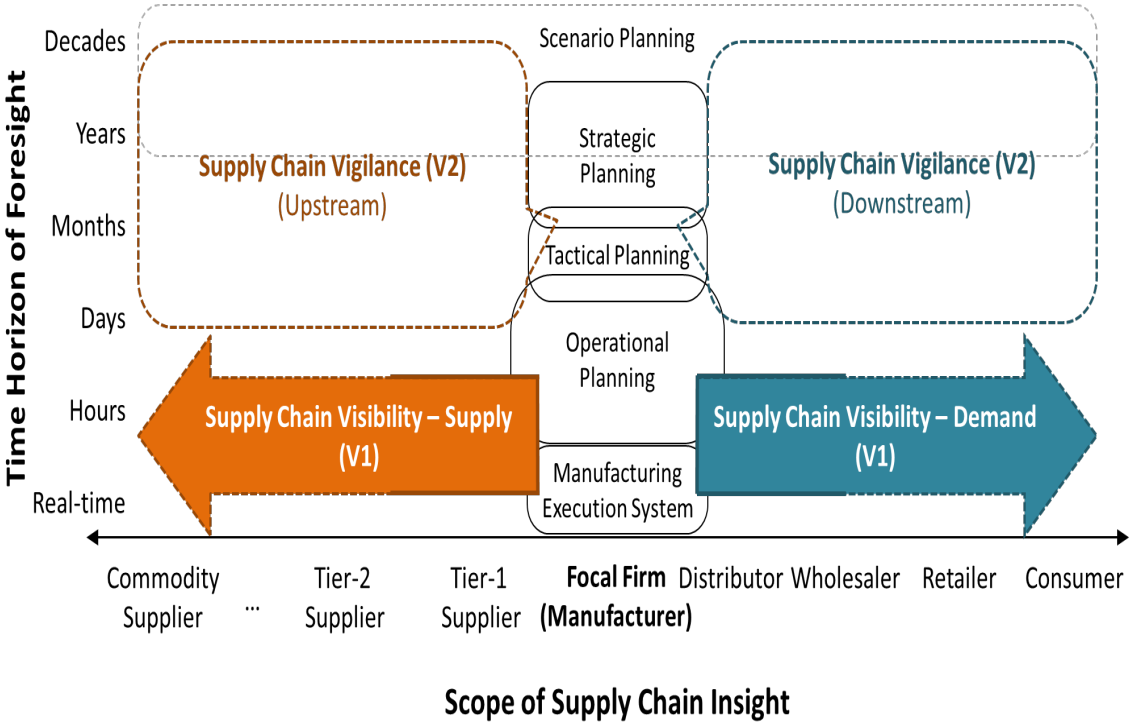
Domain	**Definition or description of agility**
Original Latin	Agilitās or agilis meaning "nimble, fleet, quick"
Webster's dictionary	"Flexibility, with ease and grace"
Sports (Solo)	"Rapid whole-body movement with change of velocity or direction in response to a stimulus" (Sheppard & Young, 2006)
Sports (Team)	Coordinative decision-making and perceptual factors (Paul et al., 2016)
Ballet	"Ability to change the body's position efficiently […using] static and dynamic balance, coordination, speed, strength and endurance" (Ljubojevic et al., 2020)
Strategic Management	Flexibility and adaptation; conflicting views about speed (e.g., Brueller et al., 2014; Weber & Tarba, 2014; Prange, 2021)
Operations & Supply Chain (SC)	Responding to marketplace changes expeditiously (Lee, 2004; Swafford et al., 2006; Braunscheidel & Suresh, 2009; Blome et al., 2013)
Marketing	Sensing, rapid iterations, fast execution, and internal scaling (Kalaignanam et al., 2021)
HR	Strategic sensitivity, resource fluidity, and collective commitment (Doz, 2020)
IT	"Ability to detect and seize market opportunities with speed and surprise" (Sambamurthy et al., 2003)
Organization Design	Dynamic capability to sense the need for change, execute changes routinely, and sustain above-average performance (Worley & Lawler, 2010)

Adapted from Schoemaker (2024)

However, various authors in the agility literature consider such proactive, forward-looking plans dangerous and misguided when dealing with radical uncertainty, in which case "decision-making beyond the numbers" is also needed (Kay & King, 2020). These agility advocates would recommend more reactive, nimble maneuverings instead of dealing with hard-to-foresee events in timely ways. Relying on fast, flexible responses when encountering surprises is a common attribute of agility we encountered across a wide range of domains, as briefly summarized in Table 1. Also noteworthy is how the specific meanings of agility and the means to achieve them vary considerably by application area.

Of course, nimbly maneuvering interconnected supply chain assets such as factories, distribution networks, or supplier relationships is by no means simple. Coordinating such moves with other firms in the supply chain on the fly is even more challenging. Global supply chains are, in many ways, too complex for system-wide optimization by any single actor, architect, or hub in the system. Figure 3 (Phadnis & Schoemaker, 2022) highlights the full complexity of planning and responsiveness in supply chains and indicates where strategic planners versus operational managers typically focus their attention. The diagram makes a key distinction between *visibility* (V1), which has been heavily emphasized in the OSCM literature for nimble operational adjustments, and the less common industry notion of *vigilance* (V2), which has been more fully addressed in the SM literature. In general terms, vigilance is a heightened state of situational awareness among leaders characterized by timely "sensing, probing and interpreting weak signals from both inside and outside the organization" (Day & Schoemaker, 2019).

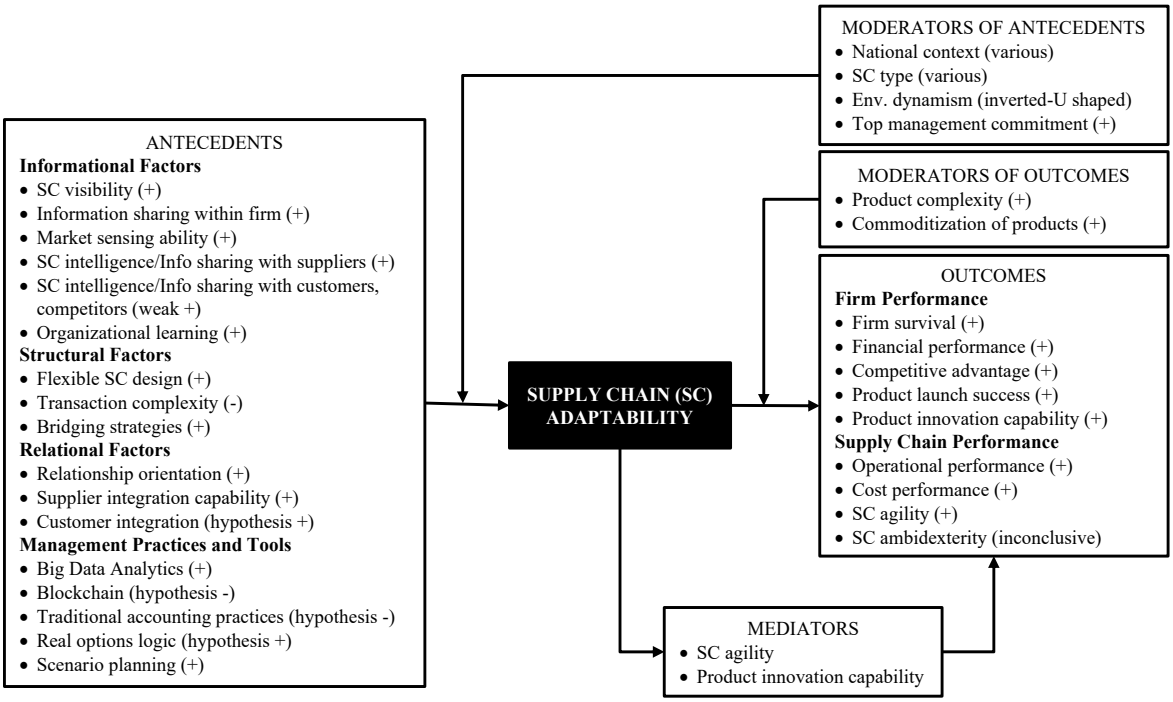
Figure 3: Agility Challenges in Extended Supply Chains



Source: Phadnis and Schoemaker (2022)

The logic of those favoring agility-based incremental adjustments is that circumstances can change unpredictably in global supply chains, potentially cutting across numerous economic systems and geographies. Each party in the supply chain may experience significant exogenous shocks differently due to its specific business model, local ecosystem, regulatory regimes, and social norms. This means external changes in global trade barriers, climate change policies, geopolitical conflicts, or socio-technological disruptions may need to be responded to differently. Such flexible responses will be needed at the firm level and in their strategic interactions with other supply chain firms. How to create and adjust supply chain infrastructures in sync with many diverse parties who are experiencing realities quite differently remains largely unsolved (Phadnis, 2024a) due to some complex competitive and collaborative coopetition issues involved. A recent review of the supply chain literature, summarized in Figure 4, identified many factors potentially influencing firms' capacity to adapt supply chain infrastructures to external change.

Figure 4: Theoretical Model of Supply Chain Adaptability

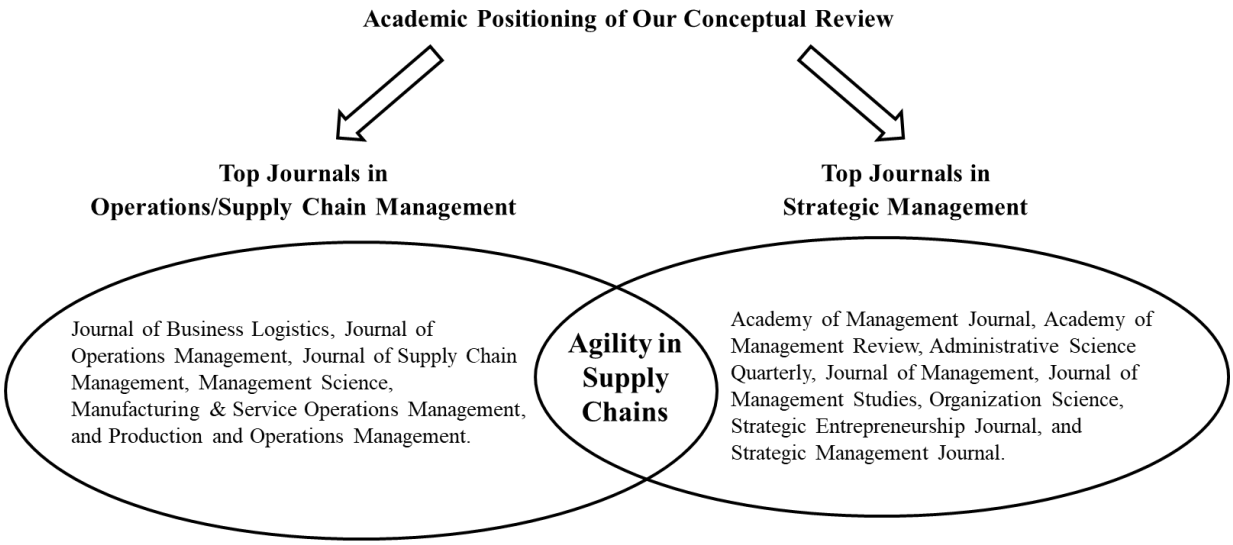


Source: Phadnis (2024a)

Most descriptions of strategic and operational agility emphasize the speed of response as its crucial attribute (Brown & Agnew, 1983; Yusuf et al., 1999; Brueller et al., 2014; Weber & Tarba, 2014). The SM literature emphasizes the importance of fast responses in times of change (Bhide, 1986; Eisenhardt, 1989). However, speed is not always an exogenous attribute of the business environment; it could also result from the firm's past decisions in the belief that it has to act fast before others do (Perlow et al., 2002). Fast decisions could thus become counterproductive since success depends on whether the fast response fits the character of the changed business environment (Prange, 2021). The earlier examples of Peloton and other companies that took bold actions to their detriment highlight speed's two-edged nature. The nature of uncertainty, in contrast to risk, where probabilities are presumed to be known, raises more profound questions about how to define and develop a firm's agility in supply chains. To explore all this further, we examined different approaches to agility in the SM and OSCM literature relevant to supply chain dynamics. For expedience, we limited our exploration to academic articles published in eight SM-related journals in the FT50 list and six OSCM-related journals on the FT50 or SCMList, as summarized

in Figure 5 above. Our conceptual review revealed that the treatment of strategic agility in management literature is quite varied and incomplete.

Figure 5: Overview of Relevant Literature Domains



Note: All journals listed rank in the Financial Times top 50 and/or the SCMList

3 Current Views about Agility in Supply Chains: A Synthesis

Brown and Agnew (1983) defined *corporate agility* as "the capacity to react quickly to rapidly changing circumstances" (p. 29). The evolution of management since then has turned the concept of organizational agility into a multi-faceted construct that has become fuzzy. Many definitions of agility today still reflect some of its original essence(which was "nimble, fleet, and quick") but with considerable dilution, thematic shifts, and metaphoric extensions (see Schoemaker, 2024). To understand how researchers have modified agility to fit the context of multi-tiered supply chains, we next focus on two core dimensions evident in the current literature: the locus of organizational responses to external changes and the scope of the supply chain actors involved.

3.1 Locus of Organizational Response

Managers can respond to external changes by either modulating their supply chain operationally while retaining its current configuration or adapting its infrastructure systemically. Both approaches entail strategic implications whenever they affect a firm's value creation or the basis of its competitive advantage in a dynamic environment.

Operational Adjustments. Agility's deep roots in OSCM go back to at least 1991, when scholars at Lehigh University's Iacocca Institute developed the concept of *agile manufacturing*. Agility in operations is defined as the "successful exploration of competitive bases (speed, flexibility, innovation proactivity, quality, and productivity) through the integration of reconfigurable sources and best practices" in a firm (Yusuf et al., 1999, p. 37). Due to global outsourcing, the concept of manufacturing agility was extended to supply chains. The OSCM tries to synchronize operations across firms to better to unexpected changes in the environment, like supply disruptions, demand spikes, or both, as in bullwhip effects (Lee, 2004; Swafford et al., 2006; Braunscheidel & Suresh, 2009; Blome et al., 2013). Integrated planning between Sales/Marketing, Operations, and Sourcing among firms enables nimble operational adjustments to unexpected changes. The SM literature likewise highlights the importance of meeting customer needs quickly and fully (Adner & Zemsky, 2006; Priem, 2007). Operationally, this requires understanding the current as well as latent needs of customers and then orchestrating supply networks to satisfy these (Phadnis, 2024b).

Systemic Adaptation. Changing a supply chain's configuration will require *strategic* agility, as explained in the earlier quotes from Weber & Tarba (2014) and Doz & Kosonen (2008). Likewise, Lee (2004) argued that *supply chains* need *adaptability* to "adjust supply chain's design to meet [long-term] structural shifts in markets; [and] modify supply network to strategies, products, and technologies." This description resembles the concept of adaptation in the SM literature, as explored in such classic case studies as Polaroid's slow and eventually fatal response to digital photography (Tripsas & Gavetti, 2000) or Royal Dutch Shell's successful adjustment to drastic changes in oil industry's competitive dynamics (Wack, 1985a,b; Ben-Menahem et al., 2013).

A recent review of the OSCM literature by Phadnis (2024a) showed that supply chain adaptability benefits operational and competitive performance due to their complementarities. Operational adjustments of supply chains usually entail shorter time frames, more manageable external changes, and clearly defined decision processes. They are, therefore, quicker, especially when implemented within the existing operational infrastructure. In contrast, systemic adaptations may require longer planning periods, especially if heavy capital investments are called for and existing intra- and inter-organizational relationships must be modified.

3.2 Scope of Strategic Actors Involved

The primary locus of strategic actions taken by supply chain participants can range from each firm in the link acting primarily alone to buyer-supplier dyads or multiple firms acting in tandem to coordinate changes in the supply chain. Several factors might favor a firm's single agile response versus a joint response with other firms. First, other firms in the supply chain may not experience the same business issues and need to adapt. This happened during COVID-19 when businesses experienced divergent conditions globally based on local infection rates and governmental mandates. For example, China closed a terminal in Ningbo-Zhoushan port—the world's third busiest port—after a single COVID-19 infection in August 2021 in line with its zero-COVID policy. In contrast, U.S. states like Texas removed statewide executive orders limiting occupancy so that businesses could operate at full capacity, even while experiencing double-digit deaths from COVID every day.

Second, even if exposed to very similar environmental conditions, different firms may interpret the local conditions differently or prioritize their response in other ways. A supplier may prioritize employee health and safety above all, while the buyer firm tries to conduct as much business as possible or vice versa. Third, even if the firms in a particular dyad are completely aligned in their values and options to keep the business running, the transportation links connecting the two through ports and logistics service providers may be disrupted (see our diagram in Figure 1). Finally, the synchronicity of responses would need to consider the entire supply chain to keep the flow of materials, tooling, and supporting services uninterrupted.

Single Firm Alone. Most literatures on strategic agility examine a single firm's response to unexpected changes. Acting autonomously, a firm can increase production by working overtime, renting storage, using spot-market freight, etc. It can also make longer-term infrastructure changes by discontinuing suppliers, forging new partnerships, divesting or investing in an operations capacity, entering or exiting markets, etc. However, strategic agility in the supply chain also requires organizational learning and market reorientation, which can benefit from partnerships. Also crucial is better operational visibility along the supply chain, up and down, in terms of demand, supply, product and component inventory, and production and distribution capacity (Barratt & Oke, 2007; Braunscheidel & Suresh, 2009; Eckstein et al., 2015). In addition, heightened vigilance about changes in the broader business environment is needed, especially

about second-order effects on demand, supply, inventory, and capacity (Phadnis & Schoemaker, 2022). Doing all this alone is not always the smartest way, so partnerships also matter.

Partnership. Coordination is the lynchpin that fosters agility in supply chains through partnerships among firms engaged in buyer-supplier relationships. Coordinated multi-firm responses require solid foundations of trust, collaboration, and prior knowledge development to act with agility to unexpected challenges in the supply chain (Narayanan et al. 2015). Supply chain collaborations involve goal and incentive alignment, decision synchronization, resource and information sharing, collaborative communication, and joint knowledge creation. When done well, this can boost firm performance and create collaborative advantages (like efficiency, flexibility, quality, business synergy, and innovation), resulting in higher sales, profits, growth, return on investment as well as lower transaction costs (Cao & Zhang, 2011; Um & Kim, 2019). The positive association between collaboration and performance is particularly strong in turbulent environments (Hult et al., 2007) among large firms. They might deploy Vendor Managed Inventory (VMI), campaign activities like collaborative Planning, Forecasting, and Replenishment (CPFR), and even longer-term resilience planning. However, their application for longer-lasting infrastructure changes is less common (Phadnis & Joglekar, 2021).

Network leadership. In contrast to a dyadic partnership approach, network leadership involves one firm taking the lead role in orchestrating the actions of multiple supply chain partners for joint gain. The lead firm is often called the *supply chain maestro*, akin to a conductor who recruits musicians for the orchestra and scores, rehearses, and conducts their performances. The value-creation potential of supply chain orchestration (Fung et al., 2007; Phadnis, 2024b) does not necessarily lie in the productive capabilities of the maestro firm(s); rather, it may emanate from the maestro's deep knowledge of individual firms' concerns, industry expertise, and the ability to align individual firms in ways that are Pareto optimal (i.e., many winners, no losers).

4 A Typology for Strategic Agility in Supply Chains

Combining the above two conceptual dimensions yields various types of agile responses for rapidly changing circumstances. Table 2 This presents the first dimension in binary form and the second dimension as a triplet, yielding six possible combinations, each marked with * signs below. We shall illustrate each type briefly with a business case.

Table 2: Types of Strategic Agility in Supply Chains

Case Type	Organizational Response Focus		Strategic Actors Involved			Case Examples Profiled in Text
	Operational	*Systemic*	*Firm*	*Partnership*	*Network*	
1	*		*			COVID-19 response of furniture-maker Jiaju
2		*	*			Toyota chip stockpile, UPS's adaptation to e-commerce
3	*			*		Supply chain coordination through VMI and CPFR
4		*		*		Intel, TSMC fabs amid US-China trade war
5	*				*	Li & Fung's customized supply chains
6		*			*	P&G's response to sustainability concerns

Case 1: Jiaju's Operational Changes to Navigate COVID-19 Disruptions Globally

One example of a firm modulating the operation of its current infrastructure is office furniture manufacturer Jiaju, a pseudonym (Phadnis & Schoemaker, 2022). Its Asian factories produced parts and subassemblies and shipped them to its European and U.S. factories to assemble the final product. When its Chinese factory was ordered closed for one week by the local government to curb the spread of a novel coronavirus in January 2021, Jiaju's production planners prepared for other Asian factories to be impacted as well by the virus's spread. They asked their factories in India and Malaysia to produce parts and subassemblies ahead of schedule and ship them to Western plants. The planners also cleverly reserved extra shipping capacity on ocean liners to handle any unanticipated increases in future shipping needs.

The company also created a "war room" for daily reviews of parts requirements given the changing demands for finished goods, availability of production capacity, and supply of raw materials at different factories. All of these incurred frequent changes since different regions of the world experienced varying COVID-19 infections and government responses. Jiaju took these actions several weeks before the World Health Organization declared the coronavirus spread a global pandemic. Jiaju may have anticipated this partly because of its experiences with earlier pandemics in the region, such as the 2002 SARS outbreak and the H1N1 influenza pandemic in 2009. The extraordinary steps Jiaju took in early 2020 helped fashion an agile operational response to a transient (albeit long-lasting) disruption of its operations network.

Case 2: Toyota's Supply Disruptions

A successful example of strategic agility via systemic changes—which also happened during the COVID-19 pandemic—was Toyota's prescient stockpiling of six months of semiconductor chips. This move paid dividends in February 2021, when major automakers all over the world were cutting their production targets. Even after demand for cars had recovered from their precipitous drops during the peak COVID months, carmakers still lacked sufficient supplies of automotive semiconductors. Carmakers had lowered their chip forecasts and reduced production capacity reservations with semiconductor producers during the 2020 pandemic months. That capacity got reserved or booked instead by makers of computers, tablets, and phones, whose products surged during the pandemic's stay-at-home regimes.

While most automakers were starved for semiconductor supply when car demand surged, Toyota'searnings report of February 2021 said that it was not cutting production targets since it had stockpiled enough semiconductor chips. Toyota had decided to violate its own mantra of just-in-time supply for semiconductors after it got badly burned by the Tōhoku tsunami in 2011. This rare event knocked out a plant of Renesas Electronics – Toyota's major semiconductor chips supplier – which took months to recover. Recognizing the long lead times for semiconductor supply, Toyota made systemic changes in its inventory policy to better accommodate transient changes in semiconductor demand and supply.

Case 3: Operational Supply Chain Coordination through VMI and CPFR

VMI and CPFR are widely used supply chain management practices that offer strategic agility through operational adjustments in buyer-supplier dyads (Ireland & Bruce, 2000). Since 1985, Walmart and Procter & Gamble abandoned hostile buyer-supplier relationships in favor of partnerships built "on trust and commitment to a shared vision [to] meeting the customer's needs while driving out excess costs in the system" (Buzzell & Ortmeyer, 1995, p. 85). By sharing Walmart's point-of-sales retail data electronically with P&G, the companies improved on-time deliveries while lowering inventory levels. They reduced costs through buyer/supplier duplicity (using point-of-sales scans to decide stock replenishment) and eliminated redundancies (via order entries by both customer and supplier). It required reassigning tasks between buyer and supplier to enhance the supply chain system's overall efficiency (e.g., suppliers putting price tags on

merchandise to make it retail floor-ready or creating a single forecast as a basis for both retailer and supplier planning).

Operational efficiencies gained through such measures cannot only reduce costs but also allow the dyad to respond faster to the changing needs of the ultimate customer. The operational gains resulted from the elimination of material buffers and information blockages between the supply chain partners. However, creating this type of strategic agility in the supply chain requires that both trading partners cooperate.

Case 4: Semiconductor System's Change after U.S.-China Trade War

Prominent examples of this type of agility-building are semiconductor companies like TSMC, building large semiconductor fabrication facilities ("fabs") in the U.S. One key aim is to reduce dependence on manufacturing facilities in China due to growing trade tension between the U.S. and China. In 2021-22, TSMC—the world's largest semiconductor maker—announced that it would invest $40 billion to build a fab in the U.S. Semiconductor fabrication requires highly sophisticated machinery, tooling, and chemicals. TSMC's suppliers in Taiwan have been divided over setting up facilities in the U.S., although several large suppliers—such as clean-room design service provider United Integrated Services, wafer cleaning chemicals supplier LCY, and flow controller Taiwan Puritic—announced building U.S. facilities to supply TSMC.

Whether suppliers of these suppliers (i.e., Tier-2 suppliers) and their suppliers (Tier-3 suppliers), plus further tiers, will also follow TSMC into the U.S. remains to be seen. An important distinction of this type of agility is that it is unlikely that a single firm can adequately create the necessary adaptation on its own. Its supply chain partners need to make joint commitments by developing co-specialized assets and thus face holdover risks. Coordinating such systemic supply robustness, which may require joint investments in capital-intensive assets across multiple firms, is far from trivial. This is, in part, why governments are creating incentives—such as the U.S. CHIPS and Science Act of 2022—that hedge some of the uncertainties inherent in long-term specialized investments.

Case 5: Li & Fung's Supply Network Orchestration

Supply chain orchestrator Li & Fung develops customized manufacturing programs to produce garments for U.S. and European apparel retailers in as little as five weeks at low cost. It does not own any manufacturing facilities but gets its new products made through a network of thousands of factories in Asia. For each new program, it works with retailers to translate fashion sketches into product designs that can be manufactured quickly. Li & Fung then purchases the necessary materials for its suppliers, manages the production schedules of their partners' factories, and oversees the logistics of goods movement to get the products to market quickly (Magretta, 1998).

Li & Fung seldom knows all the details of its customers' new programs in advance. However, it will still reserve undyed yarn and production capacity for its key suppliers. Once its retailer customers start developing garment plans for a season, its own planning wheels start turning. It gets prototypes made and tested quickly. Once the designs are finalized, it will organize various suppliers into a temporary supply chain customized for just that specific program. The supplier factories will not know the details of the new production program but trust that Li & Fung will keep its promises by using the reserved material and capacity.

Agility through such bespoke supply chains tailored for each program builds on the trust that Li & Fung has developed by fostering long-term relationships. Li & Fung's seasoned help in scheduling suppliers' own operations allows it to navigate transient shifts in the mercurial fashion industry and thus helps its own customers operate their retail businesses better. Li & Fung's value creation stems from orchestrating its own suppliers' production, logistics assets, and practices. It also helps retail customers meet contemporary and fickle fashion changes better (Phadnis, 2024b), making this a quintessential example of strategic agility supply network collaborations.

Case 6: Systemic Supply Network Adaptation to Enhance Sustainability

In 2014, Greenpeace organized a massive protest outside P&G in Cincinnati, blaming it in part for the destruction of tropical rainforests to secure Palm oil, plus the killing of orangutans and Sumatran tigers in Indonesia and Malaysia. This key oil ingredient is used in many consumer packaged goods, from soaps and shampoos to ice creams, chocolates, and more. No alternative oil is technically as efficient in terms of land and water usage. P&G realized that concerns about deforestation were not going to subside, and so they viewed the protests as a structural shift in their

business environment. However, P&G did not own any oil palm plantations, and neither did their suppliers. An extensive supply chain mapping exercise revealed that the farms were often six to seven tiers removed from P&G (Ata et al., 2023). The local farmers had no idea that extracts of their crop ended up in one of the world's largest company's products and were just too poor to care about the "Western fashion of sustainability" while barely eking out a living.

To adapt to this structural shift toward environmental sustainability, P&G decided to reach deep into its supply network to thousands of farms. It created initiatives to educate the farmers to make their operating practices more sustainable (such as no deforestation, peat, exploitation, or burning crops). P&G also developed tools for assessing the sustainability of farming practices and launched certification programs that are applicable locally. Indonesia and Malaysia produce nearly 85% of the world's palm oil, and having an impact there would help meet global sustainability goals. Through this multi-year initiative, P&G managed to turn a big environmental negative into a major plus for good citizenship (Ata et al., 2023).

5 Canonical Issues for Strategy Research

We chose the intersection of supply chains and strategic agility for multiple reasons in exploring new scholarship opportunities in strategic management. First, global supply chains have received much attention in recent years, which surfaced deeper strategic issues about organizational agility in times of change. Second, despite these challenges, the strategic potential to create value through operational agility in supply chains remains underexplored. Third, organizations often have limited knowledge of other firms in their supply chains beyond their immediate suppliers and customers despite their critical dependence. Even for those few suppliers they know well, organizational leaders may do little to coordinate behaviors when needed. Fourth, successful adaptative agility depends much on an organization's prescient views of its business environment as rooted in managerial cognition. However, the collective absorptive capacity of other key firms linked in the supply chain to anticipate and interpret changes in the environment also matters greatly. The topic of strategic agility in supply chains raises several questions about canonical issues in SM, such as the nature and behavior of firms as well as their environments. We selected four of these canonical issues for further analysis, as summarized in Table 3 with illustrative questions.

Table 3: Canonical Strategic Management Issues about Strategic Agility in Supply Chains

Four Topic Areas	Strategic Questions
Collaborative and Competitive Interactions	• How do collaboration and competition among partner firms interact in various forms of strategic agility in supply chains? • How does the uncertainty about a firm's ability to be operationally agile and collaborate with other firms affect inter-firm engagement and supply network configurations? • How do collaboration and competition influence and shape the systemic risk of supply chain disasters?
Speed of Strategic Decision-making and Response	• Is decision-making speed a defining attribute of strategic agility? • What factors determine the appropriate speed of decision-making and response to the changes in the supply chain environment? • What conditions facilitate or deter co-learning about the changing business environment among supply chain partner firms?
Nature of Environmental Change	• Under what circumstances, if any, can changes in the business environments be classified into different types, ex-ante? • What lessons can strategic management draw from historical studies of changes in organizational environments, ex-post?
Managing Knightian Uncertainty	• How should leaders recognize Knightian uncertainty and accept unavoidable subjectivism in strategy? • What types of decision-making and planning tools are required to achieve strategic agility across different types of environments? • How should exploration and exploitation of the environment, proactive preparations, and reactive response be balanced?

5.1 Cooperative and Competitive Interactions

Whether to tackle strategic issues alone as a single firm or in unison with other industry players is a broad field in the SM literature concerning value creation and appropriation, as well as regulatory and media risks about price fixing, collusion, and antitrust. First, inter-firm interactions in a supply chain are not limited to creating value through operational coordination; they also involve strategizing to extract a greater share of that value. The dynamics of collaborating to create value while also competing to receive a higher share are worth exploring deeper (Panico, 2017). The analytical framework of value creation and capture by Gans & Ryall (2017), for example, can help model value appropriation by supply chain partners. A related area for future research is whether and how coopetition dynamics vary across types of strategic agility in supply chains (like our cases 4 and 6 in Table 2). Cases may differ in terms of short-term vs. long-term response orientations, a firm's role in fostering agility to handle uncertain events, frequency of partner interaction, etc. Several of these relate to Transaction Cost Economics (Williamson, 1985), which could guide

further research on this. Information impact, bounded rationality, small numbers, and opportunism all seem relevant to the above.

5.2 Speed of Strategic Decision-making and Response

Another unsettled matter is whether speed should primarily be viewed as an enabler of agility or primarily as a consequence of this capability. Numerous studies emphasize speed or hustle, focusing on operational aspects (Bhide 1986; Eisenhardt 1989), which are central in supply chains. Yet, other studies recommend slowing down rather than speeding up when facing ambiguous shifts in the business environment (Sull 2005; Prange 2021). Sull (2005) calls it "strategy as active waiting" and cautions executives against romanticizing that they can divine the future and formulate winning long-term strategies. Instead, he favors"anticipating, preparing for, and seizing opportunities and dealing with threats as they arise" (p. 124). Thus, one question is whether the speed of decision-making and response is or should be a defining attribute of strategic agility.

Aside from evolutionary biology, compelling logics exist for speed and slowness in different ecologies, with the sloth being exhibit A for the latter (due to its peculiar digestive demands and habitat). The editors of a recent special issue of the *California Management Review* also proposed that "business agility is a dynamic capability for adaptation in unpredictable environments, but it should not necessarily be associated with speed" (Girod et al., 2023, p. 7). Teece et al. (2016), however, warned again, equating agility and dynamic capability, noting that "because change is costly and achieving agility often involves sacrificing efficiency, one cannot assert that business firms should organize continuously for agility. Knowing when (and how much) agility is needed and being able to deliver it cost-effectively is a crucial managerial capability." Ambiguity, uncertainty, and indeterminacy about environmental changes should matter when deciding if agility should become a core competence and how fast to move. The optimal speed of decision-making, however, is not entirely driven by exogenous features of the business environment since the firms often create their own "speed traps." Just the belief that a firm must decide fast, based perhaps on similar decisions in the past, will create endogenous factors in the immediate environment (Perlow et al., 2002). As such, an important question is what factors, both internal and external to a supply chain, should determine the appropriate speed of decision-making.

5.3 Nature of Environmental Change

Different typologies of environmental change exist: causal texture of environments (Emery & Trist, 1965), environmental jolts (Meyer, 1982), high vs. low environmental velocity (Eisenhardt, 1989), operational disruptions versus structural shifts (Lee, 2004), regime change blindspots (Massey & Wu, 2005), and more. How to characterize a firm's environment for planning purposes was early on examined by Emery and Trist (1965) from a system's perspective by postulating four increasingly complex causal textures: placid, clustered, disturbed, and turbulent. Other typologies have been proposed since then (Roney, 2010), with VUCA being recently borrowed from the military, but none have enjoyed broad acceptance across disciplines or application domains. Although discerning such typologies ex-post would seem far easier in hindsight than in foresight, historians would emphasize that *documenting* what happened long ago is far easier than *explaining* why it happened the way it did. Much depends on whether a single event is considered or a large number of connected ones, how many outcomes are envisioned, and what time horizon is adopted. Ex-ante, it may be even more difficult to assess what kind of external changes may lie ahead, given that the true texture and deeper structure of the future are often indeterminate or masked by random noise (and human biases).

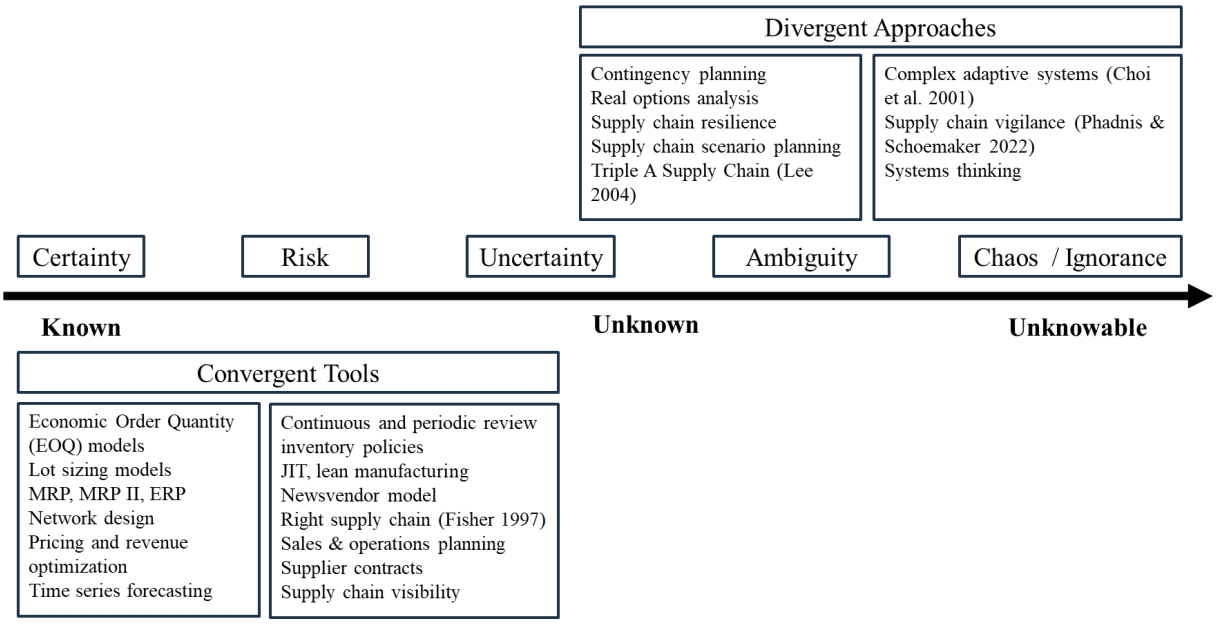
This is one reason why counterfactual analysis of history, such as examining what would have happened if America had stayed out of the Second World War, remains a controversial research stream in history. However, both backward and forward environmental views are important in strategic management since the recent past often serves as the prologue for what happens next, while the distant past holds valuable lessons. Understanding history is crucial since future scenarios, in essence, try to project kinds of histories that could possibly happen in the future (see Schoemaker, 2020). Adopting historical lenses when studying the nature of change in business environments presents promising opportunities in a world increasingly marked by rapid, unexpected changes of the Knightian kind, plus some Black and Grey Swans thrown in as well.

5.4 Managing under Knightian Uncertainty

As noted, an important open-ended and closely related research topic is to better appreciate why different kinds of external environments, in terms of their complexity and uncertainty, may require different approaches to agility and strategy. Figure 6 depicts a decreasing knowledge spectrum leaders may face depending on how much is unknown about their problems. The charts also list

various commonly used tools, with those on the left-most suited to well-defined cases of certainty and risk (as routinely taught in MBA programs). Problems more toward the right side entail likely Knightian uncertainties (no solid probabilities and ambiguous problem definitions) and Black Swans (being blind to surprising events). These ill-defined problems are less about optimizing well-specified problems framed as cases of certainty or risk and more about reducing ambiguity and ignorance through faster learning. A significant portion of supply chain planning, however, still traces back to early mathematical models on the left side, starting with optimal order quantities for inventory replenishment.

Figure 6: Tools for Managing Supply Chains in Stable and Turbulent Environments



Adapted from Schoemaker (2002)

The classic Economic Ordering Quantity model (EOQ)simply assumes known future demand, fixed costs for ordering and storing supplies, and guaranteed delivery times (i.e., entirely a case of certainty). Subsequent variations extended this model to probabilistic demand fluctuations and stochastic delivery times, which still allowed mathematically optimal determinations of inventory policies. The same transition happened with Critical Path Models (CPM) for factory or airplane construction. It started deterministically in identifying bottlenecks and then evolved into Program Evaluation and Review Techniques (PERT), in which probabilities were used to lay out an optimal

production plan. Government programs, such as the notorious cost overruns of the Polaris Missile project, provided the impetus for PERT by mandating their use after intolerable delays and budget overruns had become the norm among subcontractors. Fisher (1997) then introduced a broader supply chain framework, although still static, to ask deeper strategic questions about the right metrics and design parameters for key product-market attributes. Finally, Lee (2004) addressed environmental uncertainty and dynamic strategies more by calling for agility, adaptability, and alignment in supply chains. Both of these HBR articles became seminal in the SC field even though they still left important aspects unanswered about how to handle the right side of the spectrum, where ambiguity, chaos, and ignorance reign. Recent work on vigilance and agility, however, has started to address these tougher issues as well (Day and Schoemaker, 2019 & 2020; Phadnis & Schoemaker, 2022), although much remains to finalize the integrated tool picture.

6 Summary

After surfacing multiple conceptual lenses about agility in supply chains kaleidoscopically, we synthesized key perspectives from different academic fields into a broader theoretical framework. Our literature review surfaced two dimensions that are central to published research about organizational agility: allocations of managerial attention and proceeding alone as a firm versus in unison with other ones. We crossed these dimensions to compare six prototypical cases in terms of problem type, organizational context, and strategic solutions. We then further examined various real-world examples, including an in-depth Peloton example and six archetypal cases, to help surface remaining research questions about strategic agility in supply chains.

The value-creation potential of highly agile supply chain orchestrations, such as those of Li & Fung, remains rather underexplored in the OSCM literature (Phadnis, 2024b). The SM literature, in contrast, has deeply examined the value of open innovation platforms like Haier, which exhibit similar agility benefits (Cassiman & Valentini, 2016). The skills, processes, organizational structures, decision rules, etc., needed for such platform strategies often draw on multiple dynamic capabilities (Teece, 2007; Teece et al., 2016). A deeper understanding of business models based on this type of strategic agility would require better integrations of open innovation models, the resource-based view, inter-organizational networks, transaction cost economics, and dynamic capabilities in the context of supply chains.

Navigating Knightian uncertainty also remains a major challenge for both SM and OSCM due to humans misreading signals and noise due to overestimating their knowledge base. When uncertainty is high, flexible strategies and options thinking carry the day. Detecting weak signals surrounded by random noise, however, is notoriously difficult (Silver, 2012) and often requires a shift in perspective via scenario analysis, awareness of biases, and reframing techniques (Shankar et al., 2023). In such environments, exploration through actively probing the environment is essential, even in the OSCM domain that has historically focused on exploitation. Strategy tools like scenario planning, however, are starting to be used by operationally focused managers to explore the business environment more widely (Phadnis & Darkow, 2021). More research will be needed, though, on better balancing exploration and exploitation or proactive preparation versus reactive response in supply chain management, highlighting the role of ambidexterity in strategic agility.

Complexity theory taught us decades ago that non-linear systems, even if totally deterministic and lawful, can produce surprising outcomes (that seem random) due to subtle non-linear feedback loops (Lorenz, 1972; Gleick, 1987). Management scholars acknowledge that in the context of Knightian uncertainty, the boundary between what is known and what is unknown will be "fuzzy." Clearly, assessing whether environmental changes are permanent or temporary is not easy, and indeed, it may not be the right question to ask when things are still in flux. Behavioral research on overconfidence, anchoring, and other cognitive biases (Tversky & Kahneman, 1974) shows that people often misperceive uncertainty and commonly believe that they can predict more than is really possible.

Massey and Wu (2005) tested University of Chicago students (who, on average, had taken three mathematics or statistics courses) on their ability to separate signals and noise. Using computer-based experiments, they found that the students were overly sensitive to surface feature changes produced by random noise and not sensitive enough to occasional regime shifts that had been unobtrusively introduced into their stochastic experiments. Behavioral findings like these suggest that Knightian uncertainty is hard to assess without bias and further underscore that strategic decisions will, in part, rest on subjective beliefs and inference rather than only on hard, provable facts. The quest for logical positivism has to give way to considerable subjectivism when on the right side of the uncertainty spectrum in Figure 6, where ignorance outweighs knowledge.

Kleindorfer (2010) addressed this conundrum more fully for the fields of economics and finance in view of recent crises.

Our paper sought to surface this kind of canonical issue for supply chains with broader questions about the kind of conceptual models or theories needed to guide managerial advice. Acknowledging that different conceptual lenses have to be used to examine complex problems like supply chains is a good start. However, the fundamental academic challenge then remains about how to reconcile alternative views, especially opposing ones, into viable organizational guidelines that leaders can use to better navigate uncertainty. For example, how should rational versus behavioral views about business problems be reconciled or blended into winning decisions? Schoemaker (2024) addressed these core challenges in general terms for strategic management, with various avenues for integration offered. We did not apply these methods to the specific supply chain issues we examined here but hope other researchers will explore the associated challenges more deeply via case studies, theoretical models, and empirical tests. If so, a rich research agenda and important new findings shall await us in the field of strategy.

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