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Environmental turbulence, strategic orientation

Modeling supply chain integration

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Abstract *Though supply chain integration has emerged in the past several decades as a major foundation for corporate competitiveness, there is a paucity of research devoted to the theory linking the corresponding strategic management notion of vertical integration with the applied concept of supply chain integration. Built on the work of Harrigan, this paper delineates supply chain integration as a multidimensional construct and proposes a model in which environmental turbulence and strategic orientation have a direct impact on the degree, stages, and breadth of supply chain integration. Contributions, limitations, and implications are offered.*

Introduction

Vertical integration is a long-held and central precept of management theory, and, more specifically, of strategic management; further, corporations in numerous industries, including transportation, energy, and communications, have been vertically integrated for many years. Various theoretical rationale support vertical integration, including the economies of prorating management and overhead costs across a greater range of production/distribution processes and the efficiencies of communication among serially-related activities. Vertical integration may also facilitate stabilization of production quality or quantity, and management of the process flow of costly or risky technologies, permitting a more efficient, standardized, and high-volume output. Forward integration involves greater control over the activities of a firm's customers; backward integration involves greater control over the activities of a firm's suppliers.

Recently, however, the notion of a more applied and functionally integrated perspective of integration has emerged, often called supply chain integration, which suggests both an operational and cross-functional focus. Heskett (1977) was among the first to identify and operationalize the contribution of logistics integration as a way to improve corporate performance. Previously, integration meant financial influence or leverage, corporate diversification, and control of resources and customers, as well as environmental factors; however, by the early 1980s, firms turned inward to focus on efficiency and integration of their serial processes (LaLonde, 1994). Supply chain management initially emphasized local optimization of each supply chain activity (Reyes *et al.*, 2002), or more specifically, minimization of costs and maximization of services at each stage (Mentzer, 1991).

Local optimization can, however, have dysfunctional consequences. Lee *et al.* (1997) describe the tendency toward local optimization of each component of the system as

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an information distortion, or "the bullwhip effect," and suggest with others (Akkermans *et al.*, 1999; Lawrence, 1999; McAfee *et al.*, 2002; Stassen and Waller, 2002) the need to balance the entire supply chain. Competition, they assert, is not between companies or activities, but between supply chains. Stated more succinctly, in the long run, the best supply chain wins. Lummus *et al.* (1998) add other reasons why a strategic balance of supply chain activities is important:

- increasing global competition forces the extraction of supply chain efficiencies; and
- greater specialization or focused products and processes generates an inefficient or disintegrating effect, which must be counterbalanced by greater system integration.

Of course, external factors such as the deregulation of global telecommunications and transportation systems have further advanced the economies of integration.

Harrigan (1985, p. 397) defines vertical integration as involving "a variety of decisions concerning whether corporations, through their business units, should provide certain goods or services in-house or purchase them from outsiders instead." This definition suggests the classic strategic management economic and large-corporation-based concept of vertical integration. A more recent applied definition, adapted from Cox and Blackstone (2001), is the degree to which a firm chooses to produce in multiple value-adding stages from raw material to the ultimate consumer. This latter approach emphasizes the choices and tradeoffs in the management of serial production and distribution activities, as well as a range of serial process activities.

There is, however, a limit to both vertical and supply chain integration. That limit is best captured in the concept of "focus", initially suggested by Skinner (1974), which states that a production activity must focus on one or a small number of products (or product lines), one or a few production processes, and one or two similar technologies. If a production activity attempted too many products, processes, or technologies, it would become "unfocused" and less efficient, ultimately ceding market share to more efficient, focused processes. This explains, for example, why a Rolls Royce automobile cannot be built in a facility designed to produce a Ford.

Thus, the foundation of supply chain integration theory was initially based on the economic and financial theory of vertical integration. More recent operationalizing efforts emphasize logistics and communications efficiencies. An early contribution by Thoburn and Takashima (1992) emphasized the traditional role of strategic cost accounting to evaluate subcontracting as a mechanism of integration. As such, subcontracting strategies are viewed as a major component of the cost- and risk-based decisions of integration efforts. Birou *et al.* (1998) use the product life cycle as the basis to define integrative links, but find that "the degree of alignment begins to break down as individual activities are matched with stage of life cycle" (p. 44). Further, Narasimhan and Carter (1998) link purchasing practices and business competitive priorities; however, respondent bias has been noted as a limitation in this type of research (Stuart, 1997; Birou *et al.*, 1998). Thus, as the field has evolved, no single elaboration or construct has been put forward linking environmental and strategic contingencies under which supply chain integration would be appropriate or how process continuity contributes to supply chain efficiency.

Given this conundrum, this paper develops the notion that supply chain integration is an application and extension of vertical integration theory, and models the contingencies of environmental turbulence, strategic orientation and process continuity. Specifically, the current study addresses the following research questions: how do environmental turbulence and strategic orientation of a firm affect its degree, breadth, and stages of supply chain integration, and to what extent, does production technology (process continuity) moderate the relationships of environmental turbulence and strategic orientation with supply chain integration variables?

This paper is structured as follows. We first present and aggregate a definition of vertical integration and supply chain integration, then identify and describe several dimensions. Subsequently, we build on the work of Williamson (1975), Miles and Snow (1986), Harrigan (1985), and Hayes and Wheelwright (1979a, b, 1984) to propose an integrated theoretical model delineating the impacts of environmental turbulence and strategic orientation on supply chain integration, with process continuity as the moderating variable. Propositions related to the model are then proposed. Finally, this paper concludes with implications for researchers and practitioners.

Revevant theoretical background

Conventional definition of supply chain integration

The concept of a supply chain, first suggested in 1985 by Houlihan (Cooper and Ellram, 1993), includes management of "all different processes and activities that produce value in the hands of the ultimate customer" (Lummus *et al.*, 1998, p. 49) and supply chain management is "the process for building improved and stronger upstream and downstream business linkages" (McAfee *et al.*, 2002, p. 1). Other definitions include: "how to integrate and perform logistics and manufacturing activities" (Pagh and Cooper, 1998, p. 13), or more generally: collaboration among supply chain partners (Sanders and Premus, 2002; Andraski, 1998; Stank *et al.*, 2001). A more elaborate and applied definition is:

> The connected series of activities concerned with the planning and controlling of raw materials, components, and finished products from suppliers to the final customer (Vickery *et al.*, 1999, p. 16).

Minimally, then, as pointed out by Akkermans *et al.* (1999), the characteristics of a supply chain include:

- multiple echelons;
- focus on integration; and
- goals of service and profitability.

Additionally, the supply chain may also involve:

- collaborative processes and activities; and
- concern with adding value for the customer.

As might be expected, there is a notable correspondence between the strategic precept of vertical integration and the operations notion of supply chain integration. Certainly the concepts of consistency of organization culture and policies (McAfee *et al.*, 2002), of organizational fit (Stonebraker, 1986), and of complementarities of various components of the organization strategy (Brewer and Hensher, 2001) express this correspondence. However, Voss (1995) notes that attempts to match manufacturing with corporate strategy may not be appropriate in all cases. Further, the entire integration/disintegration issue at all levels may be highly dynamic and may vary at different stages of supply chain activity (Murphy *et al.*, 1998), as well as over time, as exemplified in the automotive industry (Salter, 1996). Table I generally classifies these differences between vertical integration and supply chain integration to demonstrate that supply chain integration is an evolving and applied elaboration of the more theoretical concepts of vertical integration. Further, it offers a continuum from the linear and uni-dimensional focus of vertical integration to the more variable and multi-dimensional perspective of supply chain integration.

Several researchers suggest that supply chain integration has been conventionally defined and operationalized as a uni-dimensional construct (Akkermans *et al.*, 1999), perhaps as a result of its evolution from the generally more static and strategic notion of vertical integration. Such simplicity in theorizing may contribute to the diverse and inconsistent findings regarding the antecedents and consequences of supply chain integration. As a further and direct example, Sanders and Premus (2002) report conflicting results among information technology firms regarding the nature of information technology support and the cost and flexibility competitive priorities of the firm (p. 79).

Supply chain integration as a multidimensional construct

Given the conceptual congruence between vertical integration and supply chain integration, models and findings from vertical integration have great relevance to the evaluation of supply chain integration. Suggesting the transition from vertical integration to supply chain integration, Harrigan (1985) argues that vertical integration is a multi-dimensional strategy; specifically, she proposes four dimensions. Stages of integration refers to:

> The number of steps in the chain of processing which a firm engages in-from ultraraw materials to the final consumer (p. 400).

Breadth of integration is defined as:

> The number of activities that firms perform in-house at any particular level of the vertical chain (p. 401).

	Vertical integration	→	Supply chain integration
Focus	Theory		Application
Original discipline	Strategic management		Operations management
Functional foundation	Economics, finance		Logistics, communication
Entity	Corporate		Activities or workcells
Entity size	Generally large		Small or large
Measures	Efficiency		Coordination, smoothness
Integrating mechanism	Ownership		Cross-functional and business contractual
Process	Control		Collaboration
Rate of change	Generally more static		Generally more dynamic
Paradigm	Consistency		Irregularity
Pattern	Uniformity		Heterogeneity
Dimensionality	Uni-dimensional		Multi-dimensional

Note: The arrow suggests the general evolution of organizations on a continuum of vertical integration to supply chain integration

Table I.
General classification of vertical integration vs supply chain integration

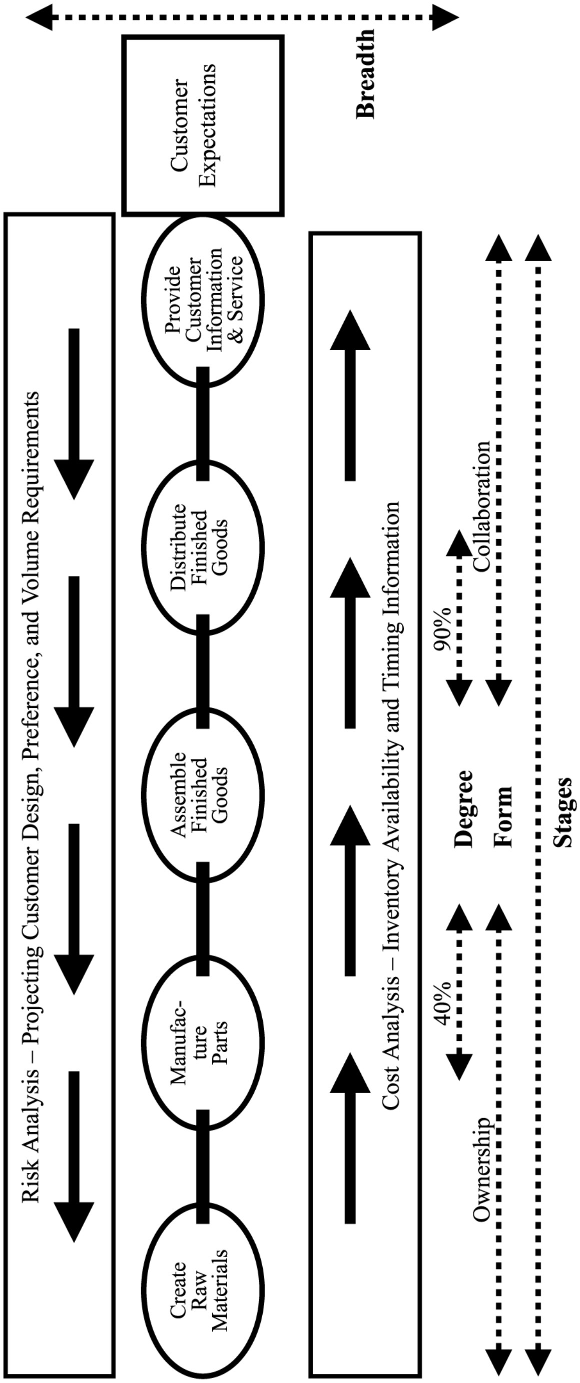
Degree of integration is conceptualized as the percentage of total production outputs exchanged with sister units. The final dimension, form of integration, means ownership of integrated units or quasi-integrated arrangements to control a business unit, such as shared ownership with other firms.

Among the numerous mechanisms of form that can be used to manage the integrated supply chain are ownership and such quasi-ownership mechanisms as share ownership, capital underwriting, and ownership of other stakes in the company, as well as long-term contracts and other leveraging activities (Harrigan, 1985). However, in application, as inefficiencies are increasingly identified and squeezed out, the forms of integration may become more subtle, informal, and dynamic. The knowledge that a competitor might potentially undercut a firm's price or service, for example, may be sufficient to encourage higher levels of collaboration. Thus, the form of integration, one of Harrigan's four dimensions, is a highly categorized and dynamic variable, for which a suitable continuous dimension has not been operationalized. For that reason, this paper does not further evaluate the form dimension.

A stylized supply chain usually involves five stages of activity: creation of raw materials, manufacture of parts and components, assembly of finished goods, distribution of goods and services, and customer service. Each of these stages may involve several serial production or distribution activities or steps, and each activity will likely involve internal functions of purchasing, operations, and logistics. Additionally, flows of information and exchange, including market research, demand forecasts, order flows and cash, as well as goods, credit, and prototypes are included. Further, the form of integration may range from management by one company or entity, as in the case of integrated oil companies to various quasi-ownership and informal forms (Harrigan, 1985; Williams *et al.*, 1997).

Multiple activities or processes may exist at each stage, or activities may be totally separated. Supply chain flows are both forward and backward. Though products (often enhanced with a variable service component) flow forward, information flows backward (customer demand requirements - design and volume) as well as forward (product promotional information and availability). Cash and credit movements are also part of the forward and backward flows on the integrated supply chain (Stonebraker and Liao, 2004). Thus, the notion of the supply chain emphasizes non-ownership and the lesser formality of applied linkages at all stages, whether the firms are large or small. Unfortunately, the process is anything but smooth; it consists of a variety of roadblocks and enablers, each with varying efficiencies (Akkermans *et al.*, 1999).

Integration is difficult because integrated supply chains usually develop initially as "chained pairs" of activities, and subsequently are broadened to multi-stage or fully integrated chains. The activities, processes, risks, and costs associated with customer service levels and support are often differentially defined by each activity. For example, economic lot or shipment sizes are likely to differ among serial activities, as would the risks and costs of information technology implementation and the debtor-creditor relationships. Ultimately, these differences create a complex web of both formal and informal relationships among the multiple entities of the supply chain, all of which must be satisfied by the overall balancing of interests. Figure 1 shows the stylized activities of an integrated supply chain, with the closely corresponding Harrigan dimensions of integration superimposed.



Note: The four Harrigan (1985) dimensions are superimposed with dotted lines:
Breadth – "the number of activities that firms perform in-house at any particular level of the vertical chain."
Degree – the percent of total production exchanged with sister units (shown here as 40% and 90%).
Stages – "the number of steps in the chain of processing which a firm engages in – from ultra raw materials to the final customer."
Form – ownership, quasi-ownership, or other more collaborative means of control of the integrative mechanisms.

Figure 1.
A stylized representation of the supply chain with integration dimensions superimposed

Theoretical model and hypotheses development

As previously defined, supply chain integration involves a variety of decisions concerning whether corporations should provide certain goods or services in-house or purchase them from outside (stages), how many activities (breadth) are performed in-house as compared to outsourcing, and how much is purchased from outsiders compared to serial internal business units (degree). These decisions ultimately capture a balance between cost efficiency and organizational flexibility. A firm would integrate only to the extent to which organizational inflexibility and its associated risks, as well as increased bureaucratic costs, were offset by cost efficiencies derived from integration.

Ultimately, such risk/cost analyses and decisions become a contingent tradeoff across all activities of the supply chain. Skinner's (1974) definition of manufacturing "focus" may be extended to other supply chain activities. As such, the benefits of economic specialization are juxtaposed against economies of overhead distribution; however, sequential activities may not be sufficiently similar to permit focus, and thus cannot be effectively managed by one group. Braithwaite and Christopher (1991) identify four costs (transport, inventory, materials and production) of the supply chain and four different strategies (direct ship and three consolidation approaches) to contingently address these costs. The "logistics loop" proposed by Lawrence (1999) further elaborates the supply chain's dimensionality and texture. One approach to supply chain management focuses toward low cost and high volumes of defined products/services, with ready inventory availability to achieve customer expectations. Alternatively, more dynamic markets constantly generate design and volume changes, adjust payment terms and credit needs, and manage prototype flows, all of which result in higher costs, lower volumes, customization, and more complex inventory control.

Pagh and Cooper (1998) describe the issue as a tradeoff of postponement versus speculation at each stage of the supply chain. A manager could either postpone a decision to pre-build a product at any stage, thus reducing the cost of inventory and potential for obsolescence, but risking that the item would not be available when needed. Alternatively, the manager could speculate (possibly based on a forecast or projected order) about the designs and volume that the customer wants, and pre-build and deploy units, but with greater inventory costs and design risks.

Theoretical model

Figure 2 depicts our proposed theoretical model. We argue that the level of environmental turbulence and the strategic orientation of a firm have a direct positive impact on each dimension of supply chain integration. The relationships between independent and dependent variables are expected to be moderated by the core production technology (Woodward, 1965; Hayes and Wheelwright, 1979a, b, 1984; Hayes *et al.*, 1988; Hill, 1994). For previously noted reasons, this study has chosen not to address the "form" variable as defined by Harrigan (1985).

The choices of environmental turbulence and strategic orientation as independent variables, and process continuity as a moderating variable are based upon the following considerations. First, environmental turbulence or volatility is one of the most influential factors on a firm's integration of its production-distribution process. Environmental turbulence is referred to as changes in industry structure and competition (Caves and Porter, 1977). Of course, recent technology developments and the removal of constraints to transportation and communication systems have notably

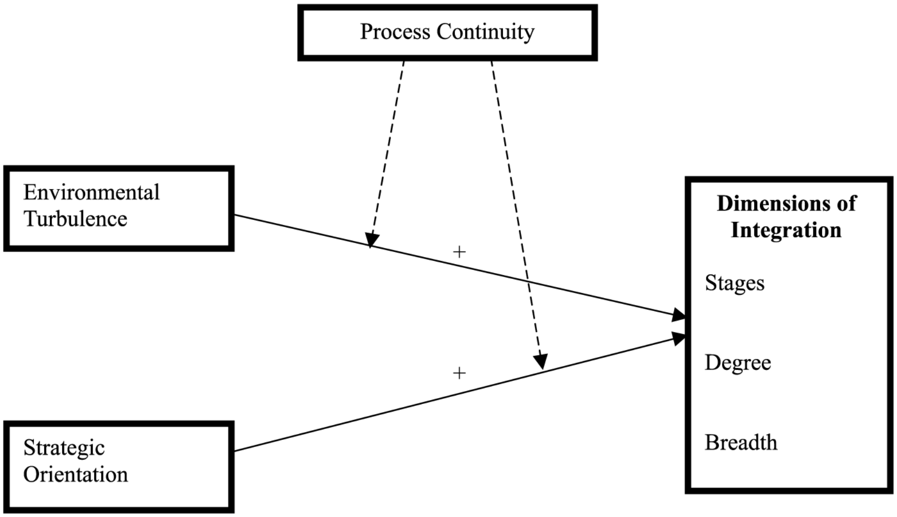


Figure 2.
An integrative model of supply chain management

enhanced globalization and thus the potential for increased environmental turbulence. High turbulence makes both adaptation to competitor's actions and adjustment to business cycles difficult for the firm. Second, strategic orientation is conceptualized as relatively enduring in nature and reflects a general approach of a firm to its environment. It is commonly defined as:

> How an organization uses strategy to adapt and/or change aspects of its environment for a more favorable alignment (Manu and Sriram, 1996, p. 79).

A firm's strategic orientation would have an impact on supply chain integration because strategic orientation comprises "a pattern in a stream of decisions that a) guides the organization's ongoing alignment with its environment and b) shapes internal policies and procedures" (Hambrick, 1983, p. 5).

Third, viewing supply chain integration as one form of organizational design, the decision to produce in-house or outsource should also be affected by the core production technology of a firm - the degree of process continuity. Woodward (1965) identified three basic, discrete forms of technology: unit or small batch technology, large-batch or mass-production technology, and continuous-processing technology, which have been variously elaborated in subsequent research (Hayes and Wheelwright, 1979a, b, 1984; Hayes *et al*., 1988; Hill, 1994).

Classical constructs suggest that manufacturing and distribution variables are continuous, rather than fixed and constant. The familiar Hayes and Wheelwright (1979a, b) product/process continuum, the product life cycle (Abernathy and Utterbach, 1975; Birou *et al*., 1998), and the Bowersox and Daugherty (1987) typology of logistics all suggest that operations/logistics activities involve a continuum of non-discrete variables. However, for descriptive clarity, as well as measurement in empirical studies, these variables are often categorized with generalized discrete markers.

Hill (1994) defines five distinct manufacturing environments, following the widely accepted general classification (project, jobbing, batch, line, and continuous processing) described by Hayes and Wheelwright, (1979a, b) by establishing four disjoints or "volume transitions" between those five classifications. Despite a number of more recent adaptations, such as "C cells" or "horseshoe-shaped cells", and concepts such as JIT, lean manufacturing, and mass customization, which blur these distinctions, the basic five classifications remain. They are decoupled by four disjoints:

- One-of-a-kind to low volume.
- Low volume to repeat order/decoupled flows.
- Decoupled to dedicated flows.
- Dedicated discrete to non-discrete (continuous) production.

Thus, a "process continuity" scale can be defined which describes the repetitiveness and discreteness of production and the extent of decoupling or dedication of the process. Lower process continuity is associated with projects, jobs, and batches and higher process continuity is associated with lines and continuous processes. Numerous characteristics of each "marker" have been identified (Stonebraker and Leong, 1994, p. 226). A summary of key process characteristics and the associated disjoints is given at Figure 3.

Brewer and Hensher (2001, p. 18) found "a strong complementarity between logistics strategy and key business practices" including operations and supply chain integration. Thus, it is expected that stabilized, high-volume line operations would permit purchasing and logistics efficiencies over longer periods, with the corresponding economies, but simultaneously reduced flexibility. For example, higher production volumes would facilitate efficiencies of blanket and system purchasing contracts, as well as the establishment of more structured electronic data interchange. Correspondingly, distribution techniques such as milk runs, shared deliveries, and kanbans facilitate these efficiencies; however, these purchasing and distribution efficiencies may systematize the process and reduce flexibility.

Thus, though the concepts of "complementarity" and "fit" between the disciplines of strategic management, supply chain logistics, and operations management have been generally, though not indisputably, established in the literature, the demonstrated relationship between environmental, integration, and operational variables is, at best, tenuous and spotty. Specifically, there is little reliable research that:

	Project	Job	Batch	Line	Continuous
Flow	None	Jumbled	Disjoined	Flow Discrete	Flow Non-discrete
Volume	One-at-a-time	Low	Moderate	High	Highest
Variety	Unique	Customized	Low	Standardized	Little/none
Competitive Priority	Flexibility				Cost
Quality	Customer-defined				Market -defined
Demand	Variable				Stable
Example	Bridge, art	Molds, prints	Drugs, nails	Autos	Refinery
Disjoint	One-of-a-kind –	Low Volume –	Decoupled –	Dedicated (Discrete) –	Continuous

Figure 3.
Key differentiating characteristics of the five classifications of process continuity

- the environmental variables of turbulence and strategic orientation are related to the dimensions of integration; and
- the operations variables associated with process continuity are related to either the environmental or integration variables or to the nexus of those variables.

This paper then establishes, based on extant literature and projected intuition, these relationships, both as an integrated model and as a series of propositions.

Environmental turbulence and supply chain integration

Environmental turbulence is usually related to transaction costs, including the costs of finding, selling, negotiating, monitoring, and resolving disputes with other firms in open market transactions (Coase, 1937). Supply chain integration is one mechanism through which transaction costs may be minimized. From the perspective of transaction cost theory, integration describes a variety of make-or-buy arrangements that a firm might use to obtain ready supplies of raw materials and services and ready markets for their outputs. In theory, integration occurs where markets cannot allocate resources in a manner that alleviates uncertainty (Williamson, 1975). In an imperfectly competitive market, suppliers or buyers can manipulate prices through such mechanisms as supply shortages and output gluts. However, to achieve price stability in such less-than-perfect and uncertain markets, firms must either write and monitor risky contracts with suppliers or buyers or pursue various forms of integration. Theoretically, integrated firms internalize input and output activities within their boundaries to reduce the risks and costs associated with self-interested behavior by suppliers or buyers and uncertain market exchanges (Carlton, 1979; Coase, 1937).

Greater environmental turbulence calls for greater supply chain integration to capture the benefits of coordinated activities derived from organizational hierarchies (Williamson, 1975). Under turbulent environmental conditions, costs associated with production decoupling, inventory scheduling and R&D coordination across multiple parties, are substantially increased. For example, R&D in one stage of production may have implications that can be shared with other stages. Overall, supply chain integration is more likely to occur in industries with rapid changes in technology, demand, or competition than in more stable industrial environments (Balakrishnan and Wernerfelt, 1986). Firms thus will use integration as a mechanism to control external turbulence. Based on the above arguments, we assert the following proposition:

P1. Environmental turbulence is positively related to supply chain integration.

Firms must also make decisions about their vertical boundaries - the number of steps in the chain of processing in which a firm engages. With regard to number of stages, as environmental turbulence increases, the cost of coordinating across external multiple stages of production increases exponentially. In a particular stage, for each technologically distinct processing activity (breadth), an SBU may elect to perform some activities in house while outsourcing others. When facing turbulent environments, the cost of coordinating such multiple activities also increases. To reduce organizational uncertainty and achieve cost efficiency, firms are expected to increase the stages and breadth of integration in response to increased environmental turbulence. In this sense, integration is a mechanism to reduce the risks of environmental uncertainty. Additionally, more turbulent environments may lead firms to rely more on purchases among SBUs (degree) rather than independent third-parties. Based on the above rationale, we propose:

- *P1a*. The degree of environmental turbulence is positively related to the stages of supply chain integration.
- *P1b*. The degree of environmental turbulence is positively related to the degree of supply chain integration.
- *P1c*. The degree of environmental turbulence is positively related to the breadth of supply chain integration.

The core production technology of a firm is expected to moderate the relationship between environmental turbulence and supply chain integration. Specifically, when a firm uses small-batch production technology, the product is custom-made and produced in small quantities, and the process is usually loosely coupled (Woodward, 1965; Hill, 1994). For this reason, transaction cost economies associated with supply chain integration are more difficult to achieve, compared to those of a firm with a continuous process technology where distinct activities and stages are closely coupled. Steel manufacturing offers a classic example. Very high temperatures are required for several stages of production, so a single integrated plant can achieve cost savings by heating the steel once and performing several steps in the conversion process. Further, Sanders and Premus (2002) found that new information technology firms chose flexibility (a key characteristic of low process continuity production) as an enabler in turbulent environments. Given the same level of environmental turbulence, we would expect that firms with continuous-process technology (high process continuity) would engage in greater supply chain integration than those with small-batch process technology (low process continuity).

Integration has consistently been shown (Williamson, 1975; Carlton, 1979; Coase, 1937) as a risk-reducing response to uncertainty. Several stages of production activities are integrated to minimize the bullwhip effect (Lee *et al*., 1997) and to smooth supply chain inefficiencies particularly those with costly technologies, standardized quality, or high volumes, thus minimizing costs and enhancing custom service. Increasing process continuity would stabilize the process against risk and the associated uncertainty. Thus, as process continuity increases, the stages, degree, and breadth of integration are postulated to simultaneously increase. Based on these arguments, we propose:

- *P2*. The greater the degree of process continuity, the greater the impact of environmental turbulence on supply chain integration.
- *P2a*. The greater the degree of process continuity, the greater the impact of environmental turbulence on the stages of supply chain integration.
- *P2b*. The greater the degree of process continuity, the greater the impact of environmental turbulence on the degree of supply chain integration.
- *P2c*. The greater the degree of process continuity, the greater the impact of environmental turbulence on the breadth of supply chain integration.

The proposed relationships of *H1-H2* are depicted in Figure 4a.

Strategic orientation and supply chain integration

Several typologies of strategic orientation have been set forth in the strategic management literature (i.e. Porter, 1981; Miles and Snow, 1978). For example, Miles and Snow (1978) postulate that competing firms within an industry exhibit patterns of behavior representative of several ideal competitive strategy types: defenders, prospectors, analyzers, and reactors. Prospectors are characterized by their constant search for and experimentation with new products, processes, and markets. Consequently, prospectors tend to adopt a proactive stance toward their environment and endeavor to exploit new opportunities along product, production process, and market development growth vectors. In contrast, defenders have a narrow and stable product, process, and market domain and seldom make major adjustments to technology or structure. The emphasis is on more efficient ways of producing a given product or service. Analyzers are a hybrid of these two types. Finally, reactors lack any clear strategy and only respond to competitive circumstance when forced to do so in a characteristically inconsistent and unstable manner. A common yet key dimension underlying this typology is a firm's proactiveness in pioneering products, processes, and markets.

Quinn *et al.* (1990) and Miles and Snow (1986) question the value of highly integrated firms in fast-changing, highly-competitive environments, such as those with numerous cost-conscious competitors or in which technology changes quickly or drastically. For example, Quinn *et al.* (1990) note that firms operating in competitive, turbulent environments tend to avoid vertical integration to minimize the risks associated with an elaborate and likely more inflexible structure. When a firm adopts a more proactive strategy, it reflects the firm's tendency for exploiting emerging opportunities, experimenting with change and mobilizing first-mover actions. Therefore, it will likely be less vertically integrated and will opt for a more flexible organizational form such as outsourcing. The advantages associated with outsourcing (as compared to vertical integration) may include: hiring suppliers with the best value, quickly substituting inferior components or services produced in-house with those of competitors, switching supply sources when new technology appears, and avoiding idle capacity and inventory swings in the entire production chain during a cyclical or temporary downturn (D'Aveni and Ilinitch, 1992). Thus, under a more proactive strategy, the firm's need to flexibly innovate products and adapt to markets may out-weigh efforts to reduce risks by smoothing inputs. Consequently, vertical **dis**integration is expected to be a mechanism to improve organizational flexibility.

In contrast, firms with a less proactive strategy would emphasize cost efficiency and therefore are more likely to engage in integration. Based on these arguments, we propose:

P3. Strategic proactiveness is negatively related to supply chain integration.

D'Aveni and Ilinitch (1992) point out that highly vertically integrated firms create high interdependence among multiple product lines. Such interdependence may lead to inflexibility in changing strategies, abandoning obsolete technologies, or filling unevenly balanced upstream or downstream capacity (Harrigan, 1985). It would be difficult for firms with a greater number of integrated stages to adopt a more proactive strategic orientation. Similarly, the more distinct processing activities (breadth)

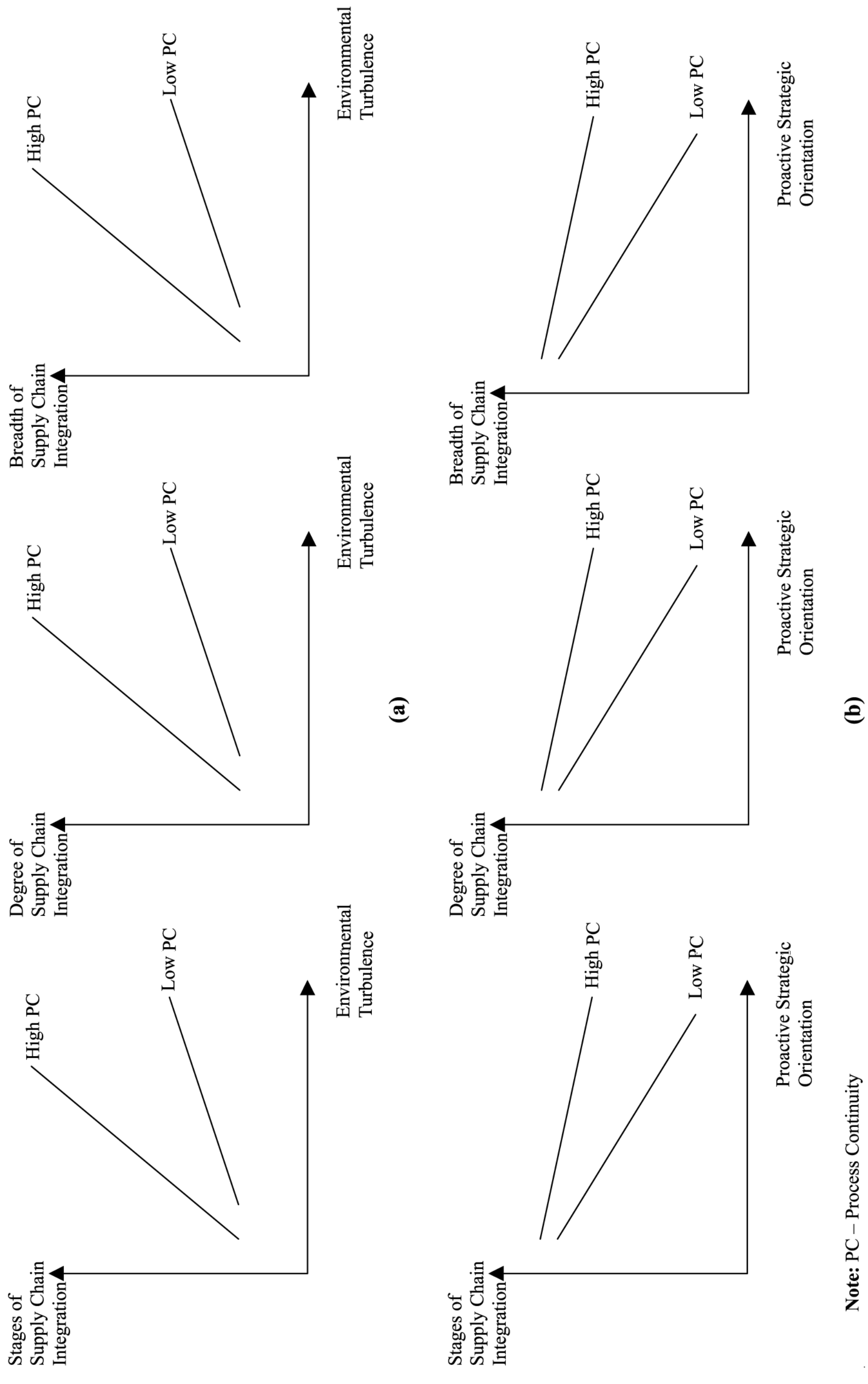


Figure 4. Environmental turbulence, strategic orientation, production technology and supply chain integration

Note: PC – Process Continuity

engaged in at each stage, and the greater proportion purchased from within (degree), the less flexibility a firm may have in creating new products, developing new processes, and venturing into new market. Based on this rationale, we argue:

P3a. The degree of strategic proactiveness is negatively related to the stages of supply chain integration.

P3b. The degree of strategic proactiveness is negatively related to the degree of supply chain integration.

P3c. The degree of strategic proactiveness is negatively related to the breadth of supply chain integration.A firm's core production technology would be expected to moderate the relationship between strategic orientation and vertical or supply chain integration. Given the same level of strategic orientation, we would expect firms with a continuous process technology (high process continuity) to have a greater degree of supply chain integration than those with small-batch process technology (low process continuity). Based on these arguments, we propose:

P4. The greater the degree of process continuity, the greater the impact of strategic proactiveness on supply chain integration.

P4a. The greater the degree of process continuity, the greater the impact of strategic proactiveness on the stages of supply chain integration.

P4b. The greater the degree of process continuity, the greater the impact of strategic proactiveness on the degree of supply chain integration.

P4c. The greater the degree of process continuity, the greater the impact of strategic proactiveness on the breadth of supply chain integration.

The proposed relationships of *H3-H4* are depicted in Figure 4b.

There is a seeming inconsistency between the relationships of environmental turbulence and proactiveness of strategic orientation with the integration and process continuity variables. High turbulence, based on the literature, is associated with increased integration and with greater moderation by process continuity. Yet, simultaneously, the literature and theory suggest that strategic proactiveness is negatively associated with supply chain integration and with greater moderation by process continuity. Simply put, does high process continuity equally mediate between the positive relationship of turbulence and integration and the negative relationship of proactiveness and integration? This seeming incongruence begs the further question: under what process continuity situations should operations managers pursue integration and with what expected outcomes?

Conclusions and implications

This paper has pursued the notion that supply chain integration is an evolving application of the well-established vertical integration theory. We base this assertion on the rationale that, for efficiency, a strategic fit must exist between environmental, integration, and operations variables. That fit would attenuate "bullwhip" inefficiencies and reduce inventory costs and improve customer service. As such, this paper presents a cross-functional and static approach to relate strategic management theory to the more multi-dimensional and dynamic operations applications. In that pursuit, this study makes a number of contributions, yet simultaneously has some limitations.

This study is one of the first to posit and define the relationship between the strategic notion of vertical integration and the operational concept of supply chain integration. Additionally, it departs from the early and well-established uni-dimensional constructs of vertical integration by emphasizing a continuum of emerging multi-dimensional supply chain factors. Though there are definitive differences in the focus of these two approaches and the corresponding research efforts that have emerged, clearly supply chain integration is an applied and operationalized approach of the more theoretical and strategic notion of vertical integration. This paper is also among the first to suggest that integration, whether strategic or operational, is very much the same in terms of costs and risks. In fact, the recent increase of environmental turbulence has lead to a need for less direct ownership, but greater and tighter control of supply chain activities.

Additionally, while numerous earlier studies have defined the environmental and integration variables to be unidimensional and static, this study, following recent supply chain analyses, addresses vertical/supply chain integration as a continuous and multidimensional variable. We argue that environmental uncertainty and strategic orientation determine a firm's integration strategy, and their impacts are moderated by a firm's core production technology. Note that environmental turbulence would tend to increase the need for integration while proactive strategic posture is expected to be associated with lesser integration effort. This dichotomous impact suggests the further research question of which is a more important contributor to integration decision-making and under what circumstances.

This research did not find prior studies that have addressed operational variables as moderators of the relationship between the environmental factors and the integration variables. Thus, this study suggests and dimensionalizes the relationships of moderating variables to the primary independent and dependent variables, positing that high process continuity has a greater moderating impact between the strategic variables and integration.

This study does, however, have several notable limitations. Of course, this paper has focused on the model building, dimensionalization, and proposition-positing activities only. Given the general lack of theoretical research in this cross-functional area, this study is an initial attempt to address the modeling activities. It has not developed or operationalized a high-confidence test of the model. That work is yet to be done.

Certainly the omission of several variables, such as the form dimension of integration and the uncertainty, complexity, and munificence variables of the environment, detracts from the overall scope of the model. These variables are likely extensively entwined with those of the present study and should be pursued, both separately and in concert, in future efforts. Of course, there is a tradeoff between the preciseness of the definition of a study and the manageability of a study. The more variables that are described, the greater the number of potential hypotheses, and, as the study moves toward empirical testing, the larger and more complex the survey, the sampling process, the method, and the exposition.

Thus, this study is an example of a cross-disciplinary and cross-functional analysis that is increasingly relevant to the more dynamic and integrated environment of global business. It establishes the foundations for numerous future conceptual and empirical research efforts. The environmental variables of uncertainty, munificence, and complexity, as well as the form dimension of integration should be the focus of further conceptual research to establish the nature and strengths of their interrelationships with current study variables. Further, this study begins the process of evaluating and diagnosing situational variables focused toward answering the questions: under what environmental and operational circumstances should management pursue supply chain or vertical integration, at what costs, and with what expectancies for success?

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