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STRATEGIC SUPPLY CHAIN MANAGEMENT: IMPROVING PERFORMANCE THROUGH A CULTURE OF COMPETITIVENESS AND KNOWLEDGE DEVELOPMENT

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For many firms, using their supply chains as competitive weapons has become a central element of the strategic management process in recent years. Drawing on the resource-based view and theory from the organizational learning and information-processing literatures, this study uses a sample of 201 firms to examine the influence of a culture of competitiveness and knowledge development on supply chain performance in varied market turbulence conditions. We found that synergies exist between a culture of competitiveness and knowledge development: their interaction has a positive association with performance. In addition, based on behavioral and contingency theories, we found that market turbulence moderates these relationships, having a positive influence on the knowledge development–performance link and a negative influence on the culture of competitiveness–performance link. Managers who are confident about the level of market turbulence they will face can use this sense to decide whether to emphasize developing either a culture of competitiveness or knowledge development in their supply chains. For those firms whose managers are unlikely to be able to predict the degree of turbulence they will face over time, a focus on both a culture of competitiveness and knowledge development is critical to ensuring success. Copyright © 2007 John Wiley & Sons, Ltd.

INTRODUCTION

The quest to discover the determinants of firm performance has long been central to the strategic management field. Indeed, many leading scholars have argued that building knowledge about why some firms outperform others is the cornerstone of the field (e.g., Hitt, Boyd, and Li, 2004; Rumelt, Schendel, and Teece, 1994; Summer *et al*., 1990). In recent years, the nature of competition has increasingly shifted toward 'supply chain vs. supply chain' struggles (Handfield and Nichols, 2002; Slone, 2004). Supply chains are value-adding relations of partially discrete, yet inter-reliant, units that cooperatively transform raw materials into finished products through sequential, parallel, and/or network structures (Bowersox, Closs, and Stank, 1999). When rivals such as UPS and FedEx clash, it is not merely their individual capabilities, but rather the collective capabilities of their respective supply chains, that determine the outcome.

Historically, the strategic management field has not devoted much empirical attention to supply chains, while related disciplines such as marketing and operations management have long emphasized the performance implications of operational activities. For example, in a review of the operations management literature, Anderson, Cleveland, and Schroeder (1989: 134) noted: 'proper strategic

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positioning or aligning of operations capabilities can significantly impact competitive strength and business performance of an organization.' In recent years, a small body of strategic management research has begun to examine 'strategic supply chain management'—the use of a supply chain not merely as a means to get products where they need to be, but also as a tool to enhance key outcomes (e.g., Hult, Ketchen, and Nichols, 2002; Hult, Ketchen, and Slater, 2004). The value of strategic supply chain management is reflected in how firms such as Wal-Mart, Zara, Toyota, and Dell have used their supply chains as competitive weapons to gain advantages over peers. Meanwhile, failing to strategically manage supply chains offers serious negative consequences. As Lee (2004) describes, for example, supply chain difficulties led Cisco to write off $2.25 billion in inventory in 2001 and led Motorola to lose many crucial early camera phone sales in 2003. Given the implications for profits and sales, it is perhaps not surprising that the announcement of a major supply chain problem erodes a firm's market value by an average of 10 percent (Hendricks and Singhal, 2003).

Like the Hult *et al*. studies, we focus on explaining order fulfillment cycle time—the length of time between taking an order and delivery of the needed product to the customer. As Ray, Barney, and Muhanna (2004) note, measuring the effectiveness of business processes helps test resource-based logic and taps into the competitive advantages developed within important activities. Cycle time is a key metric for directly assessing supply chain functioning (Nichols, Retzlaff-Roberts, and Frolick, 1996). More importantly, cycle time is central to a firm's strategic success. As Handfield and Nichols (2002: 13) note, cycle time not only has 'a direct linkage to profits' at the firm level, but excellence in cycle time allows firms to 'grow faster and earn higher profits relative to other firms in their industry, increase market share through early introduction of new products, control overhead and inventory costs, and move to positions of industry leadership.' In contrast to the single-organization focus of the Hult *et al*. studies, we examine the supply chains of multiple firms. This design feature allows us to shed new light on the critical issue of why some firms outperform others.

This paper is devoted to taking what we view as a next logical step in the emerging stream of research on strategic supply chain management. We build on Hult *et al*. (2002), who introduced the concept of 'cultural competitiveness' as a reflection of innovativeness, entrepreneurial, and learning orientations,[1] and Hult *et al*. (2004), who examined the knowledge development process, both within the context of achieving superior performance. Learning is a key element of both studies but the frameworks tested are distinct. Taking the previous studies' shared concern for learning as our point of departure, we build on the resource-based view (Wernerfelt, 1984), and theory from the organizational learning (Huber, 1991) and information-processing (Daft and Weick, 1984) literatures to argue that neither a culture of competitiveness nor knowledge development by itself is sufficient to achieve superior performance in varied market conditions. Instead, these phenomena operate in tandem to achieve desired outcomes. Using data from 201 firms, we apply a sophisticated technique—parsimonious latent-variable interaction modeling (e.g., Ping, 1995)—to highlight the potential value of two phenomena that together can facilitate superior cycle time.

THEORETICAL FOUNDATION AND HYPOTHESES

Recent research by Ray *et al*. (2004) and Schroeder, Bates, and Junttila (2002) highlights the value of examining resources within a firm's operations management process. In line with this work, Figure 1 presents our conceptual model, which is intended to explain cycle time in supply chains. The model includes two higher-order factors—culture of competitiveness and knowledge development—composed of seven first-order indicators (each of which, in turn, has a set of reflective indicators—see Appendix 1), as well as their interaction. Culture of competitiveness (CC) is defined as the 'degree to which [supply] chains are predisposed to detect and fill gaps between what

[1] Hult, Ketchen, and Nichols (2002) introduced the concept of 'cultural competitiveness.' As an anonymous referee pointed out, the term 'cultural competitiveness' seems to denote a comparison of one firm's competitive characteristics against those of another to see which is more successful. Based on this referee's suggestion, we adopt the term 'culture of competitiveness.' This better reflects the underlying concept's focus on the degree to which values and beliefs centered on customer service are developed. We appreciate the referee's insights on this issue.

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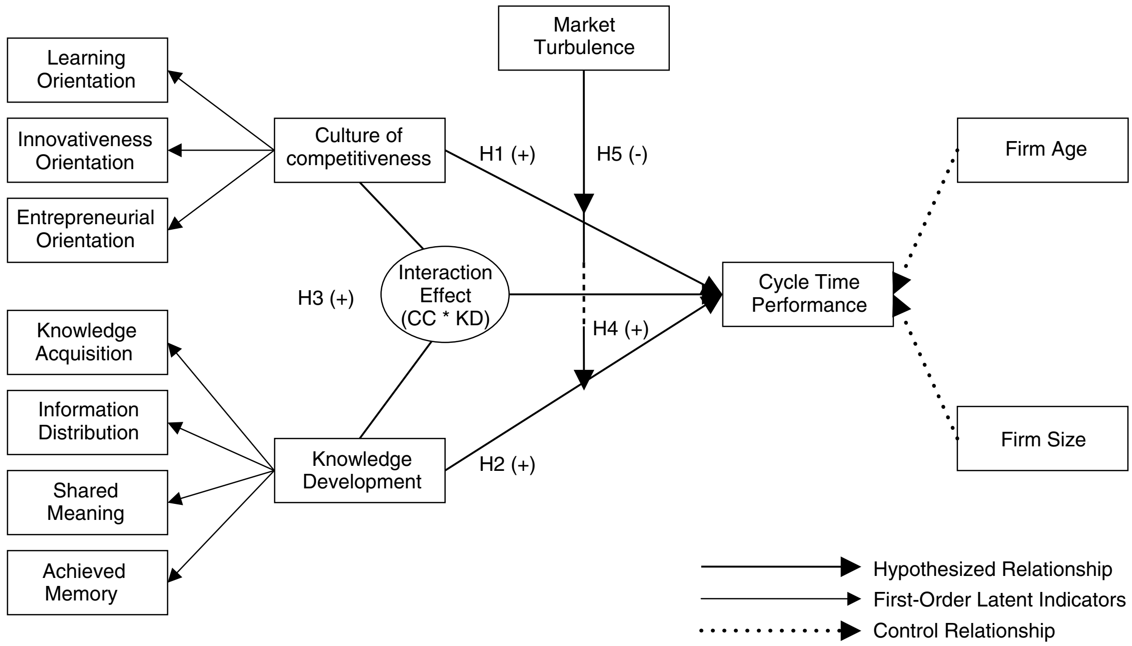

Figure 1. A model of culture of competitiveness, knowledge development, and cycle time performance in supply chains

the market desires and what is currently offered' (Hult *et al*., 2002: 577). Drawing on the resource-based view (Wernerfelt, 1984), CC is conceptualized as an unobservable latent factor (Godfrey and Hill, 1995) that is reflected in three orientations—innovativeness, entrepreneurial, and learning—that affects performance. The latter orientation—learning—is the critical element that helps integrate CC and knowledge development. Specifically, learning orientation focuses on the values and beliefs that direct supply chains toward the behaviors required for knowledge development.

Knowledge development (KD), on the other hand, is a phenomenon wherein actions lead to knowledge acquisition, information distribution, shared meaning, and achieved memory in the supply chain (Hult *et al*., 2004; cf. Huber, 1991). As such, a learning orientation is reverberated in a set of knowledge-seeking *values* (Baker and Sinkula, 1999) while KD is reflected by knowledge-producing *behaviors* (e.g., Grant, 1996). Research on organizational learning (e.g., Huber, 1991) and information processing (Daft and Weick, 1984) serve as the primary foundation for the four first-order indicators of KD—knowledge acquisition, information distribution, shared meaning, and achieved memory—and its higher-order relationship with performance in supply chains. The broader learning literature (i.e., learning orientation and organizational learning) is the basis for integrating CC and KD in the model (e.g., Argyris and Schön, 1978; Hedberg, 1981; Nystrom and Starbuck, 1984).

Culture of competitiveness in supply chains

As Barney and Mackey (2005: 5) note, the continued theoretical development of the resource-based view requires scholars to not 'simply correlate aggregate measures of resources' at the firm level but rather to move their investigations to the levels of analysis 'where resources reside.' Thus, theory and empirical attention should be aimed 'at the level of the resource, not the level of the firm.' The supply chain offers one such level of analysis where resources reside, and resources' role at this level can be prominent. Indeed, as Hult *et al*. (2002: 580) observe, because chain members do not all share 'a common organizational affiliation, the development of unique resources ... may be vital to chain outcomes.' In this sense, shared supply chain resources can substitute for traditional features that bind members of a firm, such as structure, culture, and strategy (cf. Weick, 1987).

Building on the resource-based view, Hult *et al*. (2002) argue that a culture of competitiveness

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functions as an intangible strategic resource that can be developed by interaction and cooperation among supply chain members. CC provides supply chain members with a pattern of shared values and beliefs that assert the importance of certain elements (and omit others) and drive the chain's approach to the marketplace. As such, CC is rooted in the broad phenomenon of 'culture' but is narrowly focused on a distinct set of cultural orientations—entrepreneurial, innovativeness, and learning—that lead supply chains to strategically fill gaps between customers' future desires and what is currently offered.

An entrepreneurial orientation is defined as the chain members' values associated with the pursuit of new market opportunities and the renewal of existing areas of supply chain activities (e.g., Naman and Slevin, 1993). An innovativeness orientation refers to supply chain members' values associated with new idea generation (i.e., members' openness to new ideas; Hurley and Hult, 1998). A learning orientation is defined as members' values associated with the generation of new insights that have the potential to shape supply chain activities (cf. Huber, 1991). Each of these three orientations is necessary, but individually insufficient, for the emergence of the higher-order intangible strategic resource of culture of competitiveness (Hult *et al*., 2002). Most importantly, rooted in the resource-based view, CC appears to be a valuable, rare, and inimitable strategic resource in supply chains (Barney, 1986; Wernerfelt, 1984) that can provide a sustainable competitive advantage and enhanced performance (Hult *et al*., 2002). Thus, we expect that:

Hypothesis 1: Culture of competitiveness has a positive association with cycle time performance.

Knowledge development in supply chains

Huber (1991: 90) describes four dimensions that are paramount to learning efforts. Hult *et al*. (2004) built on these elements to develop a model of knowledge development. The first dimension is knowledge acquisition—the process by which entities, such as organizations or supply chains, obtain wisdom. Information distribution is the process by which information from different sources is shared. In supply chains, this sharing occurs throughout the chain, including its various nodes and members (Kohli, Jaworski, and Kumar, 1993). Information interpretation, or shared meaning, is the process by which members develop common understandings about data and events (Corner, Kinicki, and Keats, 1994). Given the lack of a strong culture in typical supply chains, shared meanings of supply chain data and events are needed to harness collective action (Hult *et al*., 2004). Perhaps the most integral component of KD is 'organizational memory' (Huber, 1991), labeled 'achieved memory' for the supply chain context by Hult *et al*. (2004) based on work by Moorman and Miner (1997). Memory is defined as the amount of knowledge, experience, and familiarity with the supply chain process, its operations, and behaviors; it serves as the mechanism by which knowledge is stored for future strategic use and, as such, is critical as a 'launching' point for future learning behaviors.

Theory from the organizational information-processing literature provides the basis for expecting that, as a group, the four dimensions should enhance supply chain performance. Information-processing theory argues that gathering, processing, and interpreting information is the primary job of organized collectivities (Daft and Weick, 1984) such as supply chains (Bowersox *et al*., 1999). Research on 'strategic sensemaking' has extended this argument to demonstrate that information-processing activities profoundly shape the strategic decisions made within firms and the resultant outcomes (Meyer, 1982; Thomas, Clark, and Gioia, 1993). The knowledge-based view (Grant, 1996) also supports a knowledge development–performance link. Building on the resource-based view's notions of value, rarity, and inimitability, the knowledge-based view centers on the notion that unique abilities to create and exploit wisdom create competitive advantages and thereby enhance outcomes (e.g., Hult *et al*., 2004). As such, within the supply chain context, our contention is that:

Hypothesis 2: Knowledge development has a positive association with cycle time performance.

Synergy between culture of competitiveness and knowledge development

The broader learning literature (e.g., Argyris and Schön, 1978; Hedberg, 1981; Nystrom and Starbuck, 1984) serves as the theoretical foundation

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for learning being the key integrator of a culture of competitiveness and knowledge development in supply chains. While Hult *et al*. (2002, 2004) developed both the CC and KD constructs within supply chains, they did not integrate the two concepts. This is unfortunate because the learning orientation construct within the CC framework is focused on the supply chain's knowledge-seeking values (Baker and Sinkula, 1999) that guide its knowledge-producing behaviors within the KD development framework (e.g., Grant, 1996; Huber, 1991). As such, learning is both the missing link in the conceptualizations by Hult *et al*. (2002, 2004) and the resultant integrator of the two frameworks. In other words, their shared concern for learning suggests that neither CC nor KD is sufficient to maximize performance. Instead, they supplement and reinforce each other for a stronger strategic effect than either alone can provide.

For example, Baker and Sinkula (1999: 416) argue that 'if members of an organization [e.g., supply chain] have an enhanced learning orientation, they will not only gather and disseminate information about markets but also constantly examine the quality of their interpretive storage functions and the validity of the dominant logic that guides the entire process.' At the same time, stressing knowledge-producing behaviors in the supply chain is likely to lead to the 'culture of competitiveness' infrastructure exemplified by the values inherent in a learning orientation (e.g., Slater and Narver, 1995). Applied within supply chains, the expectation of a synergistic interaction between CC and KD is also consistent with Day's (1994) inside-out and outside-in processes that center on the strategic interaction between superiority in process management, integration of knowledge, and diffusion of learning. Based on this logic, we expect that:

Hypothesis 3: The interaction between culture of competitiveness and knowledge development has a positive association with cycle time performance.

The moderating role of market turbulence

Starbuck's (1976) review of organizational task environments provided a wealth of potential dimensions that can affect firm strategy and operations. In our study, we draw from this literature to focus on market turbulence—the rate of change in the composition of customers and their preferences (Jaworski and Kohli, 1993)—as one critical element of the environment that theoretically has an influence on the relationships studied in this research (e.g., Dess and Beard, 1984). In addition, we place particular emphasis on the notion that managerial perceptions, particularly regarding market uncertainty, shape strategic choice and decision making (Child, 1972; Duncan, 1972; Lawrence and Lorsch, 1967). Similarly, Sharfman and Dean (1991: 682) state that 'the environment is those parts of the external information flow that the firm enacts through attention and belief.' One logical extension is that environmental perceptions and beliefs shape culture and behavior (Dutton and Jackson, 1987).

We expect that this argument also will hold true in supply chains. For example, one of behavioral theory's tenets is that organizational memory is dependent on the conditions in which the firm operates (Cyert and March, 1963; Levitt and March, 1988). Thompson (1967: 159) considered dealing with uncertainty to be the 'essence of the administrative process.' Accordingly, supply chains are likely to realize a positive influence of market turbulence on the knowledge development–cycle time relationship given the dynamic nature of the behaviors involved in KD. Indeed, applying the concept of requisite variety (Ashby, 1956) suggests that, as the environment's pace of change increases, a premium on developing knowledge emerges. Requisite variety means that organizational entities, such as supply chains, must match the environment's complexity with their own internal strategies and activities. A supply chain adept at developing knowledge possesses a greater arsenal of wisdom for overcoming the complexities created by rapid change than do other supply chains. Thus:

Hypothesis 4: Market turbulence has a positive influence on the relationship between knowledge development and cycle time performance.

Structural contingency theory suggests that the value of a resource depends on the context within which it is deployed (Lawrence and Lorsch, 1967). Building on this general tenet, we expect market turbulence to suppress the culture of the competitiveness–performance relationship. As defined above, CC reflects a supply chain's predisposition to spot and strategically plug gaps between what the market desires and what the chain currently offers (Hult *et al*., 2002). Under low levels of turbulence, these gaps are relatively consistent and slow developing, suggesting that CC can be effectively targeted at filling the gaps. When turbulence is high, however, the market's desires shift rapidly and unpredictably, leading the gaps that CC seeks to fill to be fluid and nebulous.

Indeed, as Aldrich (1979: 69) stresses, a high level of turbulence 'leads to externally induced changes ... that are obscure to administrators and difficult to plan for.' Weiss and Heide (1993) also note that rapid change in the marketplace can be destructive and detrimental to already-existing cultural competencies (e.g., a culture of competitiveness) that are deeply ingrained and embedded in the values and belief system of supply chain members. Thus, while greater market turbulence increases the supply chain's knowledge development requirements (Levinthal and March, 1981), greater turbulence in the marketplace also serves as a detriment to a culture of competitiveness. As such, we expect that:

Hypothesis 5: Market turbulence has a negative influence on the relationship between a culture of competitiveness and cycle time performance.

METHOD

Data collection

Prior to collecting the data in 1999, we pretested our scale items with eight academics and seven supply chain management executives. Also, we performed a pilot study with 36 supply management executives to assess the research design's quality. These steps resulted in some changes being made, mainly to the instructions to respondents and the need to keep the responses anonymous to secure study participation (i.e., we opted not to code the surveys for identification purposes based on concerns raised in the pretests and pilot study). Following Huber and Power's (1985) guidelines on how to get quality data from key informants, a survey was developed using Dillman's (1978) method and administered to supply chain management executives drawn from the membership of the Institute of Supply Management (ISM). Founded in 1915, ISM is a not-for-profit professional organization of about 45,000 individuals who have responsibilities in supply chain management. ISM is best known for its Purchasing Managers' Index (PMI)—a composite index of purchasing activity among manufacturing firms that is closely monitored by financial institutions and economists.

We restricted our sample to manufacturing firms, and instructed respondents to focus on the last order fulfillment process within their supply chains. The sampling frame consisted of a total of 2000 supply chain management professionals with 201 responding for an effective response rate of 10.73 percent (127 were non-deliverable). These individuals had been with their firms an average of 11 years, and they represented firms that had existed for an average of 64 years, employed an average of 13,688 people, and had an average of 38 people in their supply management unit. The executives who responded had titles such as Director of Purchasing, Director of Purchasing and Materials Management, Vice President of Procurement, and Chief Purchasing Officer.

We used Armstrong and Overton's (1977) extrapolation procedure to assess non-response bias. Table 1 summarizes the results. Although we found a significant difference ($p < 0.05$) between the first and fourth quartiles of the respondents for firm age (with early respondents firms' averaging 55 years and late respondents averaging 74 years), no systematic differences were found between the early and late respondents. Thus, non-response bias is likely not an inhibitor in our analyses.

Measures

Tables 2 and 3 present the results of the measurement assessment. Table 2 summarizes the variables' means, standard deviations, correlations, and shared variances. Table 3 reports the average variances extracted, construct reliabilities, factor loadings, and fit indices. Established scales were used to measure culture of competitiveness (learning, innovativeness, and entrepreneurial orientations), knowledge development (knowledge acquisition, information distribution, shared meaning, and achieved memory), market turbulence, and cycle time performance. Also, firm age and size were included as control variables (e.g., Amburgey and Rao, 1996). Appendix 1 lists the scales used and their sources.

Table 1. Comparison of early and late respondents

	Respondents	N	Mean	S.D.
Learning orientation	Early	50	5.67	1.19
	Late	51	5.92	0.83
Innovativeness orientation	Early	50	5.13	1.23
	Late	51	5.08	1.29
Entrepreneurial orientation	Early	50	3.97	1.29
	Late	51	4.36	1.31
Knowledge acquisition	Early	50	4.22	1.21
	Late	51	4.19	1.14
Information distribution	Early	50	4.62	1.32
	Late	51	4.75	1.32
Shared meaning	Early	50	4.78	1.11
	Late	51	4.78	1.33
Achieved memory	Early	50	5.31	1.12
	Late	51	5.51	0.87
Market turbulence	Early	50	4.95	1.21
	Late	51	4.82	1.17
Cycle time	Early	50	4.35	0.96
	Late	51	4.70	1.09
Firm age*	Early	50	55.24	42.06
	Late	50	74.29	45.39
Firm size	Early	50	15158.94	32458.88
	Late	50	15625.24	25446.49

* $p < 0.05$.

All perceptual measures were subjected to assessments of dimensionality, reliability, and validity. The psychometric properties of the nine latent constructs involving 44 items were evaluated simultaneously in one confirmatory factor analysis (CFA) using LISREL 8.80 (Jöreskog *et al.*, 2000). Additionally, we examined the higher-order structure of CC and KD to provide empirical support, in addition to the theoretical rationale, for the focus on these constructs at the higher-order aggregate level.

Fit of the measurement model

The model fit was evaluated using a series of indices recommended by Gerbing and Anderson (1992) and Hu and Bentler (1999)—the DELTA2, relative noncentrality (RNI), comparative fit (CFI), Tucker–Lewis (TLI), and the root mean square error of approximation (RMSEA) indices. After removing inadequate items (see Appendix 1), an excellent fit to the data was achieved for the first-order based CFA, with DELTA2, RNI, CFI, and TLI all being 0.96, and RMSEA = 0.07 ($\chi^2 = 986.92$, d.f. = 491).

Higher-order cultural competitiveness (CC) and knowledge development (KD) model

Given the theoretical arguments underlying the CC and KD constructs in Figure 1, we next conducted a higher-order assessment of these constructs, including all purified items, the first-order indicators, and the second-order indicators. The results indicate that, in addition to the item loadings reported in Table 3 for each of three CC and four KD dimensions, there is support for each construct's higher-order structure. As such, learning (loading = 0.64, t-value = 8.26, $p < 0.01$), innovativeness (loading = 0.88, t-value = 11.25, $p < 0.01$), and entrepreneurship (loading = 0.81, t-value = 8.91, $p < 0.01$) function as first-order indicators of the higher-order construct of CC (R^2s range from 40% to 78%), where the first-order indicators are composed of the reflective indicators included in Appendix 1. Likewise, knowledge acquisition (loading = 0.80, t-value = 8.72, $p < 0.01$), information distribution (loading = 0.89, t-value = 8.62, $p < 0.01$), shared meaning (loading = 0.88, t-value = 11.82, $p < 0.01$), and achieved memory (loading = 0.56, t-value = 7.11, $p < 0.01$) function as first-order indicators of the higher-order construct of KD (R^2's range from 31% to 78%). The model fit for the higher-order structure was 0.96 for each of the DELTA2, RNI, CFI, and TLI indices, and 0.08 for RMSEA ($\chi^2 = 624.85$, d.f. = 267).

Composite reliability

We assessed the latent factors' reliability by calculating a composite reliability for each construct (Fornell and Larcker, 1981). The formula specifies that

$$\mathrm{CR}_\eta = \frac{(\sum \lambda\gamma_i)^2}{(\sum \lambda\gamma_i)^2 + (\sum \varepsilon_i)}$$

where CR_η = composite reliability for scale η; λ_{yi} = standardized loading for scale item γ_i, and ε_i = measurement error for scale item γ_i. Along with the reliability calculations, we also examined the parameter estimates and their associated t-values as well as the average variances extracted

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Table 2. Means, standard deviations, correlations, and shared variances ($n = 201$)

	Mean	S.D.	LO	IN	EO	KA	ID	SM	AM	MT	CT	AGE	SIZE
Learning orientation (LO)	5.88	0.98	—	0.30	0.11	0.12	0.12	0.14	0.17	0.00	0.11	0.00	0.00
Innovativeness orientation (IO)	5.33	1.13	0.55	—	0.41	0.19	0.24	0.30	0.22	0.00	0.19	0.01	0.04
Entrepreneurial orientation (EO)	4.43	1.27	0.33	0.64	—	0.29	0.25	0.31	0.20	0.01	0.22	0.02	0.04
Knowledge acquisition (KA)	4.33	1.15	0.34	0.44	0.52	—	0.49	0.37	0.18	0.08	0.18	0.01	0.03
Information distribution (ID)	4.84	1.22	0.35	0.49	0.50	0.70	—	0.46	0.24	0.05	0.04	0.00	0.06
Shared meaning (SM)	4.99	1.16	0.37	0.55	0.56	0.61	0.68	—	0.23	0.01	0.14	0.00	0.06
Achieved memory (AM)	5.55	1.00	0.41	0.47	0.45	0.42	0.49	0.48	—	0.03	0.12	0.01	0.02
Market turbulence (MT)	4.72	1.18	0.04	0.06	0.12	0.29	0.22	0.11	0.17	—	0.01	0.00	0.01
Cycle time (CT)	4.57	1.06	0.33	0.44	0.47	0.42	0.40	0.37	0.34	0.11	—	0.02	0.06
Firm age (AGE)	63.62	43.27	−0.04	−0.12	−0.14	−0.09	−0.06	−0.06	−0.08	−0.02	−0.14	—	0.13
Firm size (SIZE)	13,688	32,948	−0.05	−0.20	−0.20	−0.18	−0.24	−0.25	−0.15	0.09	−0.24	0.36	—

The correlations are included in the lower triangle of the matrix. All correlations ≥ 0.14 are significant at the $p < 0.05$ level. Shared variances are included in the upper triangle of the matrix.

Table 3. Summary statistics of the confirmatory factor analysis ($n = 201$)

Construct	Average variance extracted	Composite reliability	Range of loadings
Learning orientation	62.0%	0.82	0.47 to 0.93
Innovativeness orientation	69.8%	0.90	0.81 to 0.89
Entrepreneurial orientation	60.5%	0.86	0.70 to 0.83
Knowledge acquisition	50.5%	0.80	0.61 to 0.79
Information distribution	59.3%	0.81	0.64 to 0.89
Shared meaning	74.0%	0.92	0.83 to 0.89
Achieved memory	76.0%	0.90	0.80 to 0.91
Market turbulence	56.2%	0.86	0.68 to 0.81
Cycle time	45.0%	0.74	0.36 to 0.95
$\chi^2 = 986.92$			
d.f. = 491			
DELTA2 = 0.96			
RNI = 0.96			
CFI = 0.96			
TLI = 0.96			
RMSEA = 0.07			

(Anderson and Gerbing, 1988). Average variance extracted was calculated as

$$V_\eta = \frac{\sum \lambda \gamma_i^2}{\sum \lambda \gamma_i^2 + \sum \varepsilon_i}$$

where V_η = average variance extracted for η; λ_{yi} = standardized loading for scale item γ_i, and ε_i = measurement error for scale item γ_i. The scales' reliabilities ranged from 0.74 to 0.92, the factor loadings ranged from 0.36 to 0.95 ($p < 0.01$), and the average variances extracted ranged from 45 to 76 percent (Table 3). The 34 purified items were also found to be reliable and valid when evaluated based on each item's error variance, modification index, and residual covariation.

Discriminant validity

Following the reliability analysis, we established discriminant validity by two independent methods. First, we calculated the shared variance between each pair of constructs and verified that it was lower than the variances extracted for the involved constructs (Fornell and Larcker, 1981). Shared variance was calculated as

$$\gamma^2 = 1 - \psi$$

where $\gamma^2 =$ shared variance between constructs, and with the diagonal element of ψ indicating the amount of unexplained variance. Because η and ε were standardized, γ^2 was equal to the squared correlation between the two constructs. As shown in Table 3, the average variances extracted were above 50 percent for all but one construct (cycle time, 45%). The shared variances between pairs of all possible scale combinations indicated that the average variances extracted were higher than the associated shared variance in all cases (Table 2).

Second, we examined all possible pairs of constructs, as suggested by Bagozzi and Phillips (1982), in a series of two-factor CFA models using LISREL 8.80. Specifically, each pairwise CFA model was run twice: first, constraining the ϕ coefficient to unity; and second, allowing ϕ to vary freely. Based on the results of a χ^2 difference test, the unconstrained model performed significantly better than the associated constrained model when $\phi = 1$ (i.e., $\Delta\chi^2_{(1)} > 3.84$ was exceeded in all cases). The lowest $\Delta\chi^2_{(1)}$ was found between knowledge acquisition and information distribution ($\Delta\chi^2_{(1)} = 32.06$).

Finally, as detailed in Appendix 2, assessment at the measurement level found no evidence of common method variance. Appendix 2 also describes a more sensitive test conducted at the hypothesis level. Overall, the nine measures and their 34 purified indicators were found to be reliable and valid in the context of this study.

ANALYSIS AND RESULTS

Table 4 summarizes the results. Hypothesis testing was accomplished via two techniques: (1) hierarchical regression; and (2) a parsimonious latent-variable interaction technique (e.g., Ping, 1995) via LISREL 8.80. This dual testing allows for a robust assessment of the hypotheses, within the different strengths and constraints of each technique (e.g., Shook *et al.*, 2004). For example, on the one hand, hierarchical regression allows the direct assessment of change in explanatory power between iterative steps (which we cannot accomplish definitively using SEM given that our step 1 equation, for example, is saturated). Further, as a traditional technique, it provides a baseline set of results for our predictions. On the other hand, the more complex 'parsimonious latent-variable interaction technique' allows for the inclusion of measurement errors and indicators of the higher-order factors, and can account for potential CMV problems (e.g., Netemeyer *et al.*, 1997; Podsakoff *et al.*, 2003).

Hierarchical moderator regression analysis

As a first step in testing the hypotheses, we used hierarchical regression. Because three interaction terms were included in the equation, we standardized all variables to reduce the potential effects of multicollinearity (Cohen *et al.*, 2003). The technique of least squares was used with the control variables entered as a block in step 1 (firm age and size), followed by the main effects in step 2 (culture of competitiveness, knowledge development, and market turbulence), and the interaction and moderators in step 3. Specifically, the following regression equation was analyzed in three hierarchical steps:

$$Y_1 = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_4 X_5 + \beta_7 X_3 X_4 + \beta_8 X_3 X_5 + \varepsilon$$

where $Y_1 =$ cycle time performance (CT), $\alpha =$ intercept, $X_1 =$ firm age (AGE), $X_2 =$ firm size (SIZE), $X_3 =$ market turbulence (MT), $X_4 =$ culture of competitiveness (CC), $X_5 =$ knowledge development (KD), and $\varepsilon =$ random disturbance terms. Consistent with the literature on simultaneous testing of main effects along with their interactions, we examined each main effect (CC $\rightarrow$ CT and KD $\rightarrow$ CT) as the effect of a given predictor when the predictor it interacts with is at its mean (Aiken and West, 1991). As such, we discuss the main effect regression results of CC conditioned on the notion that KD is at its mean, and vice versa.

Within the regression testing, market turbulence was created as a summated index. In addition,

DOI: 10.1002/smj

Table 4. Standardized results of the hypothesis testing with cycle time as the criterion variable ($n = 201$)

Predictor variables	Three-step hierarchical regression analysis		Three-step parsimonious latent-variable interaction analysis				Findings
			Constrained model		Unconstrained model		
	β	t	γ	t	γ	t	
Step 1: Control variables							
Firm age (AGE)	−0.06	−0.76	−0.07	−0.86	−0.04	−0.16	
Firm size (SIZE)	−0.22	−2.91***	−0.23	−2.91***	−0.54	−2.25***	
Same-source factor (to assess CMV)	—	—	—	—	0.51	7.02***	
R^2	0.06		0.07		0.33		
Model fit	$F = 6.10$***		Saturated model		Saturated model		
Step 2: Main effects							
Firm age (AGE)	−0.04	−0.53	−0.03	−0.36	−0.02	−0.29	
Firm size (SIZE)	−0.12	−1.69*	−0.12	−1.54	−0.14	−1.78*	
Market turbulence (MT)	0.04	0.69	0.06	0.82	−0.11	−1.44	
Culture of competitiveness (CC)	0.35	4.21***	0.52	3.25***	0.41	2.14**	H1 supported
Knowledge development (KD)	0.19	2.17**	0.07	0.39	−0.19	−0.75	H2 partially supported
Same-source factor (to assess CMV)	—	—	—	—	0.39	5.04***	
R^2	0.30		0.39		0.39		
Model fit	$F = 16.58$***		CFI = 0.98		CFI = 0.97		
Step 3: Interactions							
Firm age (AGE)	−0.06	−0.92	−0.06	−0.89	−0.05	−0.72	
Firm size (SIZE)	−0.09	−1.33	−0.07	−0.98	−0.10	−1.33	
Market turbulence (MT)	0.06	0.91	0.08	1.04	−0.12	−1.52	
Culture of competitiveness (CC)	0.39	4.59***	0.58	3.58***	0.46	2.29**	
Knowledge development (KD)	0.22	2.54**	0.11	0.68	−0.21	−0.79	
CC × KD	0.15	2.36**	0.25	3.07***	0.23	2.85***	H3 supported
KD × MT	0.17	2.01**	0.23	1.94*	0.22	1.81*	H4 supported
CC × MT	−0.24	−2.84***	−0.33	−2.83***	−0.32	−2.68***	H5 supported
Same-source factor (to assess CMV)	—	—	—	—	0.45	5.22***	
R^2	0.34		0.46		0.46		
Model fit	$F = 12.28$***		CFI = 0.98		CFI = 0.97		

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$.

based on the higher-order analysis of the measures, empirical justification exists (in addition to the theoretical foundation; Hult *et al*., 2002; cf. Hult and Ketchen, 2001) to create a summated index of CC based on the three dimensions of learning, innovativeness, and entrepreneurial orientations, with each construct weighted at one-third. Likewise, KD was assessed via an index composed of knowledge acquisition, information distribution, shared meaning, and achieved memory weighted equally based on both empirical and theoretical rationale (e.g., Huber, 1991; Hult *et al*., 2004).

Together with the regression results, we examined the variance inflation factors (VIF) to assess the likelihood that multicollinearity affects the results. In each of the three steps in the hierarchical regression model, the VIFs were lower than 2.10, indicating that multicollinearity does not affect the weights of the controls or hypothesized variables (Mason and Perreault, 1991). To assess Hypotheses 1 and 2, we first examined the results in step 2. In this step, both CC ($p < 0.01$) and KD ($p < 0.05$), when entered along with market turbulence, are significantly associated with cycle time, providing initial support for both Hypothesis 1 and Hypothesis 2. The inclusion of market turbulence, CC, and KD in step 2 of the model explained significant variance in cycle time beyond that explained by the control variables in step 1 ($p < 0.01$), with the step 2 equation explaining a total of $R^2 = 0.30$.

The results of Hypotheses 1 and 2 are shown to be robust when the full model is specified in step 3

DOI: 10.1002/smj

to assess Hypotheses 3, 4, and 5. Specifically, the main effects of CC and KD as well as the hypothesized interaction term of CC × KD ($p < 0.05$) and the moderators of KD × MT ($p < 0.005$) and CC × MT ($p < 0.01$) had significant associations with cycle time. Age, size, and market turbulence had no direct association with cycle time. Given that the direct relationship between MT → CT is insignificant, the results indicate that MT serves as a pure moderator of the CC → CT (negative) and the KD → CT (positive) relationships (Sharma, Durand, and Gur-Arie, 1981). The inclusion of the interaction and moderator terms (CC × KD, KD × MT, and CC × MT) in step 3 explained significant variance beyond step 2 ($\Delta R^2 = 0.04$, $p < 0.01$). The fully specified model (i.e., including steps 1, 2, and 3) resulted in $R^2 = 0.34$ ($p < 0.01$). Overall, all five hypotheses were supported in the hierarchical regression analysis.

Parsimonious latent-variable interaction analysis

As a second step in testing the hypotheses, we used a parsimonious latent-variable interaction technique via LISREL 8.80. This technique, developed by Ping (1995, 1998), is a more parsimonious estimation technique for latent interaction and quadratic variables than its predecessors by Kenny and Judd (1984) and Hayduk (1987). Our use of this technique to examine the hypotheses adds to the hierarchical regression analysis in two ways. First, the latent-variable technique allows us to incorporate measurement errors for the main and interaction effects (Ping, 1995, 1998) in order to assess whether such errors undermine any statistical significant links within the results (Busemeyer and Jones, 1983). Second, we are able to incorporate a test of potential CMV issues at the hypothesis-testing level to determine whether CMV inflates or curtails the magnitude of the obtained effects (e.g., Netermeyer *et al.*, 1997; Podsakoff *et al.*, 2003). Appendix 2 contains details on this analysis.

The results of the parsimonious latent-variable interaction analyses mirror those in the hierarchical regression analysis, with the exception that KD is not significant in either the unconstrained or the constrained models (i.e., Hypothesis 2 is not supported). Consistent with the hierarchical regression analysis, we followed Ganzach's (1997) hierarchical procedure to SEM testing to estimate whether the inclusion of main and interaction effects is empirically meaningful (the results for each of the three steps are included in Table 4).

In the full three-step and constrained model, the results indicate that CC ($p < 0.01$) and the hypothesized interaction term CC × KD ($p < 0.01$) as well as the two moderators of KD × MT ($p < 0.10$) and CC × MT ($p < 0.01$) had significant relations with cycle time ($R^2 = 0.46$; $\chi^2 = 83.63$, d.f. = 48, DELTA2, RNI, CFI, and TLI all = 0.98, RMSEA = 0.06). Likewise, in the unconstrained model, the results indicate that CC ($p < 0.05$), the interaction term CC × KD ($p < 0.01$), the two moderators of KD × MT ($p < 0.10$) and CC × MT ($p < 0.01$), and the 'same-source' factor ($p < 0.01$) had a significant association with cycle time ($R^2 = 0.46$; $\chi^2 = 120.20$, d.f. = 53, DELTA2, RNI, CFI, and TLI all = 0.97, RMSEA = 0.08). The results for steps 1 and 2 are also included in Table 4 for completeness. In comparing steps 2 and 3, using the method devised by McCallum and Mar (1995), the third step in both the constrained and unconstrained models explained an additional 7 percent of variance beyond that explained by earlier steps.

These results verify that the strengths of the Hypotheses 1, 3, 4, and 5 paths were consistent and supported across the hierarchical regression and parsimonious latent-variable interaction analyses. However, Hypothesis 2 was supported in the hierarchical regression analysis only. Finally, based on an anonymous referee's suggestion, we checked whether our model had greater explanatory value than a simpler model wherein all first-order factors (i.e., LO, IO, EO, KA, ID, SM, and AM) along with the controls (e.g., AGE, SIZE, MT) and the moderators (e.g., CC × KD, KD × MT, CC × MT) were allowed to affect cycle time directly. In this path model test, the three moderators of CC × KD (parameter estimate = 0.14, $p < 0.05$), KD × MT (PE = 0.17, $p < 0.01$), and CC × MT (PE = −0.24, $p < 0.01$) along with EO (PE = 0.23, $p < 0.01$) and KA (PE = 0.15, $p < 0.01$) were the only significant variables ($R^2 = 0.35$). Overall, the higher-order model had a greater explanatory power than the direct model ($R^2 = 0.46$ vs. $R^2 = 0.35$), lending support to our conceptualization of higher-order structures of at least CC and potentially KD (at least in its moderated format).

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DISCUSSION

Some caveats apply to our findings. We were unable to draw on objective indicators of performance due to informants' concerns about the sensitivity of that information. Also, the inferences that can be drawn from the results are restricted by use of cross-sectional data drawn from key informants. Using multiple informants from each firm over time would likely enhance the robustness of future studies, especially in light of the fact that objective supply chain performance data are often not available. Also, our study tapped into one firm in a supply chain, limiting our ability to fully capture our variables for entire chains. Despite these limitations, the results offer important steps in building knowledge about 'strategic supply chain management' in general and about why some supply chains outperform others in particular. Below, we discuss the implications of our findings. Specifically, we focus on (1) the main effects of CC and KD (i.e., Hypotheses 1 and 2) for cycle time performance, (2) the interaction between CC and KD (Hypothesis 3), and (3) the moderating role of market turbulence (Hypotheses 4 and 5). Managers should recognize that the importance of the normative implications we offer below is tied to the extent to which their firms compete based on cycle time.

Culture of competitiveness, knowledge development, and cycle time performance

Our initial predictions examined the potential main effects relating culture of competitiveness (Hypothesis 1) and knowledge development (Hypothesis 2) to cycle time performance. Both analyses we conducted supported the main effect for CC, but only the hierarchical regression analysis supported the main effect for KD. This set of findings can be addressed from both a technical perspective and from a substantive, conceptual perspective. In terms of technical issues, structural equation takes into account the potential error variances in measurement, whereas regression does not. Thus, it may be that SEM simply offers a more precise test, suggesting that its results for Hypothesis 2 are the ones in which we should have confidence. As such, it is reasonable to conclude that CC has a direct link with cycle time (as shown in the tests of Hypothesis 1) but KD does not.

In terms of substantive issues, this conclusion offers implications for firms, especially those that are interested in gaining the benefits of strategic supply chain management, but whose supply chains currently rate poorly in terms of CC and KD. Dramatic reorientations of supply chains are difficult to accomplish (Hult *et al.*, 2002), and it is unlikely that the lack of both elements can be remedied quickly. Our results suggest that such firms might benefit by building a culture of competitiveness first, and then emphasizing knowledge development once the cultural elements are established. This would ensure that the firm enjoys at least some cycle time reduction benefits as soon as possible. Achieving such benefits is valuable strategically because of cycle time's links with profits and other firm-level metrics (Handfield and Nichols, 2002).

The interaction between culture of competitiveness and knowledge development

Building on two recent works on 'culture of competitiveness' (Hult *et al.*, 2002) and 'knowledge development' (Hult *et al.*, 2004) as vehicles to improve cycle time performance in supply chains, we used the learning component that is at the core of both the CC and KD frameworks to link these elements. Specifically, we drew on the resource-based view and theories from organizational learning and information processing to offer a theoretical delineation that integrates the concepts and predicted an interaction effect (Hypothesis 3). The results showed that the CC–KD interaction explains a significant amount of variance in cycle time above and beyond individual effects. These findings suggest that neither a culture of competitiveness, nor knowledge development, by itself is sufficient to achieve the supply chain performance goals examined by Hult *et al.* (2002, 2004).

Based on the results of Hypotheses 1 and 2, we suggested above that firms that are launching a strategic supply chain management approach should focus first on building CC and then pursue KD initiatives. The results for Hypothesis 3 indicate that once both foundational elements are in place, potential synergies between CC and KD can be exploited in order to gain additional cycle time performance. The results also inform firms

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whose supply chains are currently good at knowledge development, but that have not yet established much of a culture across supply chain members. These firms are likely to find that stressing knowledge development without a reinforcing culture will not significantly enhance cycle time. Such firms should focus attention on developing shared beliefs and values across their supply chains.

We view learning as central to these processes. Learning is the concept that links CC and KD. As such, it may be the linchpin for firms seeking to exploit synergies between CC and KD. Learning in the CC context is manifested in a set of knowledge-seeking values (Baker and Sinkula, 1999), while learning in the KD context is manifested in a set of knowledge-producing behaviors (e.g., Huber, 1991). These values perform a dual role as the learning element of CC while also being the glue that centers innovativeness and entrepreneurial orientations on supply chains' competitiveness in the marketplace.

Similarly, the learning behaviors within the KD framework (i.e., knowledge acquisition and information distribution) also serve in a dual capacity. Specifically, they are the main knowledge-producing activities as well as the cultural builders of a 'common affiliation' that facilitates members arriving at shared meanings and the effective storage of new knowledge in achieved memory (cf. Daft and Lengel, 1986; Gioia and Thomas, 1996). Thus, supply chain members' desire to acquire knowledge and then distribute it to other members provides a mechanism to achieve a bonding that has been found to be critical in complex supply chain relationships (Anderson, Håkansson, and Johanson, 1994).

The moderating role of market turbulence

The tests of Hypotheses 4 and 5 revealed that market turbulence moderates the effects of both CC and KD, although one caveat is that the results involving KD were weakly supported ($p < 0.10$) in our SEM analysis. These findings are critical to understanding what drives supply chain success. For example, on the one hand, the results indicate that a firm that devotes a great deal of effort on developing a supply chain culture focused on satisfying the market (i.e., a culture of competitiveness) is likely to reap positive advantages in stable market environments, but will fall behind when market turbulence is strong (cf. Slone, 2004). On the other hand, firms that focus on developing appropriate knowledge development behaviors reap lesser results in stable environments (i.e., their supply chains are not able to take full advantage of their superior learning skills) but are likely to reap greater advantages in turbulent markets (because they are prone to knowledge seeking and establishing the requisite variety needed to operate effectively in turbulent market conditions).

The results suggest that managers who are confident in their sense about the level of market turbulence they will face can use this sense to decide whether to emphasize developing either CC or KD in their supply chains. For those firms whose managers are unlikely to be able to predict the degree of turbulence that will be present in their marketplace over time, learning efforts centered on both CC and KD are critical to sustained success (cf. Lee, 2004). In fact, our results would tend to suggest that supply chains that develop strong elements of both a culture of competitiveness *and* knowledge development may be able to offset the effects that the environment has on their operations (at least with respect to market turbulence; other aspects of environmental turbulence need to be investigated in future research to better understand the full potential value of the synergistic effect of a culture of competitiveness and knowledge development). From a resource-based perspective, a supply chain's unique confluence of a culture of competitiveness and knowledge development seems likely to provide the high level of inimitability that is required to establish a sustainable competitive advantage (cf. Barney, 1991; Ray *et al*., 2004; Schroeder *et al*., 2002).

CONCLUSION

One of the central trends in today's economy is that competition is becoming less 'firm vs. firm' and more 'supply chain vs. supply chain.' Indeed, firms such as Dell and Wal-Mart have, in essence, rewritten the rules of strategy and rivalry in their respective industries through using supply chains not just as a means for moving material, but also as a competitive weapon. Drawing on multiple theories, our study advances the emerging research stream on strategic supply chain management by shedding new light on why some firms outperform others in terms of cycle time. Given that supply chain activities shape firms' profits, growth, market share, and

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other key metrics (Handfield and Nichols, 2002), closing the gap between what we know and what we need to know about the determinants of cycle time across multiple firms is important. While past inquiry suggests independent roles for a culture of competitiveness and knowledge development, our results highlight the criticality of simultaneously considering these two concepts and market turbulence in order to minimize cycle time.

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APPENDIX 1: MEASUREMENT SCALES

The respondents were asked to relate their answers to the last order fulfillment process that they had undertaken in the supply chain, with a focus on the 'inbound' portion of the chain (i.e., as applicable to their organization's supply management activity). 'We' and 'participants' refer to the users, buyers, and suppliers that participate in the order fulfillment process. 'Products' refer to both tangible (physical goods) and intangible products (services). An item with '[a]' at the end of the question was deleted after the measurement purification process. Seven-point Likert-type scales were used for all items ranging from 'strongly disagree' to 'strongly agree.'

Learning orientation (Hult, 1998)

- We agree that our ability to learn is the key to improvement in the supply management process.
- The basic values of this supply management process include learning as a key to improvement.
- Once we quit learning in the supply management process we endanger our future.[a]
- The sense around there is that employee learning is an investment not an expense.

Innovativeness orientation (Hurley and Hult, 1998)

- Technical innovation, based on research results, is readily accepted in supply management.
- We actively seek innovative supply management ideas.
- Innovation is readily accepted in the supply management process.
- People are not penalized for new ideas that do not work.[a]
- Innovation in our supply management process is encouraged.

Entrepreneurial orientation (Naman and Slevin, 1993)

- We emphasize research and development and technological leadership.[a]
- We initiate actions to which other organizations respond.
- We are fast to introduce new administrative techniques and operating technologies.

- We have a strong proclivity for high-risk projects.
- We are bold in our efforts to maximize the probability of exploiting opportunities.

Knowledge acquisition (Kohli, Jaworski, and Kumar, 1993)

- We meet regularly to find out what products we need in the future.
- We do a lot of in-house research on products we may need.
- We are fast to detect changes in our product preferences.
- We poll participants once a year to assess the quality of our supply management services.[a]
- We are fast to detect fundamental shifts in the supply management environment.
- We periodically review the likely effect of changes in the supply management environment.[a]

Information distribution (Kohli, Jaworski, and Kumar, 1993)

- We frequently have interdepartmental meetings to discuss trends in supply management.[a]
- We spend time discussing future supply management needs.
- We immediately know when something important happens in the supply management process.
- We share data on participant satisfaction in the supply management process on a regular basis.[a]
- We alert participants when something important happens in the supply management process.

Shared meaning (Hult, Ketchen, and Slater, 2004)

- We share supply management information effectively between the supply management participants.
- We share supply management information effectively in the supply management process.
- We develop a shared understanding of the available supply management information.
- We develop a shared understanding of the implications of a supply management activity.

Achieved memory (Moorman and Miner, 1997)

- We have a great deal of knowledge about the supply management process.
- We have a great deal of experience with the supply management process.
- We have a great deal of familiarity with the supply management process.
- We have invested a great deal of research and development in the supply management process.[a]

Market turbulence (Jaworski and Kohli, 1993)

- In our kind of business, customers' product preferences change quite a bit over time.
- Our customers tend to look for new products all the time.
- We have demand for our products from customers who never bought them before.
- New customers have product needs that are different from our existing customers.
- We continuously cater to many new customers.

Cycle time performance (Hult, Ketchen, and Nichols, 2002; Hult, Ketchen, and Slater, 2004)

- The length of the supply management process is getting shorter every time.
- We have seen an improvement in the cycle time of the supply management process recently.[a]
- We are satisfied with the speediness of the supply management process.
- Involving the participants in decision making shortens the supply management process.
- Based on our knowledge of the supply management process, we think it is short and efficient.
- The length of the supply management process could not be much shorter than today.[a]

APPENDIX 2: DETAILS ON COMMON METHOD VARIANCE ANALYSIS

We assessed the potential problem of common method variance inhibiting the analyses at both the measurement and hypothesis-testing levels.

Measurement-level analysis

To examine common method variance at the measurement level, we employed Harman's one-factor test within a confirmatory factor analysis setting. If CMV poses a serious threat, a single latent factor would account for all manifest variables (Podsakoff and Organ, 1986). A worse fit for the one-factor model provides support that CMV does not pose a serious threat. The one-factor model resulted in a $\chi^2 = 2543.16$ with d.f. $= 527$ (vs. a $\chi^2 = 986.92$ and d.f. $= 491$ for the measurement model). Thus, CMV does not appear to be a problem at the measurement level.

Hypothesis-level analysis

To examine common method variance at the hypothesis level, we used the method described by Netemeyer *et al*. (1997) and Podsakoff *et al*. (2003) within the parsimonious latent-variable interaction technique (e.g., Ping, 1995). Specifically, in addition to the hypothesized model (labeled 'constrained model' in Table 4), we tested a latent-variable interaction model using structural equation modeling via LISREL 8.80 that includes a 'same-source factor' to the indicators of all constructs. In this analysis, we included the summated first-order indicators of culture of competitiveness and knowledge development as direct, reflective indicators of those higher-order constructs in conjunction with single indicants for each of the latent interaction and moderator terms (CC $\times$ KD, KD $\times$ MT, and CC $\times$ MT), a summated indicator for market turbulence, the two controls, and a single indicant for the same-source factor. Regarding the latter, we opted to include a single indicant (a summated score incorporating all the purified indicators) for the same-source factor instead of all applicable factor loadings because of the complexity of fitting three interaction terms and two higher-order factors (CC and KD). This approach also corresponds to the level of analysis of the other indictors. Thus, the following overall equation was tested (i.e., excluding the depiction of the relationships of the first-order indicators of CC and KD):

$$\eta_1 = \gamma_{11}X_1 + \gamma_{12}X_2 + \gamma_{13}X_3 + \gamma_{14}X_4 + \gamma_{15}X_5 + \gamma_{16}X_4X_5 + \gamma_{17}X_3X_4 + \gamma_{18}X_3X_5 + \gamma_{19}X_6 + \zeta_1$$

where $\eta_1 =$ cycle time performance (CT), $X_1 =$ firm age (AGE), $X_2 =$ firm size (SIZE), $X_3 =$ market turbulence (MT), $X_4 =$ culture of competitiveness (CC), $X_5 =$ knowledge development (KD), $X_6 =$ 'same-source' factor, and $\zeta_1 =$ disturbance term. A comparison was made of the unconstrained model (in which the same-source factor is estimated freely) with a constrained model (in which the same-source factor loading is set to zero). The results of the constrained and unconstrained models are reported in Table 4. While the 'same-source' factor was significant in the unconstrained model, CMV did not have a significant effect on the magnitude of hypothesized relationships. Thus, CMV does not inhibit the analysis of the hypothesized relationships (e.g., Netemeyer *et al*., 1997).

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