Market Knowledge Dimensions and Cross-Functional Collaboration: Examining the Different Routes to Product Innovation Performance

There is consensus in the marketing literature that market knowledge and cross-functional collaboration are two fundamental resources for successful product innovation. However, few studies examine the dimensions or characteristics of market knowledge and how and why these resources influence product innovation performance. Drawing on contingency theory and the knowledge-based view of the firm, the authors argue that knowledge integration mechanisms may account for the effects of market knowledge dimensions (i.e., breadth, depth, tacitness, and specificity) and cross-functional collaboration on product innovation performance. They find that market knowledge specificity and cross-functional collaboration affect product innovation performance through knowledge integration mechanisms. In contrast, whereas the effect of market knowledge depth is partially mediated, market knowledge breadth has a direct, unmediated effect on product innovation performance. A test of an alternative moderating perspective shows that the effects of market knowledge depth and cross-functional collaboration on product innovation are negatively moderated by knowledge integration mechanisms. By showing the differential effects of market knowledge dimensions on product innovation performance, the authors provide a more refined understanding of the interplay among market knowledge, its integration, and the firm’s performance in product innovation. The authors also conclude that by overlooking the role of knowledge integration mechanisms, previous research may have provided an overly optimistic view of the value of cross-functional collaboration in product innovation.

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we are to examine how market knowledge matters in product innovation performance.

Second, previous studies have focused almost entirely and separately on the effects of market knowledge (e.g., Atuahene-Gima 1995, 2005; Li and Calantone 1998) and cross-functional collaboration (e.g., Kahn 1996; Song, Montoya-Weiss, and Schmidt 1997) on product innovation outcomes. No detailed explanations are offered as to how and why KIMs matter in these relationships. Yet it is often implicitly assumed that KIMs are salient factors in transforming market knowledge and cross-functional activities into product innovation performance (Griffin and Hauser 1996; Hoopes and Postrel 1999). The current state of the literature is lacking and inconsistent because a key assumption of the KBV is that it is not knowledge itself but rather its integration among functional units in the firm that drives sustainable competitive advantage (Grant 1996a). For this reason, product innovation is often characterized as a process by which a firm transforms knowledge embedded in cross-functional teams into new products (Madhavan and Grover 1998, p. 2). Understanding how market knowledge and cross-functional collaboration are transformed into innovation outcomes through KIMs may shed light on the salience of this factor, which the KBV suggests is at the root of the firm’s competitive advantage.

Third, KIMs have traditionally been positioned as moderators in the relationship between sources of information and the breadth and depth of the firm’s knowledge (Zahra, Ireland, and Hitt 2000) and between internal and external capabilities and innovation outcomes (Zahra and Nielsen 2002). Still, there is another view based on structural contingency theory that suggests that because knowledge characteristics (e.g., complexity) make communication flow difficult among functional units, knowledge becomes a key contingency factor that determines the nature of integration designs (Thompson 1967). Furthermore, the increased information-processing requirements resulting from interdependence among functional units can be met only by corresponding increases in information-processing capacity through the design of coordination mechanisms (e.g., Galbraith 1973, p. 6). Thus, this theory asserts that by increasing the information-processing demands in the firm, strategic interdependence or collaboration among functions dictate the type and degree of organizational integration mechanisms adopted to transfer knowledge within the firm (see Kumar and Seth 1998; Thompson 1967).

The KBV suggests that knowledge is sticky; in other words, its characteristics make it difficult, costly, and uncertain to transfer and recombine within the firm (e.g., Galunic and Rodan 1998; Grant 1996a; Szulanski 1996). For this reason, Birkinshaw, Nobel, and Ridderstråle (2002) and others (e.g., Germain and Droge 1997) argue that the characteristics of knowledge complicate the process of transfer by increasing uncertainty and ambiguity and, through this

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**Theory Development**

Contingency theory has been one of the major strands of thinking about firms and their structures and strategic actions (Galbraith 1973). Drazin and Van de Ven (1985) note two fundamental strands of contingency theory. The first is the “fit-as-mediation” view (Venkatraman 1989), which posits that managers choose or adopt organizational structures, processes, and strategies that reflect the particular circumstances of their organizations (Galbraith 1973, p. 2). In particular, because the organization is essentially an “information-processing network” the objective of organizational design is to achieve an efficient correspondence between the information-processing requirements of its strategic contingencies and the information-processing capabilities of its integration mechanisms (Galbraith 1973, p. 6).

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**FIGURE 1**

**Conceptual Model of the Role of Cross-Functional Collaboration, Market Knowledge Dimensions, and KIMs in Product Innovation**

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**Cross-Functional Collaboration**

**Market Knowledge Dimensions**
- Breadth
- Depth
- Tacitness
- Specificity

**KIMs**

**Product Innovation Performance**

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**Mediating view of KIMs**

**Moderating view of KIMs**
complication, increase the likelihood that firms will develop appropriate KIMs. In this view, knowledge characteristics are the fundamental quality to which managers adapt organizational integration structures. Consistent with the KBV, market orientation theory indicates that market knowledge generation is an outside-in process and that firms use internal processes to integrate the acquired knowledge (Day 1994; Jaworski and Kohli 1993). If the KBV tenet is accepted—that is, it is not knowledge per se but rather its integration that affects competitive advantage (Grant 1991, 1996b)—it suggests that KIMs are mediators of the link among market knowledge dimensions, cross-functional collaboration, and firm performance.

The second strand of contingency theory is the interactive fit argument, or “fit-as-modernization” view (Venkatraman 1989). This view proposes that the firm’s performance is attributable to a match between its strategic behaviors and the internal and external environment conditions (Atuahene-Gima and Murray 2004; Zeithaml, Varadarajan, and Zeithaml 1988). This suggests that KIMs moderate the effect of market knowledge and cross-functional collaboration on performance. Given the limited attention the mediating view of KIMs has received, we focus on this perspective, though we also empirically examine the moderating view.

**Effect of Market Knowledge Dimensions on KIMs**

*KIMs.* According to Barki and Pinsonneault (2005, p. 166), integration captures the extent to which distinct but interdependent functional units, departments, and resources are coordinated or made to constitute a unified whole. The task of integration or coordinating interfunctional interactions is often accomplished by the use of structures and processes (see Griffin and Hauser 1996; Sobek, Liker, and Ward 1998). As Olson, Walker, and Ruekert (1995, p. 49, emphasis in original) note, integration mechanisms are “lateral linkage devices or structural coordination mechanisms” that firms use to coordinate cross-functional interactions (see also Griffin and Hauser 1996, p. 203). Following Zahra, Ireland, and Hitt (2000, p. 930), we define KIMs as structures and processes, such as the use of documentation, information-sharing meetings, analysis of successful and failed projects, project reviews, and briefings by external experts and consultants, that ensure the capture, analysis, interpretation, and combination of knowledge within the firm. These structures and processes enable managers to determine systematically and understand what has been learned in the product innovation process, to interpret and articulate the importance of the learning, and to devise ways to exploit the knowledge competitively (Zahra and Nielsen 2002).

**Market knowledge dimensions.** Information about the market environment, particularly about customers and competitors, is the source of stimulation for the firm’s knowledge (Day 1994; Nonaka 1994, p. 27) and the driver of a market-oriented strategy (Day and Nedungadi 1994, p. 32). This implies that a firm that correctly identifies, collects, and uses information about customer and competitor conditions is deemed to be knowledgeable about the market. Knowledge about technology and other environmental properties is important, but only to the extent that it enhances the understanding of customers’ and competitors’ behavior. For this reason, Srinivasan, Lilien, and Rangaswamy (2002, p. 49) show that the firm’s ability to sense and respond to technology developments per se is different from its market orientation, that is, the ability to sense and respond to customers and competitors. Thus, we define market knowledge as the firm’s knowledge of its customers’ behaviors and needs as well as its competitors’ behavior. We examine the effects of four characteristics of market knowledge on KIMs: breadth, depth, tacitness, and specificity.1

Knowledge breadth refers to the number of different knowledge domains with which the firm is familiar (Bierley and Chakrabarti 1996). Prabhu, Chandy, and Ellis (2005, p. 116) offer a similar view, referring to knowledge breadth as the range of fields over which the firm has knowledge. We define “market knowledge breadth” as the firm’s understanding of a wide range of diverse customer and competitor types and factors that describe them. In other words, a firm is said to have broad market knowledge if it has knowledge of a wide variety of current and potential customer segments and competitors and also uses a diverse set of parameters related to customers (e.g., needs, behaviors, characteristics) and competitors (e.g., products, markets, strategies) to describe and evaluate them (e.g., Zahra, Ireland, and Hitt 2000). This concept highlights the broad understanding of customers and competitors that is deeply rooted in the market orientation construct.

Firms with a broad knowledge base have a greater potential to recombine different elements of the knowledge to improve opportunity recognition and creative potential (Kogut and Zander 1992). However, knowledge breadth might hamper knowledge recombination because the high degree of heterogeneity of knowledge elements contributes to the complexity of transfer across functional units (Galunic and Rodan 1998). In contrast, limited market knowledge can be easily disseminated to and internalized by members of different departments. Furthermore, because customer segments and competitors’ strategies change over time, broad market knowledge may involve frequent and numerous variations that further increase the difficulties of cross-functional transfer. In addition, when market knowledge is broad, not all of it can be usefully employed in every innovation project. Bringing in marginally useful information or leaving out relevant information might be detrimental to performance (Leonard-Barton 1992). Thus, the increased difficulties in sharing broad knowledge lead managers to develop KIMs to provide the necessary information-processing capacity for the organization. Empirically, Germain and Droge (1997) find that the breadth of the firm’s knowledge about a task is an antecedent to processes for knowledge integration because these processes are the nec-

1Galunic and Rodan (1998) identify another characteristic of knowledge, namely, knowledge dispersion. We contend that this characteristic is reflected in the construct of market knowledge breadth because it captures different elements underlying market knowledge (Turner and Makhija 2006).
ecessary mechanisms to combat excessive compartmentalization of the diverse knowledge. Thus:

H$_3$: The broader the market knowledge, the greater is the use of knowledge integration mechanisms.

Prabhu, Chandy, and Ellis (2005) describe technical knowledge depth as the amount of within-field knowledge the firm possesses. McEvily and Chakravarthy (2002) also argue that complex knowledge reflects the degree to which knowledge consists of many different, unique, and interdependent elements, such that knowing how one element works reveals little about how the different elements work together. Consequently, we define “market knowledge depth” as the level of sophistication and complexity of a firm’s knowledge of its customers and competitors. It captures the level of sophistication with which the firm is able to connect the unique and interdependent relationships among the factors that describe key issues about customers and competitors. Knowledge of the interdependencies of elements such as customers’ needs, behaviors, and preferences and competitors’ products and strategies indicates that a firm has a deep understanding of its market. Thus, whereas breadth captures the horizontal dimension of knowledge, depth captures the vertical dimension.

There are two reasons market knowledge depth should affect KIMs. First, deep market knowledge implies high and complex interdependencies among the knowledge elements (McEvily and Chakravarthy 2002). The transfer of such knowledge is error prone and involves a greater risk of misinterpretation and misapplication in product innovation (Galunic and Rodan 1998). This is because deep functional knowledge limits the firm’s ability to draw new conclusions and find new links among diverse pieces of knowledge. Second, deep market knowledge implies differential functional expertise in collecting and disseminating market information. This leads to different “thought worlds” (Leonard-Barton 1992), which further increase the uncertainty and ambiguity of knowledge transfer (Szulanski 1996). For these reasons, deep knowledge tends to lead to rigidities in knowledge transfer and sharing, hindering the firm’s ability to assimilate knowledge. Consequently, firms develop coordinating structures to provide functional units with the means to understand and develop confidence in one another’s analysis and interpretation (Hoopes and Postrel 1999). Thus:

H$_3$: The deeper the market knowledge, the greater is the use of KIMs.

“Market knowledge tacitness” is the extent to which market knowledge is not explicit but rather is difficult to codify and communicate (e.g., Nonaka 1994). Market knowledge is tacit when people and functional units find it difficult to articulate explicitly what they know about customers and competitors and are unable to explain effectively the causal relationships between their actions and the associated outcomes. Tacitness slows the internal transfer of market knowledge because tacit knowledge cannot be fully codified and articulated even by an expert. It can be transferred from one person to another only through a long process of apprenticeship, which necessarily involves face-to-face interactions, review of successful and unsuccessful projects, and frequent advice from experts (Galunic and Rodan 1998; Szulanski 1996). As an embedded knowledge, tacit knowledge requires the development of KIMs to unearth its potential value (Madhavan and Grover 1998). Birkinshaw, Nobel, and Ridderstråle (2002) find that the degree of observability (i.e., explicitness) of technology knowledge is negatively related to knowledge integration structures. Thus:

H$_4$: The more tacit the market knowledge, the greater is the use of KIMs.

“Market knowledge specificity” refers to the extent to which the firm’s knowledge is tailored to the requirements of specific contexts in which it is maximally effective but loses its value in other contexts (Galunic and Rodan 1998). For example, a firm’s knowledge can be related to the attitudes of a specific customer segment toward a specific product or strategy. Specific competitor knowledge may result from an in-depth analysis of the behavior, products, and strategies of a particular competitor. In both cases, the knowledge acquired is valuable only in the context of the focal firm. For example, Lenovo’s knowledge of the computer market was so specific to the Chinese context that it needed to acquire IBM’s personal computer division to increase its ability to compete on the global level.

Specific market knowledge is likely to be acquired and used by experienced people and experts in specific market domains. Thus, it could be argued that the transfer of such knowledge is unproblematic even in the absence of KIMs. However, we have three reasons to predict a positive effect of specific market knowledge on KIMs. First, because specific market knowledge is valuable in the context in which it has been generated, its value is highly time sensitive. Subramani and Venkatraman (2003) show that because specific market knowledge must be exploited in a timely manner, it engenders strong norms of joint decision making, a key aspect of KIMs. Second, specific market knowledge diminishes knowledge recombination, impairing timely and effective contextual use (Galunic and Rodan 1998, p. 1197). Third, specific market knowledge reflects the use of idiosyncratic routines in the collection and use of market information by different functions. As Galunic and Rodan (1998) argue, by producing specific knowledge, these routines make the transfer of knowledge to other functions difficult. These properties of specific market knowledge increase the implementation of KIMs to ensure early settlement of communication difficulties and enable timely flow and recombination of knowledge from different functional units in the product innovation process.

H$_4$: The more specific the market knowledge, the greater is the use of KIMs.

Effect of Cross-Functional Collaboration on KIMs

Cross-functional collaboration refers to the degree of cooperation, the extent of representation, and the contribution of marketing, R&D, and other functional units to the product innovation process (Kahn 1996; Li and Calantone 1998; Ruekert and Walker 1987; Song, Montoya-Weiss, and Schmidt 1997). Cross-functional collaboration is intangible, volitional, and unstructured in that it reflects only the recog-
nition by functional units of their strategic interdependence and their need to cooperate for the benefit of the organization (Galunic and Rodan 1998, p. 1198; Kahn 1996; Kahn and Mentzer 1998; Olson et al. 2001). It ensures the alignment of goals among functional units. In contrast, KIMs permit regular patterns of interactions that enable the transfer, recombination, and use of knowledge from different functions. Therefore, KIMs respond to the problem of coordinating different knowledge elements to execute complex organizational tasks.

Anecdotal evidence supports the distinction between cross-functional collaboration and KIMs. First, despite the high degree of cooperation among its functional units, Toyota established coordinating mechanisms, including standardized reporting and documentation, formalized work processes (e.g., project reviews), problem-solving meetings, and integrative leaders, to ensure knowledge sharing and integration among its different units (Sobek, Liker, and Ward 1998). Second, a study of the most innovative firms in the world indicates that two such firms, Southwest and BMW, have adopted mechanisms, such as colocating, face-to-face meetings, and standard documentation, to integrate the knowledge among members of their cross-functional teams, despite their high degree of cooperation proclivity (BusinessWeek 2006). The distinction of the two constructs is salient because coordinating knowledge—particularly, specialized and complex knowledge—among different units is problematic for firms, even when perfect goal congruence (or full collaboration) is established among them (Grant 1996b, p. 114).

Contingency theory offers two principal reasons that cross-functional collaboration predicts KIMs. First, cross-functional collaboration implies increased resource dependency among functional units and, thus, a greater need for enhanced information-processing capability to coordinate the acquired knowledge. As the need for sharing knowledge and other resources among functional units increases, their interdependence grows along with the volume of resource flows and increases the use of coordinating mechanisms (see Olson, Walker, and Ruekert 1995, p. 53). Thus, increased collaboration represents a critical strategic contingency for the design of coordination mechanisms (Galbraith 1973; Kumar and Seth 1998, p. 581). As Kahn and Mentzer (1998) suggest, collaboration reflects the willingness of different functional units to cooperate; yet firms need to provide structural mechanisms to put such willingness into action. Indeed, Birkinshaw, Nobel, and Ridderstråle (2002) find that functional interdependence influences the design of interunit KIMs in the firm.

Second, the transfer and flow of knowledge among interdependent units is often costly, ambiguous, and uncertain because of the diversity of functional information, backgrounds, experiences, and thought worlds. This complicates analysis and interpretation and hinders the likelihood of novel recombinations of the firm’s knowledge (Galunic and Rodan 1998). For this reason, Madhavan and Grover (1998) argue that the collective knowledge of functional units constitutes only potential knowledge. As a result, Ruekert and Walker (1987, p. 6) argue that to obtain value from cross-functional interactions, “mechanisms [must] evolve to help reduce the uncertainty and ambiguity of resource, work, and assistance flows.” Similarly, Garud and Nayyar (1994, p. 372) point out that firms develop integration mechanisms because of the uncertainty and ambiguity in translating embedded collective knowledge into knowledge embodied in the new product (see also Griffin and Hauser 1996, p. 209). In brief, we argue that increased functional collaboration leads to the greater use of KIMs to regulate communication flow and learning in new product projects.²

H₃: The greater the cross-functional collaboration, the greater is the use of KIMs.

**Market Knowledge, Cross-Functional Collaboration, and Product Innovation Performance**

**Market knowledge.** Extant research considers market knowledge the fundamental driver of product innovation performance (Atuahene-Gima 1995, 2005; Li and Calantone 1998; Moorman and Miner 1997). However, few studies have provided detailed insights into the effects of different market knowledge characteristics on product innovation performance. Market knowledge breadth engenders product innovation performance because it increases the firm’s ability to make connections among disparate market information, ideas, and concepts to gain broader and insightful perspectives (Reed and DeFillippi 1990). This logic underpins the general idea about the positive role of market orientation in product innovation (Atuahene-Gima 1995, 2005; Li and Calantone 1998). A firm with broad market knowledge has heterogeneous information and understanding of customers and competitors, enabling it to design products that match the diverse needs of its customer segments. By enhancing the firm’s purview of the market, broad market knowledge also increases the firm’s ability to implement and execute complex tasks quickly in product innovation processes (Kogut and Zander 1992). It does this by enhancing the chances of what Prabhu, Chandy, and Ellis (2005) call “happy accidents,” in which concepts from different knowledge domains are applied in unexpected ways.

A new product based on deep market knowledge limits a competitor’s ability to observe and understand the whole set of distinct and interdependent knowledge elements that underlies it (Reed and DeFillippi 1990). This is because market knowledge depth reflects a complex understanding of the causal interdependencies among customer problems and requirements and potential competitor strengths and

²The direction of causality can be questioned here. However, in addition to structural contingency theory, several other arguments support our interpretation. First, rational managers would invest in costly KIM processes only when they are satisfied that different functions are willing and able to collaborate. Second, rational managers know that structures such as KIMs may be ineffective in imposing collaboration, which is more of a human and social condition. Indeed, prior research suggests that an attempt to impose cross-functional collaboration through an early implementation of KIMs can yield the opposite result (Kahn 1996). Xie, Song, and Stringfellow (2003, p. 233) also note that merely imposing a cross-functional structure for product innovation cannot ensure that different functional units will collaborate.
responses, thus increasing the likelihood of the emergence of new ideas that are highly unique to the firm (Galunic and Rodan 1998). As McEvily and Chakrarvathy (2002) find, competitor efforts to reconstruct such a product are likely to be undermined or lead to partial and erroneous results. Prabhu, Chandy, and Ellis (2005, p. 116) also contend that knowledge depth results in superior products because it allows for the cross-fertilization of knowledge elements that increases flexibility in generating complex patterns of new knowledge.

Tacit market knowledge leads to better new product performance because it allows for differences in cross-functional logics (Galunic and Rodan 1998). Prahalad and Bettis (1986) suggest that such differential logics ensure thoughtful deliberations and generate new perspectives, novel strategic alternatives, analyses, and interpretations that enhance the efficiency of the firm’s innovation activities. Furthermore, tacit knowledge develops in a “community of interaction” (Nonaka 1994) and thus is highly embedded in the firm’s social system. Competitors find it difficult to imitate the social context within which the focal firm develops its new products (Reed and DeFillippi 1990).

Finally, specific market knowledge enhances innovation performance because it ensures a long-term relationship with specific contexts (e.g., customer segment) that generates highly idiosyncratic insights for product innovation. This protects the new products the firm develops from imitation because competitors lack the contextual customer knowledge that went into the process. Furthermore, a new product based on specific market knowledge is more likely to be differentiated to suit the specific customer and competitor conditions (McEvily and Chakrarvathy 2002).

Cross-functional collaboration. The positive effect of cross-functional collaboration on product innovation performance is well documented in the literature (see Griffin and Hauser 1996; Luo, Slotegraaf, and Pan 2006; Song and Parry 1997). The logic is that cross-functional collaboration ensures that marketing, technical, and other functional capabilities are combined to develop a product that satisfies customer needs. It accomplishes this by improving the efficiency of knowledge use and allowing for quality decision making in new project teams (Madhavan and Grover 1998).

H6: The greater the market knowledge (a) breadth, (b) depth, (c) tacitness, and (d) specificity, the better is the product innovation performance.

H7: The greater the cross-functional collaboration, the better is the product innovation performance.

Mediating Effect of KIMs on Product Innovation Performance

The direct-effects arguments for the impacts of market knowledge and cross-functional collaboration on product innovation performance are persuasive. However, a careful inspection indicates that the arguments implicitly assume a role for KIMs. As we argued previously, both the KBV and contingency theory suggest that the stickiness of market knowledge and the increased information-processing demands that result from cross-functional collaboration constitute factors that determine the firm’s integration mechanisms (Birkinshaw, Nobel, and Ridderstråle 2002; Galbraith 1973; Germain and Droge 1997; Kumar and Seth 1998; Thompson 1967). Indeed, the KBV suggests that it is not knowledge per se but rather its integration that ensures competitive advantage (Grant 1991, 1996a). Specifically, KIMs ensure better performance because they enhance the likelihood of finding solutions in the product innovation process by infusing the functional units with collective learning capability. Implicit in this argument is the notion that KIMs connect knowledge to performance. Because KIMs are mandated processes for learning, they provide formal structure for knowledge integration, KIMs also provide a common forum for periodic feedback, which ensures quality decision making and completeness of a project team’s activities. In so doing, KIMs reduce wasteful explorations and errors in product innovation (Sheremata 2000). Thus, dimensions of market knowledge and cross-functional collaboration affect product innovation performance indirectly through their effects on KIMs. This discussion suggests the following hypotheses:

H8: The greater the KIMs, the better is the product innovation performance.

H9: KIMs mediate the effects of market knowledge (a) breadth, (b) depth, (c) tacitness, and (d) specificity on product innovation performance.

H10: KIMs mediate the effect of cross-functional collaboration on product innovation performance.

Research Methods

Sample and Data Collection

China is an ideal context for this study. The extreme complexity and dynamism of this transitional environment means that firms must confront not only the challenges of new (and often dysfunctional) competition but also collapsing capabilities (Li and Atuahene-Gima 2001). For this reason, cross-functional collaboration and mechanisms for using market knowledge in product innovation are critical for firms to sustain innovation performance. The instrument was prepared in English and then translated into Chinese. It was checked for accuracy in line with the conventional back-translation process. We pretested the instrument with 25 managers who had at least three years of business experience in China to examine the face validity and to assess informants’ understanding of the survey questions. The study used a sample of 750 firms selected randomly from a mailing list of 2500 high-technology firms provided by a local consulting firm.

As with previous studies in China (Atuahene-Gima 2005; Li and Atuahene-Gima 2001), we collected the data on-site. An interviewer scheduled appointments with the marketing manager/director as a first informant, who then nominated a second knowledgeable informant. The interviewer presented the key informants with the survey questionnaire and collected the questionnaire on completion. We motivated respondents by assuring them of confidentiality.
and by offering a summary of the research results and a free workshop on the research findings—information that would be meaningless to them in the absence of accurate data (Li and Atuahene-Gima 2001). We received 363 usable questionnaires, for a response rate of 48%. We compared a sample of 50 participating firms with a sample of nonparticipating firms for which we had data on sales, R&D expense, and number of employees. Analyses of variance indicated no significant differences between the two groups on number of employees ($F = 1.01$), sales in the most recent year ($F = .89$), and R&D expenditure as percentage of sales ($F = .98$).

Of the first informants, 90% were from marketing and sales, 4% were chief executive officers/general managers, and 6% were product development managers. These informants had a mean industry experience of 8.18 years and a mean firm experience of 4.77 years. Of the second informants, 73% were product development director/managers, 9% were from marketing/sales, 11% were chief executive officers/general managers, and 7% were from R&D. These informants had a mean industry experience of 7.76 years and a mean firm experience of 4.55 years. We also examined the quality of the informants by asking them to indicate on a ten-point scale their degree of knowledge of (1 = “not at all knowledgeable,” and 10 = “extremely knowledgeable”) and involvement in (1 = “no involvement,” and 10 = “very high involvement”) product development issues in the firm. The means for the first and second informants, respectively, were 7.55 and 7.40 for the first item and 8.00 and 7.78 for the second item. Using a multigroup analysis, we obtained the following results: unconstrained confirmatory factor analysis (CFA) model for the marketing and nonmarketing groups: $\chi^2 = 2225.7, d.f. = 1440$; constrained model for marketing and nonmarketing groups with equality constraints for structural paths, variances, and covariances: $\chi^2 = 2307.6, d.f. = 1540; \Delta \chi^2 = 81.9, \Delta d.f. = 100; p > .10$. Given these results of tests of invariance, we pooled the data for analysis.

**Measures of Constructs**

**Market knowledge dimensions.** We measured market knowledge breadth with four items that asked respondents, for example, to evaluate their firms’ market knowledge on a continuum from “limited” to “wide ranging” (Zahra, Ireland, and Hitt 2000). We measured market knowledge depth with four items that asked the respondents, for example, to evaluate their firms’ customer knowledge on a continuum from “basic” to “advanced” (Zahra, Ireland, and Hitt 2000). We measured market knowledge tacitness with four items that addressed the degree to which a firm’s market knowledge could be formally documented, communicated, and learned without personal experience (Szulanski 1996). On the basis of Reed and DeFillippi’s (1990) work, we measured market knowledge specificity with three items that reflected the extent to which market knowledge is specific to the firm’s environment.3

Cross-functional collaboration. On the basis of prior studies (e.g., Li and Calantone 1998), we measured cross-functional collaboration with three items that reflected the extent of cooperation among functions. For example, we asked the respondents to rate the extent to which different functional units cooperate in establishing goals and priorities for the firms’ product innovation.

**KIMs.** Two previous studies (Zahra, Ireland, and Hitt 2000; Zahra and Nielsen 2002) informed the measure of KIMs. We used five items that addressed the extent to which a firm uses a set of formal processes (e.g., information-sharing meetings, formal analysis of projects) to capture, interpret, and integrate knowledge.

**Product innovation performance.** On the basis of Atuahene-Gima, Slater, and Olson’s (2005) research, we measured product innovation performance with five items that asked respondents to indicate the extent to which the firm has achieved its product development objectives, such as market share and profitability.4

**Control variables.** In testing our hypotheses, we controlled for firm size and slack, which reflect the firm’s resources and market power to exploit existing competencies, build new ones, and develop innovations (Chandy and Tellis 1998). To prevent skewness, we measured firm size with the logarithm of the number of employees. We measured slack with three items that tapped the availability of excess resources to fund new projects. We controlled for environmental uncertainty because the KBV suggests that knowledge integration becomes even more critical in uncertain and competitive environments (Grant 1996a). Furthermore, functional units tend to perceive higher interdependence and therefore are motivated to implement integration mechanisms in uncertain environments (Ruekert approach to the concept of market knowledge. Because the characteristics of knowledge we describe here are the same for customer and competitor knowledge, we did not have any theoretical rationale to expect differential effects of customer and competitor knowledge on KIMs. Thus, to reduce the complexity of the model and the burden on our informants, we chose a more aggregated measure of market knowledge.

4We took steps to ensure that respondents did not confuse this measure of the achievement of the firm’s product innovation objectives with its overall performance. We measured overall firm performance relative to competitors with eight items: return of sales, growth in profit, return on assets, sales growth, market share growth, cash flow, overall operational efficiency, and reputation for performance. We performed three discriminant tests for product innovation performance and firm performance. First, a CFA two-factor solution yielded the following: $\chi^2 = 351.20, d.f. = 64$. When we constrained them into one factor, we obtained the following: $\chi^2 = 773.30, d.f. = 65$. Therefore, we have a significant change in chi-square of 422.10 ($d.f. = 1, p < .000$), suggesting discriminant validity. Second, we performed discriminant tests using Fornell and Larcker’s (1981) approach. The average variance extracted for both product innovation performance (.72) and firm performance (.71) was greater than the squared correlation between them (.66). Finally, the correlation between product innovation performance and firm performance was .81, with a standard error of .02. The two-standard-error confidence interval for this correlation estimate is between .77 and .85. Because it does not include 1, discriminant validity is demonstrated (Anderson and Gerbing 1988).

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3Unlike other studies (e.g., Atuahene-Gima 2005; Li and Calantone 1998; Narver and Slater 1990) that differentiate between customer and competitor knowledge, we take a holistic measurement.
and Walker 1987). We examine two aspects of uncertainty. First, market uncertainty reflects the speed of change in customer needs and preferences and in competitor actions; we measured this with three items that cover the speed of change of customer needs and competitive conditions. Second, technological uncertainty reflects the speed of change and instability of the technology environment; we measured this with four items that tap the speed and unpredictability of technological changes.

Finally, we controlled for the degree of radicalness of the firm’s product innovation activities to capture the firm’s learning capability, which influences propensity for knowledge sharing and product innovation outcomes (see McGrath 2001). We measured product innovation radicalness with three items that assessed the newness of the firm’s innovation activities in terms of, for example, customers targeted and products offered. The Appendix presents all the measures and their sources.

Assessing the Reliability and Validity of Measures

We performed an exploratory factor analysis with Varimax rotation for data we obtained from both types of informants. Both the first and the second informants’ responses resulted in 11 factors with eigenvalues greater than 1, accounting for 68.58% and 68.50% of the total variance, respectively. For both informants, all the items loaded cleanly on the expected factors, without significant cross-loadings. Then, we tested the measurement model for both informants with a CFA, using AMOS 6.0. All the items loaded significantly on the expected constructs, indicating convergent and discriminant validity of the measures. The fit indexes showed that the model fit the data reasonably well for both the first ($\chi^2$/d.f. = 1.56, goodness-of-fit index [GFI] = .87, comparative fit index [CFI] = .94, and root mean square error of approximation [RMSEA] = .04) and the second ($\chi^2$/d.f. = 1.43, GFI = .88, CFI = .95, and RMSEA = .03) informant. In each case the models had acceptable levels of reliability, average variance extracted (AVE), and discriminant validity.5

Next, we submitted data from the two informant groups to two multigroup analyses to assess the invariance of the measurement model. First, we specified a model in which we constrained factor loadings, variances, and covariances in the two groups to be equal and compared it with a baseline model with no equality constraints, using a chi-square difference test (Byrne 2001). The results suggested the absence of significant differences in factors loadings, variances, and covariances in the two groups to be equal and compared it with a baseline model with no equality constraints, using a chi-square difference test (Byrne 2001). The results suggested the absence of significant differences in factors loadings, variances, and covariances in the two groups to be equal and compared it with a baseline model with no equality constraints, using a chi-square difference test (Byrne 2001). 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5The exceptions were the AVEs for KIMs and market knowledge breadth for the second informant group, which were slightly below the highest squared correlation with the other latent variables, indicating weak discriminant validity. For these two constructs, we performed an additional test based on the work of Bagozzi, Yi, and Phillips (1991). In all cases, the two-factor model fit the data better than the constrained one-factor model. Detailed results of these analyses are available on request.

6For the seven-point scale adopted for product innovation performance, $-1.25 \leq r_{ag} \leq 1$.

7The results were as follows: market knowledge breadth versus market knowledge depth (unconstrained model: $\chi^2$ [d.f.] = 138.26 [19]; constrained model: $\chi^2$ [d.f.] = 279.28 [20]; $\Delta \chi^2$ [d.f.] = 141.02 [1]), market knowledge breadth versus market knowledge tacitness (unconstrained model: $\chi^2$ [d.f.] = 79.08 [13]; constrained model: $\chi^2$ [d.f.] = 461.05 [14]; $\Delta \chi^2$ [d.f.] = 381.97 [1]), market knowledge breadth versus market knowledge tacitness (unconstrained model: $\chi^2$ [d.f.] = 89.83 [19]; constrained model: $\chi^2$ [d.f.] = 544.78 [20]; $\Delta \chi^2$ [d.f.] = 454.95 [1]), market knowledge breadth versus cross-functional collaboration (unconstrained model: $\chi^2$ [d.f.] = 96.33 [13]; constrained model: $\chi^2$ [d.f.] = 250.23 [14]; $\Delta \chi^2$ [d.f.] = 153.90 [1]), market knowledge breadth versus KIMs (unconstrained model: $\chi^2$ [d.f.] = 238.20 [26]; constrained model: $\chi^2$ [d.f.] = 488.29 [27]; $\Delta \chi^2$ [d.f.] = 250.09 [1]), market knowledge breadth versus technology uncertainty (unconstrained model: $\chi^2$ [d.f.] = 95.89 [19]; constrained model: $\chi^2$ [d.f.] = 525.09 [20]; $\Delta \chi^2$ [d.f.] = 429.20 [1]), market knowledge breadth versus technological changes. Ass}
TABLE 1
Correlation Matrix and Descriptive Statistics of Measures

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Market knowledge breadth</td>
<td>.70</td>
<td>.70</td>
<td>.09</td>
<td>.07</td>
<td>.57</td>
<td>.58</td>
<td>.47</td>
<td>.23</td>
<td>.17</td>
<td>.45</td>
<td>.54</td>
</tr>
<tr>
<td>2. Market knowledge depth</td>
<td>.56</td>
<td>.71</td>
<td>-.01</td>
<td>.04</td>
<td>.62</td>
<td>.53</td>
<td>.41</td>
<td>.19</td>
<td>.06</td>
<td>.43</td>
<td>.35</td>
</tr>
<tr>
<td>3. Market knowledge tacitness</td>
<td>.07</td>
<td>-.02</td>
<td>.78</td>
<td>.23</td>
<td>.11</td>
<td>.18</td>
<td>.07</td>
<td>.31</td>
<td>.23</td>
<td>.03</td>
<td>.12</td>
</tr>
<tr>
<td>4. Market knowledge specificity</td>
<td>.06</td>
<td>.04</td>
<td>.24</td>
<td>.77</td>
<td>.20</td>
<td>.02</td>
<td>.15</td>
<td>.17</td>
<td>.27</td>
<td>.31</td>
<td>.20</td>
</tr>
<tr>
<td>5. KIMs</td>
<td>.49</td>
<td>.51</td>
<td>.10</td>
<td>.20</td>
<td>.69</td>
<td>.62</td>
<td>.43</td>
<td>.30</td>
<td>.13</td>
<td>.54</td>
<td>.34</td>
</tr>
<tr>
<td>6. Cross-functional collaboration</td>
<td>.44</td>
<td>.42</td>
<td>.12</td>
<td>.04</td>
<td>.53</td>
<td>.72</td>
<td>.27</td>
<td>.10</td>
<td>.03</td>
<td>.36</td>
<td>.39</td>
</tr>
<tr>
<td>7. Product innovation performance</td>
<td>.41</td>
<td>.41</td>
<td>.04</td>
<td>.11</td>
<td>.39</td>
<td>.26</td>
<td>.86</td>
<td>.23</td>
<td>.17</td>
<td>.35</td>
<td>.24</td>
</tr>
<tr>
<td>9. Market uncertainty</td>
<td>.18</td>
<td>.08</td>
<td>.24</td>
<td>.22</td>
<td>.13</td>
<td>.07</td>
<td>.14</td>
<td>.49</td>
<td>.73</td>
<td>.22</td>
<td>.40</td>
</tr>
<tr>
<td>10. Organizational slack</td>
<td>.38</td>
<td>.38</td>
<td>.02</td>
<td>.25</td>
<td>.45</td>
<td>.34</td>
<td>.31</td>
<td>.18</td>
<td>.19</td>
<td>.80</td>
<td>.36</td>
</tr>
<tr>
<td>11. Radical innovation</td>
<td>.42</td>
<td>.29</td>
<td>.11</td>
<td>.17</td>
<td>.29</td>
<td>.31</td>
<td>.19</td>
<td>.22</td>
<td>.32</td>
<td>.31</td>
<td>.73</td>
</tr>
<tr>
<td>12. Firm size</td>
<td>.07</td>
<td>-.11</td>
<td>-.04</td>
<td>-.17</td>
<td>.06</td>
<td>-.02</td>
<td>.24</td>
<td>-.01</td>
<td>-.02</td>
<td>.07</td>
<td>-.03</td>
</tr>
</tbody>
</table>

Number of items: 4 4 4 3 5 3 5 4 3 3 3 N.A.

Notes: The diagonal elements are square roots of the AVE. The upper-right triangle elements are the correlations among the latent variables (φ). The lower-left triangle elements are correlations among the composite measures (unweighted mean of the items for each construct).

Given these results, we used the average of the responses of the two informants for all the remaining analyses to reduce the potential for common method variance (Slater and Atuahene-Gima 2004). Table 1 reports descriptive statistics and correlations among the study variables. Note that we measured product innovation performance on a seven-point scale. This provides a different psychological frame to the informants compared with the other variables measured on five-point scales, thus hindering common method bias.

Analysis and Results

Direct Effects

We used regression analysis to test the direct effects of market knowledge characteristics and cross-functional collaboration on KIMs and product innovation performance. As Table 2 (Model 1) shows, market knowledge breadth (b = .16, p < .01), market knowledge depth (b = .20, p < .01), market knowledge tacitness (b = .31, p < .01), and cross-functional collaboration (b = .31, p < .01) have positive and significant effects on KIMs. These results support H1, H2, H4, and H5. The effect of market knowledge breadth, depth, and tacitness are positively related to KIMs, but only firm size is related to product innovation performance (b = .21, p < .01).

Mediating Effect of KIMs

We followed the three-step regression procedure that Baron and Kenny (1986) recommend to examine the mediating role of KIMs. As we showed previously, market knowledge breadth, depth, and specificity have positive and significant effects on product innovation performance. Furthermore, all dimensions of market knowledge, except for tacitness, and cross-functional collaboration are positively related to KIMs. When KIMs are entered into Model 3 (Table 2), it shows a positive and significant effect on product innovation performance (b = .14, p < .05), in support of H3. The inclusion of KIMs leads to a slight decrease in the effect size of market knowledge breadth (from .26 to .24) and of market knowledge depth (from .18 to .15), but both remain significant, suggesting partial mediation. The effect of market knowledge tacitness on product innovation performance was not significant, suggesting full mediation.

Recall that market knowledge tacitness and cross-functional collaboration are unrelated to product innovation performance. Testing for mediation for these variables violates Baron and Kenny’s (1986) first test condition. However, several recent studies in various fields of research have argued that this constraint may be relaxed without hamper-
TABLE 2
Results of Regression Analysis: Standardized Path Coefficients (t-Values)

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>KIMs Product Innovation Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
</tr>
<tr>
<td><strong>Control Variables</strong></td>
<td></td>
</tr>
<tr>
<td>Organizational slack</td>
<td>.16</td>
</tr>
<tr>
<td>(3.38)**</td>
<td>(1.94)</td>
</tr>
<tr>
<td>Radical innovation</td>
<td>–.02</td>
</tr>
<tr>
<td>(–.41)</td>
<td>(–.87)</td>
</tr>
<tr>
<td>Firm size</td>
<td>.04</td>
</tr>
<tr>
<td>(1.05)</td>
<td>(4.52)**</td>
</tr>
<tr>
<td>Technology uncertainty</td>
<td>.16</td>
</tr>
<tr>
<td>(3.52)**</td>
<td>(1.43)</td>
</tr>
<tr>
<td>Market uncertainty</td>
<td>–.07</td>
</tr>
<tr>
<td>(–1.45)</td>
<td>(.49)</td>
</tr>
<tr>
<td><strong>Main Effects</strong></td>
<td></td>
</tr>
<tr>
<td>Market knowledge breadth</td>
<td>.16</td>
</tr>
<tr>
<td>(3.13)**</td>
<td>(4.40)**</td>
</tr>
<tr>
<td>Market knowledge depth</td>
<td>.20</td>
</tr>
<tr>
<td>(3.88)**</td>
<td>(3.08)**</td>
</tr>
<tr>
<td>Market knowledge tacitness</td>
<td>.01</td>
</tr>
<tr>
<td>(1.3)</td>
<td>(–.26)</td>
</tr>
<tr>
<td>Market knowledge specificity</td>
<td>.13</td>
</tr>
<tr>
<td>(3.00)**</td>
<td>(1.79)*</td>
</tr>
<tr>
<td>Cross-functional collaboration</td>
<td>.31</td>
</tr>
<tr>
<td>(6.73)**</td>
<td>(.73)</td>
</tr>
<tr>
<td><strong>Mediating Effect</strong></td>
<td></td>
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<tr>
<td>KIMs</td>
<td>.14</td>
</tr>
<tr>
<td>(2.19)*</td>
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</tbody>
</table>

*\(p < .05\) (one-tailed test for hypotheses, and two-tailed test for control variables).
**\(p < .01\) (one-tailed test for hypotheses, and two-tailed test for control variables).

Notes: \(N = 351\).

Structural Equation Modeling

We examined the robustness of the preceding results with structural equation modeling (SEM). The first model (SEM1) examined the direct effects of the independent variables on product innovation performance with the path from KIMs constrained to zero. The fit indexes (\(\chi^2\) [d.f.] = 1206.80 [751], CFI = .94, and RMSEA = .04) suggested a good fit with the data. The second model (SEM2), which involved a full mediation of the effects of the independent variables by KIMs, also showed a good fit with the data (\(\chi^2\) [d.f.] = 1228.10 [755], CFI = .94, and RMSEA = .04). Finally, based on modification indexes, a third partial mediation model (SEM 3), which allowed a direct effect of market knowledge breadth on product innovation performance, showed a good fit (\(\chi^2\) [d.f.] = 1203.50 [754], CFI = .94, and RMSEA = .04). Model comparisons with the chi-square difference test indicated that SEM3 performed better than both SEM1 (\(\Delta \chi^2\) [\(\Delta \text{d.f.}\] = –3.3 [3], \(p > .10\)) and SEM2 (\(\Delta \chi^2\) [\(\Delta \text{d.f.}\] = –24.6 [1], \(p < .001\)).
With the exception of a nonsignificant effect of market knowledge depth, the structural paths in SEM3 were consistent with the results we obtained using the regression analysis, and KIMs (β = .18, t = 1.70, p < .05) and market knowledge breadth (β = .39, t = 3.50, p < .01) were significantly related to product innovation performance. Following Brown’s (1997), Shrout and Bolger’s (2002), and others’ (see n. 8) recommendations, we again tested the significance of the specific mediation effects as follows: market knowledge breadth (total effect b = .85, p < .05; direct effect = .83, p < .05; indirect effect b = .03, not significant [n.s.]), market knowledge depth (total effect b = .16, n.s.; direct effect = .09, n.s.; indirect effect b = .07, p < .10), market knowledge specificity (total effect b = .14, n.s.; direct effect = .10, n.s.; indirect effect b = .04, p < .10), and cross-functional collaboration (total effect b = -.05, n.s.; direct effect = -.17, n.s.; indirect effect b = .12, p < .10).10

Overall, the results of this study suggest four conclusions: First, market knowledge specificity and cross-functional collaboration influence product innovation performance through KIMs. Second, market knowledge depth has both a direct and an indirect effect (through KIMs) on product innovation performance. Third, market knowledge breadth has a direct, nonmediated effect on product innovation performance. Fourth, product innovation performance is not influenced either directly or indirectly by market knowledge tacitness.

**Discussion**

Our goal in this article was to advance the marketing literature by untangling the complex relationships among market knowledge dimensions, cross-functional collaboration, KIMs, and product innovation performance. We found that market knowledge depth and specificity affect product innovation performance through KIMs. Note that though the direct effect size of KIMs on product innovation performance is small relative to the effect of market knowledge breadth, it plays the additional role of linking not only market knowledge breadth and specificity but also cross-functional collaboration to product innovation performance. These results echo the view that being a sticky asset, knowledge is a contingency variable and that the design for KIMs needs to take into account the nature of the knowledge base of the firm (e.g., Birkinshaw, Nobel, and Ridderstråle 2002; Germain and Droge 1997).

We found no support for the direct, positive effect of cross-functional collaboration on product innovation performance. Instead, we found that cross-functional collaboration positively affects product innovation performance through KIMs. This is consistent with the structural contingency theory argument that increased information-processing demands that result from the interdependence of functional units determine the degree to which KIMs are adopted. Although cross-functional collaboration and KIMs are important factors in the product innovation process, as is widely reported in the marketing literature, we offer the new insight that the latter factor is the route that makes the former a more valuable resource in product innovation.

In summary, our findings imply that market knowledge tacitness on KIMs was a surprise because prior research has found that it increases the difficulty of knowledge transfer. The lack of a relationship between market knowledge tacitness and product innovation performance echoes the mixed perspectives pertaining to the effect of tacitness in extant research (see Galunic and Rodan 1998; Hedlund 1994; McEvily and Chakravarthy 2002). We conducted a series of post hoc moderating tests with other variables in this study but found no significant nonlinear or moderated effects of market knowledge tacitness on product innovation performance. A possible explanation for our finding may be gleaned from the work of Nonaka (1994), who argues that tacit knowledge is created by individuals and is initially shared within homogeneous “communities of interaction,” such as functional units. To overcome problems of different thought worlds among such units, firms may rely on project leaders with A-shaped capabilities to “craft a unifying vision that does justice to all the disciplines represented” (Madhavan and Grover 1998, p. 4). As Griffin and Hauser (1996, p. 209, emphasis added) note, “These successful developers may have internalized a process that allows them to get product to market successfully.” This implies that unlike other market knowledge dimensions, integration of tacit market knowledge may be achieved through the tacit skills of effective team leaders rather than through formal KIMs. This appears to explain why firms such as Toyota employ the “integrative leader” as one of the key KIMs in product development (Sobek, Liker, and Ward 1998, p. 40).

As we mentioned previously, in other contexts, scholars have argued convincingly that KIMs are moderators. We evaluated this view and found significant interaction effects only between KIMs and cross-functional collaboration (β = -.11, t = -1.95, p < .05) and market knowledge depth (β =...
els containing the relevant interaction terms are as follows:

for which all the terms on the right-hand side are taken from the depth interaction (χ² [d.f.] = 1298.10, CFI = .94, and RMSEA = .04), KIMs

pair of constructs X and Z forming an interaction, we mean-

Ping (1995) suggests to build the interaction terms. First, for each underscore the need for market orientation theory to
effects of market knowledge depth and specificity also

Narver and Slater 1990). However, the indirect, positive

(Atuahene-Gima 1995, 2005; Jaworski and Kohli 1993; Narver and Slater 1990). However, the indirect, positive
effects of market knowledge depth and specificity also underscore the need for market orientation theory to

embrace a more fine-grained notion of market knowledge. Without this, marketing theory is unlikely to unearth new insights into the role of market knowledge in product innovation, such as those we offer here.

Second, the results regarding the effects of market knowledge dimensions suggest that theoretical exploration of the failure of firms in product innovation should not be ascribed mainly to their failure in cross-functional collaboration, as suggested in much of the previous research and in anecdotal reports. Rather, it may be possible for firms to fail even when they have effective and efficient cross-functional collaboration, if they do not have broad, deep, and specific market knowledge. This study indicates that examining only the direct effects of market knowledge and cross-functional collaboration separately may lead to an incorrect view of their power and, thus, to erroneous implications about their role in product innovation.

Third, we clarify how and why KIMs matter in product innovation performance by showing simultaneously their mediating and moderating roles. We show that KIMs convert some market knowledge dimensions and cross-functional collaboration into product innovation performance. This new insight implies that by failing to consider the mediating role of KIMs, previous research may have assumed away the information-processing demands in product innovation and thus may have reached a premature, and perhaps overly optimistic, view of the importance of market knowledge and cross-functional collaboration in product innovation. More important, these findings suggest an important qualification of the dual tenets of KBV, namely, that knowledge is a necessary but not a sufficient condition for competitive advantage and that effective integration of knowledge is the key driver of competitive advantage. We show that KIMs play an important role in product innovation performance, as predicted by the KBV, by partially mediating the effects of market knowledge depth and by completely mediating the effects of market knowledge specificity and cross-functional collaboration on product innovation performance. In other words, and consistent with the KBV’s contention, market knowledge depth and specificity as well as cross-functional collaboration may not be intrinsically valuable; their value may be realized through KIMs.

Fourth, contrary to the KBV tenet, market knowledge breadth is valuable in and of itself because it has a direct, unmediated effect on product innovation performance. Thus, it is a sufficient condition for product innovation performance. These differential strengths of market knowledge characteristics suggest that the KBV understates the inherent value of some types of market knowledge. Thus, this study suggests the need for further research to focus on the explicit articulation of the types of market knowledge and the consideration of their different roles in understanding the firm’s effectiveness in product innovation. Without such an approach, a more nuanced understanding of the role of market knowledge may be missed.

Fifth, given the complexity of the study context, the negative moderating effects of KIMs suggest that at high levels, they could stifle the effects of market knowledge

To test interactions with SEM, we followed the procedure that Ping (1995) suggests to build the interaction terms. First, for each pair of constructs X and Z forming an interaction, we mean-centered all their indicators x₁–xₙ and z₁–zₘ. Second, for each pair of constructs X and Z, we computed a single indicator that represents the latent product xz as (x₁ + … + xₙ)(z₁ + … + zₘ). Third, we specified a model including the two focal constructs and their interaction term. The loading and error for the latent product are given by two equations:

for which all the terms on the right-hand side are taken from the measurement model (Ping 1995). The fit indexes for the five models containing the relevant interaction terms are as follows: KIMs × market knowledge breadth interaction (χ² [d.f.] = 1306.49 [823], CFI = .94, and RMSEA = .04), KIMs × market knowledge depth interaction (χ² [d.f.] = 1325.09 [823], CFI = .94, and RMSEA = .04), KIMs × market knowledge tacitness interaction (χ² [d.f.] = 1298.10 [823], CFI = .94, and RMSEA = .04), KIMs × market knowledge specificity interaction (χ² [d.f.] = 1327.92 [823], CFI = .94, and RMSEA = .04), and KIMs × cross-functional collaboration interaction (χ² [d.f.] = 1284.85 [823], CFI = .94, and RMSEA = .04).

This study contributes to marketing theory of product inno-
vation in five main ways. First, the direct effect of market knowledge breadth sheds new light on the importance ascribed to the concept of market orientation in product innovation and the importance that marketing theory places on broad understanding of customers and competitors (Atuahene-Gima 1995, 2005; Jaworski and Kohli 1993; Narver and Slater 1990). However, the indirect, positive effects of market knowledge depth and specificity also underscore the need for market orientation theory to

Second, the results regarding the effects of market knowledge dimensions suggest that theoretical exploration of the failure of firms in product innovation should not be ascribed mainly to their failure in cross-functional collaboration, as suggested in much of the previous research and in anecdotal reports. Rather, it may be possible for firms to fail even when they have effective and efficient cross-functional collaboration, if they do not have broad, deep, and specific market knowledge. This study indicates that examining only the direct effects of market knowledge and cross-functional collaboration separately may lead to an incorrect view of their power and, thus, to erroneous implications about their role in product innovation.

Third, we clarify how and why KIMs matter in product innovation performance by showing simultaneously their mediating and moderating roles. We show that KIMs convert some market knowledge dimensions and cross-functional collaboration into product innovation performance. This new insight implies that by failing to consider the mediating role of KIMs, previous research may have assumed away the information-processing demands in product innovation and thus may have reached a premature, and perhaps overly optimistic, view of the importance of market knowledge and cross-functional collaboration in product innovation. More important, these findings suggest an important qualification of the dual tenets of KBV, namely, that knowledge is a necessary but not a sufficient condition for competitive advantage and that effective integration of knowledge is the key driver of competitive advantage. We show that KIMs play an important role in product innovation performance, as predicted by the KBV, by partially mediating the effects of market knowledge depth and by completely mediating the effects of market knowledge specificity and cross-functional collaboration on product innovation performance. In other words, and consistent with the KBV’s contention, market knowledge depth and specificity as well as cross-functional collaboration may not be intrinsically valuable; their value may be realized through KIMs.

Fourth, contrary to the KBV tenet, market knowledge breadth is valuable in and of itself because it has a direct, unmediated effect on product innovation performance. Thus, it is a sufficient condition for product innovation performance. These differential strengths of market knowledge characteristics suggest that the KBV understates the inherent value of some types of market knowledge. Thus, this study suggests the need for further research to focus on the explicit articulation of the types of market knowledge and the consideration of their different roles in understanding the firm’s effectiveness in product innovation. Without such an approach, a more nuanced understanding of the role of market knowledge may be missed.

Fifth, given the complexity of the study context, the negative moderating effects of KIMs suggest that at high levels, they could stifle the effects of market knowledge
depth and cross-functional collaboration on product innovation performance. It appears that though some characteristics of market knowledge and cross-functional collaboration may make KIMs necessary, the degree of KIMs must be tempered by the amount of contextual complexity the firm faces and the resulting need for functional flexibility and, perhaps, autonomy (Eisenhardt and Martin 2000). At high levels, KIMs may stifle the flexibility and creativity of cross-functional interactions and in the use of deep market knowledge (Kumar and Seth 1998, p. 583). Although previous studies in other contexts have found positive moderating roles for KIMs, the new insight we offer is that there may be a threshold of the KIM level beyond which market knowledge depth and cross-functional collaboration may have detrimental effects on performance. Thus, the use of KIMs appears to involve a trade-off between their necessity occasioned by stickiness of market knowledge and the information-processing demands of cross-functional collaboration on the one hand and the implementation costs of KIMs on the other hand. This is a trade-off that has not been uncovered in extant research.

Managerial Implications

The argument that market knowledge and cross-functional collaboration enhance product innovation performance has gained wide acceptance among practitioners. Our study supports this conclusion but also qualifies it in several ways for managers. First, our study calls on managers to consider the attributes of the market knowledge they use in new product projects to design KIMs properly. Marketing managers are fervent adherents of the market orientation tenet with respect to the value of acquiring broad and comprehensive knowledge about customers and competitors. This notion is justified given the research on the positive effects of market orientation on product innovation outcomes. However, this study digs deeper into the features of market knowledge by finding that though broad market knowledge is important, managers need to pay equal attention to deep and specific market knowledge. These dimensions of market knowledge appear to influence the design of KIMs, which in turn affect product innovation performance. Thus, the new insight for managers is that broad market knowledge is inherently valuable for product innovation performance, but emphasizing breadth over other market knowledge characteristics and integration mechanisms may be detrimental for the achievement of the full potential of the firm’s new product projects. Managers need to endow new project teams with the human and financial resources to acquire and apply broad, deep, and specific market knowledge in new product development activities. In this respect, our measures of market knowledge characteristics could serve as guides for managers who want to collect and use customer and competitor knowledge in line with these characteristics.

Second, the results suggest that it is the structured knowledge integration processes that enable the translation of cross-functional collaboration into better product innovation performance. This means that managers who encourage cross-functional collaboration as an end in itself but neglect formal knowledge integration processes may not achieve their intended objectives in product innovation. Toyota provides a good example of a company that values cross-functional collaboration but takes the extra step of deploying KIMs (Sobek, Liker, and Ward 1998). Finally, managers must be creative in balancing the need for KIMs engendered by the information-processing demands of cross-functional collaboration and market knowledge and the need for functional flexibility in the collaboration and use of market knowledge. Our results suggest that KIMs are not without costs of implementation, which could trap the unwary and thus lead to less effective use of market knowledge and cross-functional collaboration.

Limitations and Future Research Directions

This study has several limitations that should be considered in the interpretations of the findings. First, we used cross-sectional data, which cannot suggest causal relationships. In particular, if the theoretical lens is organizational learning and knowledge creation, it could be theorized that KIMs are antecedents to the dimensions of market knowledge we discussed here (e.g., Zahra, Ireland, and Hitt 2000). However, our focus was on knowledge integration viewed from a structural contingency theory lens and, more specifically, on the view of knowledge as a contingency variable (Birkmaw, Nobel, and Ridderstråle 2002; Germain and Droge 1997; Olson, Walker, and Ruekert 1995). This perspective suggests that the type of knowledge determines the nature of coordination mechanisms for knowledge integration (Galbraith 1973). Future studies based on the former lens could examine how KIMs affect the dimensions of market knowledge.

Second, the generalizability of the results is limited because we used data from a sample of firms in China. Third, extant research (Olson, Walker, and Ruekert 1995; Sobek, Liker, and Ward 1998) and contingency theory describe several integrative mechanisms (Galbraith 1973) that we did not consider here and should be investigated in further research for their ability to leverage market knowledge in product innovation. Fourth, our exclusive focus on market knowledge is a limitation, given the role of technological knowledge in product innovation. A more explicit incorporation of the nature of technological knowledge along the dimensions used for market knowledge in future studies may provide a better understanding of knowledge integration and product innovation performance.

Fifth, although we controlled for several factors that account for variance in firms’ growth, market power, and technological skills (i.e., firm size, slack, environmental conditions, and radical innovation), we did not include some potentially influential covariates that have been considered in previous studies, such as industry maturity (Eisenhardt and Tabrizi 1995), company age (Sinkula 1994), and R&D strength (Li and Calantone 1998). This might limit the definitive evaluation of the relative importance of the antecedents of KIMs and product innovation performance in the current study, and it offers a chance for future researchers to take steps in this direction. Finally, two of our scales, market knowledge breadth and KIMs, did not
meet the .50 threshold for AVE, suggesting the need for further scale development. In addition to alleviating these limitations, there are other fertile avenues for further research.

First, our study highlights the key role of market knowledge characteristics in enhancing KIMs and product innovation performance and underscores the central importance accorded to knowledge and its integration in the concept of market orientation. However, despite the numerous studies on market orientation, scholars are yet to recognize the distinctions among different knowledge characteristics espoused in the KBV. We argue that market-oriented firms may differ with respect to the type of market knowledge they collect and use in their product innovation processes. Thus, we suggest that two firms with the same degree of market orientation that have differential levels of market knowledge breadth, depth, tacitness, and specificity could display markedly different effectiveness in product innovation. This implies that examining the role of market orientation in product innovation without isolating and accounting for the fine details of market knowledge characteristics may lead to an incomplete understanding or even misleading results.

Second, our findings underscore the need for researchers to examine factors that may be more proximate antecedents of product innovation performance and, thus, potential drivers of the effect of cross-functional collaboration. Researchers need to move past their exclusive focus on the direct effects of cross-functional collaboration and begin to examine factors that may moderate or mediate its role in product innovation. These include different types of firm internal and external environments, such as internal commitment and competitive uncertainty (Song and Parry 1997); different managerial styles; different routines in the product innovation process, such as product standards and market definition (Dougherty 1992); different functional relationship experiences; and so forth. Indeed, with the exception of Maltz and Kohli (2000), we and other scholars in the marketing literature seem to have a positive bias toward cross-functional collaboration. However, cross-functional collaboration involves potential bottlenecks, such as functional competition, conflicts, and personality differences. Although not exhaustive, these aspects point to important opportunities for further research to provide a deeper examination of how cross-functional relationships and knowledge affect innovation.

The results of this study, along with those in previous studies, suggest that there is little understanding of the value of tacit knowledge. McEvily and Chakravarthy (2002) indicate that tacitness may involve two dimensions: characteristic ambiguity and linkage ambiguity, the former dimension being an antecedent of the latter dimension. Given the KBV’s arguments that tacitness is a key factor that could erect imitation barriers to protect the firm’s advantage, research is needed on whether these two dimensions apply to market knowledge and whether they offer similar or differential advantages in product innovation. Finally, further research should examine more closely the dynamic interplay between market knowledge characteristics and technological knowledge characteristics in the linkage between cross-functional collaboration and KIMs in product innovation. We believe that given the potential synergies between market and technological knowledge in product innovation, further research should tease out subtler, but still important, combined effects of the different characteristics of these kinds of firm knowledge.

In conclusion, this study challenges researchers and managers to take a more sophisticated assessment of how and why market knowledge and cross-functional collaboration affect product innovation outcomes. We believe that by delineating the differential relative effects of the dimensions of market knowledge and cross-functional collaboration and by showing the dual mediating and moderating roles of KIMs, this study illuminates in a more systematic way how such a goal can be achieved. With additional work that builds on this study and incorporates the role of technological knowledge, a more comprehensive account of the complexity of the processes by which firms develop successful product innovations can be achieved.
Market Knowledge Dimensions and Cross-Functional Collaboration

APPENDIX
CFA of Measures

<table>
<thead>
<tr>
<th>Measure and Source</th>
<th>Description</th>
<th>Standardized Factor Loadings</th>
<th>t-Value</th>
<th>rwg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product innovation performance(^a) (Atuahene-Gima, Slater, and Olson 2005)</td>
<td>Rate the extent to which your firm has achieved the following product development objectives:</td>
<td>.76</td>
<td>16.72</td>
<td>.91</td>
</tr>
<tr>
<td></td>
<td>•Market share relative to the firm’s stated objectives.</td>
<td>.81</td>
<td>18.49</td>
<td>.92</td>
</tr>
<tr>
<td></td>
<td>•Sales relative to stated objectives.</td>
<td>.93</td>
<td>23.12</td>
<td>.92</td>
</tr>
<tr>
<td></td>
<td>•Return on assets relative to stated objectives.</td>
<td>.93</td>
<td>23.09</td>
<td>.92</td>
</tr>
<tr>
<td></td>
<td>•Profitability relative to stated objectives.</td>
<td>.87</td>
<td>20.76</td>
<td>.91</td>
</tr>
<tr>
<td>Market knowledge breadth(^b) (Zahra, Ireland, and Hitt 2000)</td>
<td>Compared to major competitors, our firm’s knowledge of</td>
<td>.63</td>
<td>12.27</td>
<td>.90</td>
</tr>
<tr>
<td></td>
<td>•Competitors’ strategies is narrow vs. broad.</td>
<td>.60</td>
<td>11.55</td>
<td>.87</td>
</tr>
<tr>
<td></td>
<td>•Our customers is narrow vs. broad.</td>
<td>.78</td>
<td>16.12</td>
<td>.90</td>
</tr>
<tr>
<td></td>
<td>•Our customers is limited vs. wide ranging.</td>
<td>.76</td>
<td>15.80</td>
<td>.91</td>
</tr>
<tr>
<td></td>
<td>•Competitors’ strategies is specialized vs. general.(^f)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>•Our customers is specialized vs. general.(^f)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market knowledge depth(^b) (Zahra, Ireland, and Hitt 2000)</td>
<td>Compared to our major competitors, our firm’s knowledge about</td>
<td>.68</td>
<td>13.40</td>
<td>.90</td>
</tr>
<tr>
<td></td>
<td>•Competitors’ strategies is shallow vs. deep.</td>
<td>.62</td>
<td>11.80</td>
<td>.89</td>
</tr>
<tr>
<td></td>
<td>•This firm’s customers is shallow vs. deep.</td>
<td>.76</td>
<td>15.58</td>
<td>.90</td>
</tr>
<tr>
<td></td>
<td>•This firm’s customers is basic vs. advanced.</td>
<td>.78</td>
<td>16.16</td>
<td>.88</td>
</tr>
<tr>
<td>Market knowledge tacitness(^c) (Szulanski 1996)</td>
<td>Market knowledge competencies are difficult to</td>
<td>.86</td>
<td>19.29</td>
<td>.84</td>
</tr>
<tr>
<td></td>
<td>•Comprehensively document in manuals or reports.</td>
<td>.88</td>
<td>19.91</td>
<td>.85</td>
</tr>
<tr>
<td></td>
<td>•Comprehensively understand from written documents.</td>
<td>.68</td>
<td>13.93</td>
<td>.86</td>
</tr>
<tr>
<td></td>
<td>•Identify without personal experience in using them.</td>
<td>.68</td>
<td>13.94</td>
<td>.84</td>
</tr>
<tr>
<td></td>
<td>•Precisely communicate through written documents.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>•There is no precise list of market knowledge skills necessary to successfully perform our activities.(^f)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market knowledge specificity(^c) (New items based on Reed and DeFillippi 1990)</td>
<td>Please indicate your agreement with each of the following statements with respect to your firm’s market knowledge:</td>
<td>.66</td>
<td>13.16</td>
<td>.84</td>
</tr>
<tr>
<td></td>
<td>•Our knowledge of customers and competitors is quite specific to our kind of business.</td>
<td>.86</td>
<td>17.74</td>
<td>.84</td>
</tr>
<tr>
<td></td>
<td>•It will be very difficult for an employee to transfer market knowledge acquired in our firm to other business environments.</td>
<td>.79</td>
<td>16.23</td>
<td>.83</td>
</tr>
<tr>
<td></td>
<td>•Our market knowledge and skills are tailored to meet the specific conditions of our business.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>•Our market knowledge largely depends on the human and physical assets we have dedicated to acquiring information about market conditions.(^f)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KIMs(^d) (Zahra, Ireland, and Hitt 2000; Zahra and Nielsen 2002)</td>
<td>To what extent does your firm use each of the following activities to capture, interpret, and integrate knowledge and information about market and technology conditions?</td>
<td>.72</td>
<td>14.84</td>
<td>.87</td>
</tr>
<tr>
<td></td>
<td>•Regular formal reports and memos that summarize learning.</td>
<td>.77</td>
<td>16.19</td>
<td>.88</td>
</tr>
<tr>
<td></td>
<td>•Information sharing meetings.</td>
<td>.71</td>
<td>14.32</td>
<td>.88</td>
</tr>
<tr>
<td></td>
<td>•Face-to-face discussions by cross-functional teams.</td>
<td>.60</td>
<td>11.70</td>
<td>.85</td>
</tr>
<tr>
<td></td>
<td>•Formal analysis of failing product development projects.</td>
<td>.59</td>
<td>11.46</td>
<td>.86</td>
</tr>
<tr>
<td></td>
<td>•Formal analysis of successful product development projects.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>•Use of experts and consultants to synthesize knowledge.(^f)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cross-functional collaboration(^e) (Li and Calantone 1998)</td>
<td>In this organization different departments</td>
<td>.75</td>
<td>14.81</td>
<td>.88</td>
</tr>
<tr>
<td></td>
<td>•Cooperate fully in generating and screening new ideas for new products.</td>
<td>.79</td>
<td>14.96</td>
<td>.86</td>
</tr>
<tr>
<td></td>
<td>•Fully cooperate in establishing goals and priorities for our strategies.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### APPENDIX

Continued

<table>
<thead>
<tr>
<th>Measure and Source</th>
<th>Description</th>
<th>Standardized Factor Loadings</th>
<th>t-Value</th>
<th>(r_{wg})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technological uncertaintyc (Jaworski and Kohli 1993)</td>
<td>Please indicate your agreement with each of the following statements with respect to your firm’s environment: • It was very difficult to forecast technology developments in our industry. • Technology environment was highly uncertain. • Technological developments were highly unpredictable. • Technologically, our industry was a very complex environment.</td>
<td>.61</td>
<td>11.52</td>
<td>.87</td>
</tr>
<tr>
<td>Market uncertaintyc (Jaworski and Kohli 1993)</td>
<td>Please indicate your agreement with each of the following statements with respect to your firm’s environment: • Customer needs and product preferences changed quite rapidly. • Customer product demands and preferences were highly uncertain. • It was difficult to predict changes in customer needs and preferences. • Market competitive conditions were highly unpredictable.</td>
<td>.58</td>
<td>10.91</td>
<td>.88</td>
</tr>
<tr>
<td>Organizational slackc (New scale)</td>
<td>Please indicate your agreement with each of the following statements with respect to your firm: • We have uncommitted resources that can be used to fund strategic initiatives at short notice. • We have a large amount of resources available in the short run to fund our initiatives. • We will have no problems obtaining resources at short notice to support new strategic initiatives. • We have a large amount of resources at the discretion of management to fund new strategic initiatives.</td>
<td>.72</td>
<td>14.89</td>
<td>.86</td>
</tr>
<tr>
<td>Radical innovatione (McGrath 2001)</td>
<td>To what extent does each of the following factors describe this firm’s product development? • The products offered were new to the firm and the industry. • The customer or client needs served were new to the firm. • The users of the products or services were new to the firm. • The new products were based on revolutionary changes in technology.</td>
<td>.72</td>
<td>15.40</td>
<td>.88</td>
</tr>
</tbody>
</table>

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\[^{a}Seven-point scale (1 = “low,” and 7 = “high”).\]
\[^{b}Five-point semantic differential scales (anchoring points in italics).\]
\[^{c}Five-point scale (1 = “strongly disagree,” and 5 = “strongly agree”).\]
\[^{d}Five-point scale (1 = “never used,” and 5 = “widely used”).\]
\[^{e}Five-point scale (1 = “to no extent,” and 5 = “to great extent”).\]
\[^{f}Items were dropped from the scale during the measure purification phase.\]

Notes: CR = composite reliability.

### REFERENCES


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