Int. J. Production Economics 125 (2010) 215–223

Contents lists available at ScienceDirect

Int. J. Production Economics

journal homepage: www.elsevier.com/locate/ijpe

The knowledge management strategy and its effect on firm performance: A contingency analysis

Jie Yang

School of Business Administration, University of Houston-Victoria, 14000 University Blvd, Sugar Land, TX 77479, USA

ARTICLE INFO

Article history:
Received 27 February 2010
Accepted 17 March 2010
Available online 21 March 2010

Keywords:
Knowledge management
Strategy
performance
Contingency
Competency

ABSTRACT

This study seeks to examine the impact of knowledge management strategy on strategic performance in Chinese High Technology firms drawing on the theory of resource-based view. The results from moderated regression analysis show that the knowledge management strategy—performance connection is contingent on both performance-driven strategies, (including reward system and process innovation) and knowledge management-based competencies, such as R&D from past projects, market intelligence, and intraorganizational knowledge sharing. The findings suggest that both performance-driven strategies and knowledge management-based competencies should be considered in the implementation of knowledge management strategy in Chinese High Technology firms. These results have important implications for researchers investigating the effectiveness of high technology firms' adoption of knowledge management strategies in transitional economies as well as practitioners seeking to improve corporate strategic performance.

© 2010 Elsevier B.V. All rights reserved.

0. Introduction

Knowledge management has been considered a critical strategy for firms to obtain competitive advantage in recent years (King, 2001; Ndlela and du Toit, 2001; Ofek and Sarvary, 2001). Scholars have been focusing on diverse dimensions of knowledge management (Krogh et al., 2001). However, there is at present no conclusive research on the relationship between knowledge management strategy and firm performance.

A small number of studies indicate a negative relationship where knowledge management strategy did not support competitive strategy (Hansen et al., 1999). Matusik (2002) found a negative relationship between certain firm knowledge and product development performance. On the other hand, the vast majority of studies in the literature of knowledge management suggest that knowledge management positively impacts firm performance (Hoopes and Postrel, 1999; Lloyd, 1996; Lubit, 2001). One possible explanation for the conflicting findings is that most prior studies did not investigate the factors that may have a moderating effect on the relationship between knowledge management strategy and firm strategic performance.

In the context of knowledge management, strategy refers to the organizational intention and enabling condition for organizational knowledge creation (Nonaka and Takeuchi, 1995). King (2001) observed that knowledge management strategy focuses on the acquisition, explication, and communication of mission-specific professional expertise that is largely tacit in nature to organizational participants and contexts in a manner that is focused, relevant, and timely. Given the growing significance of contingency factors in strategy research (Ginsberg and Venkatraman, 1985), there exists a major research gap in accounting for the impact of moderating factors on the relationship between knowledge management and firm strategic performance.

This study makes three contributions to existing literature on knowledge management strategy in a high technology industry. First, Eisenhardt and Schoonhoven (1990) elaborated that high technology firms, compared with others, are facing severe problems of limited managerial and financial resources. Yet, knowledge management is characterized as innovative and resource-consuming. Knowledge management strategy may not be a viable option to high technology firms with limited resources, as evidenced in the rate of failure to achieve high performance. Thus, how both performance-driven strategy and knowledge management-based competence moderate the knowledge management strategy—performance relationship becomes an important issue. Second, the high technology industry in China is the research object. Xin and Pearce (1996) suggested that firms face great challenges in terms of resource and management in transitional economies. Thus, the Chinese high technology industry presents an interesting setting for investigating the link between knowledge management strategy and strategic performance. Third, the relationship between knowledge management strategy and competitive strategy has been explored extensively. Firms always emphasize that doing better than their competitors is the way to gain advantage. As a result, competition becomes the

E-mail addresses: jie130@gmail.com, yangj2@uhv.edu.

0925-5273/$ - see front matter © 2010 Elsevier B.V. All rights reserved.
doi:10.1016/j.ijpe.2010.03.012

final point for all strategic thoughts. After endless endeavor, firm performance improvement is only slight rather than a big jump. This study analyzes the link between knowledge management strategy and strategic performance by considering knowledge management as a dynamic firm capability.

1. Theoretical framework and hypotheses

There are two major research streams on knowledge management in prior literature. The resource-based stream focuses mainly on the increase of knowledge stock and the reuse of knowledge repositories (Barney, 1991; Kamara et al., 2002). In this stream, knowledge management refers to the developing body of methods, tools, techniques and values through which organizations can acquire, develop, measure, distribute and provide a return on their intellectual assets (Snowden, 1999). The process-based stream stresses processes, organizational structure, and IT applications that enable individuals to leverage their creativity and capabilities to deliver business value and to sense and then seize opportunities promptly and effectively (e.g., Teece, 2000). This research stream defines knowledge management as a transformation process going from tacit knowledge into explicit knowledge in order to facilitate flows of organizational knowledge (Lubit, 2001; Schulz and Jobe, 2001). In this stream, organization, strategy, and people have become central issues in knowledge management.

It has been recognized that IT implementation alone does not result in the success of knowledge management (Brown and Druid, 1998; Gomory and Schmitt, 1998). We posit that knowledge management is a framework within which the organization views all its processes as knowledge processes. The key point of knowledge management is to harvest the tacit knowledge residing in individuals and make it a firm asset, rather than to only leave it in the heads of the particular individuals.

In prior research, there are two levels in the process-based research stream. Some studies focus on the project level and investigate knowledge sharing among the project team and marketing, the R&D needed for innovation and improved project performance including shortened cycle time, improved new product quality and successful market launch (e.g., Gupta and Souder, 1998; Kamara et al., 2002; Lee et al., 2001). The others emphasize firm level and examine knowledge management as a dimension of the inimitable competitive strategy of firms (Holsapple and Singh, 2001; Lubit, 2001), as a key to long-term organizational success (Lloyd, 1996), and as a source of competitive advantage (Ndlela and du Toit, 2001).

Informed by resource-based view, knowledge is viewed as a resource within a firm in knowledge management strategic posture. Emphasis is on the variety of knowledge management tools, and efficiency and effectiveness in knowledge sharing (Holsapple and Singh, 2001; Hoopes and Postrel, 1999; Krogh et al., 2001). In line with this viewpoint, knowledge management strategy is defined as the reflection of a firm's competitive strategy to foster the firm's dynamic capability to create and transfer knowledge for the purpose of delivering superior value and meeting the evolving expectations of its clients. Therefore, for a high technology firm in China, knowledge management strategy includes: allocation of substantial resources to knowledge management, developing a variety of knowledge management tools, effectively creating and transferring knowledge, quickly acquiring knowledge new to the firm, making significant contributions to the organization's knowledge base, creating a knowledge-oriented environment, and supporting and encouraging innovation.

As noted earlier, previous inconclusive research on knowledge management and performance drives us to put forward a contingency approach in this study, which has been considered legitimate for the study of the relationship between strategy and performance across different contexts (Ginsberg and Venkatraman, 1985). The organizational contexts include organizational variables such as the performance-driven strategy and knowledge management-based competencies. The contingency perspective has long been adopted in strategic research (Ginsberg and Venkatraman, 1985; Miller and Cardinal, 1994) and has been employed in recent knowledge management research (Becerra-Fernandez and Sabherwal, 2001; Yang, 2004).

The resource-based view is also employed as a theoretical basis in this study. Penrose (1959) argues that resources are valuable only to the extent that they can deliver valuable services. The most critical resources are no longer the traditional tangible assets, but the intangible dynamic capability to achieve enhanced performance (Teece, 2000). Consequently, profits come primarily from core competence which is strictly idiosyncratic (Dierickx and Cool, 1989). Knowledge has been the most important strategic resource for high technology firms. Barney (1991) emphasizes the stock of knowledge as a potential source of sustained competitive advantage. According to Amit and Schoemaker (1993) and Grant (1997), the core competence is aimed at exploring, coordinating, and applying different resources. The resource-based view offers answers to the questions of why firms employ knowledge management strategies and why such a strategy's effect on performance may be contingent on the performance-driven strategies and knowledge management-based competence.

In particular, there are two major notions relevant to this study (Amit and Schoemaker, 1993). One is that firms attempt to enrich their resources to encourage innovation and value creation in order to enhance their performance. The other is that firms emphasize the stock of knowledge as a potential source of competence. As a result, performance-driven strategy and knowledge management-based competence are considered when practitioners make strategic decisions attempting to "conceive and implement strategies that improve its efficiency and effectiveness" (Daft, 1983). The two notions lead us to propose that the effectiveness of the knowledge management strategies of Chinese high technology industry depends on performance-driven strategy and knowledge management-based competence.

1.1. Moderating role of performance-driven strategy

Knowledge is regarded as a potential creation in the first notion of the resource-based view (Teece, 1998). Drawing on this viewpoint, we argue that the effectiveness of knowledge management strategies implementation in Chinese high technology firms depends on the firms' recognition of the necessity and importance of facilitating innovation and value creation to facilitate a knowledge management strategy. Firms will achieve these by realizing that employee's knowledge is valuable and should be rewarded through a motivating reward system and process innovation (Santosus and Surmacz, 2002). We argue that the performance of Chinese high technology firms' use of a knowledge management strategy may depend not only on how they manage the reward system of the firm but also on how they achieve process innovation.

The reward system refers to the financial or economic supports which a firm provides to motivate a specific behavior in its employees. Reward systems play a crucial role in stimulating specific behaviors in a firm. Group behavior guided by joint goals is stimulated by performance evaluations that recognize the

interdependence between the tasks of different employees (Griffin and Hauser, 1996). Sarin and Mahajan (2001) proposed a positive relationship between outcome-based rewards and team performance. In order for the company to have positive performance, its strategy concerning an employee incentive program must not be taken lightly. A reward system will encourage more employees to participate in the implementation of knowledge management strategy. Reward system orientation has been found to increase intelligence generation, dissemination and the responsiveness of an organization (Jaworski and Kohli, 1993). The knowledge management program will get great support from a reward system, thus boosting a firm's strategic performance since such support will alleviate the risk of losing all technology and experience and reinventing something that already exists (Dash, 1998).

Process innovation refers to the extent to which a firm's activities are developed and performed by imaginative methods. It caters to the critical issues of organizational adaptation, survival and competencies in light of a dynamic environment. A firm's strategies will depend on the interpretive flexibility of the creative minds in the organization. The new business environment places a premium on creativity and innovation (Gold et al., 2001), and rewards it.

Santosus and Surmacz (2002) recommended that firms should foster innovation and creativity by encouraging their employees to brainstorm and engage in a free flow of ideas. Process innovation interacts with knowledge management solutions and strategies to achieve radical and continuous improvement. Kamara et al. (2002) showed that successful firms are filled with innovation and creativity when they implement knowledge management strategy. Innovation translates competencies into new products, processes and services which enable firms to achieve competitive advantage (Danneels, 2002). Since knowledge management is an intellectual capital-based strategy, innovation and creativity which put best processes or practices into use should help to increase the efficiency as well as the effectiveness of high technology firms in China pursuing such a strategy (Dash, 1998). This discussion suggests the following hypotheses.

Hypothesis 1a. The relationship between the use of a knowledge management strategy and the strategic performance of a firm is moderated positively by a reward system.

Hypothesis 1b. The relationship between the use of a knowledge management strategy and the strategic performance of a firm is moderated positively by process innovation.

1.2. Moderating role of knowledge management-based competencies

For those firms implementing knowledge management strategy, knowledge has been a crucial strategic resource due to its uniqueness and non-substitutability (Barney, 1991). Teece (1998) regarded knowledge as a potential source of innovation and value creation. It is not the stock of knowledge that may give the firm a competitive advantage, but rather the way the knowledge is applied in a firm which informs knowledge management strategy. Four modes of knowledge conversion (socialization, externalization, combination, and internalization) were postulated by Nonaka and Takeuchi (1995) based on the assumption that knowledge is created through the interaction between tacit and explicit knowledge. The essence of a knowledge management strategy lies in developing the organizational capability to acquire, create, accumulate and exploit knowledge (Nonaka and Takeuchi, 1995). The capability in turn leads to knowledge-based competence. The analysis on the four modes forms knowledge-based competence.

When knowledge is combined into unique processes at the firm level, core competence may be developed, thereby indicating a knowledge-based sustainable competitive advantage (Prahalad and Hamel, 1990; Saarenketo et al., 2004; Lööf and Heshmati, 2002), which in turn leads to positive returns (Peteraf, 1993). Knowledge cannot create value without effective knowledge management solutions. We investigate three such competencies: the R&D integration of knowledge from past projects, market intelligence, and intraorganizational knowledge sharing. In knowledge-intensive high technology firms, these factors are part of the firms' innovation capability. Chandler et al. (1998) identified three levels of a firm's capability: static, improvement, and evolutionary. The latter two can be regarded as the first-order and second-order dynamic capabilities respectively. Innovation capability is here emphasized due to its dynamic feature, which enables a firm to promptly respond to a dynamic environment to sustain competitive advantage (Prahalad and Hamel, 1990). The dynamic capability approach emphasizes the capacity of firms to accumulate, deploy, renew, and reconfigure resources in response to changes in the external environment (Teece et al., 1997; Winter, 2000; Eisenhardt and Martin, 2000).

R&D integration of knowledge from past projects refers to a firm's ability to learn from success and failure to improve R&D. In a turbulent and rapidly changing environment, organizations face the challenge of how to best manage their knowledge assets to generate value for the marketplace and obtain a competitive advantage (Armbrecht et al., 2001). The integration of knowledge derived from R&D is based on tacit knowledge flow. A central focus of the integration process should be the successful exploitation of ideas to add value in the organization.

R&D is the primary source of internal knowledge creation. The faster the knowledge can be created, the more value a company can deliver to further its growth. Integration of R&D knowledge expands the creative potential of the entire organization. According to Armbrecht et al. (2001), facilitation of knowledge flow and knowledge creation is an increasing returns activity, improving a firm's bottom-line. R&D integration of knowledge from past projects provides strong support to the knowledge management program, thus support is significant for the firm's performance since it shortens the cycle time of developing new products (Sherman et al., 2000).

Market intelligence reflects the extent to which data is generated about the competitive situation in a specific industry, and is then processed into knowledge to significantly increase intelligence and achieve a better fit of strategy for the firm. Market intelligence, categorized as one of three types of competitive intelligence (Deschamps and Ranganath Nayak, 1995), is crucial to the understanding of the trends of customers' needs and preferences, market opportunities, and the threat of major competitors. To build a strong business intelligence solution, firms need to better utilize market intelligence data and integrate it into the knowledge building process.

The generation and dissemination of market intelligence are two vital factors in achieving high business performance (Jaworski and Kohli, 1993). Market intelligence gathers necessary information about the market and customers, and competitors. In the intensively competitive high technology industry, market intelligence facilitates the implementation of knowledge management strategy to achieve high performance. It is a crucial factor for new product success and for keeping the firm ahead of its competitors (Adams et al., 1998; Wren et al., 2000).

Intraorganizational knowledge sharing refers to the degree of communication and sharing of experiences, ideas, and expertise among employees within an organization. It is collective beliefs or

behavioral routines related to the spread of learning among different units within an organization (Moorman and Miner, 1998; Zaltman et al., 1973). Management of intellectual capital has become a commonly cited source of competitive advantage. Not surprisingly, a wide range of companies have implemented knowledge management initiatives to help their employees share their best ideas and practices. Hoopes and Postrel (1999) stressed that knowledge sharing is a value added activity in the value chain of the organization. This implies that the more experts in an organization share their knowledge, the more value is added to the chain.

However, some employees may hesitate to share information with others because they feel it will decrease their personal value to the firm to share secrets that they have learned over the years (Santosus and Surmacz, 2002), thus it is essential that firms institute a knowledge sharing policy for employees for effective participation in the implementation of the knowledge management strategy. Greater shared knowledge tends to create new knowledge, through the reflective process, in the light of personal experience (Kolb, 1984). Intraorganizational knowledge sharing is also necessary to prevent the loss of information (Lukas et al., 1996), and leads to the accumulation of knowledge. Firms that encourage the free circulation of information and knowledge within the organization appear to come up with better products faster, and use fewer man-hours in doing so (Hoopes and Postrel, 1999). For those firms adopting knowledge management strategy, the accumulation of knowledge is crucial to learning organization performance (Moorman and Miner, 1998).

Knowledge has been demonstrated as a valuable commodity to the individual, and shared knowledge is viewed as a symbol of trust and unity in an organization (Brown and Woodland, 1999). Incentives to sharing knowledge in an organization can foster the knowledge creation process. The best way to manage knowledge effectively is to establish a knowledge sharing culture within the firm. The above discussion leads to the following hypotheses.

Hypothesis 2a. The relationship between the use of a knowledge management strategy and the strategic performance of a firm is moderated positively by R&D integration of knowledge from past projects.

Hypothesis 2b. The relationship between the use of a knowledge management strategy and the strategic performance of a firm is moderated positively by market intelligence.

Hypothesis 2c. The relationship between the use of a knowledge management strategy and the strategic performance of a firm is moderated positively by intraorganizational knowledge sharing.

2. Methods

2.1. Sample and data collection

This study examined a sample of 500 high technology firms in China. High technology firms were chosen because they are knowledge-intensive firms which provide an appropriate setting for research on knowledge management. Knowledge-intensive refers to the extent that knowledge is a key factor of production (Coff, 2003). Firms investing heavily in R&D (Cohen and Levinthal, 1990) or drawing heavily on educated or skilled employees (Coff, 1999) can be considered as knowledge-intensive.

These high technology firms provide several advantages for testing the hypotheses. First, knowledge acquisition and dissemination play a crucial role in developing new products in high technology firms. The implementation of knowledge management strategies facilitates knowledge innovation in designing leading new products in this highly competitive high technology arena. Second, the transitional economy in China strongly depends on the development of high technology. The performance of these firms directly impacts the pace of economic growth. These properties make the firms good settings for examining the knowledge management strategy and performance link. The firms also offer rich settings for testing the hypotheses because each firm takes knowledge management seriously and connects it to strategic performance. They therefore engage in various knowledge management strategies, which provide the researchers with many opportunities to observe the implementation process.

It is helpful to focus on a single industry in identifying key firm resources leading to core competence (Dess et al., 1990). In this study, an attempt is made to understand the dynamics of knowledge management, strategy, and competencies in high technology firms. Studies on traditional firms offer limited insight compared to knowledge-based firms (Starbuck, 1993), like high technology firms.

High technology firms mainly rely on their dynamic capability to transform knowledge residing in the organizations into value for their customers. Value creation is a knowledge-intensive process. It requires a firm to adopt knowledge management strategy to foster the value creation of its core competencies. In addition, high technology firms are valued for their effect on regional development (Feldman and Kutay, 1997; Shefer and Frenkel, 1998).

Data were collected using the CEO/general manager and senior manager as the key informant (Kumar et al., 1993). The key informant approach has been widely used in empirical studies (e.g., Morgan and Hunt, 1994; Sen and Egelhoff, 2000; Stump and Heide, 1996) because of the key informants' knowledge of the firm, access to strategic information, and familiarity with the environment of the firms (Aguilar, 1967). They were mailed a questionnaire and a letter explaining the purpose of this study and offered the research results if respondents returned the completed questionnaire. The average size of the firms is 93. The firms surveyed cross different industries including electronic information, mechanical products, bioengineering, energy, scientific instruments, etc.

Follow-up phone calls were made to all potential respondents who had not returned the surveys after four weeks. A comparison of the early-responding firms with the late-responding firms showed that these groups did not differ in terms of number of employees, sales revenue, years in business, or any of the key variables in this study. As a result, 190 usable questionnaires were returned, yielding an effective response rate of 38%. This response rate is similar to those obtained by others who have surveyed top management (e.g., Geletkanycz, 1997) and to those who have studied similar issues in knowledge management (e.g., Decarolis and Deeds, 1999; Gold et al., 2001).

2.2. Measures

All multi-item variables were measured on a seven-point scale to ensure a uniform scale width. These scales ranged from "Strongly Disagree" to "Strongly Agree," unless otherwise mentioned. Some items were adapted and re-worded to fit the present context. Essentially, the items were reworded to focus on the contribution of employees to their firms' knowledge base and innovation, as opposed to salespeople's intelligence. The measures in this study were drawn from several sources. The measure of reward system was adapted from Jaworski and Kohli (1993). For process innovation, the measure developed by Murray et al. (1995) was used reflecting the degree of process innovation in product development, the level of process innovation relative to

main competitors, and the number of potential applications of the process innovations. R&D integration of knowledge from past projects was measured by five items drawn from the study by Sherman et al. (2000), reflecting the degree of sharing lessons learned from the past, conducting post-launch meetings, incisive discussions, and application of past lessons. Drawing from the work by Song and Parry (1997), market intelligence was measured by indicating the extent of accurate forecasts of market demand, knowing customers' needs, competitors, and potential market. Intraorganizational knowledge sharing was adopted from Hult and Ferrell (1997), reflecting the degree of organizational conversation, facilitation of lessons sharing, and top management's emphasis on knowledge sharing.

Based on extensive interviews with academic scholars and executives, the measure of knowledge management emphasizes knowledge sharing, repositories accessibility, repositories growth, and commitment to sharing and innovation to tap various facets of knowledge management strategy. Strategic performance is a new scale measured by four items based on a comprehensive literature review. Strategic position, competencies, market share, and leadership position in an industry were used to tap into the various facets of strategic performance. This measure is grounded in the works of Shapiro (1985), Shapiro and Varian (1999), Wiersema and Liebeskind (1995), and Taylor and Cosenze (1997). Thus firm strategic performance, as measured here is based on the respondent's perception of their firm's performance.

2.3. Reliability and validity analyses

In order to provide subjective assessments of content validity (Rosenthal and Rosnow, 1991), the initial survey instrument was sent to several scholars who are familiar with the literature. This led to minor modifications to some of the items, and the scales were then sent to several executives for comments. Based on their comments, the survey was rearranged and reworded for some items.

To assess the discriminant validity of multiitem measures, factor analysis with a varimax rotation was conducted using SPSS. Results of this analysis show that all measures loaded on the expected factors with loadings above .40, with the exception of top management's emphasis on knowledge sharing in measuring intraorganizational knowledge sharing, which has a loading of 0.31. "As a rule of thumb, factor loadings greater than ± 0.30 are considered to meet the minimal level; Loadings of ± 0.40 are considered more important; and if the loadings are within ± 0.50 or greater, they are considered practically significant" (Hair et al., 1998). Table 1 shows that all measures have a Cronbach alpha ranges from 0.68 to 0.90, thus indicating a good evaluation of reliability of these measures.

In examining the unidimensionality and convergent validity of the constructs, we performed confirmatory factor analyses using AMOS 4 on two measurement models because of the restriction of the sample size (Bentler and Chou, 1987). The constructs are grouped in terms of their theoretical relevance, discussed in the earlier section. The first model includes performance-driven strategy variables and the second model includes knowledge management-based competence variables. The fit indices suggest a good fit for both models with strategy variables (GFI=0.99, AGFI=0.97, NFI=0.98, CFI=1.00, RMSEA=0.00) and competence variables (GFI=0.95, AGFI=0.92, NFI=0.91, CFI=0.98, RMSEA=0.04).

Three control variables were included to account for firm characteristics and innovation activity that may influence the relationship between the knowledge management strategy and strategic performance. First, dummy variables were included to control for differences in strategic performance that could be attributed to the adoption of innovation diffusion activity (dummy-coded: "yes"=1, "no"=0). Two control variables were also included in the analyses that identify differences in physical firm attributes: firm age (in years) and firm size (the natural logarithm of the number of employees). Firm knowledge management strategy may be influenced by the age of firms. Thus, a variable for firm age, which was calibrated in years was included.

Also included was a variable for firm size to control for issues related to effectiveness of strategy implementation (Hoskisson et al., 1994). Based on prior literature, missteps can be avoided by small firms to overcome the vulnerability of the firms (Aram and Cowen, 1990), while dysfunctional inertia can be promoted by the bureaucratic features of large firms (Hitt et al., 1990). Firm size was measured as the total number of employees reported for each firm, which was transformed using log transformations to correct for its skewed distribution.

3. Analysis and results

The data were analyzed using hierarchical moderated regression in SPSS to test the hypotheses in this study. Its estimators are the most robust and appropriate for small sample sizes (Hanushek and Jackson, 1977). In the first analytical model, the control variables and independent variables were entered and the main effect of the use of knowledge management strategy is tested. Second, the five moderators were added to check for interacting effects. The moderated relationship is represented as

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_1X_2$$

where b_0, intercept; b_1X_1, linear effect of X_1; b_2X_2, linear effect of X_2; $b_3X_1X_2$, moderator effect of X_2 on X_1.

Table 1
Correlation matrix for measurements.*

		1	2	3	4	5	6	7	8	9	10
1	Knowledge management strategy	*0.87*									
2	Strategic performance	0.21	*0.90*								
3	Reward system	0.22	0.14	*0.77*							
4	Process innovation	0.20	0.01	0.37	*0.88*						
5	R&D integration of knowledge from past projects	0.09	0.07	0.41	0.38	*0.82*					
6	Market intelligence	−0.11	0.25	0.30	0.38	0.48	*0.79*				
7	Intraorganizational knowledge sharing	0.14	0.10	0.61	0.23	0.42	0.23	*0.68*			
8	Firm age	0.06	0.22	−0.08	−0.16	−0.13	−0.01	−0.07	*NA*		
9	Firm size	0.10	0.15	−0.23	−0.08	−0.23	−0.12	−0.16	0.51	*NA*	
10	Innovation diffusion activity	0.27	0.07	0.26	0.19	0.17	0.13	0.16	0.23	0.02	*NA*

The coefficient alpha for each measure is on the diagonal (in italics).

* Correlations above $\rho=0.23$ are significant at $p<0.05$.

Table 2
Results of regression analyses.

Independent variables	Strategic performance			
	Model 1		Model 2	
	β	t	β	t
Controls				
Firm age	0.14	1.45	0.04	1.90
Firm size	0.09	0.95	−0.01	−1.12
Innovation diffusion	−0.04	−0.44	0.00	−0.02
Direct effects				
Knowledge management strategy	0.26	2.85*	0.18	2.15**
Reward system	0.10	0.87	0.02	0.93
Process innovation	−0.15	−1.57	−0.19	−3.51***
R&D integration of knowledge from past projects	0.08	0.73	−0.01	−0.20
Market intelligence	0.36	3.64***	−0.23	−4.03***
Intraorganizational knowledge sharing	0.02	0.18	−0.01	−0.56
Moderating				
Knowledge management strategy_ reward system			0.43	5.69***
Knowledge management strategy_process innovation			0.22	2.45**
Knowledge management strategy_R&D integration of knowledge from past projects			0.01	0.06
Knowledge management strategy_market intelligence			−0.59	−5.91***
Knowledge management strategy_intraorganizational knowledge sharing			1.02	19.33***
Adjusted R^2	0.14		0.79	
ΔR^2			0.65***	
F	3.37***		298.89***	

* $p<0.01$.
** $p<0.05$.
*** $p<0.001$.

In testing the contingent hypotheses, the potential problem of multicollinearity was overcome by using the mean-centered value for both independent and dependent variables (Aiken and West, 1991). The tolerances range between 0.21 and 0.44, which are larger than the threshold value of 0.10 (Hair et al., 1998). This indicates a low degree of multicollinearity among the independent variables.

3.1. The moderating effect of performance-driven strategy

Table 2 presents the results of the hierarchical moderated regression using the centered data. The results in model 1 show a significant positive relationship between knowledge management strategy and strategic performance ($\beta=0.26$, $t=2.85$). The first set of hypotheses focuses on the moderating effect of performance-driven strategy on strategic performance. Hypothesis 1a predicts a positive moderating effect of reward system on the relationship between knowledge management strategy and strategic performance. Results support this contingent prediction ($\beta=0.43$, $t=5.69$). Hypothesis 2a predicts that the relationship between knowledge management strategy and strategic performance will be positive when process innovation is high. The results support this hypothesis ($\beta=0.22$, $t=2.45$).

3.2. The moderating effect of knowledge management-based competence

The second set of hypotheses posits a moderating effect of knowledge management-based competence on the link between knowledge management strategy and strategic performance. Results suggest that the impact of knowledge management strategy and strategic performance is not strengthened by R&D integration of knowledge from past projects, which fails to support Hypothesis 2a. Market intelligence is posited to have a moderating effect on the relationship between knowledge management strategy and strategic performance, but results show that the direction of that significant moderating effect is negative ($\beta=-0.587$, $t=-5.91$), contrary to the expectation that it would be positive in Hypothesis 2b. Intraorganizational knowledge sharing has a significant moderating effect on the relationship between knowledge management strategy and strategic performance ($\beta=1.02$, $t=19.33$), indicating that Hypothesis 2c is supported.

3.3. Overview of the results

This study examined the contingent effects of performance-driven strategy (reward system and process innovation) and knowledge management-based competence (R&D integration of knowledge from past projects, market intelligence, and intraorganizational knowledge sharing) on the positive relationship between knowledge management strategy and strategy performance. The study tested five hypotheses derived from a conceptual model of knowledge management strategy and strategic performance. The hypotheses are generally supported.

The results show that strategic performance is significantly related to knowledge management strategy and the relationship is positively moderated by reward systems, process innovation, and intraorganizational knowledge sharing. However, the results show that the moderating effect of market intelligence is negative, in contradiction to the hypothesis. Unexpectedly, R&D integration of knowledge from past projects does not moderate the relationships of interest.

4. Discussion and implications

In this empirical study, we explored how performance-driven strategy and knowledge management-based competence moderate the relationship between knowledge management strategy and perceived strategic performance. Performance-driven strategy is divided into two factors, including reward system and process innovation. Similarly, knowledge management-based competence includes R&D integration of knowledge from past

projects, market intelligence, and intraorganizational knowledge sharing. The results suggest that reward system, process innovation, and intraorganizational sharing enhance the effectiveness of these high technology firms' knowledge management strategy. The broad findings described above, along with more specific features of these relationships, point to important priorities for practitioners seeking to improve corporate strategic performance by enhancing the competency of knowledge management, and suggest fruitful areas for further research.

The unexpected finding of this study is that market intelligence seems to hinder the positive impact of knowledge management strategy on the strategic performance of high technology firms in China. This surprising finding contradicts the theoretical arguments and empirical findings by Deschamps and Ranganath Nayak (1995), Jaworski and Kohli (1993), and Wren et al. (2000). In particular, the results show that market intelligence plays a negative role in the effective implementation of knowledge management strategy to improve high technology firms' strategic performance.

One possible explanation might be that although market intelligence carries a positive connotation as a product of market intelligence generation and dissemination in the process of continuous learning (Jaworski and Kohli, 1993), organizational learning does not always lead to positive outcomes (Miner and Mezias, 1996). Just as with individuals, learning does not always lead to intelligent or improved behavior (Levitt and March, 1988). Organizations can incorrectly learn. They can also correctly learn that which is incorrect (Huber, 1991). Although market intelligence is crucial for firms to acquire the information from their customers and competitors, in the process of learning and acquiring, the increased knowledge associated with a learning process may reduce the variability of performance rather than increase it (March, 1991). Hence, learning makes performance more reliable but the risk associated with reduced variability is that the organization may become resistant to contradictory information.

The results of this study offer two main implications for researchers and practitioners of high technology firms. First, future research should investigate the effectiveness of high technology firms' adoption of knowledge management strategies in transitional economies such as China. Such study would address diverse and complicated performance-driven strategies that these high technology firms adopt. Second, the results imply that successful knowledge management strategy may require assessment of the potential conflicting impacts of the managerial strategies high technology firms adopt to gain their competences. In this study, we found that market intelligence tends to hinder the effectiveness of a knowledge management strategy. This unexpected finding differs from those for reward system, process innovation, and intraorganizational knowledge sharing.

The limitations of this study constrain the interpretation of the results. First, this study does not control for the firm's ownership and origin. The ownership (e.g., independent and corporate) and origin (joint venture and privately owned) could affect the effectiveness of a knowledge management strategy. Thus, future research should control for these variables. Second, in measuring intraorganizational knowledge sharing, we adopted four items from prior research (Hult and Ferrell, 1997), but only three items were retained in testing the contingency model. The item measuring "the extent to which a firm's analysis of unsuccessful organizational endeavors and communication of the lessons learned widely" is removed because of its low loading on its factor, resulting in lower reliability of this construct with an alpha of 0.68. Given its low reliability in this study, future research needs to examine its diverse dimensions. Third, future research should examine other contingency factors such as organizational structure, environmental factors, and business strategy. Including these factors could result in another issue of interest in exploring the effectiveness of a knowledge management strategy. Fourth and finally, future research could explore the possibility that classes of firms in high technology industry develop differing knowledge structures and strategies and examine how they affect the evolution of the high technology industry.

Appendix A

A.1. Study measures

Knowledge management strategy[1] *new scale*:

- Place emphasis on knowledge sharing through allocation of substantial financial resources.
- Develop a large variety of repositories which are easily accessible to all employees.
- Increase the rate of updating repositories due to employees' contribution.
- Increase the firm's overall commitment to sharing and innovation.

Reward system[1] (Jaworski and Kohli, 1993):

- No matter which department they are in, people in this business unit get recognized for being sensitive to competitive moves.
- Formal rewards are forthcoming to anyone who consistently provides information/knowledge.
- Employee's performance is measured by the degree they make contribution to the firm's innovation.

Process innovation[2] (Murray et al., 1995):

- To your firm, the level of process innovation in the product (i.e., the set of innovative ideas involved in the product) is
- Relative to your competitors, the level of process innovations in your product is…
- The number of potential applications of the process innovations in the product is…

R&D integration of knowledge from past projects[1] (Sherman et al., 2000):

- Lessons learned from past products are thoroughly shared and discussed with others in the organization.
- Post-launch meetings are frequently conducted.
- Incisive discussions from post-launch meetings frequently occur.
- Your firm applies the lessons learned from past products to future projects.
- Your firm applies information learned from new product post-launch meetings.

Market intelligence[1] (Song and Parry, 1997):

- You have accurate forecast of the market demand for new products.
- You know well your customers' needs.
- You know how your competitors would react to the introduction of new products.

[1] Seven-point scale where 7=strongly agree and 1=strongly disagree.
[2] Seven-point scale where 7=high and 1=low.

- You know well the size of your potential market for the new products.

Intraorganizational knowledge sharing[1] (Hult and Ferrell, 1997):

- There is a good deal of organizational conversation that keeps alive the lessons learned from history.
- You always analyze unsuccessful organizational endeavors and communicate the lessons learned widely.
- You have specific mechanisms for sharing lessons learned in organizational activities from department to department.
- Top management repeatedly emphasizes the importance of knowledge sharing in your firm.

Strategic performance new scale:

- The strategic position of your firm in your industry is very strong.
- Your firm is very competitive over your major competitors.
- Your market share is very high relative to your major competitors.
- You have been able to build a leadership position in your industry.

References

Adams, M.E., Day, G.S., Dougherty, D., 1998. Enhancing new product development performance: an organizational learning perspective. Journal of Product Innovation Management 15, 403–422.

Aguilar, F., 1967. Scanning the Business Environment. Macmillan Publishing, New York.

Aiken, L.S., West, S.G., 1991. Multiple Regression: Testing and Interpreting Interactions. Sage, Newbury Park, CA.

Amit, R., Schoemaker, P.J.H., 1993. Strategic assets and organizational rent. Strategic Management Journal 14 (1), 33–47.

Aram, J.D., Cowen, S.S., 1990. Strategic planning for increased profit in the small business. Long Range Planning 23 (6), 63–70.

Armbrecht, F.M.R., Chapas, R.B., Chappelow, C.C., Farris, G.F., 2001. Knowledge management in research and development. Research Technology Management 44 (4), 28–49.

Barney, J.B., 1991. Firm resources and sustained competitive advantage. Journal of Management 17 (1), 99–120.

Becerra-Fernandez, I., Sabherwal, R., 2001. Organizational knowledge management: a contingency perspective. Journal of Management Information Systems 18 (1), 23–55.

Bentler, P.M., Chou, C.P., 1987. Practical issues in structural modeling. Sociological Methods and Research 16, 78–117.

Brown, J., Druid, P., 1998. Organizing knowledge. California Management Review 40 (3), 100–103.

Brown, R.B., Woodland, M.J., 1999. Managing knowledge wisely: a case study in organizational behavior. Journal of Applied Management Studies 8 (2), 175–198.

Chandler, A.D., Hagstrom, P., Solvell, O., 1998. The Dynamic Firm: The Role of Technology, Strategy, Organization, and Regions. Oxford University Press, NY.

Coff, R., 2003. Bidding wars over R&D-intensive firms: knowledge, opportunism, and the market for corporate control. Academy of Management Journal 46 (1), 74–85.

Coff, R.W., 1999. When competitive advantage doesn't lead to performance; the resource-based view and stakeholder bargaining power. Organization Science 10 (2), 119–134.

Cohen, W.M., Levinthal, D.A., 1990. Absorptive capacity: a new perspective on learning and innovation. Administrative Science Quarterly 35, 128–152.

Daft, R., 1983. Organization Theory and Design. West, New York.

Danneels, E., 2002. The dynamics of product innovation and firm competences. Strategic Management Journal 23 (12), 1095–1122.

Dash, J., 1998. Knowledge is power. Software Magazine 18 (1), 46–51.

Decarolis, D.M., Deeds, D.L., 1999. The impact of stocks and flows of organizational knowledge on firm performance: an empirical investigation of the biotechnology industry. Strategic Management Journal 20, 953–968.

Deschamps, J.P., Ranganath Nayak, P., 1995. Product Juggernauts. HBS Press, MA.

Dess, G.G., Ireland, R.D., Hitt, M.A., 1990. Industry effects and strategic management research. Journal of Management 16, 7–27.

Dierickx, I., Cool, K., 1989. Asset stock accumulation and sustainability of competitive advantage. Management Science 35 (12), 1504–1511.

Eisenhardt, K.M., Martin, J.A., 2000. Dynamic capabilities: what are they. Strategic Management Journal 21 (special issue), 1105–1121.

Eisenhardt, K.M., Schoonhoven, C.B., 1990. Organizational growth: linking founding team, strategy, environment, and growth among US semiconductor ventures in 1978–1988. Administrative Science Quarterly 35, 504–529.

Feldman, M.P., Kutay, A.S., 1997. Innovation and strategy in space: towards a new location theory of the firm. In: Bertuglia, C.S., Lombardo, S., Nijkamp, P. (Eds.), Innovative Behavior in Space and Time. Springer, Berlin, Heidelberg, NY, pp. 239–250.

Geletkanycz, M., 1997. The salience of 'culture's consequences': the effects of cultural values on top executive commitment to the status quo. Strategic Management Journal 18 (8), 615–634.

Ginsberg, A., Venkatraman, N., 1985. Contingency perspectives of organizational strategy: a critical review of the empirical research. Academy of Management Review 10 (3), 421–434.

Gold, A.H., Malhotra, A., Segars, A.H., 2001. Knowledge management: an organizational capabilities perspective. Journal of Management Information Systems 18 (1), 185–214.

Gomory, R., Schmitt, R., 1998. Science and product. Science (May), 1131.

Grant, R.M., 1997. The knowledge-based view of the firm: implications for management practice. Long Range Planning 30 (3), 450–454.

Griffin, A., Hauser, J.R., 1996. Integrating R&D, and marketing: a review, and analysis of the literature. Journal of Product Innovation Management 13, 191–215.

Gupta, A.K., Souder, W.E., 1998. Key drivers of reduced cycle time. Research Technology Management 41 (4), 38–44.

Hair, J.F., Anderson, R.E., Tatham, R.L., Black, W.C., 1998. Multivariate Data Analysis. Prentice-Hall, New Jersey.

Hansen, M.T., Nohria, N., Tierney, T., 1999. What's your strategy for managing knowledge. Harvard Business Review (March–April), 106–116.

Hanushek, E.A., Jackson, J.E., 1977. Statistical Methods for Social Scientists. Academic Press, New York.

Hitt, M.A., Hoskisson, R.E., Ireland, R.D., 1990. Mergers and acquisitions and managerial commitment to innovation in M-form firms. Strategic Management Journal 11, 29–47.

Holsapple, C.W., Singh, M., 2001. The knowledge chain model: activities for competitiveness. Expert Systems with Applications 20, 77–98.

Hoopes, D.G., Postrel, S., 1999. Shared knowledge, glitches, and product development performance. Strategic Management Journal 20, 837–865.

Hoskisson, R., Johnson, R., Moesel, D., 1994. Corporate divestiture intensity in restructuring firms: effects of governance, strategy, and performance. Academy of Management Journal 37 (5), 1207–1252.

Huber, G.P., 1991. Organizational learning: the contributing processes and the literatures. Organizational Science 2, 88–115.

Hult, G.T.M., Ferrell, O.C., 1997. Global organizational learning capacity in purchasing: construct and measurement. Journal of Business Research 40 (2), 97–111.

Jaworski, B.J., Kohli, A.K., 1993. Market orientation: antecedents and consequences. Journal of Marketing 57, 53–70.

Kamara, J.M., Anumba, C.J., Carrillo, P.M., 2002. A clever approach to selecting a knowledge management strategy. International Journal of Project Management 20, 205–211.

King, W.R., 2001. Strategies for creating a learning organization. Information Systems Management (Winter), 12–20.

Kolb, D.A., 1984. Experiential Learning. Prentice-Hall, Englewood Cliffs.

Krogh, G.V., Nonaka, I., Aben, M., 2001. Making the most of your company's knowledge: a strategic framework. Long Range Planning 34, 421–439.

Kumar, N., Stern, L.W., Anderson, J.C., 1993. Conducting interorganizational research using key informants. Academy of Management Journal 36 (6), 1633–1651.

Lee, C.C., Yang, J., Yu, L.M., 2001. The knowledge value of customers and employees in product quality. Journal of Management Development 20 (8), 691–704.

Levitt, B., March, J.G., 1988. Organizational learning. Annual Review of Sociology 14, 319–340.

Lloyd, B., 1996. Knowledge management: the key to long-term organizational success. Long Range Planning 29 (4), 576–580.

Lööf, H., Heshmati, A., 2002. Knowledge capital and performance heterogeneity: a firm-level innovation study. International Journal of Production Economics 76 (1), 61–85.

Lubit, R., 2001. Tacit knowledge and knowledge management: the keys to sustainable competitive advantage. Organizational Dynamics 29 (4), 164–178.

Lukas, B.A., Hult, G.T.M., Ferrell, O.C., 1996. A theoretical perspective of the antecedents and consequences of organizational learning in marketing channels. Journal of Business Research 36 (3), 233–244.

March, J.G., 1991. Exploration and exploitation in organizational learning. Organization Science 2 (1), 71–87.

Matusik, S.F., 2002. An empirical investigation of firm public and private knowledge. Strategic Management Journal 23, 457–467.

Miller, C.C., Cardinal, L.B., 1994. Strategic planning and firm performance a synthesis of more than two decades of research. Academy of Management Journal 37 (6), 1649–1665.

Miner, A.S., Mezias, S.J., 1996. Ugly duckling no more: pasts and futures of organizational learning research. Organization Science 7, 88–99.

Moorman, C., Miner, A.S., 1998. Organizational improvisation and organizational memory. Academy of Management Review 23 (4), 698–723.

Morgan, R.H., Hunt, S.D., 1994. The commitment-trust theory of relationship marketing. Journal of Marketing 58 (3), 20–39.
Murray, J.Y., Kotabe, M.W., Wildt, A.R., 1995. Strategic and financial performance implications of global sourcing strategy: a contingency analysis. Journal of International Business Studies 26 (1), 181–205.
Ndlela, L.T., du Toit, A.S.A., 2001. Establishing a knowledge management program for competitive advantage in an enterprise. International Journal of Information Management 21, 151–165.
Nonaka, I., Takeuchi, H., 1995. The Knowledge-Creating Company. Oxford University Press, New York.
Ofek, E., Sarvary, M., 2001. Leveraging the customer base: creating competitive advantage through knowledge management. Management Science 47 (11), 1441–1456.
Penrose, E.T., 1959. The Theory of the Growth of the Firm. Wiley, New York.
Peteraf, M.A., 1993. The cornerstones of competitive advantage: a resource-based view. Strategic Management Journal 14, 179–191.
Prahalad, C.K., Hamel, G., 1990. The core competence of the corporation. Harvard Business Review 68 (3), 79–92.
Rosenthal, R., Rosnow, R.L., 1991. Essentials of Behavioral Research: Methods and Data. McGraw-Hill, New York.
Saarenketo, S., Puumalainen, K., Kuivalainen, O., Kyläheiko, K., 2004. Dynamic knowledge-related learning processes in internationalizing high-tech SMEs. International Journal of Production Economics 89 (3), 363–378.
Santosus, M., Surmacz, J., 2002. ABCs of knowledge management. Available from: 〈www.cio.com〉.
Sarin, S., Mahajan, V., 2001. The effect of reward structures on the performance of cross-functional product development teams. Journal of Marketing 65 (April), 35–53.
Schulz, M., Jobe, L.A., 2001. Codification and tacitness as knowledge management strategies: an empirical exploration. Journal of High Technology Management Research 12, 139–165.
Sen, F.K., Egelhoff, W.G., 2000. Innovative capabilities of a firm and the use of technical alliances. IEEE Transactions on Engineering Management 47 (2), 174–183.
Shapiro, C., 1985. Patent licensing and RandD rivalry. American Economic Review 75 (2), 25–31.
Shapiro, C., Varian, H.R., 1999. Information Rules. Harvard Business School Press, MA.
Shefer, D., Frenkel, A., 1998. Local milieu and innovativeness: some empirical results. Annals of Regional Science 1, 185–200.
Sherman, J.D., Souder, W.E., Jenssen, S.A., 2000. Differential effects of the primary forms of cross functional integration on product development cycle time. Journal of Product Innovation Management 17, 257–267.
Snowden, D., 1999. Liberating Knowledge. Caspian Publishing, London.
Song, X.M., Parry, M.E., 1997. The determinants of Japanese new product success. Journal of Marketing Research 34, 64–76.
Starbuck, W.H., 1993. Strategizing in the real world. International Journal of Technology Management 8 (1/2), 77–86.
Stump, R.L., Heide, J.B., 1996. Controlling supplier opportunism in industrial relationships. Journal of Marketing Research 33 (4), 431–442.
Taylor, S.L., Cosenze, R.M., 1997. Limitless vs. sustained growth strategies: what's the answer to the corporate growth dilemma? Business Forum 22 (2/3) 29–34.
Teece, D.J., Pisano, G., Shuen, A., 1997. Dynamic capabilities and strategic management. Strategic Management Journal 18 (7), 509–533.
Teece, D.J., 1998. Capturing value from knowledge assets: the new economy, markets for know-how, and intangible assets. California Management Review 40 (3), 55–79.
Teece, D.J., 2000. Strategies for managing knowledge assets: the role of firm structure and industrial context. Long Range Planning 33, 35–54.
Wiersema, M.F., Liebeskind, J.P., 1995. The effects of leveraged buyouts on corporate growth and diversification in large firms. Strategic Management Journal 16 (6), 447–461.
Winter, S.G., 2000. The satisficing principle in capability learning. Strategic Management Journal 21 (special issue), 981–996.
Wren, B.M., Souder, W.E., Berkowitz, D., 2000. Market orientation and new product development in global industrial firms. Industrial Marketing Management 29, 601–611.
Xin, K.R., Pearce, J.L., 1996. Guanxi: connections as substitutes for formal institutional support. Academy of Management Journal 39, 1641–1658.
Yang, J., 2004. Knowledge management opportunities for cycle time reduction. International Journal of Innovation and Learning 1 (2), 192–207.
Zaltman, G., Duncan, R., Holbek, J., 1973. Innovations and Organizations. Wiley, New York.