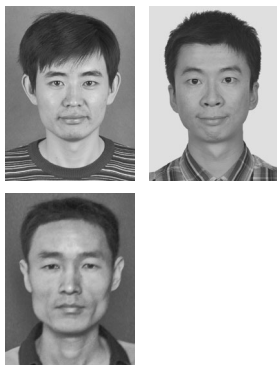


Are internal knowledge transfer strategies double-edged swords?

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Abstract

Purpose – After identifying two kinds of internal knowledge transfer strategies, the purpose of this paper is to examine their effectiveness and whether they induce knowledge spillovers among firms.

Design/methodology/approach – This study collected data in China and 219 questionnaires were achieved. Then, structure equation model by LISREL was used for hypotheses testing.

Findings – The empirical results suggest that both codification and rich-media strategies have positive effects on internal knowledge transfer. Moreover, codification strategy has a negative effect on knowledge spillovers while rich-media strategy does not influence knowledge spillovers significantly. Thus, codification and rich-media strategies are not double-edged swords.

Practical implications – This study provides firms with two strategies, codification and rich-media, to promote internal knowledge transfer. Moreover, these strategies do not accelerate knowledge spillovers, and codification strategy even reduces knowledge spillovers. Firms can use these strategies to construct and sustain competitive advantages.

Originality/value – While many knowledge creation, storage and protection strategies are studied, little is known about internal knowledge transfer strategies. This study suggests two internal knowledge transfer strategies and confirms their effectiveness. Moreover, because the relationship between internal knowledge transfer strategies and knowledge spillovers has been puzzling for a long time, this study clarifies the relationship and finds that these strategies do not accelerate knowledge spillovers and some even restrain knowledge spillovers.

Keywords Knowledge transfer, Competitive advantage, Internal knowledge transfer, Knowledge spillovers, Codification, Media

Paper type Research paper

1. Introduction

Knowledge has become one of the most important resources for the survival and prosperity of firms (Teece *et al.*, 1997; Spender and Grant, 1996), and managing and utilizing knowledge effectively is vital for firms to take full advantage of the value of knowledge (Boh, 2007). It is argued that internal knowledge transfer, which means that knowledge disseminates inside a firm and exerts influences on one unit (e.g. individual, group, department, or division) (Nonaka and Konno, 1998; Szulanski, 1996; Teece, 2000; Argote and Ingram, 2000; Tsai, 2001), is the basis for sustained competitive advantage (Argote and Ingram, 2000). Nevertheless, internal knowledge transfer is difficult, and failures occur frequently (Kane *et al.*, 2005).

Systematization and personalization are two widely accepted knowledge storage methods, and several studies examine how knowledge storage forms influence firm knowledge creation (Choi and Lee, 2002) or firm performance (Choi and Lee, 2003). However, strategies regarding the transfer and use of stored knowledge do not receive enough attention (Szulanski and Jensen, 2004). Thus, more research is needed to address the issue about how to conquer internal knowledge transfer barriers and promote internal knowledge transfer (Szulanski and Jensen, 2004; Argote and Ingram, 2000).

Meanwhile, there is another kind of knowledge flow named knowledge spillovers, which mean that a firm's knowledge crosses the firm's boundaries and is utilized without permission by other firms (Knott *et al.*, 2009; Chang and Xu, 2008; Arrow, 1962; Zander and Kogut, 1995). Knowledge spillovers undermine knowledge inimitability and scarcity and damage the firms' competitive advantage sustainability (Barney, 1991). As a result, the owners of knowledge usually cannot reap all the benefits of knowledge because it often spills over to other firms (Eeckhout and Jovanovic, 2002; Owen-Smith and Powell, 2004). Thus, firms are frightened of knowledge spillovers, and they try to control knowledge spillovers tightly or even reduce their R&D investments (Harhoff, 1996).

While internal knowledge transfer contributes to competitive advantage construction, knowledge spillovers undermine competitive advantage persistence (Argote and Ingram, 2000). Thus, firms should simultaneously promote internal knowledge transfer and restrain knowledge spillovers. Because both internal knowledge transfer and knowledge spillovers are flow of knowledge, internal knowledge transfer strategies might also influence knowledge spillovers; therefore, firms should be cautious when adopting internal knowledge transfer strategies. However, because no agreement has been reached about the relationship between internal knowledge transfer strategies and knowledge spillovers (Argote and Ingram, 2000; Oxley and Wada, 2009; Agarwal *et al.*, 2009; Song *et al.*, 2003), a dilemma remains: are internal knowledge transfer strategies double-edged swords?

To address these gaps in research, this study suggests two internal knowledge transfer strategies, namely codification strategy and rich-media strategy, based on knowledge storage forms, and constructs a theoretical model linking codification strategy, rich-media strategy, internal knowledge transfer, and knowledge spillovers to clarify the relationship between internal knowledge transfer strategies and internal knowledge transfer/knowledge spillovers. This study focuses on the following contributions.

First, in regard to knowledge management, this study classifies internal knowledge transfer strategies into codification strategy and rich-media strategy according to methods of knowledge storage, and this study argues that these strategies promote internal knowledge transfer respectively. Second, in regard to knowledge spillovers, this study suggests that codification and rich-media strategies might influence knowledge spillovers. Specifically, this study theoretically and empirically examines whether codification and rich-media strategies have positive or negative effects on knowledge spillovers to clarify whether they are double-edged swords in the internal knowledge transfer process. Paradoxes within the theory enable scholars to explore and gain a better understanding of our surrounding world (Lado *et al.*, 2006; DiMaggio, 1995), and this study contributes to the resource-based view and knowledge-based view by analyzing a paradox within firms' promotion of internal knowledge transfer and restraint of knowledge spillovers. Third, in regard to strategic management, this study considers internal knowledge transfer and knowledge spillovers simultaneously in one conceptual framework and compares influences of internal knowledge transfer strategies on internal knowledge transfer and knowledge spillovers. Because internal knowledge transfer and knowledge spillovers contribute respectively to the construction of competitive advantage and the undermining of competitive advantage sustainability, this study helps people gain a deeper understanding about how firms construct and sustain competitive advantages in strategic management.

This study investigates the above questions in China for two reasons. First, China is the largest emerging economy in the world, and the great competitive pressures in China force firms to pay more attention to innovation and promotion of internal knowledge transfer to gain competitive advantages (Jiang *et al.*, 2007; Liu *et al.*, 2009). Second, due to the dynamic and competitive environment, knowledge spillovers are serious in China (McGaughey *et al.*, 2000), making it a proper context to investigate the causes of knowledge spillovers.



2. Theoretical background and hypotheses

2.1 Organization dimension of the VRIO framework

Developing the new VRIO (acronym for value, rarity, imitability, and organization) framework, Barney (2001) indicates that a firm's resources should be combined with appropriate organization to take full advantage of the value of the resources. As a result, dynamic capabilities are required after valuable, rare and inimitable resources have been acquired (Teece *et al.*, 1997). Then, because knowledge is one of the most important resources of firms, they should manage it properly to gain its benefits. In particular, after knowledge is created, firms should store, transfer and use it efficiently.

Human beings are the creators of knowledge. They mainly generate knowledge in the process of doing their work, and most of the knowledge is in their heads (Olivera, 2000). As knowledge is used repeatedly and becomes mature, some of the tacit components can be codified and documented, making it more explicit; however, knowledge always remains partly tacit in the minds of those creating it (Saviotti, 1998).

Accordingly, there are two kinds of knowledge storage methods, which are systematization and personalization (Choi and Lee, 2002, 2003). The systematization knowledge storage method tries to separate knowledge from the people holding it, and the difficulty lies in documenting the tacit part of the knowledge. In contrast, the personalization knowledge storage method does not affect the knowledge, keeping it in the employees' heads. Instead, it designates that who knows what, and if someone needs some particular knowledge, he or she can contact the people possessing it and learn the knowledge.

Nonaka and Takeuchi (1995) propose that there are four modes of knowledge transfer: socialization (tacit to tacit), externalization (tacit to explicit), combination (explicit to explicit) and internalization (explicit to tacit) (Guzman and Wilson, 2005). Thus, whether knowledge is stored in firms by a systematization or personalization method, firms should implement strategies to make it disseminate in firms. Then, based on the two kinds of knowledge storage methods, there should be two kinds of internal knowledge transfer strategies.

The systematization knowledge storage method records knowledge in an explicit form, and this explicit knowledge is easy to access and understand (Hansen *et al.*, 1999). Thus, the acquisition method of knowledge stored with a systematization storage method is document-to-person and one way. Employees do not need help from other people to access knowledge stored by the systematization method, and the knowledge can disseminate in firms as long as employees utilize the knowledge database efficiently. Therefore, the key in transferring this kind of knowledge successfully is to codify knowledge carefully. As the key for the transfer of knowledge stored in a systematization method is to extract the knowledge from the people holding it, this study uses codification to represent the internal knowledge transfer strategy for this kind of knowledge, which means that firms extract knowledge from people to other carriers and resort to the interaction between people and knowledge carriers (excluding people) to transfer knowledge.

In contrast, the personalization knowledge storage method keeps knowledge in employees' heads. As a result, people cannot acquire the knowledge stored by such a method by themselves (Wu and Lin, 2009), and they have to contact the holders of the knowledge. Specifically, knowledge demanders resort to various languages, cues, and rapid feedback to acquire the knowledge from the holders (Daft *et al.*, 1987). Furthermore, because the demanders often learn by observing and acting (Hansen *et al.*, 1999), it is necessary for knowledge demanders and holders to interact extensively. As a result, the knowledge stored through the personalization method can only transfer in firms via knowledge networks, such as discussion forums (Greiner *et al.*, 2007), which involve a complex system of learning and social interaction (Mueller, 1996). Thus, internal transfer of knowledge stored using a personalization method is an interactive process, and media of high richness, such as face-to-face and meeting, are necessary (Treviño *et al.*, 2000). Therefore, this study uses rich-media to represent the internal knowledge transfer strategy for knowledge stored with a personalization method, which means that firms resort to people interaction linked through media of high richness to transfer knowledge.



The essential difference between codification and rich-media strategy is social interaction (Gammelgaard and Ritter, 2005). Thus, rich-media strategy enables an organization to more effectively disseminate tacit knowledge which is mainly stored with a personalization method, whereas codification strategy focuses more heavily on transferring explicit data and information that is stored with a systematization method.

2.1.1 Codification strategy and internal knowledge transfer. It is widely accepted that codified knowledge transfers more readily than knowledge that is not codified (Argote and Ingram, 2000). Thus, the aim of codification strategy is to make knowledge explicit in order to facilitate employees' access to and utilization of the knowledge.

First, codification strategy makes knowledge ready for transfer. Tacit knowledge, or knowledge that has not been articulated, is more difficult to transfer than explicit knowledge (Nonaka, 1991). Through a codification strategy, knowledge is extracted from the people holding it and is carefully recorded. Thus, knowledge becomes explicit, and the opacity of knowledge and the difficulty of deciphering cause-effect relationships which frustrate the leveraging of the knowledge by employees decrease (Szulanski, 1996). In addition, codification strategy makes knowledge decontextualized (Schulz, 2001). Consequently, the knowledge is more ready for transfer and the employees needing the knowledge can acquire it more easily and adapt it to their context more effectively.

Second, codification strategy creates organization-wide knowledge repositories and provides convenient access to knowledge (Boh, 2007). People needing the knowledge would spend less time and effort accessing codified knowledge. Thus, if firms stress codification strategy and the knowledge is carefully codified and stored in documents, databases, and drawings, then employees can access and exploit the knowledge easily. For example, Schulz (2001) suggests that codification strategy positively affects knowledge flow because it enhances the ease of the transmission of knowledge between distant organizational locations, and Hensen (1999) finds that codification strategy reduces the time of internal knowledge transfer. Moreover, because codification strategy allows people to search and retrieve codified knowledge without having to contact the person who originally generates it or the people who now hold it, it opens up the possibility of achieving an economy of scale in knowledge reuse and promotes internal knowledge transfer (Hansen *et al.*, 1999).

Third, one factor impeding knowledge transfer is that employees who learn from others directly often feel inferior (Gupta and Govindarajan, 2000). Because of this, even though others' knowledge is of great use for their work, the employees might be reluctant to consult the knowledge holders. With a codification strategy, the knowledge is codified using a "people-to-document" approach, meaning that the knowledge is extracted from the person who generates or holds it. Consequently, the knowledge becomes separated from people. Thus, using a codification strategy, employees can access knowledge without others knowing it, and they feel comfortable utilizing others' knowledge. Knowledge can be reused for various purposes (Hansen *et al.*, 1999), and firms' internal knowledge transfer is at a high level. Therefore, this study suggests:

H1. Codification strategy has a positive effect on internal knowledge transfer.

2.1.2 Rich-media strategy and internal knowledge transfer. Knowledge stored in a personalization method usually stays in its original state and contains many tacit components. Internal transfer of this kind of knowledge is challenging, and media of high richness are usually required (Nadler *et al.*, 2003). Rich-media strategy stresses the interaction between knowledge acquirers and holders in the process of internal knowledge transfer and transfers knowledge without changing its tacit components.

Rich-media strategy resorts to various languages, cues, and rapid feedback to transfer knowledge in firms. Thus, rich-media strategy focuses on dialogue between individuals, not knowledge objects in a database (Hansen *et al.*, 1999). It enables interactions between people to facilitate clarification and better understanding of the knowledge (Boh, 2007). In addition, media of high richness have a high level of personal focus. As a result, the sender



can learn much about the context of the recipient and customize the knowledge to fit the context of the recipient. For example, moving employees is generally seen as a powerful mechanism to facilitate knowledge transfer in organizations (Galbraith, 1990) because it allows them to interact effectively. Argote and Ingram (2000) also suggest that moving technology or task from one site to another is more effective when accompanied by the movement of people because people are capable of adapting the tools and technology to the new context.

If knowledge is stored with a personalization method and firms do not want to change the state of the tacit components of the knowledge (Hansen *et al.*, 1999), rich-media is a proper internal knowledge transfer strategy. Choi and Lee (2002) argue that effective transfer mechanisms of tacit knowledge are personal interaction and mental models, which are specific forms of rich-media strategy. Hensen (1999) finds that strong ties allowing for repeated personal interaction promote tacit knowledge transfer and shorten project completion time; along similar lines, Baum and Berta (1999) find that learning between student groups in a business simulation is greater when there is a higher degree of social contact. Thus, this study suggests:

H2. Rich-media strategy has a positive effect on internal knowledge transfer.

2.2 Imitability dimension of the VRIO framework

In the VRIO framework, imitability determines the lasting time of the competitive advantages created by valuable and rare knowledge; therefore, taking measures to guarantee knowledge inimitability plays an important role in firms' knowledge management (Winter, 1987; Greve, 2009).

Internal knowledge transfer and knowledge spillovers are two forms of knowledge flow. Intuitively, the internal knowledge transfer strategies of codification and rich-media might have a similar effect on knowledge spillovers as they do on internal knowledge transfer. Therefore, when firms use codification and rich-media strategies to promote internal knowledge transfer, they should guard knowledge spillovers. Some scholars, however, hold the opposite view about the effect of codification and rich-media strategy on knowledge spillovers (Oxley and Wada, 2009; Agarwal *et al.*, 2009). Thus, the relationship between internal knowledge transfer strategies and knowledge spillovers needs future clarification.

2.2.1 Codification strategy and knowledge spillovers. While making knowledge explicit enough to be embedded in carriers, such as documents and databases, eases its internal transfer, such a codification strategy might speed its spillovers to other organizations (Argote and Ingram, 2000; Schulz and Jobe, 2001).

First, codification strategy makes knowledge explicit. Tacitness is a self-protection mechanism against knowledge spillovers (Szulanski, 1995), but codification strategy contains a process transforming tacit knowledge into explicit forms. Thus, codification strategy is detrimental to knowledge' self-protection mechanism against knowledge spillovers. Furthermore, codification strategy translates knowledge into documents, drawings, and information systems (Schulz, 2001). Carriers of explicit knowledge, such as databases, formulas, specifications and blue prints, diffuse among firms easily (Schulz and Jobe, 2001). Competitors can understand the knowledge in these carriers easily. Then, they can utilize the knowledge not only to counterattack firms' strategies but also to develop similar resources to enhance their own competitive advantages.

Second, codification strategy decontextualizes knowledge from where it functions, and the codified knowledge becomes more generalized knowledge (Schulz, 2001). The opacity of the knowledge and the difficulty of deciphering cause-effect relationships, which are generated by specificity and can frustrate the leveraging of such knowledge by other firms, decrease as knowledge is codified (Szulanski, 1996). If it transfers to other firms, they can adapt the knowledge to their specific contexts and put it into use effectively.

Therefore, codification strategy can facilitate involuntary transfer of knowledge to competitors (e.g. leakage of databases, formulas, specifications and blue prints), which



undermines the rarity of knowledge and, thereby, hurts a firm's competitive advantage. As a result, spillovers of strategically important knowledge to competitors create significant disincentives to codification strategy in firms (Kogut and Zander, 1993; Zander and Kogut, 1995), and organizations might abstain from codification strategy and choose to keep their knowledge tacit (Schulz and Jobe, 2001). Thus, this study suggests:

H3a. Codification strategy has a positive effect on knowledge spillovers.

However, appropriability is not only the function of explicitness but also the function of firms knowing the code (Saviotti, 1998). Although codification strategy makes it easier for knowledge to transfer to competitors, it is not a sufficient precondition for knowledge spillovers and does not necessarily lead to low appropriability of knowledge benefits.

In addition, firms can take measures to prevent knowledge spillovers more effectively with the help of codification strategy. Competitive advantage sustainment requires knowledge to be scarce, and firms have the incentives to take measures to prevent knowledge from spilling to competitors. However, knowledge is difficult to manage because firms often do not know where valuable knowledge lies (Zack, 1999), and causal ambiguity – the relative difficulty of deciphering causal links between organizational resources and outcomes – suggests that managers are limited in their ability to understand the source of sustained competitive advantages (Lippman and Rumelt, 1982; Lado *et al.*, 2006). Codification strategy can cause firms to know where the knowledge is and which knowledge is valuable and important (Zack, 1999). On this basis, firms can take more effective measures to protect their knowledge, and unwanted knowledge spillovers to other firms will be reduced (Gold *et al.*, 2001). For example, control, including the enforcement of employee conduct rules and job responsibilities and restriction of employee mobility (Oxley and Wada, 2009), is an important measure of knowledge flow management; firms can use their control and monitoring ability to reduce potential harmful leakage of valuable intellectual property during internal knowledge transfer by adopting a codification strategy (Oxley and Wada, 2009). Therefore, firms can protect knowledge from spillovers more effectively with the help of the codification strategy, meaning that the codification strategy restrains rather than promotes knowledge spillovers. Thus, this study suggests:

H3b. Codification strategy has a negative effect on knowledge spillovers.

2.2.2 Rich-media strategy and knowledge spillovers. Most scholars advocate that internal knowledge transfer strategies that involve people contact reduce the likelihood of knowledge transferring to external organizations (Argote and Ingram, 2000). Thus, a rich-media strategy that recurs to people interaction to transfer knowledge internally can reduce knowledge spillovers during internal knowledge transfer.

First, knowledge transferred through a rich-media strategy is less likely to fit other firms' contexts. Knowledge transferred with a rich-media strategy usually does not change its state and contains many tacit components. Thus, a rich-media strategy is not detrimental to knowledge's self-protection mechanism against knowledge spillovers, which is produced by its tacitness. It is difficult for other firms to understand firms' knowledge. Moreover, knowledge transferred through a rich-media strategy is usually highly context specified and is more likely to be compatible with the contexts inside the organization rather than with contexts outside the organization (Argote and Ingram, 2000). Thus, internal knowledge transfer using a rich-media strategy makes it problematic for other firms to absorb firms' knowledge spillovers.

Second, due to selection, socialization, training, and communication, people in an organization are familiar with each other, but they are not familiar with people from other firms. Thus, rich-media strategy, which resorts to people interaction to transfer knowledge, can foster differences between internal knowledge transfer and knowledge spillovers. On the other hand, if firms transfer knowledge internally using a codification strategy, the carriers of the knowledge are similar in different firms and can be used by other firms. Similarity increases the pressures for mimetic isomorphism (DiMaggio and Powell, 1983). Then, compared to firms using a rich-media strategy, competitors have more incentives to



imitate such firms' knowledge who transfer knowledge using a codification strategy (Feinberg and Gupta, 2004). Therefore, rich-media strategy might reduce knowledge spillovers. According to the above discussion, this study suggests:

H4a. Rich-media strategy has a negative effect on knowledge spillovers.

Rich-media strategy emphasizes the role of people interaction in the process of internal knowledge transfer, and employees are the carriers of knowledge when firms transfer knowledge internally using a rich-media strategy. However, if employees holding the knowledge leave the firm and go to the competing firms, the firm's knowledge spills over to other firms. In addition, because people leaving the firm can adapt the knowledge effectively to fit other firms' context, other firms can use the knowledge effectively. "Job hopping" by employees is widely heralded as an important channel of knowledge spillovers (Agarwal *et al.*, 2009; Song *et al.*, 2003). Thus, if employee mobility is high, firms face a high level of knowledge spillovers when they transfer knowledge internally using a rich-media strategy. Therefore, this study puts forward:

H4b. Rich-media strategy has a positive effect on knowledge spillovers.

3. Methods

3.1 Sampling and data collection

This study collected data through a survey. Before data collection, the authors conducted a pilot test with ten firms' managers that the authors were familiar with in order to ensure the accuracy of the questionnaire. These managers were asked to review the questionnaire for structure, readability, ambiguity, and completeness (Dillman, 1978). The authors further revised the questionnaire according to the feedback. The formal study informants were managers, who mainly graduated from or were MBA students of a university located in northwest China.

In order to minimize the social desirability bias, this study maintained full anonymity for all informants throughout the survey process. In the cover guide, the authors informed the respondents that the survey was designed for research only and there were no right or wrong answers to the questions. This study also followed the measures suggested by Fisher (1993) to use more specific and less direct questions to reduce the social desirability bias.

Questionnaires were sent to the managers with an explanation of the research objectives and the requirements of the survey in September, 2009. In the cover guide, the respondents were prompted to consult with other knowledgeable members of their firms when filling out the questionnaires. The data collection process lasted about 4 months. The authors sent out 516 questionnaires, and a total of 219 usable questionnaires were achieved after the removal of ones with missing data or dubious answers, constituting a 42.4 percent response rate.

In order to test non-response bias, this study compared the responses of early and late waves of returned questionnaires with *t*-test on firm size, industry, and ownership (Armstrong and Overton, 1977; Lambert and Harrington, 1990). The *t*-tests performing on these two groups yielded no statistically significant differences (at a 99 percent confidence interval), which indicated that non-response bias was not a problem.

3.2 Measures

Multi-item scales were used to operationalize all the constructs. A five-point Likert scale with end points of "strongly disagree" and "strongly agree" was used to measure the items. This study used the existing literature as references to develop the questionnaire. The questionnaire was first prepared in English and then translated into Chinese. The Chinese-version of the questionnaire was back-translated into English by a third party to check the consistency. This ensured comparability between items in Chinese and their original formats in English in order to rule out any problems arising from idiomatic or colloquial wording (Parameswaran and Yaprak, 1987).



Codification strategy was measured following the work of Zander and Kogut (1995) and Choi and Lee (2003), and the items were:

- a useful manual describing important knowledge can be written easily;
- extensive documentation describing critical knowledge exists in our company;
- a majority of knowledge is stored in employees' heads (R);
- it is easy to explain knowledge to colleagues;
- large parts of our knowledge are difficult to be documented (R); and
- large parts of our knowledge are ambiguous (R).

Items of rich-media strategy were adapted from the research of Webster and Trevino (1995) and Carlson and Zmud (1999), which were:

- the employees give timely feedback when someone contacts them;
- the employees give attention to specific requirements of colleagues when they collaborate;
- the employees can communicate a variety of cues (such as emotional tone, attitude, and formality) when they interact with others; and
- the employees can use rich and varied language in the collaboration process.

Internal knowledge transfer was measured following the research of Szulanski (1995) and Foss and Pedersen (2002), and the items were: B: knowledge transfers among departments and individuals in completeness and accuracy; necessary modification to knowledge transferred is made and the knowledge fits the new context; knowledge diffuses in the firm extensively; the speed of knowledge transferring among departments and individuals is high; all valuable knowledge can transfer and be used in the firm. Items of knowledge spillovers were adapted from the research of Autio *et al.* (2000) and Steensma and Gorley (2000), which were:

- a lot of knowledge is imitated by competitors;
- competitors often imitate our innovations;
- it is easy to copy or imitate our core technology; and
- similar knowledge appears soon after our company creates it.

3.3 Common method variance

This study took Harman's single factor approach to test common method bias (Harman, 1967; Podsakoff and Organ, 1986). According to this test, if common method bias exists, then either a single factor will emerge from a factor analysis of all survey items (Podsakoff and Organ, 1986), or one general factor accounting for most of the common variance existing in the data will emerge (Doty and Glick, 1998). An un-rotated factor analysis using the eigen-value-greater-than-one criterion was conducted. The results revealed four distinct factors that accounted for 54.36 percent of the variance, and the first factor captured only 20.97 percent of the variance in the data. Since no single factor emerged and the first factor did not account for most of the variance, this study concluded that common method bias was not an issue.

Furthermore, a confirmatory factor analysis (CFA) approach was also used to test common method bias (Menon *et al.*, 1996). A model positing that a single factor underlay the study variables was assessed by linking all items of the dependent and independent factors to a single factor. This model did not fit the data (NFI = 0.59, NNFI = 0.60, CFI = 0.64, GFI = 0.68, AGFI = 0.60, RMSEA = 0.157; chi square/degree of freedom = 6.37), and hence the results showed that common method bias was unlikely to be a threat to the findings of this study.



3.4 Reliability and validity

Cumulative normal probability plots demonstrated that each of the items was normally distributed. The correlation matrix, the means, and standard deviations for the constructs are indicated in Table I.

Reliability was assessed using the internal consistency method via Cronbach's alpha (Cronbach, 1951). Diagonal numbers in Table I present Cronbach's alphas of the constructs, which range from 0.66 to 0.84 and exceed the minimum level suggested in the literature (Nunnally, 1994; Flynn *et al.*, 1990). Thus, constructs in this study exhibit reliabilities.

Prior to data collection, the content validity of the instrument was established by grounding it in existing literature whenever possible. As indicated earlier, multi-item scales were developed to measure the theoretical constructs.

Convergent validity was established using exploratory factor analysis (EFA) and CFA. As anticipated, all indicators loaded onto their underlying constructs during EFA using the principal components method with varimax rotation. The eigen-values for these factors were above the 1.0 cut-off point (Hair *et al.*, 1998), while the percentage of variation was around 54.36 percent, which are shown in Table II. Following the recommendations of Ayers *et al.* (1997), the scales were also assessed in two phases to assess convergent validity using CFA. One CFA was performed for the independent variables, and a separate CFA was performed for the dependent variables. The measurement models were tested for their goodness of fit. The results of the measurement models are given in Table III. The overall fit indices are good, and the loadings of measurement items to their respective constructs are highly significant ($p < 0.001$). Thus, the constructs show convergent validity (Song *et al.*, 2005).

Discriminant validity was checked using CFA. Measurement models were constructed for all possible pairs of the theoretical constructs. Six measurement models were constructed by fixing the correlation between the two constructs at 1.0 while six alternative measurement models were constructed without fixing the correlation between the two constructs. The results showed significant differences between the fixed and free solutions, which indicated the distinctiveness of the constructs and provided strong evidence of discriminant validity among the theoretical constructs (Bagozzi *et al.*, 1991).

3.5 Structural equation modeling and the results

This study used structural equation modeling (SEM) to estimate the causal relationship among the constructs. The proposed model had two simultaneous dependent variables and multiple indicators for each latent variable, and SEM was appropriate based on its strength in accommodating multiple dependent variables in one structural model and accounting for measurement errors of the indicators (Anderson and Gerbing, 1988). The maximum likelihood estimation method was used because it had desirable asymptotic properties (e.g. minimum variance and unbiasedness) and was scale-free (Zhao *et al.*, 2008). Multivariate normality was verified using univariate Q-Q plots (Raykov and Marcoulides, 2000). The goodness of fit indices were Chi-Square = 202.37 with d.f. = 148,

Table I Means, standard deviations, correlations, and Cronbach's α

Construct	(1)	(2)	(3)	(4)
(1) Codification strategy	<i>0.662</i>			
(2) Rich-media strategy	-0.126	<i>0.735</i>		
(3) Internal knowledge transfer	0.146*	0.488*	<i>0.806</i>	
(4) Knowledge spillovers	-0.166*	-0.004	-0.112	<i>0.844</i>
Mean	3.30	3.45	3.46	2.93
Standard deviation	0.683	0.722	0.683	0.825

Note: * Correlation is significant at the 0.05 level (two-tailed); The data on the diagonal (in italic) is the Cronbach's α

Table II Exploratory factor analysis (EFA) with varimax rotation

Constructs and items	Factor 1	Factor 2	Factor 3	Factor 4
<i>Codification strategy</i>				
Item 1	-0.123	-0.074	0.669	0.170
Item 2	0.013	0.031	0.627	0.092
Item 3	0.204	-0.088	0.574	-0.095
Item 4	-0.102	-0.040	0.527	-0.105
Item 5	0.113	-0.034	0.637	-0.097
Item 6	0.201	-0.079	0.556	-0.167
<i>Rich-media strategy</i>				
Item 1	0.386	-0.006	0.137	0.482
Item 2	0.134	-0.087	-0.079	0.793
Item 3	0.217	0.072	-0.107	0.744
Item 4	0.231	-0.001	-0.138	0.729
<i>Internal knowledge transfer</i>				
Item 1	0.780	-0.098	0.075	0.184
Item 2	0.728	-0.007	-0.126	0.043
Item 3	0.787	0.027	0.052	0.146
Item 4	0.630	-0.014	0.229	0.339
Item 5	0.616	-0.063	0.098	0.281
<i>Knowledge spillovers</i>				
Item 1	-0.030	0.817	-0.005	-0.036
Item 2	-0.005	0.768	-0.163	-0.034
Item 3	0.055	0.870	-0.020	0.029
Item 4	-0.146	0.828	-0.064	0.016
<i>Results</i>				
Eigen-value	2.947	2.749	2.336	2.297
Percentage of variance explained	15.51	14.47	12.29	12.09
Cumulative percentage of variance explained	15.51	29.98	42.72	54.36

RMSEA = 0.041, NFI = 0.89, NNFI = 0.96, CFI = 0.96, GFI = 0.91, AGFI = 0.89, and standardized RMR = 0.0059, which were better than the threshold values suggested by Hu *et al.* (1992). Therefore, the model can be accepted. Figure 1 shows the structural equation model and the standardized coefficients for the paths that are significant at the 0.05 level.

According to the results, the codification strategy has a significant positive effect on internal knowledge transfer ($\beta = 0.31, p < 0.01$) and has a significant negative effect on knowledge spillovers ($\beta = -0.20, p < 0.05$), which support *H1* and *H3b*. At the same time, the rich-media strategy has a significant positive effect on internal knowledge transfer ($\beta = 0.65, p < 0.001$), which supports *H2*, but does not have a significant effect on knowledge spillovers ($\beta = -0.04, p > 0.1$), which means that *H4a* and *H4b* are not supported.

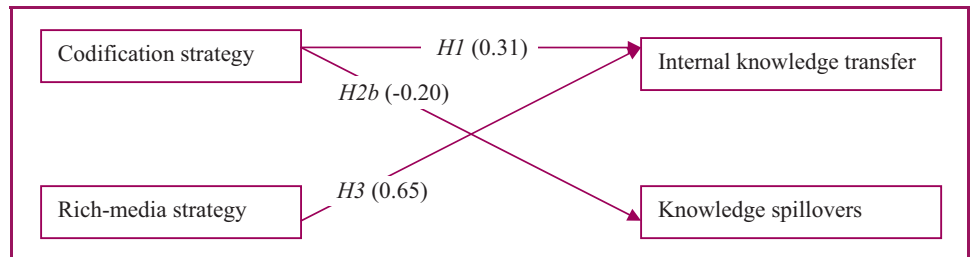
4. Discussion

This study puts internal knowledge transfer and knowledge spillovers into one framework and investigates how internal knowledge transfer strategies influence them simultaneously. This study first classifies internal knowledge transfer strategies into codification and rich-media strategies according to knowledge storage forms, and examines whether they really promote internal knowledge transfer. In addition, internal knowledge transfer and knowledge spillovers are two types of knowledge flow and might be related to each other (Argote and Ingram, 2000). If so, internal knowledge transfer strategies might also accelerate knowledge spillovers, which puts firms into a dilemma, although some scholars hold the opposite view. Thus, this study also investigates how these two strategies influence knowledge spillovers. Then, people can discover whether codification and rich-media strategies are double-edged swords in firms' internal knowledge transfer process.

Table III Confirmatory factor analysis (CFA) results

Construct/items	Loadings	t-value
Measurement model 1 ^a		
Codification strategy		
Item 1	0.49	
Item 2	0.49	4.49
Item 3	0.51	4.60
Item 4	0.40	4.00
Item 5	0.59	4.89
Item 6	0.51	4.61
Rich-media strategy		
RS1	0.43	
RS2	0.70	5.37
RS3	0.69	5.35
RS4	0.76	5.44
Measurement model 2 ^b		
Internal knowledge transfer		
Item 1	0.79	
Item 2	0.56	7.69
Item 3	0.75	10.02
Item 4	0.65	8.84
Item 5	0.63	8.56
Knowledge spillovers		
Item 1	0.74	
Item 2	0.68	9.38
Item 3	0.83	11.01
Item 4	0.78	10.59

Notes: Model fit: ^a Chi-Square = 38.84, Df = 34, RMSEA = 0.026, Std RMR = 0.051, NFI = 0.92, NNFI = 0.98, CFI = 0.98, GFI = 0.97, AGFI = 0.94; ^b Chi-Square = 42.22, Df = 26, RMSEA = 0.053, Std RMR = 0.046, NFI = 0.95, NNFI = 0.97, CFI = 0.98, GFI = 0.96, AGFI = 0.93

Figure 1 Results of structural equation model

The empirical results suggest that codification strategy has a significant positive effect on internal knowledge transfer, which agrees with people's intuition. The reason that many scholars suggest is that codification strategy makes the tacit components of knowledge into explicit forms, and workers can use the knowledge more easily and less costly (Hansen *et al.*, 1999; Boh, 2007). Another reason is that codification strategy avoids people contact in the internal knowledge transfer process, and workers desiring the knowledge do not feel they are losing face when learning the knowledge (Thomas-Hunt *et al.*, 2003). Consequently, they use the knowledge more freely. This effect might be more significant in China than in other countries because people here value saving face more significantly (Chen and Tjosvold, 2002).

An interesting result of this study is that codification strategy does not have a positive effect on knowledge spillovers, which contradicts people's intuition and many scholars' view

(Argote and Ingram, 2000; Song *et al.*, 2005). Instead, this study shows that codification strategy has a negative effect on knowledge spillovers, which is consistent with the view of Oxley and Wada (2009). After interviewing senior managers from firms and reviewing the literature, the authors explain this finding as follows. Codification strategy just makes knowledge explicit and provides a condition necessary for knowledge spillovers, but is not a catalyst sufficient to accelerate knowledge spillovers. Moreover, before codification strategy implementation, firms often do not know where their valuable knowledge is and what they should protect (Zack, 1999; Lado *et al.*, 2006). Through a codification strategy, firms become more aware of their knowledge and its condition. Meanwhile, under the pressure of maintaining their competitive advantages, firms have the incentives to restrain knowledge spillovers (Pacheco-De-Almeida and Zemsky, 2007). Thus, with the help of codification strategy, firms can take measures to reduce knowledge spillovers more effectively. For example, firms can enforce control and incentive measures to stimulate workers to protect the firms' knowledge. As a result, codification strategy has a negative rather than positive effect on knowledge spillovers.

This study also finds that rich-media strategy has a significant positive effect on internal knowledge transfer. Although scholars underscore the effects of individual contact in knowledge management, including knowledge creation and knowledge transfer, few empirical studies confirm these effects directly (Nonaka, 1991). This study goes in this direction from a media perspective and finds that rich-media strategy does promote internal knowledge transfer. Different from codification strategy, rich-media strategy resorts to people interaction to promote internal knowledge transfer. Thus, when firms try to transfer their knowledge in firms, they should pay attention to both codification strategy and rich-media strategy.

The empirical results do not reveal a significant relationship between rich-media strategy and knowledge spillovers. When firms use rich-media strategy to transfer knowledge in firms, its tacit components stay largely intact, and knowledge's self-protection mechanism due to its tacit components does not change. On the other hand, firms do not become more aware of the condition of their knowledge, and can not restrain knowledge spillovers more effectively. Therefore, rich-media strategy does not have a significant influence on knowledge spillovers.

4.1 Theoretical contributions

This study makes the following theoretical contributions. First, in regard to knowledge management field, this study identifies two internal knowledge transfer strategies, codification and rich-media, and finds that they do promote internal knowledge transfer. Knowledge of a firm is mainly stored using two different methods, which are systematization and personalization (Choi and Lee, 2002; Choi and Lee, 2003). Accordingly, knowledge stored with different methods needs different knowledge transfer strategies. This study suggests that codification strategy, which makes knowledge explicit and convenient for employees to access, is a proper way to facilitate internal transfer of knowledge stored with a systematization method, and rich-media strategy, which stresses the interaction between knowledge acquirer and holder, is an effective transfer method for knowledge stored using a personalization method. The empirical results confirm that both codification and rich-media strategies have significant effects on internal knowledge transfer. Thus, this study complements existing knowledge management studies.

Second, this study contributes to studies on knowledge spillovers. Knowledge spillovers undermine knowledge inimitability and scarcity and thus harm the sustainability of competitive advantage. Existing research largely investigates factors influencing knowledge spillovers from the perspective of knowledge characteristics (King and Zeithaml, 2001; Ryall, 2009). Because internal knowledge transfer and knowledge spillovers are both knowledge flow, factors influencing internal knowledge transfer might also affect knowledge spillovers (Zander and Kogut, 1995; Argote and Ingram, 2000; King and Zeithaml, 2001). This study investigates whether codification and rich-media are antecedents of knowledge spillovers, and the empirical results suggest that codification significantly restrains



knowledge spillovers. Thus, this study complements other studies concerning knowledge spillovers.

Third, from the basis of the resource-based view and knowledge-based view, this study examines how firms construct sustained competitive advantages (Barney, 1991; Zander and Kogut, 1995). Internal knowledge transfer contributes to competitive advantage construction, while knowledge spillovers undermine competitive advantage persistence; this study puts them into one framework and investigates how codification and rich-media strategies simultaneously influence them. The empirical results reveal that codification is not a double-edged sword, simultaneously promoting internal knowledge transfer and restraining knowledge spillovers, while rich-media only has a significant positive effect on internal knowledge transfer. This study provides meaningful management tools in the form of actionable prescriptions, codification and rich-media internal knowledge transfer strategies, for practitioners to develop sustainable competitive advantages (Priem and Butler, 2001).

4.2 Managerial implications

There are several managerial implications. First, firms should choose their internal knowledge transfer strategies based on their knowledge storage forms. If firms mainly store knowledge using a systematization method, they should stress a codification strategy and encourage workers to access knowledge embodied in firms' documents, IT systems, and so on. On the other hand, if firms' knowledge is mainly stored in employees' brains, firms should stress a rich-media strategy and encourage people to communicate and share knowledge. For example, firms should create culture promoting collaboration and develop places or facilities supporting worker contact.

Second, firms should realize that internal knowledge transfer strategies do not lead to knowledge spillovers that harm firms' competitive advantage persistence. Because firms often do not know what to protect from knowledge spillovers, this study suggests that codification strategy can make firms realize what knowledge is valuable and where it is located. On this basis, firms can protect their valuable knowledge more effectively in the internal knowledge transfer process, and knowledge spillovers will decrease significantly. For example, firms can use patents or trade secrets to protect their knowledge. Then, they can appropriate the benefits of their knowledge for a long time.

This study has several limitations that can direct future research. First, this study is conducted in China, and future research may be conducted in other emerging or developed countries to see if there are differences in the research results. Second, this study does not investigate the effects of internal knowledge transfer and knowledge spillovers on firm performance, although it is widely accepted that the former has a positive effect while the latter have a negative effect on firm performance. Further research may include firm performance and examine how codification strategy, rich-media strategy, internal knowledge transfer, and knowledge spillovers affect firm performance simultaneously. Third, this study finds something interesting that codification strategy has a negative rather than positive effect on knowledge spillovers; however, the mechanism underlying this finding is not explored sufficiently. It is valuable to conduct qualitative research to explore the underlying mechanism of codification strategy influencing knowledge spillovers and quantitative research to confirm it. In particular, some moderators or mediators (e.g. knowledge protection) influencing the relationship between codification strategy and knowledge spillovers might be found in qualitative research, and quantitative research can be designed to test whether these moderators or mediators actually influence the relationship between codification strategy and knowledge spillovers. Fourth, this study mainly focuses on the effects of knowledge transfer strategies, codification and rich-media strategies, on internal knowledge transfer and knowledge spillovers. However, even if these strategies have valuable merits for firms' knowledge management and performance, characteristics of employees or firms may influence their implementation in firms. Thus, the investigation of the antecedents of codification and rich-media strategies is a valuable research direction.



5. Conclusions

Firms can gain persistent competitive advantages when they manage to both facilitate internal knowledge transfer and block external knowledge spillovers (Argote and Ingram, 2000). However, both internal knowledge transfer and knowledge spillovers are flow of knowledge, and strategies to promote internal knowledge transfer might also increase knowledge spillovers, which drives firms into a dilemma. Thus, this study examines an interesting question: whether internal knowledge transfer strategies are double-edged swords. As a foundation, this study first identifies two internal knowledge transfer strategies based on systematization and personalization knowledge storage methods, which are codification and rich-media strategies. Based on the knowledge-based view and media richness theory, this study then puts forward hypotheses concerning their effects on internal knowledge transfer and knowledge spillovers and tests them using data collected from China. The results suggest that codification strategy has a negative effect on knowledge spillovers as well as a positive effect on internal knowledge transfer, while rich-media strategy has a positive effect on internal knowledge transfer and no significant effect on knowledge spillovers. In particular, codification strategy restrains knowledge spillovers as well as promotes internal knowledge transfer, while rich-media strategy only promotes internal knowledge transfer. Thus, codification and rich-media strategies are not double-edged swords for firms to gain the benefits of knowledge, but engines for firms to create persistent competitive advantages.

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