

Original Paper

External Social Capital, Inter-Organizational Knowledge Trading and Enterprise Innovation Performance in Supply Chain: Evidence from Manufacturing Enterprises in China

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Abstract

Based on perspective of cooperative innovation in supply chain, a conceptual model for the effect of external social capital, inter-organizational knowledge trading on enterprise innovation performance is proposed and empirically tested using the data collected from 256 enterprises in supply chain through the structural equation modeling. The external social capital consists of external cognitive capital, external relationship capital, external structure capital and external position capital in this paper. Inter-organizational knowledge trading is divided into explicit knowledge trading and tacit knowledge trading. The results show that external structure capital and external position capital have significant positive impact on explicit knowledge trading, tacit knowledge trading and enterprise innovation performance. External cognitive capital has significant positive impact on explicit knowledge trading and tacit knowledge trading, it does not impact enterprise innovation performance significantly. Although external relationship capital has significant positive impact on tacit knowledge trading, it does not impact explicit knowledge trading and enterprise innovation performance significantly. Finally, we also find that explicit knowledge trading and tacit knowledge trading have significant positive impact on enterprise innovation performance.

Keywords

external social capital, inter-organizational knowledge trading, enterprise innovation performance, supply chain

1. Introduction

In the era of knowledge economy, the core competitiveness of enterprises depends largely on the level of technological innovation. The knowledge necessary for technological innovation activities is, however, more complex, and even large-scale firms face shortages of knowledge. Given their scarce resources, firms attempt to cooperate with other firms to acquire knowledge and resources, and engage

in cross-organizational knowledge sharing to enhance innovation performance (Handfield et al., 2015). Based on the different and complementary knowledge resources between members in supply chain, cross-organizational knowledge sharing has become an important strategy for the members to create new value, save the cost of innovation and exploit depth profit by cooperative innovation in supply chain (Dost & Rehman, 2016). Whereas, considering the members of supply chain are different stakeholders and economic agents, knowledge sharing in supply chain partnerships is more difficult than intra-organizational knowledge sharing because there is no administrative organization promoting the knowledge sharing activities (Roth et al., 2016). However, it is an effective way to achieve the goal of knowledge sharing in supply chain partnerships by establishing a knowledge market in supply chain and then utilizing the market mechanisms to guide, encourage, stimulate, supervise and regulate the knowledge trading among the members of supply chain. If the knowledge suppliers can obtain reciprocity and mutual benefit (e.g., price discounts, orders, rebates, staff training, etc.) through inter-organizational knowledge trading in supply chain, and the knowledge demanders gain knowledge which is a good value, the knowledge sharing is easily conducted. Therefore, the idea of inter-organizational knowledge trading in supply chain partnerships is a new philosophy and method for knowledge sharing and transfer, which is of theoretical significance in solving the current issues puzzling the business community and academia about the methods best suited to promote the knowledge sharing and transfer in supply chain.

The concept of an intra-organizational knowledge market was first proposed by Davenport and Prusak (1998) in their book of working knowledge. They pointed out that the participants in knowledge trading consisted of knowledge buyers, knowledge sellers and knowledge brokers, and moreover, the reward of knowledge trading included reciprocal compensation, personal reputation and altruism, etc. Based on the study of Davenport and Prusak (1998), many studies further studied the knowledge market and/or knowledge trading in intra-organizational structures. Similar to the intra-enterprise knowledge market that Davenport and Prusak (1998) proposed, the knowledge flow and sharing in supply chain are also preceded with market-driven forces to a great extent (Zhang et al., 2012). Therefore, the market mechanism can be introduced to the process of knowledge sharing or knowledge transfer in supply chain. However, current studies about the inter-organizational knowledge market and/or trading in supply chain are not found in academic circles of abroad. Previous studies of China regarding the inter-organizational knowledge trading in supply chain focused on theoretical research, such as the influencing factors of knowledge market in supply chain and the theoretical research of knowledge trading modes (Zhang et al., 2006; Xu et al., 2008; Zhao et al., 2014). Then, considering that inter-organizational knowledge trading and cooperative innovation activities have certain social background and organizational context, scholars gradually introduced variables related to organizational context and empirically studied their influence on supply chain inter-organizational knowledge trading and enterprise performance, such as research on influence of characteristics of supply chain partners (Chen & Zhang, 2013), partnerships (including variables such as trust, relationship commitment and relationship quality) (Chen et al., 2012; Cheng & Fu, 2013; Chen et al., 2016), cooperative mechanisms (market mechanisms and relationship mechanisms) (Zhang et al., 2012; Liu & Chen, 2015) on inter-organizational knowledge trading and enterprise performance (cooperative performance, innovation performance, etc.). However, in view of the members needing to connect with external suppliers, manufacturers, distributors, retailers and other external social networks in inter-organizational knowledge trading and cooperative innovation, according to the theory of social capital, external social capital of members in supply chain will inevitably affect the organizational

context of operation (Hung et al., 2014), and therefore will affect the inter-organizational knowledge trading and cooperative innovation performance in supply chain. So, the effect of external social capital on inter-organizational knowledge trading and enterprise innovation performance is an important issue for members in the process of inter-organizational knowledge trading in supply chain, especially in China, a country which thinks highly regards the social relational mechanism in trading activities.

Above all, based on the theory of social capital and knowledge management, from the perspective of supply chain cooperative innovation, this paper firstly analyzes the effect of external social capital on inter-organizational knowledge trading and enterprise innovation performance and then a conceptual model is proposed. And then, we use the structural equation model to empirically study above conceptual model with the questionnaire data from the upstream and downstream enterprises in the supply chain to explore the influence path and the mechanism of the external social capital on the inter-organizational knowledge trading and enterprise innovation performance.

2. Literature Review and Concept Definition

2.1 External Social Capital

Social capital was firstly defined formally by Bourdieu, a famous French sociologist, and applied in the study of sociology. Bourdieu suggested that social capital was an actual or potential resource pool to emphasize that interpersonal network in community is a relational resource that contributes to the development of individuals in the community (Nahapiet & Ghoshal, 1998). After that, the theory of social capital was gradually introduced into economics, management and other fields. In the field of management science, the social capital can be divided into internal and external social capital, the internal social capital of the enterprise mainly includes the internal working relationship, the external social capital of enterprise mainly includes commercial network (suppliers, distributors, customers, competitors and other stakeholders), information network (product exhibition, all kinds of databases and patent documents), research network (seminars, research institutions, technology transfer organizations and research development alliance network) and participating network (the degree of participation in various regional, national and international relationship network) (Adler & Kwon, 2002). Based on the perspective of supply chain cooperative innovation, the external social capital in this paper defines mainly refers to relationship network formed between members and other partners (suppliers, distributors, retailers and customers, etc.) in supply chain.

With regard to the division of the social capital dimension, the existing literature usually adopts the classification criteria of Nahapiet and Ghoshal (1998), which divides the social capital into four dimensions about cognitive capital, relationship capital, structure capital and position capital. So, this paper divides the external social capital into four dimensions about external cognitive capital, external relationship capital, external structure capital and external position capital.

2.2 Inter-Organizational Knowledge Trading

Davenport and Prusak (1998) pointed out that the intra-organizational knowledge market was similar to the tangible goods and service markets. As for the intra-organizational knowledge market, the people searching for knowledge in order to solve their problems are buyers, and the people holding valuable knowledge in exchange for payment are sellers, and knowledge brokers connect the buyers and sellers together. The enterprises often have to pay cash when purchasing knowledge from the external environment, while intra-organizational knowledge market rarely uses cash; it uses mainly reciprocity, reputation and altruism instead of money. Similar to the intra-organizational knowledge market, the knowledge flow and sharing among members of supply chain are also proceeded by market forces to a

great extent, and the intangible knowledge market in supply chain is actually existing. The inter-organizational knowledge trading among members of supply chain is that the knowledge supplier enterprises provide some non-core knowledge for return to knowledge demander enterprises. As a result, the mutual benefit of bilateral cooperation will be achieved and the capacity for innovation and competitiveness of supply chain will be enhanced.

Knowledge can be characterized as either explicit or tacit. Tacit knowledge is abstract and can be communicated only through active involvement of the teacher. Explicit knowledge is highly codified and is transmittable in formal, systematic language. Taken into consideration, inter-organizational knowledge trading among members of supply chain is discussed from the two perspectives of explicit and tacit knowledge trading.

2.3 Enterprise Innovation Performance

Enterprise innovation performance is mainly used to evaluate the efficiency and effect of enterprise innovation activities and it can be identified as a comprehensive reflection of innovation results (Laursen & Salter, 2006). There are no uniform definition standards for evaluating innovation performance at home and abroad. Song and Parry (1996) evaluate enterprise innovation performance from the perspective of product market and evaluation indexes include the profitability of new products in the market, relative sales performance, relative market share and new market opportunities. Hagedoorn and Cloudt (2003) mainly measure enterprise innovation performance from the perspective of product innovation, evaluation indexes include R&D, the number of patents applied, the number of patents cited and the number of new products and so on. Jantunen (2005) evaluates the innovation performance from two aspects about product innovation and process innovation. In addition, Beneito (2006) points out, the selection of innovative performance indexes should be based on the specific goals of the study and the availability of data. Undoubtedly, the definition and measurement of innovation performance have differentiation in different study background. From the perspective of inter-organizational knowledge trading among members in supply chain, this paper will draw on previous research results and combined with the purpose of this study to evaluate the enterprise innovation performance from two aspects of product innovation and market performance.

3. Hypotheses and Theoretical Model

3.1 External Cognitive Capital, Inter-organizational Knowledge Trading and Enterprise Innovation Performance

External cognitive capital refers to the common understanding and expression, many scholars in the past used the psychological term “common mental model” to measure the similarity of the view on importance of things, value, basic assumptions and causal relationship from two or more parties (Whipple et al., 2015). In this study, the external cognitive capital in the background of supply chain can be identified as the common vision, common values and organizational similarity between the members enterprises of supply chain (Yim & Leem, 2013). The common vision will help members to foresee the potential value of resource exchange (inter-organizational knowledge trading), enhance the willingness to mutually cooperate and reduce the coordination cost in knowledge trading and help to form a good atmosphere of supply chain cooperative innovation, which is conducive to the improvement of enterprise innovation performance. Common values is a kind of spiritual incentive on cooperation among members, which can promote the enterprises to actively carry out various activities collaboratively, especially activities of mutual benefit for participating enterprises, such as inter-organizational knowledge trading and cooperative innovation. Based on the above analyses, it can

be assumed:

Hypothesis 1a: External cognitive capital has significant and positive impact on explicit knowledge trading.

Hypothesis 1b: External cognitive capital has significant and positive impact on tacit knowledge trading.

Hypothesis 1c: External cognitive capital has significant and positive impact on enterprise innovation performance.

3.2 External Relationship Capital, Inter-Organizational Knowledge Trading and Enterprise Innovation Performance

External relationship capital refers to the specific relationship established by the different actors in the social network in the process of interaction, that is, the personality of the social relationship network, mainly including the trust, norms and identity between two or more parties (Whipple et al., 2015). In this paper, external relationship capital under the background of supply chain can be identified as trust, friendship, respect and reciprocity established based on previous business network among supply chain members, which emphasizes the relationship strength formed with long-term cooperation between enterprises and is used to measure relationship quality between members in supply chain (Li & Wang, 2016). Trading cost theory holds that long-term cooperative relationship established among members in supply chain can reduce trading cost. Resource dependence theory argues that relationship between members is strategic reflection of environmental uncertainty and resource dependence. Social exchange theory thinks that supply chain partnership is a need of offering reward which can make opposite side satisfied from members. Thus, external relationship capital is realized through the interaction between members in supply chain and interaction process not only includes short-term trading (product or service trading, information or knowledge trading), but also includes long-term relationship behavior. Based on the above analyses, it can be assumed:

Hypothesis 2a: External relationship capital has significant and positive impact on explicit knowledge trading.

Hypothesis 2b: External relationship capital has significant and positive impact on tacit knowledge trading.

Hypothesis 2c: External relationship capital has significant and positive impact on enterprise innovation performance.

3.3 External Structure Capital, Inter-Organizational Knowledge Trading and Enterprise Innovation Performance

External structure capital refers to the overall pattern of relationship between different actors in the social network, which is the inhumanity of social relationship network, mainly including tightness degree, stability and connectivity of network (Whipple et al., 2015). In this study, external structure capital under the background of supply chain can be identified as the density and stability of external network connection between members such as suppliers, manufacturers, distributors and retailers in supply chain (Leem & Rogers, 2017). Judging from external network density, closer the link between members and other partners in supply chain is, greater the scope of knowledge acquisition will be, which is more conducive for sharing and exchange of knowledge among member enterprises and promoting trust between member enterprises, reducing “free rider” and other non-moral opportunism behaviors. From view of external network stability, stability is a key factor in the establishment of long-term cooperative partnership between supply chain member enterprises, if the external network stability is strong, member enterprises will look at cooperative partnership among enterprises in the

long run, in the case, two sides of trading are more willing to achieve complementary advantages through knowledge trading, so that the aim of improving enterprise innovation performance and overall competitive advantage of supply chain through knowledge innovation is reached. Based on the above analyses, it can be assumed:

Hypothesis 3a: External structure capital has significant and positive impact on explicit knowledge trading.

Hypothesis 3b: External structure capital has significant and positive impact on tacit knowledge trading.

Hypothesis 3c: External structure capital has significant and positive impact on enterprise innovation performance.

3.4 External Position Capital, Inter-Organizational Knowledge Trading and Enterprise Innovation Performance

External position capital refers to the resources and assets the actors obtain from location in the social network relationship, which is mainly embodied in social status (Whipple et al., 2015). In this study, external position capital under the background of supply chain can be identified as position of member enterprises in supply chain network relationship, this position is a manifestation of comprehensive competitiveness of members and it is the foundation to determine enterprises' discourse right in the supply chain. Tsai (2001) believes that the location of enterprise in the social network determines its access to resources, that is, enterprises can obtain resources differently or resources can be allocated structurally according to enterprises' location in relationship network. Therefore, in the supply chain network relationship, if the member enterprise has good position, such as the core enterprise or strong supplier in the supply chain, according to the concept of supply chain, other member enterprises often carry out related business activities around it, these members with good positions will have more opportunities to acquire complementary knowledge resources from other members and their innovation performance may be significantly improved accordingly. Based on the above analyses, it can be assumed:

Hypothesis 4a: External position capital has significant and positive impact on explicit knowledge trading.

Hypothesis 4b: External position capital has significant and positive impact on tacit knowledge trading.

Hypothesis 4c: External position capital has significant and positive impact on enterprise innovation performance.

3.5 Explicit Knowledge Trading, Tacit Knowledge Trading and Enterprise Innovation Performance

Hitt et al. (2000) pointed out that company could acquire and create new technical knowledge from inside and outside by means of skill learning, then the performance of company could be improved through the use of integration mechanisms applying for the development strategy of company. Lyles and Salk (2007) had verified that the knowledge acquisition has a significant and positive effect on the cooperative performance in an empirical study about the impact of International Joint Venture (IJV)'s organizational characteristics, structural mechanisms and contextual factors on knowledge acquisition. Estrada et al. (2015) study from the perspective of inter-enterprise knowledge sharing, in the process of cooperation or exchange between enterprises, knowledge and resources can be mutually exchanged through connecting channels so that new thoughts or ideas are created, which can further improve enterprise innovation performance. As an effective way to achieve the goal of inter-organizational knowledge sharing and transfer among members in supply chain, knowledge trading can promote

partners to acquire more complementarity knowledge from other members, which is favorable for the improvement of competitive advantage and innovation performance. Based on the above analysis, it can be assumed:

Hypothesis 5a: Explicit knowledge trading has significant and positive impact on enterprise innovation performance.

Hypothesis 5b: Tacit knowledge trading has significant and positive impact on enterprise innovation performance.

Based on the above analyses, the theoretical model this paper set for empirical study is as shown in Figure 1:

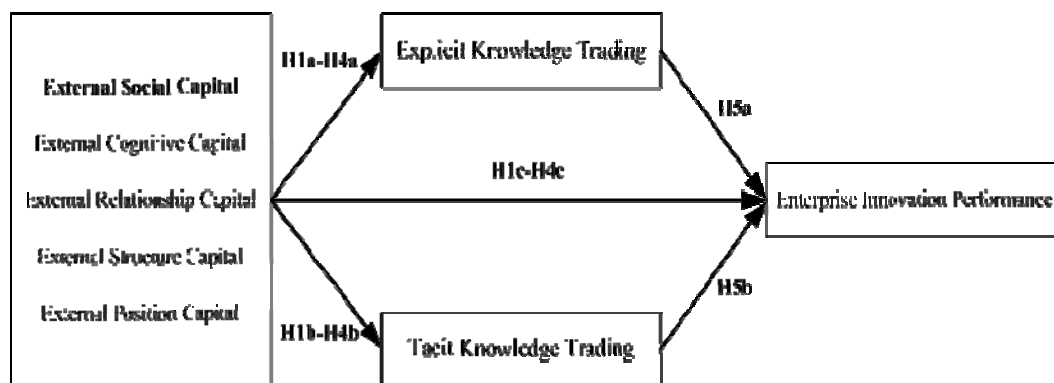


Figure1. The Theoretical Model

4. Empirical Research Design

4.1 Data Collection and Sample

Our study focus on the relationships between external social capital, inter-organizational knowledge trading and enterprise innovation performance requires an empirical setting in which enterprises must acquire and employ knowledge from other members in supply chain. China provides a rich context for this empirical requirement. Because of China's fast growing manufacturing industry and huge market potential after reform and opening-up, it hosts a larger number of local enterprises entering manufacturing industry and many well-known foreign manufacturers establishing subsidiaries in China. With the rapid development of China's manufacturing industry, market competition is very fierce in manufacturing industry as a result of the large number of competitors and the high degree of substitution between different brands, so enterprises in manufacturing industry hope to enhance their competitive advantage by acquiring the valuable knowledge from members of supply chain and thus establish a stable supply chain partnership. Therefore, the survey target mainly involved the key employees of upstream and downstream enterprises of supply chain in the manufacturing industry of China such as electronic appliances, metal and mechanical engineering, food and beverage, and chemicals.

We have used two ways to collect sample through questionnaire survey. First, we chose enterprises in Chongqing, Chengdu, Guiyang and Kunming (The southwest area of China) which had long-term cooperative relationship with our project team to finish the questionnaires through face to face interview, post or email. Second, we sent questionnaires to on-job postgraduates (e.g., EMBA, MBA, etc.) of 4 top universities in Shanghai (The east area of China), Beijing (The north area of China), Wuhan (The middle area of China) and Guangzhou (The south area of China) respectively. The

investigation was directly conducted in class. After the teachers introduced the objective of the survey, the questionnaires were completed by eligible students and taken back at the scene. A total of 387 responses were received out of the total 600 questionnaires sent with both ways, thus representing a response rate of 64.50 percent. Invalid questionnaires were eliminated with following criteria: (1) too many missing answers in the response, (2) obviously regularity of the answers, (3) obviously contradictory reactions. Finally, we have acquired 256 valid questionnaires, giving a valid response rate of 42.67 percent. Of all the 256 responses, our sample also represented a different types of manufacturing enterprises, including state-owned enterprises (36.33%), collective ownership enterprises (15.23%), private enterprises (17.58%), joint venture (22.27%) and overseas-funded enterprises (8.59%). The investigation subjects involved the key employees of supply chain. The respondents were relatively familiar to the issues involved in the questionnaire. Considering the age, 92.13 percent of the respondents were over 30 years old and 77.15 percent had a length of work for more than five years. Considering the departments, employees in technical and information departments which well known the situation of knowledge trading in enterprise were the main respondents (totally accounted for 76.56 percent). Other respondents were from customer service (7.03 percent), finance (9.77 percent), warehousing and transportation (6.64 percent). The respondents who had the title of department manager or above accounted for 79.30 percent, they had direct experience of making decisions. In addition, considering the education, all the respondents were above college education, they had no difficulties in understanding the issues and answering the questions appropriately.

Table 1. The Results of Reliability Analysis and Factor Analysis

Variables	Questionnaire items	Factor loading	Cronbach's α	Cumulative explanation (%)
External cognitive capital	We share similar values with supply chain cooperative partners	0.765	0.819	64.735
	We share similar enterprise management idea with supply chain cooperative partners	0.761		
	We share similar enterprise culture with supply chain cooperative partners	0.745		
External relationship capital	Our supply chain cooperative partners are reliable and trustworthy	0.683	0.813	65.752
	Our supply chain cooperative partners will strictly adhere to commitments	0.691		
	We can understand well each other with supply chain cooperative partners	0.717		
External structure capital	We have established extensive links with supply chain cooperative partners	0.759	0.769	65.443
	We are committed to maintain long-term relationships with our supply chain cooperative partners	0.801		
	We communicate very frequently with supply chain cooperative partners	0.795		
External position capital	We are very recognized by supply chain cooperative partners	0.771	0.809	65.231
	Supply chain cooperative partners will consider our benefit carefully when making major decisions	0.814		
	We have high prestige in the supply chain	0.783		
Explicit knowledge	We are very willing to trade some knowledge that can be structured into documents (such as	0.757	0.767	65.317

trading	management systems)			
	We and supply chain cooperative partners often deal with such knowledge which can be structured into documents	0.815		
	Through knowledge trading, we got a lot of knowledge that can be structured into documents	0.821		
	For some knowledge which is difficult to express (such as management experience), we are also very willing to take out to trade	0.789		
Tacit knowledge trading	We and supply chain cooperative partners often conduct such tacit knowledge trading by communicating or training employees with each other	0.818	0.745	65.573
	Through knowledge trading, we acquired a lot of such implicit knowledge	0.787		
	Compared with similar products on the market, our products are more innovative	0.767		
	The competitive advantages of our products are obvious (such as patent applications or technical secrets)	0.811		
Enterprise innovation performance	The products we develop can quickly open up new markets	0.823	0.827	67.234
	The market share of our products is higher than expected	0.809		
	Customers have a high degree of satisfaction with our products	0.751		

4.2 Variables Measures

We developed the questionnaire on the basis of previous studies and theories, as well as our field interviews. The variables of questionnaire were measured by the five-point Likert scale. To develop the scale items and evaluate scale properties, we employed traditional psychometric approaches. First, we created an initial pool of scale items on the basis of a thorough review of the literatures and interviews with some senior managers in manufacturing enterprises. Second, we refined the wording and expressing of several survey items on the basis of a pre-test with 30 senior managers in related departments. Finally, the formal questionnaire was formed on basis of the above two steps. In the Table 1, we provided full details about these measures to variables.

4.3 Reliability and Validity Analysis

Reliability is mainly used to investigate the consistency of empirical test results and the most commonly evaluation index is Cronbach's α coefficient. Based on this, the reliability of questionnaire is tested by Cronbach's α coefficient, results of SPSS18 statistical software show that Cronbach's α coefficient of each variable is more than 0.7 (as shown in Table 1), indicating that variables of this study have good reliability. Validity includes content validity and structural validity. For the content validity test, because the items content of each variable in this study are based on researches of domestic and foreign scholars and inspected and modified by the relevant experts in the field and through the questionnaire pre-test, so these have a good content validity. For structural validity test, this study uses factor analysis method to investigate the factor loading coefficient of each factor to the corresponding variable. Generally speaking, in the field of social science, the absolute value of factor loading coefficient which is more than 0.4 is considered valid. As shown in Table 1, factor loading coefficient of each observed variable in questionnaire is all more than 0.6, so each factor has strong

explanatory power for corresponding latent variable and good structure validity, so the quality of questionnaire is higher, further research can be carried out.

4.4 Model Testing

The evaluation of the model fitness was based on the recommendations of Bagozzi and Yi (1988); using basic standards, overall model fitness, and internal structure fitness of these indicators. First, the basic standard, the factor loading of all indicators reached the significant level of 0.6, and there was no negative measurement error. Second, the results of overall mode fitness are C-min/df=1.335, goodness of fit index (GFI)=0.937, root mean square residual (RMR)=0.023, Root Mean Square Error of Approximation (RMSEA)=0.031. It can be seen that GFI, RMR and RMSEA all reached the acceptable level. Third, for the internal structure fitness of the model, the study showed that reliability coefficient of each variable was above the acceptable level of 0.5. Based on the evaluation of combination reliability and extracted variance of the potential variables, the combination reliability of external cognitive capital, external relationship capital, external structure capital, external position capital, explicit knowledge trading, tacit knowledge trading and enterprise innovation performance were between 0.683 and 0.823. The extracted variances were between 0.517 and 0.632. They all reached the acceptable level, so it can be inferred that this model has good internal structure fitness.

4.5 Empirical Results

According to the analysis for hypothesis putted forward in this paper by structural equation modeling analysis software AMOS21.0, we get the standardized path coefficients between latent variables and corresponding P-Value, the P-Value is used to test significant relationship between variables, generally $P < 0.05$ indicating the correlation is significant and $P < 0.01$ indicating the correlation is very significant. Specific results are shown in Table 2.

Through the above empirical analysis, all hypotheses are verified except that P-Values of the hypothesis H1c, H2a and H2c are not notable and fail to pass the test. The results of study show that there are significant and positive impacts of external cognitive capital on explicit knowledge trading and tacit knowledge trading, but it does not impact enterprise innovation performance significantly; external relationship capital has significant and positive impacts on tacit knowledge trading, but it does not impact explicit knowledge trading and enterprise innovation performance significantly; external structure capital and external position capital have significant and positive impacts on explicit knowledge trading, tacit knowledge trading and enterprise innovation performance; in addition, explicit knowledge trading and tacit knowledge trading have significant and positive impacts on enterprise innovation performance.

Table 2. The Test Results of Hypothesis

Hypothesis	Path direction	Path coefficient	P-Value	Results
H1a	External cognitive capital→Explicit knowledge trading	0.185*	0.024	Pass
H1b	External cognitive capital→Tacit knowledge trading	0.273**	0.006	Pass
H1c	External cognitive capital→Enterprise innovation performance	0.198	0.065	Reject
H2a	External relationship capital→Explicit knowledge trading	0.213	0.048	Reject
H2b	External relationship capital→Tacit knowledge trading	0.489**	0.000	Pass
H2c	External relationship capital→Enterprise innovation performance	0.225	0.079	Reject
H3a	External structure capital→Explicit knowledge trading	0.468**	0.002	Pass

H3b	External structure capital→Tacit knowledge trading	0.415**	0.006	Pass
H3c	External structure capital→Enterprise innovation performance	0.389**	0.000	Pass
H4a	External position capital→Explicit knowledge trading	0.525**	0.000	Pass
H4b	External position capital→Tacit knowledge trading	0.369*	0.015	Pass
H4c	External position capital→Enterprise innovation performance	0.275**	0.003	Pass
H5a	Explicit knowledge trading→Enterprise innovation performance	0.287*	0.017	Pass
H5b	Tacit knowledge trading→Enterprise innovation performance	0.473**	0.000	Pass

Note. ** significant at $P < 0.05$; * significant at $P < 0.10$.

Table 3. Analysis of Total Path Coefficient

Hypothesis	Path direction	Path coefficient		
		Direct	Indirect	Sum
H1a	External cognitive capital→Explicit knowledge trading	0.185	0	0.185
H1b	External cognitive capital→Tacit knowledge trading	0.273	0	0.273
H1c	External cognitive capital→Enterprise innovation performance	Not significant	0.182	0.182
H2a	External relationship capital→Explicit knowledge trading	Not significant	0	0
H2b	External relationship capital→Tacit knowledge trading	0.489	0	0.489
H2c	External relationship capital→Enterprise innovation performance	Not significant	0.231	0.231
H3a	External structure capital→Explicit knowledge trading	0.468	0	0.468
H3b	External structure capital→Tacit knowledge trading	0.415	0	0.415
H3c	External structure capital→Enterprise innovation performance	0.389	0.330	0.719
H4a	External position capital→Explicit knowledge trading	0.525	0	0.525
H4b	External position capital→Tacit knowledge trading	0.369	0	0.369
H4c	External position capital→Enterprise innovation performance	0.275	0.326	0.601
H5a	Explicit knowledge trading→Enterprise innovation performance	0.287	0	0.287
H5b	Tacit knowledge trading→Enterprise innovation performance	0.473	0	0.473

Table 3 lists direct and indirect influence relationship between variables and corresponding weights. The weight analysis is total path coefficient which is equal to sum of the direct path coefficient and the indirect path coefficient, the indirect path coefficient is equal to the product of direct path coefficients of each segment and the sum of all indirect path coefficients is equal to the total indirect path coefficient. It can be seen that external cognitive capital and external relationship capital have no direct impact on enterprise innovation performance and actual impact on enterprise innovation performance is realized mainly through the intermediary variable of inter-organizational knowledge trading. Moreover, it can also be seen that external structure capital has the biggest effect on enterprises innovation

performance due to existence of intermediary role of inter-organizational knowledge trading.

5. Results and Discussion

Based on perspective of cooperative innovation in supply chain, a conceptual model for the effect of external social capital, inter-organizational knowledge trading on enterprise innovation performance is proposed and empirically tested using the data collected from 256 upstream and downstream enterprises of supply chain through the structural equation modeling. The external social capital consists of external cognitive capital, external relationship capital, external structure capital and external position capital in this paper, inter-organizational knowledge trading is divided into explicit knowledge trading and tacit knowledge trading. The results of specific empirical research and management meaning are as follows:

(1) External cognitive capital has significant and positive effect on explicit knowledge trading and tacit knowledge trading, namely, H1a and H1b passed the test; but its positive impact on enterprise innovation performance is not significant, H1c is not supported. The effect of external cognitive capital on enterprise innovation performance is realized mainly through the intermediary role of inter-organizational knowledge trading (explicit knowledge trading, tacit knowledge trading). The reason why external cognitive capital has no significant effect on the enterprise innovation performance may be that the external cognitive capital between members ensures comprehensibility and predictability of partners in the initial stage of the supply chain cooperation innovation, reduces conflict between each other, and the effectiveness of enterprise knowledge innovation has been strengthened and innovation performance has been improved. However, too much external cognitive capital will be not conducive to enterprises to understand product technology innovation from a more comprehensive perspective due to “homogenization of thought” and “group thinking”, which will produce a deterrent for some creative ideas or innovative ideas, that is to say that excessive external cognitive capital may inhibit the innovation of knowledge and it will lead to reduction of enterprise innovation performance. In summary, it can be seen that the effect of external cognitive capital on enterprise innovation performance may be “inverted U”.

(2) External relationship capital has significant and positive effect on tacit knowledge trading, namely, H2b passed the test; but its positive impact on explicit knowledge trading and enterprise innovation performance is not significant, H2c and H2c are not supported. The effect of external relationship capital on enterprise innovation performance is realized mainly through the intermediary role of tacit knowledge trading. The reason why external relationship capital has no significant effect on explicit knowledge trading may be that most of explicit knowledge is structural knowledge resources (explicit knowledge) not related to enterprises’ core technology and management experience, in general, this knowledge will not be limited to trade with the most stable and reliable strategic partners. On the contrary, for supply chain member enterprises, the value of tacit knowledge is often much higher than some explicit knowledge and it is difficult to assess actual value, some hidden knowledge resources even involve “core technology” of enterprise, in order to avoid the risk of “knowledge disclosure”, enterprise will choose partners of long-term cooperation and stable relationship to conduct knowledge trading. In addition, the reason why external relationship capital has no directly significant effect on the enterprise innovation performance may be that trust and relationship commitment in external relationship capital promote collaboration between enterprises in supply chain in the initial stage of the supply chain cooperation innovation, which creates a good atmosphere for enterprise cooperation innovation, so members can save costs and have access to complementary knowledge resources and

innovation performance will be improved significantly in supply chain.

(3) External structure capital has significant and positive influence on explicit knowledge trading, tacit knowledge trading and enterprise innovation performance (H3a-3c are tested). On the other hand, knowledge sellers will have more opportunities to express implicit knowledge with the means of comparison, metaphor, model, deduction, induction and so on, knowledge buyers are more likely to realize the transfer of tacit knowledge with strong unspeakability and system embed, in which case, it is more conducive to knowledge innovation and improve enterprise innovation performance. Therefore, in order to promote smooth progress of inter-organizational knowledge trading activities in supply chain and improve enterprise innovation performance, it is necessary to establish an extensive and effective communication mechanism among member enterprises to ensure smooth flow of information and knowledge through effective communication.

(4) External position capital has significant and positive influence on explicit knowledge trading, tacit knowledge trading and enterprise innovation performance (H4a-4c are tested). The results show that in supply chain, external position capital determines the identity and status of member enterprise in the social network, higher external position capital means greater control right or conversation right in network. According to concept of supply chain, other member enterprises will often carry out relating business activities around it, at the same time, in order to maintain and develop cooperation partnership with strong member enterprises, these member enterprises are also very willing to transfer their knowledge to each other and strong member enterprises absorb, integrate and innovate complement knowledge obtained, which is conducive to the improvement of innovation performance. Therefore, members of supply chain should pay attention to improving their own technical level and formulating a reputation strategy that meets actual situation, so as to strengthen their comprehensive competitiveness or status in the supply chain.

(5) Explicit knowledge trading and tacit knowledge trading have significant and positive influence on enterprise innovation performance (H5a and H5b are tested). The results show that as an effective means for knowledge sharing and transfer among enterprises in supply chain, inter-organizational knowledge trading can reduce the cost and risk of knowledge acquisition and creation, improve the use efficiency of knowledge, coordinate and optimize knowledge level of supply chain members, thereby enhancing the level of innovation performance of member enterprises. Therefore, designing knowledge trading mechanism between supply chain enterprises (including organizational management mechanism, incentive mechanism, price mechanism and compensation mechanism, etc.) and effective promoting for knowledge trading between member enterprises have an important significance to improve the overall competitiveness of supply chain and innovation performance.

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