Effect of Network Embedding on the Performance of Chinese Venture Capital Institutions: Mediatory Role of Organizational Learning

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Abstract. By combining organizational learning and social network theories, we used 2,935 investment dealings of 942 investment institutions in 2,345 enterprises from 1999 to 2014 as a sample to explore the mechanism of heterogeneous knowledge learning in network embedding and investment performance. Empirical results show that structural and relationship embedding remarkably improve investment performance. Heterogeneous knowledge learning plays a mediatory role between structural embedding and investment performance, as well as between relational embedding and investment performance.

Keywords: Network embedding · Heterogeneous knowledge learning · Investment performance

1 Introduction

High-risk and high-yield characteristics of investment institutions has caused network embedding to become an important feature of investment institutions. The influence of network embedding on the investment performance of investment institutions is also receiving extensive research attention. Substantial literature has discussed the impact of different network embedding features on performance involving strong connections, weak links, relationship quality, network size, network location, and structural holes. However, the necessary research and analysis of the internal mechanisms of network embedding and its influence on investment performance are still lacking. The organizational learning theory can explain the interoperability between the two because it provides a target channel for the expansion and deepening of network embedding and enables process interpretation for the improvement of organizational performance by network resources. Whether external knowledge and information brought by network embedding

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can be effectively transformed into investment performance depends on organizational learning. Organizational learning enables organizations to receive and integrate information and knowledge obtained from the network selectively and enhances the competitive advantage and business ability of organizations. Therefore, this study explores and analyzes the mechanism of organizational learning on network embedding and investment performance.

How investment institutions obtain different attribute knowledge from different embedded mechanisms and how different attribute knowledge affects investment performance is not well explained in theory. One view is that network embedding allows investment institutions to acquire heterogeneous resources, information, and knowledge and thus improve investment performance. This view is mainly based on the theory of resource complementarity. The network embedding of investment institutions enables organizations to obtain the professional and complementary knowledge of their partners better, greatly reducing the cost of organizational learning and improving investment performance and exit success rate. By acquiring the heterogeneous knowledge of partners, investment institutions can focus on deepening their specialized knowledge and effectively combine, integrate, and apply internal and external knowledge (Grant & Baden-Fuller, 2004) [1]. In the context of venture capital with high risk characteristics, co-investment through network embedding provides an effective way for investment institutions to apply heterogeneous knowledge (Rodan & Galunic, 2004) [2]. Some scholars have pointed out that diversified investment is a typical feature of the venture capital industry, which requires investment institutions with different resources and skills that can be satisfied through alliances with other venture capital institutions (Hochberg et al., 2011) [3]. Additionally, accessing these resources and skills from familiar, close-knit, and strong relationships is easier for investment institutions. Alexy et al. (2012) [4] believe that the diversification of network partners enables investment institutions to obtain heterogeneous social capital, including complementary resources, knowledge and strategic information, which greatly reduce the uncertainty of venture capital and effectively improve investment performance. Another view is that network embedding renders homogenization knowledge more accessible to investment institutions. Investors can only obtain their specialized knowledge based on the trust of their partners, and the premise of trust is that partners have similar resource attributes to themselves (Meuleman et al., 2009) [5]. The third view is that the knowledge that network embedding brings to investment institutions should be analyzed from different dimensional attributes but not as generalized as heterogeneity and homogenization. Bubna et al. (2013) argued that the network embedding of investment institutions tends to be homogenized in terms of size, impact, and geographical distribution while tending to be heterogeneous in the investment industry and investment stage [6]. In summary, limited studies have uncovered the impact of network embedding on investment performance by analyzing investment institutions' knowledge of different attributes (heterogenization and homogenization) from different network embedding dimensions.

Hansen (1999) pointed out that the learning of knowledge among alliance organizations includes two stages: knowledge search and knowledge transfer [7]. Grant & Baden-Fuller (2004) indicated that knowledge learning among organizations in the alliance includes two aspects: access and acquisition [1]. According to previous studies, structural embedding provides a channel for the circulation of non-redundant information, and relationship embedding is the key to knowledge transfer and sharing (Moran, 2005) [8]. Especially in the Chinese context characterized by relationship governance, strong relationships make it easier to access resources (Bian, 1997) [9]. In view of the intractability and quantification of "knowledge search" and "knowledge transfer," the learning effect of knowledge in the network can be reflected in the investment industry. On the basis of the network and organizational learning theories, this study examines the impact of network embedding (structure embedding and relationship embedding) of venture capital institutions on investment performance and explores the role path and impact mechanism of heterogeneous knowledge learning.

2 Theory and Research Hypothesis

2.1 Relationship of Network Embedding and Investment Performance

Network location is the result of the direct and indirect relationship between actors. The difference in network location represents the difference in the opportunities for actors to acquire knowledge, information, and resources in the network. Organizations that occupy a good network position are more dominant (Zaheer & Bell, 2005) [10]. Some scholars believe that the resources acquired by enterprises can be interpreted as a function of the location of the enterprise network (Wasserman & Faust, 1994) [11]. However, most scholars believe that the variables that best reflect and measure the location of the network are centrality and structural holes (Powell et al., 1996) [12].

Centrality is a variable that characterizes whether an investment institution is close to the core of the network and represents the position of the investment institution in the cooperative network. Investment institutions with a higher centrality performs better than others due to the following aspects: First, investment institutions in the central position have more sources of information. Centrality represents the possibility of investment institutions to acquire and control resources. More sources of information increase the selectivity of the organization's available knowledge and the possibility that institutions will receive valuable and complementary information that competitors do not have, thereby giving them a competitive advantage. Second, the central position of the institution is higher, and the reputation and privileges that it enjoys are greater. Centrality is an important indicator for evaluating the importance of investment institutions in the network and for measuring the superiority, privilege, identity, and reputation of investment institutions. The higher the centrality of the investment institution, the higher the status, the more opportunities for accessing information and resources, and the greater the positive effect on investment performance. Finally, investment institutions with higher centrality are more likely to increase their learning ability. According to the theory of organizational learning, investment institutions in the central position have more opportunities to access new information, have a broader vision, and have a higher possibility of organizational learning. Promoting the exchange and integration of knowledge inside and outside the organization is easier, thereby developing new knowledge, enhancing capabilities (Brown & Duguid, 2001) [13], and improving investment performance.

Structure hole refers to the phenomenon of non-redundant connections among actors in the network. The reasons for the higher performance of investment institutions occupying more structural holes are as follows: First, structural holes can bring more non-redundant heterogeneous connections to investment institutions, and the information and knowledge fields that can be accessed are wider, which is beneficial to the integration of internal and external knowledge (McEvily & Zaheer, 1999) [14]. Second, the more number of structural holes that investment institutions have in a cooperative network, the more non-redundant information is obtained, the more the investment institution has the advantage of maintaining and controlling knowledge, information, and resources (Burt, 1992) [15]. And the more the investment institution can obtain scarce resources that can generate competitive advantages and promote investment performance. Finally, the occupation of structural holes with non-redundant connection features can effectively reduce the transaction costs between investment institutions and other institutions, thus excellent cost and energy invested in the core business of investment institutions improve investment performance (Gnyawali & Madhavan, 2001; Soda et al., 2004) [16, 17]. Based on these ideas, this study proposes the following assumptions:

H1a: The centrality of venture capital institutions has a positive impact on investment performance.

H1b: The structural holes of venture capital institutions have a positive impact on investment performance.

Relationship embedding focuses on the dual transaction problem of direct linkage, that is, the degree of mutual understanding, trust, and commitment between the parties of direct transactions (Granovetter, 1992; Uzzi, 1997) [18, 19]. Uzzi (1997) divided relationship embedding into three dimensions: trust, information sharing, and joint problem solving. The reasons for the relationship embedding of investment institutions for the effective improvement of investment performance are as follows: First, the high degree of inter-institutional relationship embedding means a high degree of trust between the two parties, which promotes sharing, communication, and exchange of complex knowledge and information between them (Rindfleisch & Moorman, 2001) [20] and increases the probability of a successful exit of investment institutions. Second, as the degree of embeddedness of investment institutions deepens, the degree of information sharing between the two partners increases, which is more conducive to the transfer of resources, information, and knowledge between each other, especially tacit and complex knowledge (Moran, 2005) [8]. Moreover, encouraging and promoting investment activities are more likely to improve investment performance. Finally, when the investment institutions have strong connections, they are more likely to solve problems through repeated communication and negotiation, thus having a common understanding of the investment process and results (Halinen & Tornroos, 1998) [21]. Besides, they may have a common coding and cognition for complex and tacit knowledge, which is more conducive to mining and utilizing valuable knowledge that can gain strategic advantages, thereby improving investment performance. Additionally, relationship embedding greatly reduces the occurrence of opportunistic behavior. Rowley et al. (2000) argue that in a close network, the threat of reputational loss can effectively prevent opportunistic behavior among partners, thereby promoting performance improvement [22]. McFayden (2009) [23] pointed out that the strong connection of network individuals is conducive to the development of technical activities. Based on these ideas, this study proposes the following assumptions:

H1c: The relationship embedding of venture capital institutions has a positive impact on investment performance.

2.2 Mediatory Role of Organizational Learning

Similar to previous studies, the professionalization of the investment industry represents the professionalization of the knowledge acquired. Therefore, this study uses the heterogeneity of the investment industry to represent the learning of heterogeneous knowledge of investment institutions in network embedding. Hansen (1999) pointed out that knowledge learning among alliance organizations includes two stages: knowledge search and knowledge transfer [7]. Knowledge search refers to the process of finding and determining. The knowledge in this process is generally explicit, simple, independent, and easy to code. The migration of knowledge is the process of movement and integration. In this process, knowledge is generally invisible, complex, dependent, and hard to code. If an organization wants to improve its performance by learning knowledge through network embedding, knowledge search and knowledge migration are indispensable. Grant & Baden-Fuller (2004) pointed out that knowledge learning among organizations in the alliance includes two aspects: access and acquisition [1]. Access of knowledge refers to the channels and opportunities for obtaining information resources in the alliance network, whereas acquisition of knowledge refers to the absorption, transfer, and application of information resources in the alliance network. The effect of knowledge learning among venture capital institutions is ultimately reflected in the investment industry and its performance. Heterogeneous knowledge brings diverse information and resources to the organization and expands the scope and possibilities of investment. Homogenization of knowledge enables organizations to improve investment efficiency through repeated learning of knowledge. Therefore, how different will network embedding affect the learning of various attribute knowledge? What is the internal knowledge learning mechanism that influences investment performance by network embedding?

Centrality measures the characteristics of direct contact with the organization. Investment institutions in the center of the network have more direct access to information and are more likely to be exposed to a variety of new knowledge and information, which are conducive to the improvement of investment performance. Koka & Prescott (2008) pointed out that individuals in the center of the network have more direct contact with other individuals, which improves the efficiency of the organization's search information, thus, they can quickly and easily access valuable and differentiated information and obtain more opportunity for competition and strategic advantage [24]. Hoskisson et al. (1993) believe that organizations with network-centric locations gain more opportunities for knowledge and information exchange, thus, the organization's product differentiation is more pronounced [25]. Polidoro et al. (2011) pointed out that organizations in the center of the network are more likely to have the opportunity to cooperate and become partners of other network individuals [26]. The diversity of partner attributes directly leads to the benefits of information diversification, which improves organizational performance (Koka & Prescott, 2002) [27].

Structural holes pay more attention to the relationship model between organizations, emphasizing the characteristics of indirect organizational connections. According to Burt's network structure hole theory (2004), investment institutions occupying network structure holes can gain more opportunities to access non-redundant information, knowledge, and resources [28]. Hans (2008) pointed out that the maximization of network structure holes means the minimization of redundant connections between partners, which promotes the diversification, heterogeneity, and non-redundancy of knowledge and information in the network, improve the effectiveness of information circulation, and promote performance improvement [29]. Mors (2010) showed that the biggest advantage that an organization's structural holes bring to an organization is the novelty and diversity of information, which is conducive to the development of technological innovation activities [30]. Zaheer & Soda (2009) indicated that the network structure hole enables organizations to reach more bilateral non-connected partners and is more accessible to diverse information, knowledge, ideas, and resources, thus enabling access to diverse information flows, which in turn enhances the organization performance [31]. Based on these ideas, this paper proposes the following assumptions:

H2a: Heterogeneous knowledge learning plays a mediatory role between centrality and investment performance.

H2b: Heterogeneous knowledge learning plays a mediatory role between structural holes and investment performance.

Structural embedding represents the network location of an investment institution and represents the "pipeline" of access and exchange of information and resources (Cartwright, 2002) [32], affecting the search for heterogeneous knowledge. However, the difference in investment performance also depends on the migration of network knowledge, which is inseparable from the relationship between investment institutions. Structure embedding provides an opportunity for organizations to access heterogeneous knowledge, whereas relationship embedding determines whether an organization takes advantage of these opportunities to achieve the migration of the sought heterogeneous knowledge. Burt (1992) pointed out that weakly coupled and non-redundant knowledge (heterogeneous knowledge) is related rather than causal. Hansen (1999) suggested that according to Burt (1992), strong ties may still produce heterogeneous, non-redundant knowledge, and empirical studies have shown that strong linkage can considerably promote the transfer of heterogeneous and non-coding knowledge. Kohli & Jaworski (1990) indicated that the internalization of knowledge learned between partners is an important factor in the effective improvement of performance through relationship embedding, that is, only the profound understanding and absorption of information with other network members, which can be transformed into a competitive advantage to improve organizational performance effectively [33]. Although Granovetter (1992) argued that weak relationships can bring non-redundant, non-repetitive information, knowledge, and resources to the enterprise, strong relationships are the opposite. However, in the Chinese context, the knowledge brought by weak relationships has only quantitative advantages and lacks qualitative advantages. The process of knowledge learning involves the search for and migration of knowledge. The search for knowledge is the only channel for information acquisition. The transformation of information into performance also requires the transfer of knowledge, which means improvement of knowledge. Studies have shown that in a relationship governance environment, only organizations with frequent, close relationships and high trust can provide and share important information (Bian, 1997) [9]. Therefore, as mentioned above, structural embedding only means searching for heterogeneous knowledge, and relational embedding is the basis for realizing the transfer of these heterogeneous knowledge. Rindfleisch & Moorman (2001) suggested that early relationship embedding is the intensity of relationship between individual actors and is an excessive simplification of interorganizational relationships. Organizations are multiple roles at the same time. Organizational structure is complex and changeable. Through empirical research in the context of organization, strong relationships will bring more differentiated knowledge [20]. Therefore, this paper argues that relationship embedding provides conditions for implicit, non-coding, heterogeneous knowledge between investment organizations and organizational networks.

Uzzi (1997) pointed out that relational embedding includes three dimensions of trust, information sharing, and common problem solving and suggested that the trust dimension in relationship embedding is an important factor to promote knowledge transfer. Spekman et al. (1998) indicated that the number of alliances grow rapidly, but the performance of the alliance is low. One of the most important reasons is the lack of trust [34]. Trust is an important foundation for the formation of a cooperative network and an important social capital, which can reduce the incidence of speculation between organizations and reduce transaction costs (Hoang & Rothaermel, 2005) [35]. Moreover, trust can effectively promote the exchange and integration of knowledge among network members (Uzzi, 1997) and promote the transfer of knowledge. Oliver (2007) pointed out that the role of non-redundant information brought about by structural embedding is affected by trust variables between organizations [36]. With the deepening of the relationship between the two parties, the direct benefit brought by frequent contacts and exchanges is the deepening of trust between the two sides (Capaldo, 2007) [37]. This kind of relationship will help reduce opportunistic risks and will also help investment institutions to obtain rich and diverse knowledge of partners (Shi Lin et al., 2017) [38]. Grant (1996) [39] found that strong relationships between organizations remarkably improved the efficiency of organizations in discovering, acquiring, and absorbing new knowledge.

McEvily & Marcus (2005) found that the establishment of information sharing mechanisms between alliances facilitates the acquisition of heterogeneous knowledge and information [40]. The reason is that the deepening of information sharing enables organizations to share knowledge better in a timely manner and to promote the acquisition of new knowledge. Furthermore, new knowledge can be applied effectively and quickly due to the excavation and exchange of deep knowledge between organizations. A weak relationship is conducive to the search of knowledge, but it is not conducive to the sharing and transfer of knowledge, especially the use of complex knowledge (Hansen, 1999). Whereas a strong relationship is the opposite because organizations with strong relationships tend to share important, relevant, and cutting-edge knowledge and information. De Clercq (2003) pointed out that the same type of investment (investing in a certain industry) will have a "learning effect" on investment institutions. Investment institutions can improve their ability to identify, manage, and serve the invested enterprises through the knowledge and information learned in the previous investment, instead of relying only on the cooperative institutions [41]. This finding shows that the learning of heterogeneous knowledge depends more on partners.

Hansen (1999) believes that long-term and frequent contact and communication between organizations have a benefit on solving problems together. As time passes and the understanding of both parties deepens, they gradually form behavioral norms and languages suitable for cooperation between the two parties, which invisibly promote the transfer of tacit knowledge on both sides. McEvily & Marcus (2005) pointed out that an important feature of a common problem solving between organizations is feedback to the problem. By organizing feedback from both parties on the issue, the learning ability of both organizations is improved, the sensitivity to new knowledge perception and accuracy of grasping are enhanced, and the rational and effective use of new knowledge is promoted. As the mechanism for joint problem solving between organizations becomes more flawless, organizational partners will be more tacit, which can promote transfer of knowledge more efficiently, especially non-coding, implicit, non-redundant, and heterogeneous knowledge among organizations. The characteristics of the specialized knowledge acquired by venture capital institutions indicate the non-coding and complex characteristics of interagency knowledge transfer. In the case of strong links, investment institutions can spend more time and energy to gain and explain complex knowledge clearly. Granovetter (1992) also pointed out that "stronger connections with stronger motivations provide help and are generally more dependable." Therefore, strong links promote a two-way interaction between organizations (Leonard-Barton & Sinha, 2017) [42]. More opportunities and motivations are present between strong organizations to discuss, guide, and feedback. This two-way interaction promotes the migration and absorption of deep heterogeneous knowledge within directly connected organizations. Based on these concepts, this paper proposes the following assumptions:

H2c: Heterogeneous knowledge learning plays a mediatory role between relationship embedding and investment performance.

3 Research Design

3.1 Data Sample Matching

The sample from this paper comes from two major Chinese venture capital information databases: CVSource and Zero2IPO. The structure of these two databases is similar to the database of the US venture capital industry, VentureXpert of Thomson Reuters, which has been used extensively in research. The data in these two databases is available for a fee. Both CVSource database and Zero2IPO database provide basic information of VCFs, investment events and exit events of various industries over the years, so the corresponding data tables include VCFs information table, investment event table and exit event table. This study refers to the practices of predecessors (Gu & Lu, 2014), [43] matching the two databases to avoid missing information from a single database. This study uses data from venture capital investments in China from January 1, 1999 to December 31, 2014. Selecting the data from January 1, 1999 can ensure the maximum amount of sample data and minimize errors caused by missing samples. The limit for sample data collection (December 31, 2014) is based on previous studies(Gu & Lu, 2014; Matusik & Fitza, 2012), [43, 44] leaving three years to observe investment performance.

By matching the CVSourse database with the Zero2IPO data and deleting the missing data, a total of 2,942 investment dealings for 2,345 companies are obtained from 942 investment institutions.

The data in the two databases are processed as follows:

First, the corresponding raw data in the two databases are processed according to the following procedures: (1) delete the PE-PIPE sample in the investment event table (the investee in this sample is a listed start-up enterprise); (2) delete The investment event table contains samples with ambiguous information such as “undisclosed company name” and “undisclosed investor”; (3) delete duplicate records in the venture capital information table, investment event table and exit event table; (4) Relevant data of the same VCFs in the same round in the consolidated event table (some VCFs use two or more funds to invest in the invested companies, and in the original sample, the VCFs appear multiple times in the same round). Second, after preliminary processing of the original data of the two databases, the corresponding tables are matched, that is, the VCFs information table, investment event table and exit event table in the two databases are matched respectively to avoid information omission. Third, the matched VCFs information table, investment event table, and exit event table are matched to obtain the final complete sample.

3.2 Mediating Effect Test Model and Steps

The commonly used mediating estimation method is Causal Steps. According to the formula:

$$Y^{'} = cX + e_1 \tag{1}$$

$$M = aX + e_2 \tag{2}$$

$$Y'' = c'X + bM + e_3 \tag{3}$$

In the mediating effect model of the continuous dependent variable, the regression coefficient of M to X (the scale of the continuous variable), the regression coefficient of Y to M (Logit scale), and the regression coefficient of Y to X are not on the same scale. Therefore, the existence of mediating effects cannot be tested simply via dealing with the mediating effects of continuous variables. Therefore, this study follows the proposal of MacKinnon & Dwyer (1993) [45] and MacKinnon (2008) [46] to achieve the equalization of the regression coefficients through standardized conversion. The conversion method is as follows:

$$\mathrm{var}\left(Y^{'}\right) = c^2\mathrm{var}(X) + \pi^2/3 \tag{4}$$

$$\mathrm{var}\left(Y''\right) = c'^2\mathrm{var}(X) + b^2\mathrm{var}(M) + 2c'b\mathrm{cov}(X, M) + \pi^2/3 \tag{5}$$

$$b^{std} = b \cdot \frac{SD(M)}{SD(Y'')} \tag{6}$$

$$c^{std} = c \cdot \frac{SD(X)}{SD(Y')} \quad (7)$$

$$c'^{\,std} = c' \cdot \frac{SD(X)}{SD(Y'')} \quad (8)$$

The specific steps for the mediating effect test, in which the dependent variable is a dichotomous variable, and the independent and intermediate variables are continuous variables are as follows:

Step 1: Regression Analysis

First, according to Formula (1), the logistic regression of the dependent variable Y on the independent variable X is obtained, and the estimated value of c and the corresponding standard error SEc are obtained. Second, the regression of M to X is performed according to Formula (2), and the estimated value of a and the corresponding standard error SEa are obtained. Finally, according to Formula (3), the logistic regression of Y to X and M is calculated to obtain b and c' and the corresponding standard error SEb and SE c'.

Step 2: Standardization

We calculate the standard deviation and the variance of X, M, Y', Y'', and the covariance of X and M. The standard deviation, variance, and covariance of X and M are obtained from the original data. According to Formulas (4) and (5), we can obtain the variance of Y' and Y''. Then, the regression coefficients are normalized according to Formulas (6) to (8).

Step 3: Sobel Test

The standard error corresponding to the mediation effect is:

$SE\left(ab^{std}\right) = \sqrt{(b^{std})^2(SE(a^{std}))^2 + (a^{std})^2(SE(b^{std}))^2}$ Sobel test z $= ab^{std}/SE\left(ab^{std}\right)$. When |z| $>$ 1.96, the mediating effect is significant. The ratio of mediating effects to total effects is: $ab^{std}/\left(ab^{std} + c'^{\,std}\right)$.

3.3 Variable Measure

Dependent Variable

The dependent variable of this study is the investment performance of China's venture capital institutions. Ideally, income indicators should be used to measure investment performance. However, by examining the samples of CVSource and Zero2IPO, commonly used variables for measuring investment performance, such as internal rate of return and multiples of returns, are found to be seriously deficient. Therefore, the successful exit of venture capital institutions is used as a proxy variable for investment performance (Cochrane, 2005; Lerner, 2000) [47, 48]. Initial public offerings, mergers and acquisitions, and equity transfers are three types of exit methods commonly used by venture capital institutions. Therefore, in the sample observation period, if the institution withdraws by any of these three exit methods, the institution is considered to have successfully exited.

Independent Variable

In the study, the social network analysis software Ucinet6 is used to calculate the relevant variables.

(1) Structural Embedding

Most studies have shown that the size of the data window does not theoretically affect the fifinal result. According to the predecessors' practice, this study selects the data window calculated by the relevant variables for four years, which can ensure the stability of network establishment and avoid the obsolescence of the information caused by the long data window.

Centrality: This study adopts a more comprehensive degree of centrality, which refers to the ratio of the number of alliance institutions directly connected with the focused investment institutions to the total number of network nodes.

Structural holes: Structural holes refer to non-redundant connections between actors (Burt, 1992). According to Burt (1992), the four indicators that measure structural holes are effective size, efficiency, limits, and ratings. The effective scale (effsize) considers the number of structural holes and network size; thus, it can better reflect the structural hole positions of individuals in the network. Accordingly, this study uses an effective scale to measure structural holes. The effective scale is calculated by the total number of nodes directly related to node i minus the average number of connections of all nodes in the individual center network of node i.

(2) Relationship Embedding

Relational embeddedness (relational) refers to the practice of De Clercq et al. (2008), which refers to the number of contacts in the time window [49]. For example, from January 1, 2001 to December 31, 2004, the total number of cooperative investments with each partner is the degree of embedded relationship of the investment institution in 2004.

Mediator Variable: Heterogeneous Knowledge Learning

According to the Herfidhal Index, we use the differentiation of the investment industry as a proxy variable for heterogeneous knowledge learning (Zheng & Xia, 2017) [50]. The calculation formula is: Hete $= 1 - \sum_{j=1}^{N} (T_j/T)^2$, where T_j represents the number of companies investing in a certain industry, and T represents the total number of enterprises invested by the institution. The closer the value is to 1, the more diverse the investment industry is, and the higher the knowledge heterogeneity is. On the contrary, the closer the value is to 0, the more centralized the investment industry is, and the lower the knowledge heterogeneity is.

Control variable

Considering existing research at home and abroad, we control other factors that affect the successful exit of venture capital. (1) The age of investment institutions (vcage): The longer a venture capital institution is established, the more experience it will accumulate. (2) The size of the investment institution (vcsize): The logarithm of the investment fund is used as the proxy variable for the size of the investment institution. (3) Stage of investment: Four types of venture capital investment are used in this paper, namely seed stage, initial stage, expansion stage, and maturity stage. The stage of venture capital is the key factor that determines the successful exit of the institution. With the gradual maturity of the financing enterprise and the gradual occupation of the market, the probability of successful exit of the venture capital institution will gradually increase. (4) Geographical proximity (geop): Considering the practice of Zheng & Xia (2017), this study constructs the dummy variable of geographical proximity, that is, when the investment institution and the invested enterprise are in the same province, the geop is set to 1, and vice versa. (5) Type of investment institution (type): Two types of investment institutions are present in the sample, namely Venture Capital and Private Equity. (6) Funding sources (fund): Three sources of venture capital are present in the sample: Chinese, foreign, and joint ventures. Therefore, according to the research needs, two dummy variables are set. When it belongs to a certain resource type, it takes 1; otherwise, it takes 0. (7) Industry dummy variables (industry): This study classifies the industry of venture capital according to the constructs corresponding virtual variables. (8) Time dummy variable (year), which controls the change of risk investment in the time dimension and the change of the external macroeconomic environment.

4 Descriptive Statistics and Correlation Analysis

Table 1 is a descriptive statistic of the relevant variables and a Pearson correlation coefficient table. Table 1 shows that relationship embedding has a significant positive correlation with investment performance. The correlation coefficient is 0.121 ($p < 0.01$). Hypothesis H1c has been preliminarily verified. Centrality and heterogeneous knowledge learning have no significant positive correlation with investment performance. The correlation coefficients are 0.018 and 0.021. Structural holes and investment performance have no significant negative correlation, pending further examination. Additionally, results of the multicollinearity test show that the variance expansion factor VIF is less than the threshold of 10, indicating that no multicollinearity problem exists between variables.

The mean of investment performance is 0.244 and the standard deviation is 0.430, indicating that the performance of Chinese venture capital institutions is low. The mean value of variable heterogeneous knowledge learning is 0.530, and the standard deviation is 0.246, indicating that the knowledge learning of Chinese venture capital institutions tends to be homogeneous. The mean value of the variable structure hole is 5.168, and the variance is 8.311, indicating that the partners among Chinese venture capital institutions are relatively fixed and the alliance network is relatively sparse.

Table 1. Descriptive statistics of related variables and Pearson correlation coefficient

Variable	Success	Hete	Degree	Effsize	Mean	SD	VIF
Success	1				0.244	0.430	–
Hete	0.018	1			0.530	0.246	1.15
Degree	0.021	0.316***	1		0.007	0.009	9.61
Effsize	−0.012	0.303***	0.938***	1	5.168	8.311	8.81
Relation	0.121***	0.179***	0.403***	0.334***	2.948	2.917	1.26
Vcage	0.067***	0.095***	0.079***	0.038**	13.160	13.672	1.20
Vcsize	−0.002	0.019	−0.026	−0.021	6.374	0.922	1.01
stAge	0.234***	0.138***	0.015	0.024	2.998	0.791	1.08
Geop	−0.076***	−0.058***	−0.148***	−0.126***	0.332	0.471	1.15
Type	−0.116***	−0.053***	0.123***	0.098***	0.586	0.493	1.12
Fund	0.033*	0.021	0.134***	0.069***	1.349	0.528	1.28
Variable	relation	vcage	vcsize	stage	geop	type	fund
Relation	1						
Vcage	−0.043**	1					
Vcsize	−0.057***	0.018	1				
Stage	0.101***	0.014	0.039**	1			
Geop	−0.095***	−0.098***	0.004	−0.079***	1		
Type	0.036*	−0.018	0.011	−0.201***	0.206***	1	
Fund	0.091***	0.378***	−0.011	−0.060***	−0.245***	0.026	1

Note: *, **, *** indicate the level of significance of 10%, 5%, and 1%, respectively.

5 Regression Results

Table 2 presents the analysis results of the intrinsic influence mechanism of China's venture capital network embedding on investment performance under the mediatory role of organizational learning. The first step models 1–3 in Table 2 test whether centrality, structural hole, and relationship embedding have a significant relationship with investment performance. Then, coefficient c is obtained. In the second step model 4–6, heterogeneous knowledge learning is used as the dependent variable, and centrality, structural hole, and relationship embedding are sequentially used as independent variables to obtain coefficient a. In the third step model 7–9, investment performance is used as the dependent variable, centrality, structural hole, and relationship embedding are used as independent variables, and heterogeneous knowledge learning is used as a mediating variable. Simultaneously, the independent variables and the mediating variables are placed into the model. The first and third steps are estimated using the OLS method, and the second step is estimated using the Logit method. The Wald chi2 (F value) statistic for all models is significant at the 0.01 level, indicating that each measurement model has statistical power. Table 3 is a Sobel test of the mediating effect.

Table 2. Mediating effect results of organizational learning

	model	first step			second step			third step		
		1	2	3	4	5	6	7	8	9
	DV		performance			Hete			performance	
CV	vcage	0.0025	0.0026	0.0049	0.0018***	0.0018***	0.0021***	0.0029	0.0029	0.0054
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	vcsize	-0.0476	-0.0488	-0.0327	0.0054	0.0051	0.006	-0.0475	-0.0488	-0.0322
		(0.05)	(0.05)	(0.05)	(0.00)	(0.00)	(0.00)	(0.05)	(0.05)	(0.05)
	stage	0.7797***	0.7776***	0.7672***	0.0126**	0.0127**	0.0072	0.7808***	0.7785***	0.7673***
		(0.07)	(0.07)	(0.07)	(0.01)	(0.01)	(0.01)	(0.07)	(0.07)	(0.07)
	geop	-0.139	-0.1498	-0.1247	0.0006	-0.0018	-0.0092	-0.1398	-0.1508	-0.1277
		(0.11)	(0.11)	(0.11)	(0.01)	(0.01)	(0.01)	(0.11)	(0.11)	(0.11)
	type	-0.4902***	-0.4716***	-0.4913***	-0.0235***	-0.0198**	-0.0078	-0.4966***	-0.4759***	-0.4951***
		(0.10)	(0.10)	(0.10)	(0.01)	(0.01)	(0.01)	(0.10)	(0.10)	(0.10)
	fund_2	-0.1504	-0.1245	-0.1937	-0.0064	0.0019	0.0053	-0.1521	-0.1245	-0.1925
		(0.13)	(0.12)	(0.13)	(0.01)	(0.01)	(0.01)	(0.13)	(0.12)	(0.13)
	fund_3	0.1943	0.1925	0.1711	0.0126	0.0133	0.0086	0.1945	0.1928	0.1692
		(0.29)	(0.29)	(0.29)	(0.02)	(0.02)	(0.02)	(0.29)	(0.29)	(0.29)
	cons	-4.3314***	-4.2684***	-4.4868***	0.5045***	0.5136***	0.5337***	-4.1891***	-4.1565***	-4.3005***
		(0.46)	(0.46)	(0.46)	(0.05)	(0.06)	(0.06)	(0.49)	(0.49)	(0.49)
IV	degree	13.5515**			6.6268***			14.9704***		
		(5.51)			(0.55)			(5.61)		
	effsize		0.0098*			0.0062***			0.0109*	

(continued)

Table 2. (*continued*)

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
			(0.01)			(0.00)			(0.01)	
	relation			0.0922^{***}			0.0119^{***}			0.0951^{***}
				(0.02)			(0.00)			(0.02)
MV	hete							-0.2213	-0.1717	-0.2691
								(0.22)	(0.22)	(0.22)
Wald chi2/F		323.70^{***}	322.21^{***}	335.05^{***}	34.37^{***}	34.43^{***}	44.78^{***}	325.08^{***}	323.18^{***}	337.10^{***}
Pseudo R2/R2		0.1224	0.1215	0.1312	0.2471	0.2374	0.2194	0.1228	0.1217	0.1316
Log pseudolikelihood		-1432.00	-1433.52	-1417.77				-1431.49	-1433.21	-1416.99
model		Logit	Logit	Logit	OLS	OLS	OLS	Logit	Logit	Logit
N		2935	2935	2935	2935	2935	2935	2935	2935	2935

Note: Robust standard errors are in parentheses; *, **, *** indicate the level of significance of 10%, 5%, and 1%; respectively; all models control industry-fixed effects and time-fixed effects.

Table 3. Sobel test

Hypothesis	cov(X,M)	SD(Y‘)	SD(Y“)	ab^{std}	$SE(ab^{std})$*	$z = ab^{std}/SE(ab^{std})$
H2a	0.0007	1.6541	1.6553	−0.2179	23188.7103	9.3949
H2b	0.6200	1.6483	1.6488	−0.0002	0.0201	7905.6886
H2c	0.1287	1.6811	1.6823	−0.0005	0.0729	6417.5601

Note: SE(abstd)* is the corresponding value × 10–6.

Tables 2 indicate that model 1 in the first step test shows that a significant positive relationship exists between centrality and investment performance ($c = 13.5515$, $P < 0.05$), assuming H1a is supported; model 4 in the second step test shows that centrality has a significant positive impact on heterogeneous knowledge learning ($a = 6.6268$, $P < 0.01$); in the third step test, model 7 shows that after adding the independent and mediating variables, only the coefficient of the independent variable is significant ($c = 14.9704$, $P < 0.01$). According to the previous mediation effect process, the Sobel test in Table 4 shows that $|z| = 9.3949$, which is greater than 1.96, assuming that H2a is supported. Similarly, model 2 in the first step test shows that a significant positive relationship exists between structural holes and investment performance ($c = 0.0098$, $P < 0.1$), assuming H1b is supported. In the second step, model 5 shows that the structural holes have a significant positive impact on heterogeneous knowledge learning ($a = 0.0062$, $P < 0.01$). In the third step test, model 8 shows that after adding the independent variable structure hole and the mediating variable heterogeneity knowledge learning, only the coefficient of independent variable is significant ($c‘ = 0.0109$, $P < 0.1$). According to the previous mediation effect process, the Sobel test in Table 4 shows that $|z| = 7905.6886$, greater than 1.96, assuming H2b is supported. In the first step, model 3 shows that a significant positive relationship exists between relationship embedding and investment performance ($c = 0.0922$, $P < 0.01$), assuming H1c is supported. In the second step, model 6 shows that structural holes have a significant positive impact on heterogeneous knowledge learning ($a = 0.0119$, $P < 0.01$). In the third step test, model 9 shows that after adding the independent variable, relationship embedding and mediating variable, heterogeneity knowledge learning, only the coefficient of independent variable is significant ($c‘ = 0.0951$, $P < 0.01$). According to the previous mediation effect process, the Sobel test in Table 4 shows that $|z| = 6417.5601$, which is greater than 1.96, assuming that H2c is supported. At this time, the mediatory effect of heterogeneous knowledge learning on the relationship between network embedding and investment performance has been supported.

As for the control variables, the age of investment institutions has no significant positive correlation with investment performance, and the age of investment institutions has a significant positive correlation with heterogeneous knowledge learning, indicating that as the age of institutions increases, the heterogeneity of knowledge learned by investment institutions increases, leading to the diversification of investment industry. The scale of investment institutions and investment performance has no significant negative correlation, and no significant positive relationship exists with the learning performance of heterogeneous knowledge learning. The investment stage and investment performance show a significant positive correlation, indicating that in the later stage, with the increase of information and stability of investment, the probability of successful exit of investment institutions significantly improves. The learning performance of investment stage and heterogeneous knowledge shows unsteady positive correlation, which means that with the development of investment stage, the accumulation of investment institution experience, and the grasp of market sensitivity, the investment institution tends to adopt the differentiation strategy.

6 Conclusion and Enlightenment

On the basis of the organizational learning and social network theories, this study conducts theoretical analysis and empirical research on the mechanism of the impact of network embedding on the performance of China's venture capital institutions and examines the mediating effects of different knowledge attributes. The main conclusions are as follows:

(1) In the study of the relationship between network embedding and investment performance, network embedding has a positive and significant impact on investment performance. From the perspective of structural embeddedness, investment institutions located at the center of the network have more information sources and opportunities to contact new information and enjoy more superiority, privilege, identity, and reputation. Thus, centrality can remarkably improve the performance of investment. Investment institutions occupying the positions of structural holes have access to broader information and knowledge, have the right of control and priority to use information, and can effectively reduce transaction costs and improve core business, thus improving investment performance. Relational embeddedness is conducive to the establishment of mutual trust, joint problem solving, and information sharing mechanisms, improving the transfer of knowledge, as well as the common encoding of tacit knowledge. It also reduces the opportunistic behavior of network investment funding institutions, which is conducive to improve the performance of investment institutions.

(2) The study also discovers the mediating role of heterogeneous knowledge learning. The learning of knowledge undergoes two stages: access and acquisition. Structural embeddedness provides knowledge and information search channels for the institution. Located at the center position, the investment institutions have direct contact with more information channels, which may come into contact with the heterogeneity of knowledge and information. Investment institutions that occupy the location of the structure hole have the advantage of information control, with more non-redundant information channels. Relational embeddedness provides the possibility for the transfer of heterogeneous knowledge searched through structural embedding. In the context of China with relationship governance characteristics, only with a strong relationship with frequent and close contacts can investment institutions be guaranteed to acquire knowledge. Investment institutions that learn heterogeneous knowledge through network embedding can effectively cope with market fluctuations, and more diversified investment opportunities can be obtained

to adapt to market trends, which is more conducive to the improvement of investment performance and is consistent with the research conclusion of Du Qianqian (2009) [51].

The conclusions of this paper have important theoretical implications for China's venture capital institutions network practice:

(1) Investment institutions should expand their knowledge network, strengthen collaborations with other investment institutions, upgrade the center position of their networks, increase the number of structural holes, eliminate the edge of the network position, strengthen liaison with other agencies, improve trust between organizations, improve information sharing, strengthen organizational learning capability, enhance search and transfer ability, and promote investment performance.
(2) To improve investment performance effectively, investment institutions should pay more attention to heterogeneous knowledge learning. Investment institutions should use network sources rationally, improve their center position, and increase structural holes, searching for more heterogeneous knowledge opportunity. Through relationship embedding, trust relationship, information sharing and problem-solving mechanisms among investment institutions are established to improve the ability to utilize heterogeneous knowledge and promote the improvement of investment performance.

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