ENTERPRISE KNOWLEDGE HETEROGENEITY AND INNOVATION DIFFUSION: MULTIPLE MEDIATING EFFECTS OF KNOWLEDGE SHARING

ABSTRACT

Innovation diffusion is increasingly considered to be the root of the overall economic growth and technological progress. Enterprise knowledge heterogeneity will affect the understanding, absorption and utilization of knowledge, thus affecting the diffusion of innovation. This study aims to explore the impact of enterprise knowledge heterogeneity on innovation diffusion and the multiple mediating effects of knowledge sharing in this relationship. We rely on structural equation model method to test our theoretical model using a sample of 200 high-tech enterprises in Northeast China. The data are mainly collected through questionnaires. The empirical analysis leads to two key findings: (1) Enterprise knowledge heterogeneity positively affects the innovation diffusion. (2) Explicit knowledge sharing and tacit knowledge sharing play multiple mediating effects in the relationship between enterprise knowledge heterogeneity and innovation diffusion. Tacit knowledge sharing can directly promote the positive relationship between knowledge heterogeneity and innovation diffusion. Whereas explicit knowledge sharing can not only directly promote innovation diffusion, but also indirectly promote innovation diffusion through affecting tacit knowledge sharing. Together, these findings provide theoretical explanation and reference for enterprises to promote innovation diffusion by using heterogeneous knowledge.

Key words: Knowledge heterogeneity; explicit knowledge sharing; tacit knowledge sharing; innovation diffusion

INTRODUCTION

In the "made in china 2025" and "innovation-driven development" of the tide of the times, more and more enterprises are entering the active period of innovation. However, there is still a big gap between the levels of innovation among enterprises. Facts proved that it was difficult for companies to obtain continuous innovation just relying on their own technical basis. In order to break through the limitations of technical resources and R&D capabilities, to get rid of the "hurdle effect" constraints, it is essential to promote innovation diffusion, which can achieve the extensive adoption and promotion of innovative achievements and obtain leap-forward development (Chengdu & LIAO Zhigao, 2004). In recent years, innovation diffusion has increasingly been regarded as the root of national economic growth and technological progress (Andergassen R *et al.*, 2016). Effective innovation diffusion can not only give full play to the scale of innovation and achieve the social value of innovation, but also can lead to

imitation of innovation and secondary innovation in the process of innovation being adopted continuously(Zhang B *et al.*, 2002).

The researches on the diffusion of innovation have been carried out and deepened continuously in the field of agricultural sociology, education, marketing and other fields, which have never declined. In general, the traditional research on diffusion of innovation focused on two aspects: Macroscopic Perspective Diffusion Model and Individual Decision Model based on microscopic perspective. The former is based on the Bass model and has been improved in the explanatory validity of the model by constantly introducing new parameters (Bass F M, 1969; Bass F M et al., 1994; Iyengar R *et al.*, 2010; Guidolin M *et al.*, 2014). However the macro diffusion model is easy to treat consumers as homogeneous, which ignores the possible interaction between individual decisions, and does not take the role of network structure in diffusion into account. In consideration of the shortcomings of the macro diffusion model, the individual decision model begins to focus on the behaviour of potential adopters in decision-making (Chatterjee R A *et al.*, 1990; Duan M S *et al.*, 2001; Young H P, 2009; M Song *et al.*, 2016; Yong-Hong M *et al.*, 2016; Huang W Q *et al.*, 2013), the research based on network structure and heterogeneity has begun to become a new trend. Accordingly the application of social network, simulation, game and other methods on the basis of multi-agent model and cellular automaton model have been developed. Although micro-perspective research methods emerge in an endless stream, they failed to provide the overall diffusion model for innovation industries (Huang Weiqiang & Zhuang Xintian, 2007). At the same time, such studies always assume that there are same relationships between social individuals, which ignore the fact that there is no influence between individuals, nor distinguish individuals who have significant influence such as opinion leaders. This leads to the phenomenon of network homogenization (Bohlmann J D *et al.*, 2010). Throughout the study of the diffusion model, the neglect and inadequate consideration of the influencing factors of heterogeneity will, to some extent, lead to the limitations of the study.

According to E.M.Rogers's theory of innovation diffusion, in the process of popularizing and diffusing new achievements, mass communication and interpersonal communication are both promoted to effectively provide knowledge and information related to innovation 、 reduce innovation uncertainty 、 persuading people to adopt innovation. The problem of heterogeneity in diffusion is, in the final analysis, due to differences in the educational background, socioeconomic status and other attributes of the promoters and potential adopters, this difference has led directly to their different perceptions and experiences of innovation (ROGERS Everett M, 2016). Enterprise is the subject of innovation diffusion and the carrier of organizational knowledge. In the process of innovation diffusion, it is necessary to communicate innovative ideas whether they act as an innovation promoter or a potential adopter of innovation. And the heterogeneous communications are largely due to the knowledge of their own heterogeneities. However, little research has examined the mechanism of knowledge heterogeneity on the innovation diffusion. In fact, innovation diffusion is essentially the dissemination and

diffusion of knowledge (SHAO Yunfei *et al.*, 2010), giving full play to the advantage of heterogeneous knowledge can't be separated from effective knowledge sharing. As the path of innovation diffusion, knowledge sharing is the premise and guarantee of innovation diffusion, and its effectiveness directly affects the performance of innovation diffusion. To this end, we develop a multiple mediating theory model by taking knowledge sharing as a mediator variable, which aims to reveal the mechanism of enterprise knowledge heterogeneity on innovation diffusion and the differences in the role of different types of knowledge sharing, so as to further improve the existing research system. Furthermore, this study will also provide an effective theoretical basis and practical reference for promoting innovation diffusion and knowledge flow within heterogeneous enterprises.

LITERATURE REVIEW AND RESEARCH HYPOTHESIS

Knowledge heterogeneity and innovation diffusion

Enterprise knowledge heterogeneity refers to the degree of diversification and differentiation of employees in the educational attributes, professional skills, professional experience and other knowledge attributes (Tiwana A & Mclean E R, 2005; Jehn K A *et al.*, 1999; Rodan S & Galunic C, 2004). Thus, employees are the carriers and creators of enterprise knowledge, and the heterogeneous knowledge of enterprises is born from diversified knowledge scattered among different employees. Diffusion refers to the process of spreading innovation in specific groups by through specific channels in a specific time according to E.M.Rogers's definition of innovation diffusion. Generally speaking, the diffusion of an innovation, first of all, is the process in which knowledge、 information and experience are first accepted and understood by potential adopters. When the heterogeneity of enterprise knowledge is large, on the one hand, enterprises are more confident of their own development capabilities and scope of exploration (Argyres N., 2015), and their uncertainty about innovation is relatively low. So it is easier for them to adopt and digest innovation. On the other hand, complementary knowledge between heterogeneous members can create power and progress in the process of innovation (Nissen H A *et al.*, 2014). Interestingly, most innovative firms do not see management heterogeneity as governance costs, but as opportunities to perform more innovative initiatives (Tsai F S, 2016), which can increase the potential possibility of enterprises to explore new knowledge combinations and new solutions. To a certain extent, it makes the smooth implementation of the secondary innovation possible and thus accelerating the depth of innovation diffusion. At the same time, there is always a "johny window" between human, the innovation diffusion is largely heterogeneous communication (ROGERS Everett M, 2016). When the enterprise internal knowledge heterogeneity is large, the "open area" that the adopters understand and so do innovators, tends to be larger. In this way diffusion is more close to homogenization communication in a certain dimension. And this will speed up the innovation diffusion.

In conclusion, the following hypothesis is proposed:

H1: knowledge heterogeneity is positively related to innovation diffusion.

Knowledge sharing and innovation diffusion

Knowledge sharing refers to the process in which an individual is willing to share knowledge acquired or created by himself with others in the organization (Gibbert M & Krause H, 2002). This process can be done directly through communications or indirectly through some knowledge bases(Bock G W *et al.*, 2005). Based on the perspective of epistemology, knowledge can be divided into explicit knowledge and tacit knowledge. Explicit knowledge refers to the knowledge that can be encoded, whereas tacit knowledge rooted in human experience, behaviour and ideas, is difficult to be encoded. In view of this, this paper divides knowledge sharing into two types: explicit knowledge sharing and tacit knowledge sharing. The former is mainly implemented in the organization through channels such as documents, manuals and databases, and the latter is more dependent on the communication and interaction among the members of the organization. Innovative diffusion is a special type of communication and is a process which participants release and share information about innovation in order to understand each other (ROGERS Everett M, 2016). Adequate knowledge sharing can maximize returns by promoting innovation outcomes(Taylor W A, Wright G H & Shittu A J K, 2004). Li Hongyan *et al.* (2004) argue that the exchange and sharing of knowledge through formal or informal learning interactions facilitates the diffusion of innovative knowledge. This allows companies to understand the innovation outcomes more thorough, which will contribute to reducing the risk of uncertainty of innovation and thus easier for companies to adopt innovation. Specifically, explicit knowledge sharing is conducive to employees constantly learning the common knowledge within the enterprise, which is the basis for maximizing the homogeneous communication among employees and can reduce or facilitate the disagreement in the process of communicating innovative ideas. In addition, explicit knowledge sharing helps employees to constantly understand the strategic direction of the enterprise, share the vision and mission of the enterprise and act concertedly in the process of promotion or adoption of innovation. Studies indicate that to make the innovation process between heterogeneous team members efficient, it is especially important to share the knowledge base (Juan A *et al.*, 2007; Sapsed J *et al.*, 2002). Tacit knowledge sharing is an important motivator for generating or digesting new ideas. Some scholars concluded from the experience of BP and IBM in knowledge sharing that good communication among employees can help spread the technological achievements and even stimulate a new round of technological progress (Lu Lin & Liang Xueling, 2009).

In conclusion, the following hypothesis is proposed:

H2: knowledge sharing is positively related to innovation diffusion.

H2a: explicit knowledge sharing is positively related to innovation diffusion.

H2b: tacit knowledge sharing is positively related to innovation diffusion.

Analysis of multiple mediating effects and theoretical model

The differentiation of employees' knowledge constitutes the driving force of knowledge sharing and also the premise of knowledge sharing. Aranda *et al.* (2002) find that different perspectives and sources of knowledge can effectively facilitate the interaction among knowledge stakeholders and encourage them to come up with novel concepts and ideas. Gronum *et al.* (2012) argue that managers with heterogeneous educational backgrounds and experience are more likely to stimulate knowledge exchange and learning. For employees with low knowledge stock, knowledge heterogeneity will greatly stimulate learning motivation and information collection ability of team members in an organization with large knowledge differentiation (Brodbeck F C *et al.*, 2002). For employees with high knowledge stock, more diverse knowledge and skill resources can increase their willingness to share knowledge with team members due to the need for collaboration and win-win(Tsai F S, 2005). Moreover, the unique knowledge possessed by such employees tends to have higher sharing value, which makes knowledge sharing have the basic resource conditions (DUAN Guang & YANG Zhong, 2002). When knowledge heterogeneity is large, the enterprise will promote the coding of knowledge more actively in order to facilitate the management. Therefore, on the one hand, employees can quickly find out and fill vacancies through explicit knowledge sharing. On the other hand, On the other hand, tacit knowledge with higher shared value will be obtained by mutual communication.

Of course, explicit knowledge sharing and tacit knowledge sharing are not completely synchronized. The realization of tacit knowledge sharing often requires knowledge recipients to observe, imitate and practice, which takes a long time and a certain degree of knowledge base. In contrast, explicit knowledge sharing is easier to achieve. It has been shown that the intention of employees to share explicit knowledge leads to the intention of sharing tacit knowledge, and there is a positive correlation between the two (Reychav I & Weisberg J, 2010). The same is true in the actual sharing behaviour. On the one hand, effective explicit knowledge sharing can rapidly reinforce the knowledge base, which makes knowledge recipients feel more capable of absorbing tacit knowledge (Reychav I & Weisberg J, 2010). On the other hand, explicit knowledge sharing tends to work faster. This self-efficacy accumulated from explicit knowledge sharing activities can motivate employees to try more complex tacit knowledge sharing. In all, explicit knowledge sharing has created a good knowledge base and positive psychological implications for promoting tacit knowledge sharing.

According to the knowledge base view, enterprise is a knowledge processing system. The knowledge within the enterprise is man-made carrier, and integrated and created through knowledge sharing (Zhan Zhengqun & Li Fei, 2006). As a connecting link between the upper and the lower in the relationship between enterprise knowledge heterogeneity and innovation diffusion, the effect of knowledge sharing is mainly reflected in the following two aspects. First, when the enterprise knowledge heterogeneity is low, employees tend to work hard alone to digest innovative knowledge, which will reduce the speed of innovation diffusion. When there is a big difference between employees, the level of

understanding of innovative knowledge is obviously different. This will lead employees to formal or informal exchange and sharing in search of unification of innovative knowledge and so as to promote the diffusion of innovation. Second, employees with heterogeneous knowledge tend to have different cognitive systems and psychosocial characteristics, which makes the ways and means of perceiving problems vary from person to person and a variety of solutions tend to be produced (Smith K G, Collins C J & Clark K D, 2005). In this case, enterprises are more likely to share knowledge to seek for rapid digestion of innovation or even re-innovation.

In all, both explicit knowledge sharing and tacit knowledge sharing require the premise and driving force played by knowledge heterogeneity. The higher enterprise knowledge heterogeneity is , the more efficient knowledge sharing can be achieved and the more innovative knowledge can be acquired and absorbed by employees. This knowledge will further promote the innovation diffusion.

In conclusion, the following hypothesis is proposed:

H3: enterprise knowledge heterogeneity is positively related to knowledge sharing.

H3a: enterprise knowledge heterogeneity is positively related to explicit knowledge sharing.

H3b: enterprise knowledge heterogeneity is positively related to tacit knowledge sharing.

H4: knowledge sharing plays multiple mediating effects in the relationship between knowledge heterogeneity and innovation diffusion.

Based on the above assumptions, the theoretical model of this study is shown in Figure 1.
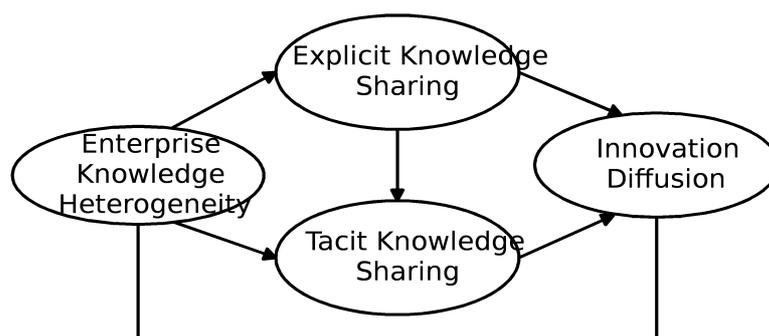

Figure 1: Theoretical Model

STATISTICS AND EMPIRICAL RESEARCH

Sample and data

On the basis of in-depth interview, the data in this paper is collected from questionnaires. Considering that innovation diffusion is relatively active in high-tech enterprises, the research object of this paper is mainly the high-tech

enterprises in Northeast China. In order to ensure the recovery rate and quality of the questionnaire, before the formal research, the author issued 50 trial questionnaires on Taidu 8, a professional survey website, and revised and perfected the respondents' questions. In the process of formal distribution, questionnaires such as face to face and e-mail have been chosen. A total of 400 questionnaires were issued and 302 questionnaires were recovered, among which 200 were valid questionnaires, and the recovery rate and the effective questionnaire rate were 75.5% and 66.2% respectively.

Among the enterprises surveyed, from an industry point of view, IT manufacturing enterprises accounted for 42.2%, the automotive industry enterprises accounted for 13.5%, accounted for 18.2% of new material industry, bio pharmaceutical industry accounted for 9.5%, accounted for 8.4% of the telecommunications equipment industry, machinery manufacturing industry accounted for 8.2%. Seeing from the nature of enterprises, state-owned enterprises accounted for 30.2%, private enterprises accounted for 43.5%, joint ventures accounted for 20.7%, foreign-funded enterprises accounted for 5.6%. Seeing from the scale of enterprises, micro enterprises accounted for 7%, small enterprises accounted for 25%, medium-sized enterprises accounted for 49%, and large enterprises accounted for 19%. According to the data above, the research objects are mainly high-tech enterprises and the distribution of industry, nature and scale of enterprises is reasonable. Therefore, the sample has some representation and is more suitable for this study.

Variable measurement

Measurement of enterprise knowledge heterogeneity (KH). This paper, based on the scale of Campion M A *et al.* (1993), set up three questions to measure the differences among employees in three areas, including professional field, background experience and personal skills.

Measurement of knowledge sharing (KS). Based on the scales of Hooff B V D & Ridder J A D (2004) and Bock G W *et al.* (2005), the scale of knowledge sharing in this paper made appropriate changes and divided knowledge sharing into two dimensions: explicit knowledge sharing (EKS) and tacit knowledge sharing (TKS), each of which was measured by 4 items .

Measurement of innovation diffusion (ID). ROGERS Everett M (2016) argues that the concern of diffusion is mainly about the speed of diffusion. To this end, based on the scale developed by ZHAO Zhonghua (2012) to measure the speed of innovation diffusion, this paper revised and streamlined it into 3 items which mainly measured the speed of enterprises in deciding to adopt innovation, understanding and digestive innovation knowledge, integrating digested innovation knowledge with existing knowledge. At the same time, based on the research of ROGERS Everett M (2016), two items were added: the situation that enterprises develop new products or services after absorbing innovation, and the situation that enterprises are actively re-innovating, which was to measure the depth and breadth of innovation diffusion. In all, the scale of innovation diffusion in this paper set up five questions.

The Likert7 scale was used to measure the extent to which respondents were in accordance with the actual situation of the enterprise about all questions in the survey. the higher the score the higher the variable level. Respondents were selected between "totally inconsistent, inconsistent, less consistent, difficult to determine, more consistent, consistent, fully consistent", and their corresponding scores were 1-7.

Reliability and validity test

SPSS19.0 and AMOS17 were used to test the reliability and validity of scales in this paper. The Cronbach's alpha coefficients of the variables KH, EKS, TKS and ID were 0.773, 0.826, 0.801 and 0.866 respectively, all of which were greater than 0.7, suggesting that each scale had a high internal consistency. At the same time, according to the further test on the combination reliability (CR), the combined reliability of the variables KH, EKS, TKS and ID were 0.773, 0.826, 0.816 and 0.870 respectively, which were both greater than 0.6, suggesting that the latent variables of the measurement model had good reliability.

Confirmatory factor analysis was used to measure the structural validity of each scale. First, the results show that the standardization load of each item is between 0.703 and 0.810, all of which were both higher than 0.5 and reached the significance level of 0.001, suggesting that the factors selected by each variable were effective and had the polymerization validity. Second, the average extraction variation (AVE) values of each latent variable were 0.532, 0.543, 0.526 and 0.573 respectively, all of which were greater than 0.5. Except for the correlation coefficient between EKS and ID, the correlation coefficients between the other variables were all lower than the square root of their AVE values, suggesting that the variable metrics were effective and had discriminant validity. Furthermore, the fitting index of all the variables reached the standard. The main fitting index of this research model satisfied: $\chi2 / df = 1.393$; RMSEA = 0.044; RMR = 0.033; GFI = 0.922; CFI = 0.981; TLI = 0.977; IFI = 0.981; PNFI = 0.765, suggesting that the overall fitness of the model were better. In summary, structural equation analysis could be further carried out.

RESULTS AND HYPOTHESIS TESTING

Descriptive statistical analysis

Table 1 reports the descriptive statistics and correlations. As can be seen, the enterprise knowledge heterogeneity, the explicit knowledge sharing and the tacit knowledge sharing were all positively correlated with the innovation diffusion. The enterprise knowledge heterogeneity was positively correlated with explicit knowledge sharing and tacit knowledge sharing. These data provided initial support for validating theoretical assumptions.

Table 1: Mean, Standard Deviation and Correlation Coefficients Matrix of the Variables

Variables	1	2	3	4
1.Enterprise Knowledge	1.000			

Heterogeneity				
2.Explicit Knowledge Sharing	0.556**	1.000		
3.Tacit Knowledge Sharing	0.668**	0.686**	1.000	
4.Innovation Diffusion	0.685**	0.749**	0.723**	1.000
Mean	5.021	5.010	4.262	4.800
Standard Deviation	0.812	0.936	0.798	0.841

Note: N=200, ** means $p < 0.01$.

Structural model test

Based on the hypothetical model, the "Specification Search" function of Amos17 was used to filter the model. With reference to the research of Pang Jiantao & Wen Ke (2017), several representative models were selected as the competitive comparison model in this paper, and the fit indices are shown in Table 2. Among them, the model M0 was the hypothetical model of this study. Competition model M1 deleted the EKS-TKS path and was a parallel multiple mediating model. Competition model M2 deleted the EKS-ID path and was a chain multiple mediating model. Competition model M3 deleted the KH-ID path and was a complete mediating model. Competition model M4 was a non-mediated model.

Table 2: Fit Indices of Different Models

Models	χ^2/df	GFI	CFI	TLI	IFI	PNFI	RMSEA
M0	1.393	0.922	0.981	0.977	0.981	0.765	0.044
M1	1.431	0.920	0.979	0.974	0.979	0.770	0.047
M2	1.427	0.920	0.979	0.975	0.979	0.771	0.046
M3	1.414	0.920	0.980	0.975	0.980	0.771	0.046
M4	7.428	0.746	0.672	0.618	0.675	0.552	0.180

As shown in Table 2, the fit indices of model M4 were not up to standard. Although the fitting indices of models M1, M2, M3 had little change compared with M0, all the three models showed significantly weaker or insignificant in terms of path coefficient significance. Specifically, the path KH-ID and EKS-ID were no longer significant in the model M1; the significance of the path KH-TKS became weaker and the path EKS-TKS was no longer significant in the model M2; the significance of path KH-TKS and EKS-TKS in model M3 was weakened. But structural equation model requires that each set of path relationships in the model should be as strong and significant as possible. Therefore, considering the model fitting and theoretical conformance, the hypothetical model M0 of this paper is the optimal model. Thus, the enterprise knowledge heterogeneity not only directly affects the innovation diffusion, but also indirectly affects it through explicit knowledge sharing and tacit knowledge sharing. At the same time, explicit knowledge sharing not only directly affects the innovation diffusion, but also positively affects the tacit knowledge sharing and finally acts indirectly on innovation diffusion. Figure 2 shows the hypothetical model fitting results in this paper and Hypothesis 1 to Hypothesis 3 were all supported.
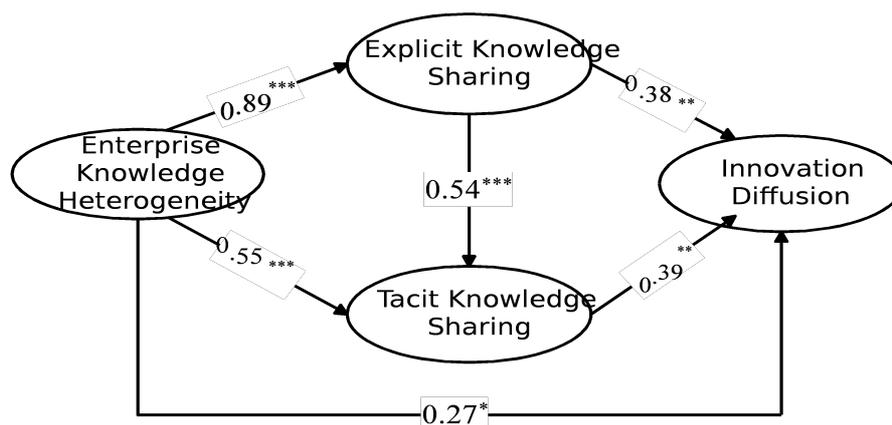
Figure 2: Fit results of the hypothesis model

Mediating effect test

The main methods to test the multiple mediating effects based on the structural equation model are Sobel's testing method and Bootstrap method. Sobel's testing method not only needs to meet the requirements of normality hypothesis and large sample, but also needs complex calculation procedures and manual calculation when estimating the interval of mediating effect (Fang Jie *et al.*, 2014). In contrast, the Bootstrap method has no specific requirements on the distribution and sample size of mediation effects, and can directly output the relevant estimates of mediating effects through software. Therefore, in order to avoid the limitations of Sobel's test, Bootstrap method based on Amos17 was used to test the significance of mediating effect.

The determinant condition of the Bootstrap method to test the significance of mediating effect is that the 95% confidence interval for the path factor does not contain zero. As can be seen from the data in Table 3, the 95% confidence intervals of the indirect effects of the three mediating paths did not contain zero, suggesting that the mediating effects of explicit knowledge sharing and tacit knowledge sharing were significant, and Hypothesis 4 was supported.

Table 3: Mediating Effect Test

Paths of Mediating Effect	Standardized Indirect Effect Estimation	95% Confidence Interval	
		Lower Bounds	Upper Bounds
KH-TKS	0.483	0.036	0.823
KH-ID	0.734	0.457	1.050
EKS-ID	0.210	0.030	0.597

Note: Bootstrap sampling number was set to 2000.

CONCLUSION AND RECOMMENDATIONS

This paper verifies the mechanism of enterprise knowledge heterogeneity on innovation diffusion by introducing knowledge sharing as a mediator variable and draws the following conclusions: (1) Enterprise knowledge heterogeneity positively influences innovation diffusion. This indicates that the increase of enterprise knowledge heterogeneity can promote innovation diffusion, which

further verifies the conclusion of Delre *et al.* (2007) that "the heterogeneity is positively correlated with innovation diffusion". Higher enterprise knowledge heterogeneity is not created out of thin air. It is often based on the gradual accumulation of knowledge and the strategic reserve of diversified employees, so that enterprises have a certain knowledge base and development ability to accept and digest unknown innovations. However, the diverse and complementary knowledge among employees not only generates momentum and progress in the innovation process, but tends to have more "open areas" to reduce barriers to heterogeneous communication when communicating with other companies for innovation , thus promoting the proliferation of innovation. (2) Knowledge sharing plays multiple mediating effects in the relationship between enterprise knowledge heterogeneity and innovation diffusion. This paper verifies the positive correlation between knowledge sharing and innovation diffusion as well as the positive correlation between knowledge heterogeneity and knowledge sharing, which agrees with Wu D *et al.* (2015) and further enriches their conclusions from the analysis perspectives of explicit knowledge sharing and tacit knowledge sharing. The results of multiple mediating effects show that the promotion effect of enterprise knowledge heterogeneity on explicit knowledge sharing and tacit knowledge sharing can promote innovation diffusion. Specifically, the implicit knowledge sharing can directly transmit the positive relationship between knowledge heterogeneity and innovation diffusion, whereas explicit knowledge sharing can not only promote innovation diffusion directly, but also indirectly promote innovation diffusion by affecting tacit knowledge sharing. In general, enterprise knowledge heterogeneity provides the premise and motivation for knowledge sharing. Explicit knowledge sharing creates a good knowledge base and positive psychological suggestion to promote tacit knowledge sharing, while knowledge sharing promotes the digestion and absorption of innovation view. Obviously, the interactive and collaborative process of the knowledge processing system laid the foundation for the smooth implementation of innovation diffusion.

The theoretical significance of this study is mainly manifested in: First, from the perspective of communication studies, discusses the mechanism of enterprise knowledge heterogeneity on innovation diffusion. Although Rogers has long pointed out that the problem of heterogeneity in diffusion ultimately results from the differences in their own attributes such as education background and socioeconomic status among innovators and potential adopters (ROGERS Everett M, 2016), few studies have investigated how this kind of difference influence innovation diffusion. Considering the differences in its own attributes largely due to the degree of heterogeneity of knowledge, this paper introduces enterprise knowledge heterogeneity as an important variable into the study of innovation diffusion, thus deepening and expanding the existing theoretical research system. Second, we propose a multiple mediating effects model that takes knowledge sharing as an intermediate variable. This paper finds out the difference between the two types of knowledge sharing behaviours, which are the explicit knowledge sharing and the tacit knowledge sharing, on the impact of innovation diffusion. It explores how the enterprise processes the knowledge

diffusion through the sharing of internal heterogeneity knowledge, thus, the effective combination of knowledge-based theory and innovation-diffusion theory is realized.

In the context of knowledge economy, this study has strong practical implications for enterprises on how to use diversified knowledge to promote innovation diffusion. First, enterprises should choose different diffusion strategies based on their degree of knowledge heterogeneity. As innovation diffusion plays a more and more significant role in technological progress in developing countries, the decision-making of enterprises for innovation diffusion is increasingly becoming a prerequisite for obtaining sustainable competitive advantage. Therefore, enterprises with larger knowledge heterogeneity should weigh their ability of digesting and exploring innovation achievements, carry out more aggressive diffusion of innovation and give full play to the advantages of knowledge heterogeneity. In particularly, enterprises with higher degree of knowledge diversification should avoid the "penguin effect" and fully play the role of opinion leaders to drive the wide dissemination of innovation achievements. For enterprises with less heterogeneity of knowledge, due to the rash adoption of innovations, they may suffer from the diffusion of "Waterloo". Thus, they should first promote the knowledge stock of enterprises from the inside through continuous introduction of talents with diversified knowledge, and then adjust the policy of adopting innovations or not constantly according to the qualitative talent pool plan. Second, enterprises should give full play to the role of knowledge sharing as a bridge between heterogeneous knowledge resources and innovation diffusion. On the one hand, enterprises should actively set up a knowledge sharing platform to encode knowledge and promote the effective sharing of explicit knowledge. For example, the use of information technology or third-party platform to establish an enterprise knowledge management system. Meanwhile, in the process of knowledge upgrading and continuous growth, enterprises should also make phased assessments to improve the operation efficiency of knowledge sharing platform continuously. On the other hand, enterprises should nurture the soil for knowledge sharing to encourage interpersonal communication among employees and promote tacit knowledge sharing. Consideration should be given to enriching staff exchange places and establishing knowledge sharing incentive mechanism. The former can be realized by creating an online employee experience exchange community and setting up employee rest area and fitness area. The latter requires public praise, remuneration and promotion incentives for effective practitioners of knowledge sharing so that employees can gain a stronger self-efficacy so as to be more actively engaged in communication and exchange activities among colleagues. At the same time, organizing employees to conduct their own knowledge management system operation training or participate in the authority of knowledge management courses, are also effective strategies to enhance employee knowledge-sharing capabilities and thus promote innovation diffusion.

The limitations of this study and future research directions are: First, in the sample collection, this paper selected cross-industry sample data, which limited the paper as a universal study, thus, future research can further examine the

impact of enterprise knowledge heterogeneity in different industries on innovation diffusion, so as to provide more specific guidance on innovation diffusion practice in different industries. Second, although this study considers both the impact of knowledge heterogeneity on innovation diffusion and the mediating effect of knowledge sharing, it is still a single dimension research. Future research can focus on the dynamic impact of enterprise knowledge heterogeneity on innovation diffusion and the influence mechanism of multidimensional knowledge heterogeneity on innovation diffusion so that the related theories can be further deepened and improved.

ACKNOWLEDGEMENTS

REFERENCES

Andergassen R, Nardini F, Ricottilli M, (2016), Innovation diffusion, general purpose technologies and economic growth. Structural Change & Economic Dynamics, 40:72-80.

Aranda D A, Molina-Fernández L M, (2002), Determinants of innovation through a knowledge-based theory lens. Industrial Management & Data Systems, 102(5):289-296.

Argyres N, (2015), Capabilities, technological diversification and divisionalization. Strategic Management Journal, 17 (5) :395-410.

Bass F M, (1969), A new product growth model for consumer durables. Springer Berlin Heidelberg: Models in Marketing.

Bass F M, Krishnan T V, Jain D C, (1994), Why the bass model fits without decision variables. Marketing Science, 13(3):203-223.

Bock G W, Zmud R W, Kim Y G, (2005), Behavioral Intention Formation in Knowledge Sharing: Examining the Roles of Extrinsic Motivators, Social-Psychological Forces, and Organizational Climate. Mis Quarterly, 29(1):87-111.

Bohlmann J D, Calantone R J, Zhao M, (2010), The effects of market network heterogeneity on innovation diffusion: an agent-based modeling approach. Journal of Product Innovation Management, 27(5):741–760.

Brodbeck F C, Kerschreiter R, Mojzisch A, (2002), The dissemination of critical, unshared information in decision-making groups: the effects of pre-discussion dissent. European Journal of Social Psychology, 32(1):35-56.

Campion M A, Medsker G J, Higgs A C, (1993), Relations between work group characteristics and effectiveness: Implications for designing effective work groups. Personnel Psychology, 48(3) : 823–855.

Chatterjee R A, Eliashberg J, (1990), The innovation diffusion process in a heterogeneous population: a micromodeling approach. Management Science, 36(9):1057-1079.

Chengdu, LIAO Zhigao, (2004), Model for innovation diffusion rate. Chinese Journal of Management, 1(3):330-340

Delre S A, Jager W, Janssen M A, (2007), Diffusion dynamics in small-world networks with heterogeneous consumers. Computational and Mathematical Organization Theory, 13(2) : 185-202.

DUAN Guang, YANG Zhong, (2014), Would knowledge diversity promote team innovation? An analysis based on mediated moderator model. Chinese Journal of Management, 11(1):86-94.

Duan M S, Zhang X L, Shu-Hua G U, (2001), An innovation diffusion model based on individual decision-making. Systems Engineering-theory & Practice, 21(6):46-51.

Fang Jie , Wen Zhonglin , Zhang Minqiang , Sun Peizhen, (2014), The analyses of multiple mediation effects based on structural equation modeling. Journal of Psychological Science, 37(3) : 735-741.

Gibbert M, Krause H, and T. H. Davenport, G. J. B. Probst, (eds.), (2002), Practice Exchange in a Best Practice Market place. Knowledge Management Case Book: Siemens Best Practices, pp. 89-105. Germany: Publicis Corporate Publishing, Erlangen.

Gronum S, Verreynne M L, Kastelle T, (2012), The role of networks in small and medium-sized enterprise innovation and firm performance. Journal of Small Business Management, 50(2):257–282.

Guidolin M, Guseo R, (2014), Modelling seasonality in innovation diffusion. Technological Forecasting & Social Change, 86(86):33-40.

Hooff B V D, Ridder J A D, (2004), Knowledge sharing in context: the influence of organizational commitment, communication climate and CMC use on knowledge sharing. Journal of Knowledge Management, 8(6) : 117-130.

Huang W Q, Yao S, Zhuang X T, (2013), The agent-based simulation of innovation diffusion based on complex social networks. Studies in Science of Science , 31(2):310-320.

Huang Weiqiang, Zhuang Xintian, (2007), Study of innovation diffusion by using stochastic network. Chinese Journal of Management, 4(5):622-627.

Iyengar R, Bulte C V D, Valente T W, (2010), Opinion leadership and social contagion in new product diffusion. Marketing Science, 30(2):195-212.

Juan A. Marm-Garcia, Elena Zarate-Martinez, (2007), A theoretical review of knowledge management and teamworking in the organizations. International Journal of Management Science & Engineering Management, 2(4):278-288.

Jehn K A, Northcraft G B, Neale M A, (1999), Why differences make a difference: a field study of diversity, conflict, and performance in workgroups. Administrative Science Quarterly, 44(4):741-763.

Li Hongyan, Chu Xuelin, Chang Bao, (2004), Social capital and technology innovation diffusion. Studies in Science of Science, 22(3):333-336.

Lu Lin, Liang Xueling, (2009), The mediating effect of knowledge sharing between interpersonal interactions and innovation. Nankai Business Review, 12(1):118-123.

M Song, P Wang, (2016), Modified micro decision-making innovation diffusion model based on individual innovative relative index. Systems Engineering-Theory & Practice, 36(4):1003-1013.

Nissen H A, Evald M R, Clarke A H, (2014), Knowledge sharing in heterogeneous teams through collaboration and cooperation: Exemplified through Public–Private-Innovation partnerships. Industrial Marketing Management, 43(3):473-482.

Pang Jiantao, Wen Ke, (2017), Effect of proactive personality on employee innovative behavior and its mechanism. Science Research Management, 38(1)：12-20.

ROGERS Everett M, (2016), Diffusion of Innovations. Beijing: Electronics Industry Press.

Rodan S, Galunic C, (2004), More than network structure: how knowledge heterogeneity influences managerial performance and innovativeness. Strategic Management Journal, 25(6):541-562.

Reychav I, Weisberg J, (2010), Bridging intention and behavior of knowledge sharing. Journal of Knowledge Management, 14(2):285-300.

SHAO Yunfei, FAN Qunlin, TANG Xiaowo, (2010), Study on competitive diffusion model of innovations in industry clusters. Science of Science and Management of S.&.T., 31(12):43-49.

Sapsed J, Bessant J, Partington D, et al, (2002), Teamworking and knowledge management: a review of converging themes. International Journal of Management Reviews, 4(1):71-85.

Smith K G, Collins C J, Clark K D, (2005), Existing knowledge, knowledge creation capability, and the rate of new product introduction in high-technology firms. Academy of Management Journal, 48(2):346-357.

Tiwana A, Mclean E R, (2005), Expertise integration and creativity in information systems development. Social Science Electronic Publishing, 22(1):13-43.

Tsai F S, (2016), Knowing what we know differently: knowledge heterogeneity and dynamically ambidextrous innovation. Journal of Organizational Change Management, 29(7):1162-1188.

Tsai F S, (2005), Composite diversity, social capital, and group knowledge sharing: a case narration. Knowledge Management Research & Practice, 3(4):218-228.

Taylor W A, Wright G H, Shittu A J K, (2004), Organizational readiness for successful knowledge sharing: challenges for public sector managers. Information Resources Management Journal, 17(2):22-37.

Wu D, Liao Z, Dai J, (2015), Knowledge heterogeneity and team knowledge sharing as moderated by internal social capital. Social Behavior & Personality An International Journal,43(3) : 423-436(14).

Young H P, (2009), Innovation diffusion in heterogeneous populations: contagion, social influence, and social learning. American Economic Review, 99(5):1899-1924.

Yong-Hong M , Wang Z Z, Huan L I, et al, (2016), Network structure, adopters preference and innovation diffusion: a simulation analysis of the S-D model of innovation diffusion based on the decision making process of adopters. Operations Research & Management Science, 25(3):106-116.

Zhang B, Yang G Y, Rong G H, (2002), Applications of diffusion models for internet consumer analysis. Chinese Journal of Management Science, 10(2):51-56.

Zhan Zhengqun, Li Fei, (2006), Knowledge-based view of the firm: an open dynamic perspective. Journal of Intelligence, 25(8):18-21.

ZHAO Zhonghua, (2012), Relationship between network relationship characteristic and innovation performance of enterprises in innovative industrial clusters based on the innovation diffusion as middle variable. Scientific Management Research, 30(6) : 37-40.