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Impact of leadership behavior of core firm on technological innovation activity in innovation network

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ABSTRACT

Based on the sample data of technological innovation networks in China, this paper conducts an empirical study on the relations between the transformational leadership behavior and patterning of attention of core enterprises in the technological innovation networks and the exploratory and exploitative innovation activities, and also observes the moderating effect of types of technological innovation network on the relations between them. The results show that, the patterning of attention of core enterprises can facilitate the development of these two types of innovation activities; the transformational leadership behavior goes against the development of exploratory innovation activity; and the complex product technological innovation network has a positive moderating effect on the relations between the patterning of attention and these two types of innovation activities, and also has a positive moderating effect on the relations between the transformational leadership and the exploratory innovation activity.

KEYWORDS

Leadership behavior; Core firm; Technological innovation activity; Innovation network,

INTRODUCTION

At present, the country has proposed to promote the technological innovation activities vigorously, mainly including technology research & development (R&D) and industrialization of strategic emerging industries such as new energy, electric vehicle, energy conservation and environmental protection, biopharmaceutics and 4G mobile communication, in the hope of driving the related enterprises to improve their capability of independent innovation through these technological innovation activities. As an important organization form in implementing these innovation activities, the technological innovation network has been paid wide attention[1-3] (Yu Xianyun, Zeng Deming, 2013; Wu Guisheng, 2006; Sun Yanwu, 2013). In the technological innovation networks, the success of technological innovation activities depends on the technology R&D on one hand and the management activities on the other. The existing study shows that, 29.68% of failure of cross-organizational collaborative technological innovation activities is attributable to the difficult coordination among organizations[4] (Chen Jing, 2007). The study mainly focuses on the technological innovation networks with low density and high centrality (Dhanaraj, 2006). Leadership behaviors include transformational leadership and patterning of attention[5](Osborn,2009). The transformational leadership means to stimulate the needs and desires of network members by making them realize the significance and responsibilities of the tasks undertaken by them, while "patterning of attention" means that the core enterprises and the network members communicate with each other, to distinguish what is important and separate the major issues and the minor issues, so as to keep the network in new developmental state[6]. Based on their research conclusions, this study mainly discusses how the leadership behaviors of core enterprises in the technological innovation networks affect different types of technological innovation activities, and brings in the effect of types of technological innovation network.

CONCEPTUAL MODEL AND HYPOTHESES

Conceptual model

The basic hypothesis in Figure 1 is that different leadership behaviors of core enterprises in different types of technological innovation networks have different effects on the exploratory innovation and exploitative innovation. This conceptual model broadens Osborn's (2009) research conclusions, which is mainly reflected in dividing the technological innovation activities into two types depending on whether the technological innovation activities are conducted on the basis of existing knowledge, including exploratory innovation and exploitative innovation. The exploratory innovation refers to the technological innovation activities that acquire and create the brand new knowledge and strive to be separated from and surpass the existing knowledge base of enterprise, while the exploitative innovation refers to the technological innovation activities that rely on the existing knowledge base of enterprise, which emphasizes on refining, integration, reinforcement and improvement of existing knowledge[7, 8]. Meanwhile, Figure 1 also brings in the effect of types of technological innovation network and attempts to analyze the situations of Chinese enterprises. The specific hypotheses are as below.

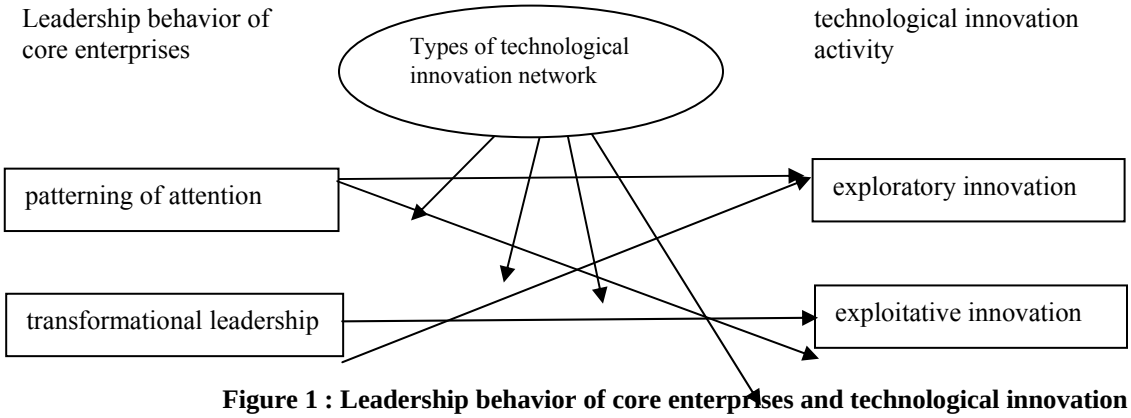

Figure 1 : Leadership behavior of core enterprises and technological innovation

Hypotheses

(1) Patterning of attention of core enterprises in the technological innovation networks and technological innovation

Osborn et al. (2009) regards the "patterning of attention" of core enterprises as that the core enterprises and the network members communicate with each other, to distinguish what is important and separate the major issues and the minor issues, so as to keep the network in new developmental state. In this process, the core enterprises need to explain and plan the information, and raise some questions, while these questions can help the network organizations to distinguish the important aspects of technological innovation activities jointly. Thus it can be seen, the behaviors represented by "patterning of attention" do not include the typical transaction affecting behaviors, such as the operational order and command of how to develop (start) the activity or how to gain the effective rewards; and also do no include a vision of the future in the transformational leadership behavior. Therefore, the patterning of attention of core enterprises can help the network members to share and spread the tacit knowledge through conversation and discussion, so as to promote the technological innovation activities.

Hypothesis 1: The patterning of attention of core enterprises in the technological innovation networks has a positive correlation with exploratory innovation.

Hypothesis 2: The patterning of attention of core enterprises in the technological innovation networks has a positive correlation with exploitative innovation.

(2) Transformational leadership of core enterprises in the technological innovation networks and technological innovation

The key issues of core enterprises are not only the motivation that stimulates other network members, but also about "how to generate ordered system in the obvious chaos"[9] (Mumford al., 2004). Marion et al. (2006) consider that the transformational leadership in learning network organization of dynamic variation may be less effective than that in more complex interactive system, because this leadership behavior will cause putting the cart before the horse, unilaterally core decision-making, controlling of communications, core enterprises determining target[10]. A large number of scholars have also emphasized that the potential importance of transformational leadership of core enterprises contributes to the success of network organizations but not the success of exploratory innovation activities (Elkins & Keller, 2003; Mumford et al., 2002).

Hypothesis 3: The transformational leadership of core enterprises in the technological innovation networks has a negative correlation with exploratory innovation.

The transformational leadership of core enterprises plays a critical role in the exploitative innovation activities, which does not show that transformational leadership can not stimulate the network members to pursue the exploitative innovation actively through the network organizations[11]. Wang Fang and Dang Xinghua (2003) consider that the attitude of core enterprises toward variation has a stronger relationship with the exploitative innovation than that with the exploratory innovation[12]. One hand, the core enterprises with middle-level transformational leadership provide remote leadership for the network members. This leadership behavior emphasizes the communication with the network members, which still needs further to deepen the existing capabilities of network members, strengthen the capabilities of existing domains and apply the existing knowledge[13] (Fitzgerald,2013). However, high-level transformational leadership pays more attention to variation, which goes against the network members to stabilize and concentrate on the exploitative innovation[14] (Denti, 2012).

Hypothesis 4: The transformational leadership of core enterprises in the technological innovation networks has an inverted U-shaped correlation with exploitative innovation.

(3) Effect of types of technological innovation network

Leadership behavior of core enterprises, exploratory innovation and types of technological innovation network

The patterning of attention does not clearly stipulate the direction of technological innovation, but only discuss which is important and which is not together with all network members, which will cause the network members with complementary core resources in the complex technological innovation network to participate in and agree with them. When the network members with certain power separately face the need to coordinate in a wide range, they will be more willing to accept the patterning of attention of core enterprises. However, for the discrete product industries, when all network members pay more attention to how to commercialize the patents of core enterprises, the network members will not willing to accept the patterning of attention. They are more willing to follow the vision defined by the core enterprises, so as to avoid failure due to unconformity of behavior and technological innovation behaviors of core enterprises.

Hypothesis 5: The types of technological innovation network has a positive moderating effect on the positive correlation between the patterning of attention of core enterprises and the exploratory innovation;

The complexity of innovative products in the complex technological innovation network increases uncertainty and technological innovation risks of network organization members, and the most important of all is that it makes the coordination between each product part become more complex (waldman et al., 2001). Every network member in the complex product technological innovation network has its own core resource and its place in the network is indispensable. Therefore, this visionary transformational leadership that determines the development direction for the network members will cause the opposition of these members, which goes against the exploratory innovation. On the contrary, in the discrete product environment, the core enterprises are fully responsible for R&D work of main patents in the innovation and other network members mainly focus on the commercialization process of patents. Therefore, when the network members experience the variation and anxiety, the transformational leadership of core enterprises can encourage the collective unity, promote the relationships among network members, and help to create an efficient atmosphere in the technological innovation network.

Hypothesis 6: The types of technological innovation network has a positive moderating effect on the negative correlation between the transformational leadership of core enterprises and the exploratory innovation;

Leadership behavior of core enterprises, exploitative innovation and types of technological innovation network

The characteristics of complex product technological innovation network are knowledge diversification, high uncertainty, unpredictability and unconventionality. The network members will consider that the patterning of attention is appropriate for implementing the exploitative innovation under the condition of perceiving the high ambiguity[15] (Bilal, 2014). Under the circumstance of high-level variation and uncertainty, the patterning of attention is more effective on clearly understanding the exception and convention of each network member. On the contrary, in the discrete product technological innovation network, the organization members will perceive that the patterning of attention emphasizes on new functions and pursues the exploratory innovation.

Hypothesis 7: The types of technological innovation network has a positive moderating effect on the positive correlation between the patterning of attention of core enterprises and the exploitative innovation;

On one hand, the transformational leadership emphasizes a kind of motivated behavior on internal need and motivation of network members, which is mainly from the view of value. With the product complexity increasing, firstly, for multiple network members with different profit motives, it is hard to confirm the core enterprises' true intentions separately; secondly, in the complex product technological innovation network, some powers will interact with each other at the same time, including the balance of power among all network members inside the network. This condition limits the freedom of transformational leadership on determining the innovation direction. On the other hand, with the transformational leadership level continuing to increase and exceeding a limit, the transformational leadership will decrease the exploitative innovation. With the technological innovation product complexity increasing, the technological innovation knowledge presents greater diversity, and some network members will become more impatient for the external uncertainty.

Hypothesis 8: The types of technological innovation network has a positive moderating effect on the inverted U shape correlation between the transformational leadership of core enterprises and the exploitative innovation;

METHOD

Selection of Sample

The biopharmaceutical industry and electronic information industry in a region is selected as the technological innovation networks (Zhang Weifeng, 2006). The specific research process is that the researchers are sent to Shaanxi, Shandong, Henan, Beijing, Shanghai and Zhejiang to collect 63 technological innovation networks. These 63 samples are strictly limited in computer, semiconductor, biopharmaceutical, new material and petrochemical divisions and 451 network members are selected from these 63 technological innovation networks for research. The data of 51 technological innovation networks regarding core enterprises, network members and at least 3 network members available to meet is collected from these 63 technological innovation networks. These 51 technological innovation networks are selected as the data analysis objects below.

Measurement of variables

One technological innovation networks is removed from these 51 technological innovation networks, because all its network members do not mention that the strategic objective of their technological innovation networks is technological innovation. The correlations of average value and standard error of variables, coefficient value and 50 unit samples are listed in Table 1. Among them, the black numbers on the main diagonal is the square root of average variance extracted value of the corresponding variable. By compared to the factor average extracted variance in the factor analysis results of variables, it can be found that the previous number is less than the later number, which indicates that in this study, all variables have distinction validity.

TABLE 1: Mean, SD and correlation coefficient

	Mean	SD	(1)	(2)	(3)	(4)	(5)
(1)exploratory innovation	4.1218	0.51284	0.4358				
(2)exploitative innovation	4.1258	0.52741	0.279**	0.4127			
(3)transformational leadership	3.9538	0.62384	0.508**	0.261*	0.5645		
(4)patterning of attention	3.2541	0.32415	0.274*	0.236**	0.374*	0.5268	
(5)scale of the network	3.7851	1.30258	0.174*	0.127*	0.524**	0.317**	0.4149

Note:p<0.01, *p<0.05**

The measurement of exploratory innovation adopts the scale improved from the scale developed by Jansen et al. (2006) (α=0.92). The measurement of exploitative innovation adopts the scale improved from the scale developed by Jansen et al. (2006)(α=0.89). The transformational leadership of core enterprises shall be measured by the scale improved from the scale developed by Castro et al. (1999) (α=0.88) [16]. The patterning of attention of core enterprises shall be measured by the scale improved from the scale developed by Osborn et al. (1999) (α=0.90). Cohen et al. (2000) divide the industry into discrete product industry (such as food, chemicals and other products with fewer compositions) and complex product industry (such as electronic products or machinery equipment and other products with more compositions). Therefore, the technological innovation network belonging to the complex product industry can be regarded as 1, and otherwise as 0. For the control variable, firstly, the data collection of every interviewee, including the age, level of education and position of interviewee, none of these individual control variables have significant correlation with other variables of any level, because these variables are removed when put into the multivariate analysis at one time. However, there is a certain influence on the network size due to the variables. Therefore, the network size is selected as the control variable, and its measurement is the number of main technological innovation partners. The specific description is that in the past two years, during the new product development process, the number of main innovation partners: assign [1,7] to [0], [1,3],[4,7],[8,10],[11,15],[15,30],>30 respectively and directly conduct the summing calculation.

RESULTS AND DISSCUSS

After the homologous deviation and multicollinearity are tested, the regression analysis and results reporting are conducted in the study step by step: firstly, the analysis results of regression model that only includes the control variable are reported; secondly, the analysis results of regression model that includes control variable and master variable are reported; at last, the analysis results of total regression model that includes control variable, main effect variable and regulation effect variable are reported. The regression analysis results of this paper are shown in Table 2.

TABLE 2: Results of regression analysis

Varibles	exploratory innovation			exploitative innovation		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Control variable						
scale of network	0.025	0.068	0.078	-0.152*	-0.047	-0.126*
Explanatory variables						
patterning of attention		0.267**	0.215**		0.312**	0.218**
transformational leadership		-0.135**	-0.112*		0.025	0.016
square of transformational leadership					0.184	0.231
Moderating variable						
types of technological innovation network(TT)			0.218**			0.311**
Interaction effect						
patterning of attention×TT			0.237**			0.192**
transformational leadership×TT			0.122*			0.227**
square of transformational leadership×TT						0.211
R^2	0.208	0.417	0.474	0.245	0.427	0.581
A R^2	0.166	0.283	0.368	0.198	0.352	0.474
F-model	2.704**	2.787**	3.485**	3.315**	3.157**	4.518**

Note: **p<0.05,* p<0.1

Model 2 shows that: The patterning of attention has a significant positive effect on the exploratory innovation (β =0.267,p<0.01), so hypothesis 1 is supported. The transformational leadership has a significant and negative effect on the exploratory innovation (β =-0.135,p<0.05), so hypothesis 3 is supported. Model 5 shows that: The patterning of attention has a significant and positive effect on the exploitative innovation (β =0.312,p<0.01), so hypothesis 2 is supported. The transformational leadership has a positive effect on the exploitative innovation, but it is not significant (β =0.025,p>0.1), and meanwhile, the square of transformational leadership has a non-significant positive effect on the exploitative innovation (β =0.184,p>0.1), so hypothesis 4 is refused.

Hypothesis 5 considers that the types of technological innovation network has a positive moderating effect on the positive correlation between the patterning of attention of core enterprises and the exploratory innovation, and the total regression model 3 shows that the patterning of attention has a significant and positive effect on the coefficient multiplied by the types of technological innovation network (β =0.237,p<0.01), so hypothesis 5 is supported. hypothesis 6 considers that the types of technological innovation network has a positive moderating effect on the negative correlation between the transformational leadership of core enterprises and the exploratory innovation, and the total regression model 3 shows that the transformational leadership has a significant positive effect on the coefficient multiplied by the types of types of technological innovation network (β =0.122,p<0.1), so hypothesis 6 is supported.

Hypothesis 7 considers that the types of technological innovation network has a positive moderating effect on the positive correlation between the patterning of attention of core enterprises and the exploitative innovation, and the total regression model 6 shows that the patterning of attention has a significant and positive effect on the coefficient multiplied by the types of technological innovation network (β =0. 192,p<0.01), so hypothesis 7 is supported. Hypothesis 8 considers that the types of technological innovation network has a positive moderating effect on the inverted U shape correlation between the transformational leadership of core enterprises and the exploitative innovation, and the total regression model 6 shows that the square of transformational leadership has a non-significant positive effect on the coefficient multiplied by the types of technological innovation network (β =0.211,p>0.1), so hypothesis 8 is refused.

CONCLUSIONS

Aiming at some issues arising in the management of technological innovation network, the models about the influence of different leadership behaviors of core enterprises in different types of technological innovation networks on

different technological innovation activities are constructed this study. Through sample survey of many technological innovation networks in several provinces in China, and verification of the constructed theoretical models and hypotheses by using the statistical analysis method. The principal conclusions are as follows:

(1)When managing the technological innovation network, the core enterprises should discuss the important aspects in the technological innovation activities with the network members and concatenate the network members together as a wide range of potential information source. That is to say, the "patterning of attention" shall be adopted. This can facilitate the generation of all kinds of technological innovation activities, including exploratory innovation and exploitative innovation.

(2)Since the vision and target are determined by the network members who have core resources separately and are indispensable in the network, the transformational leadership of core enterprises goes against the development of exploratory innovation.

(3)The types of technological innovation network has the moderating effect on the relations between the leadership behaviors of core enterprises and the technological innovation activities. The complex product technological innovation network has a positive moderating effect on the positive correlation between the patterning of attention and the technological innovation activities (including exploratory innovation and exploitative innovation), and also has a positive moderating on the negative correlation between the transformational leadership and the exploratory innovation activity.

In this study, some meaningful conclusions are drawn, but the existing scales of exploratory innovation and exploitative innovation are targeted to single enterprise and the transformational leadership and patterning of attention are targeted to the leaders in single enterprise, therefore, in this study, these scales are improved and passed the relevant empirical tests. However, the room for improvement of scales can only be discovered after being applied for many times in the future studies.

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