http://dx.doi.org/10.24212/2179-3565.2018v9i2p20-28

RISUS - Journal on Innovation and Sustainability
ISSN 2179-3565

RISUS - Journal on Innovation and Sustainability
volume 9, número 2 - 2018
ISSN: 2179-3565
Editor Científico: Arnoldo José de Hoyos Guevara
Editora Assistente: Lívia Lopes Aguiar
Avaliação: Melhores práticas editoriais da ANPAD

HOW NETWORK RELATIONS IMPACT INNOVATION PERFORMANCE OF HIGH-TECH STARTUPS: EVIDENCE FROM CENTRAL CHINA

Como as relações de rede impactam o desempenho da inovação de startups de alta tecnologia: Evidências da China Central

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Abstract: : Research on innovation performance has gradually moved from the industrial clusters level to network relations among enterprises inside clusters. This paper intends to explain the impacts of network strength, breadth and stability on the innovation performance of Startups. An empirical analysis of high-tech Startups from 6 provinces of central China displays that, network strength and breadth exert a significant positive impact on Startups' innovation performance, network stability a relatively weak one, and that environmental dynamism plays a negative role mediating between network breadth and the innovation performance.

Keywords: Innovations; Competitiveness; Sustainability; Modern technology; Enterprises

Resumo: A pesquisa sobre o desempenho da inovação foi gradualmente passando do nível dos clusters industriais para as relações de rede entre as empresas dentro dos clusters. Este trabalho pretende explicar os impactos da força, amplitude e estabilidade da rede no desempenho de inovação das Startups. Uma análise empírica de Startups de alta tecnologia de 6 províncias da China central mostra que a força e a abrangência da rede exercem um impacto positivo significativo no desempenho de inovações da Startups; no entanto a estabilidade da rede é relativamente fraca, e o dinamismo ambiental desempenha um papel negativo mediando entre amplitude e o desempenho da inovação.

Palavras-chave: Desempenho em inovação; Startups de alta tecnologia; Relações de rede; China central.

Recebido em: 02/09/2017
Aceito em: 01/06/2018

INTRODUCTION

Central China is a typical low income region in China‘s economic blocks as well as an emerging market with huge potentialities. High-tech startups are of great significance to the development of Central China. First, the booming High-tech startups have made great contributions to the development of high-tech industries and directly supported the industrial upgrading. Second, they are conducive to strengthening the capacity for innovation. Third, high-tech startups greatly promote the regional economic growth in non-public sector. Fourth, they have created many jobs opportunities for the middle and lower end labor force in central China and even attracted overseas high-end talents clustering in this low income region.

Enterprise network relation bears a close relation to the cluster‘s innovation performance. On the one hand, the flexible network structure helps the startups cluster to keep consistent and stable in the complex and volatile environment. On the other, a constant improvement of the cluster‘s innovation performance will enhance market competitiveness and coordination competency. Therefore, high-tech startups can adjust the operation strategies, cooperation and competition more flexibly, acquire a lower-cost advantage and more market opportunities, and improve the cluster‘s level and function through individual growth. But the scarcity of internal resources in high-tech startups and the absence of complete internal administrative systems lead to their increasing dependence on external network relations provided by industrial clusters. By analyzing almost 350 high-tech startups in 24 high-technology national development zones of central China, this paper empirically studies the impacts of three network structural features, network strength, network breadth and network stability on the innovation performance.

LITERATURE REVIEW

Research on high-tech startups has gradually moved from economies of scope and scale on the macro level to internal relations on the micro level. In studying the impacts of network relations on enterprise performance, most scholars refer to transaction cost theory, game theory, the resource-based theory, and the knowledge-based theory to explain the functioning mechanism within. Nevertheless, these theories can rarely explain such impacts comprehensively. For instance, the knowledge-based theory pays more attention to value additions brought by internal knowledge transfer, neglecting scope economies resulting from sharing resources such as internal railways and pipelines between districts; also, the resource-based theory, while taking into consideration the competitive advantages of resource sharing and complementarity, ignores moral risks and agency costs due to competitive relations among network members.

In recent years, an increasing number of scholars are studying the impacts of network relations on the performance of enterprises. The concept of enterprise network derives from the social network theory in sociology, which was later introduced to enterprise management. Network relations refers to a cooperative form constructed by two or more enterprises or non-enterprise subjects with formal or informal contracts. The participating subjects in the network rely on each other and share risks (Wu Aiqi, 2005).

Network relations feature network strength, network breadth and network stability, among others. After an empirical analysis of 109 enterprises in the industrial clusters of Pearl River Delta, Xie Hongming and Liu Shaochuan discovered that industrial clusters do not directly affect the competitiveness of enterprises, but achieves it indirectly through network density, network strength and network reciprocity (Xie Hongming, 2007). Via empirical studies, scholars like Li Zhigang and Tang Shukun discovered that the embedded network strength, network density, network intermediary, network stability, network reciprocity and the abundance of resources all have a positive correlation with the innovation performance of enterprises (Li Zhigang, 2007). Hu Zuguang and Zhang Dan conducted a numerical experiment to analyze the impacts of domestic enterprises‘ network embeddedness on their technical innovation (Hu Zuguang, 2010). According to them, when structural embeddedness proves more valuable than relational embeddedness, the network boundary of technical innovation would be larger, aggregation effects more significant, and the entire network is abler to present characteristics of the network in a tiny world. Peng Wei and Fu Zhengping analyzed the influence of alliance network on the competitiveness of enterprises from the perspective of Knowledge Resources (Peng Wei, 2014). The result illustrates that both network strength and network centrality of enterprise alliances exert a significant positive impact on the competitiveness of enterprises, whereas knowledge resources mediate between the two prior variables and the competitiveness; the environmental competitiveness positively mediates between network strength and competitive advantages, and the environmental dynamism mediates between network centrality and competitive advantages. According to the above analysis, network relations have close connections with the innovation performance of enterprises.

RESEARCH DESIGN

Network strength and innovation performance Network strength describes the frequency of contacts among members and the degree of commitments towards such contacts of organization resources. Granovetter divides network relations into strong ties and weak ties. The academia has not achieved consensus on the relation between network strength and enterprises‘ innovation performance (Granovetter, 1973). Uzzi contends that strong ties are more beneficial for members of the network to tackle opportunities and threats compared to weak ties, whereas Burt and Granovetter are more inclined to the weak ones. Granovetter claims that while the information and resources strong ties acquire are usually redundant, weak ties provide more abundant information. The more intimate the relations among enterprises, the easier it is for them to handle barriers for transmitting information, thus the smoother knowledge transfer among enterprises will be.

H1: Network strength of high-tech startups is positively correlated with innovation performance.

Network breadth and innovation performance

Network breadth describes the number of nodes and the scale established among enterprises. The larger the breadth, the more nodes connected to the enterprise and the larger scale of the network. Accordingly, enterprises will be granted with more opportunities and channels to acquire external information. Freeman points out that the size of the nodes represents the number of alternatives, which determines enterprises‘ exchanging rights (Freeman, 1979). The asymmetry of information in market transactions leads to incomplete information to enterprises. Therefore, it must be assumed that the more alternative schemes, the better.

H2: Network breadth of high-tech startups is positively correlated with innovation performance

Network stability and innovation performance

Network stability describes the characteristic that enterprises' network structure changes with time. From the input-output perspective, startups establish network relations on the input stage and profit from the external network on the output stage. The transition between network input and output requests certain time, during which maintaining the stability of network relations will help startups obtain innovation information from others stably and realize a stable innovation output.

H3: Network stability of high-tech startups is positively correlated with the innovation performance.

Mediating function of environmental uncertainty

While restricted by rational standards, complicated organizations are also confronted with the uncertainty of the external environment. Environmental uncertainty describes the degree of changes and unpredictability of the external environment. Enterprises should adjust to external environmental variations quickly to better satisfy market demands and acquire competitive advantages. The majority of scholars argue that the environmental uncertainty mediates positively the network and performance of enterprises. A multitude of uncertain elements in the external environment confront enterprises with larger environmental pressure, and thus require more cooperation for survival and development. This paper contends that with enormous pressure from the external environment, even constructing network relations can hardly help startups capture market information, and that environmental uncertainty may exert inconspicuous or negative impacts on the relation between network relations and performance

H4a: Environmental uncertainty mediates negatively the relation between network strength and innovation performance.

Secondly, in a highly turbulent external environment, the increasing number of startups will generate higher external organizing cost, which can overshadow economies of scale and scope produced in boundary maximization and render it partially or completely inefficient; the positive impacts of network breadth on innovation performance will also be weakened.

H4b: Environmental uncertainty mediates negatively the relation between network breadth and innovation performance.

Uncertainty in external environment may weaken the adaptability of startups and its functioning mechanism between enterprise stability and the innovation performance. When the external environment maintains stable, startups can better adapt to the external and environment and acquire continual cooperative benefits from stable relations with others.

H4c: Environmental uncertainty mediates negatively the relation between network stability and the innovation performance.

Data and variables

This paper takes high-tech startups from high-technology national development zones as samples.The eventual effective questionnaires amount to 132, taking up 37.71%. Likert 7-Scale Form is adopted to measure variables, in which 1 refers to total disagreement or dissatisfaction, 5 relative agreement or satisfaction, and 7 total agreement or satisfaction. Specific items are listed in Table 1. According to previous studies, the age, scale and nature of enterprises all exert an influence on the innovation performance. Therefore, this paper takes the three as control variables in which the age of startups is based on their registration time and the scale on the number of employees.

RESULTS

Reliability & validity test and correlation analysis

In terms of reliability, all variables‘ Cronbach’sαexceeds 0.7 with specific values listed in Table 2. With regard to convergent validity, all variables‘ normalization factor load surpasses 0.5, with the significance level reaching 0.01, the average extraction variance (AVE) over 0.5, and the composite reliability (CR) above 0.7, which are listed in Table 1. As for discriminant validity, the square root of each AVE exceeds the correlation coefficient for the specific variable and others, which are listed in Table 2. Hence, the model design of the research is both reliable and valid.

Table 1 Reliability Test and Convergent Validity Test of the Research Model

Variables	Items	Normalization Factor Load
Network Strength Cronbach'sα=0.895 AVE=0.7432 CR=0.8964	This startup has frequent interactions with cooperative partners compared to competing enterprises in the zone.	0.897***
	This startup has invested more resources compared to competing enterprises in the zone.	0.895***
	This startup has developed a win-win relation with cooperative partners.	0.790***
Network Breadth Cronbach'sα=0.836 AVE=0.6348 CR=0.8385	This startup has more upstream and downstream cooperative partners compared to competing enterprises in the zone.	0.795***
	This startup has more cooperative partners in the same industry compared to competing enterprises in the zone.	0.860***
	This startup has more non-enterprise cooperative partners such as the government, colleges and universities compared to competing enterprises in the zone.	0.730***
Network Stability Cronbach'sα=0.909 AVE=0.7758 CR=0.9117	This startup has more stable relation with upstream and downstream cooperative partners compared to competing enterprises in the zone.	0.794***
	This startup has more stable relations with cooperative partners in the same industry compared to competing enterprises in the zone.	0.937***

Continural Table 1

	This startup has more stable relations with non-enterprise cooperative partners such as the government, colleges and universities compared to competing enterprises in the zone.	0.905***
Environmental Uncertainty Cronbach'sα=0.845 AVE=0.5273 CR=0.847	Customer demands vary frequently in this industry.	0.781***
	Competition among enterprises is rather fierce in this industry.	0.736***
	Business modes frequently alter in this industry.	0.672***
	Startups are confronted with pressures from changes in the macro-environment such as laws, policies and the economy.	0.631***
Technical Innovative Performance Cronbach'sα=0.883 AVE=0.6556 CR=0.8838	Products' innovation ability of this startup is stronger compared to competing enterprises in the zone.	0.798***
	The craftsmanship innovation ability of this startup is stronger compared to competing enterprises in the zone.	0.856***
	The market innovation ability of this startup is stronger than competing enterprises in the zone.	0.799***
	The management innovation ability of this startup is stronger than competing enterprises in the zone.	0.784***

Note：***. Correlation is significant at the 0.01 level (2-tailed).

Table 2 shows the correlation coefficient matrix of all variables. The result reveals that every explained variable and explanatory variable has significant correlativity, which preliminarily verifies out previous assumptions. The fact that the maximum value of VIF in the model is smaller than 10 indicates that no multi-collinear problems occur in the model. The following part will further testify research assumptions via multi-stratum hierarchical regression analyses.

Table 2 Correlation Coefficient Matrix and Discriminant Reliability Test

	Innovation Performance	Network Strength	Network Breadth	Network Stability	Environmental Uncertainty	Enterprise Nature	Enterprise Scale	Enterprise Age
Innovation Performance	.81	.69**	.74**	0.09	.66**	-.33**	.48**	.46**
Network Strength	.72**	0.86	.76**	.22*	.60**	-.22*	.49**	.50**
Network Breadth	.77**	.80**	.80	.24**	.62**	-.14	.49**	.41**
Network Stability	.15	.29**	.29**	.88	.06	.11	.07	-.02
Environmental Uncertainty	.71**	.67**	.67**	0.13	.73	-.29**	.58**	.48**
Enterprise Nature	-.28**	-.20*	-.12	.09	-.25**	1	-.29**	-.36**
Enterprise Scale	.52**	.51**	.51**	.09	.57**	-.28**	1	.78**
Enterprise Age	.47**	.51**	.44**	.02	.50**	-.34**	.77**	1
Mean	5.1212	5.1894	4.9318	3.7652	4.9545	3.3409	3.1212	3.1364
S.D.	1.31944	1.53897	1.45777	1.76851	1.24093	1.54737	1.09844	1.15099

Note：**. Correlation is significant at the 0.01 level (2-tailed), *. Correlation is significant at the 0.05 level (2-tailed). The diagonal data is the square root of every variable's AVE; data above the diagonal line is the Spearman correlation coefficient; data below the diagonal line is the Pearson correlation coefficient.

Examination of assumptions

This paper conducts multi-stratum hierarchical regression analyses to examine the proposed assumptions. Table 3 reveals the regression result of every model. Model 1 only takes into consideration the explanatory degree of three control variables to dependent variables. On the basis of Model 1, Model 2, Model 3 and Model 4 add the explanatory degree of network strength, network breadth and network stability to the innovation performance respectively. Model 5 takes into account the influence of the three explanatory variables on explained variables comprehensively. According to the result, network strength($\beta=0.524$, $p<0.01$), network breadth($\beta=0.616$, $p<0.01$) and the innovation performance of startups are significantly and positively correlated, powerfully supporting Assumption 1 and Assumption 2. Model 4 displays a weak positive correlation between network stability and innovative performance ($\beta=0.095$, $p<0$). However, in Model 5, after taking into consideration network strength, network breadth and network stability, network stability and the innovation performance show an insignificant correlation. Therefore, it is deduced that network stability has a relatively weak positive impact on the innovation performance.

Model 6, Model 7 and Model 8 examine the mediation effects of environmental uncertainty on 'network strength-innovation performance', 'network breadth-innovation performance' and 'network stability-innovation performance'. Model 6 displays that environmental uncertainty mediates negatively between network strength and the innovation performance($\beta=-0.066$, $p<0.1$), verifying Assumption 4a. Model 7 reveals that environmental uncertainty mediates negatively between network breadth and the innovation performance($\beta=-0.086$, $p<0.05$), confirming Assumption 4b. While in Model 8, despite significant interactions($\beta=-0.167$, $p<0.01$), network stability is insignificant($\beta=0.045$, $p>0.1$), failing to verify Assumption 4c.

Table 3 Multi-stratum Hierarchical Regression Analysis

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Constant	3.564***	2.078***	1.987***	3.297***	1.890***	5.374***	5.571***	5.295***
Enterprise Nature	-.105	-.094*	-.127**	-.117*	-.111**	-.096*	-.118**	-.085
Enterprise Scale	.449**	.248*	.099	.418***	.114	.102	-.013	.129
Enterprise Age	.161	-.043	.067	.176	-.002	-.064	.017	-.086
Network Strength		.524***			.210***	.340***		
Network Breadth			.616***		.477***		.462***	
Network Stability				.095*	-.051			.045
Environmental Uncertainty						.385***	.315***	.581***
Environmental Uncertainty* Network Strength						-.066*		
Environmental Uncertainty* Network Breadth							-.086**	
Environmental Uncertainty* Network Stability								-.167***
R Square	.293	.558	.633	.309	.654	.650	.701	.611
Adjusted R Square	.277	.544	.621	.287	.637	.633	.686	.592
F	17.707	40.042	54.676	14.200	39.379	38.683	48.787	32.666
VIF Maximum Value	2.591	2.711	2.723	2.602	3.082	2.782	2.864	2.865

Note: *The significance level is at 0.1, **The significance level is at 0.05, ***The significance level is at 0.01.

CONCLUSION

On the level of high-tech startups which are unable to resist risks, acquire, integrate and utilize external resources, it is vital that they should establish their own network platform to better capture market information, understand market demands and survive in the dramatically changing external environment through cooperation, which mainly involves the following steps. Firstly, they should attach great significance to the quality of cooperation, improving the intensity of interactions and allocate more resources to cooperation so as to enhance the relation with partners and to achieve mutual profits and success. Secondly, they should expand network nodes, strengthen the breadth of the external network, establish cooperative relations with more organizations like suppliers, customers, competing enterprises, government and universities as well as trade associations to expand channels for obtaining external market information (Oliver, 2014).Thirdly, with a volatile external environment, they should try to lower transaction costs, establish complete contract mechanisms, avoid default risks in cooperation and establish win-win mechanisms, eliminating negotiation obstacles.

On the level of local government in central China, it should establish and perfect the legal mechanisms for market regulation, creating appropriate legal system mechanisms for high-tech startups so as to offset limitations and loopholes of market mechanism through macro policies. Meanwhile, the local government should actively guide high-tech startups to collaborate for warmth, setting up platforms for communication. Moreover, it should better supervise and regulate the market environment to avoid unfair competition, establish a complete financial system and increase financial supports.

ACKNOWLEDGEMENT
This paper is supported by National Social Science Fund of China(15CGL022) and Soft Science Project of Hubei Province(2017ADC091).

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