Research on Enterprise Innovation Performance Evaluation from the Perspective of Network Embedment

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Abstract: Based on social network theory, social capital theory, collaborative innovation theory and structural hole theory, and from the perspective of network embeddedness in industry-university-research collaborative innovation, this paper divides network embeddedness into relational embeddedness, structural embeddedness and cognitive embeddedness, and obtains qualitative data and quantitative data respectively through questionnaire survey and patent inquiry. The entropy weight method and grey relational degree method are combined to make a comprehensive evaluation of enterprise innovation performance. Selected 20 enterprises from the top 100 list of electronic information manufacturing enterprises in Guangdong Province, measured their innovation performance and ranked them.

Keywords: Collaborative Innovation; Network Embedding; Innovation Performance

1. Introduction

Under the ever-changing market background, it is difficult for enterprises to master the most advanced knowledge and technology under the traditional business model of isolated development. Through the diffusion, transmission and sharing of knowledge, technology, information and other resources in the network, we can fully accumulate innovation resources, improve innovation performance, and bring long-term competitive advantages for enterprises. This paper introduces social network theory and collaborative innovation theory, discusses the influence of network embedding on firm's innovation performance, and raises firm's innovation performance from the perspective of network embedding.

2. Theoretical analysis and research hypothesis

2.1 Collaborative innovation and firm innovation performance

Collaborative innovation is conducive to enterprises to grasp the leading knowledge and advanced technology, reduce the cost of research and development. Obtain external complementary resources from enterprises, universities and research institutions through collaborative innovation, and improve enterprise innovation performance by virtue of the advantages of joint research and development. Li Donghong et al. found that cooperation between enterprises and local competitors will improve their innovation performance [1]. Kang Yimin et al. believed that the cognitive diversity of all parties involved in collaborative innovation would enable enterprises to obtain rich heterogeneous resources, thus conducive to the improvement of innovation performance [2]. Wang Yuying et al. found through research that the position of enterprises in the main body of industry, university and research has a significant positive impact on the innovation performance of enterprises [3]. It can be found that collaborative innovation has a positive impact on the innovation performance of enterprises.

2.2 Network embedding and collaborative innovation

2.2.1 Relationship embedding and collaborative innovation

From the perspective of social network theory, Nahapiet and Ghoshal defined relational embedding as the social relationship developed through interaction in the network. The subject of collaborative innovation forms a network through interactive social relations, and the efficiency of the enterprise to obtain, integrate and utilize new knowledge from the network depends on the degree of relationship embedding. The trust gained by relational embedding provides the potential for actors in the network to obtain resources from other actors. In addition, close relationships reduce the risk of exchanging information and resources, thus increasing the likelihood of actors gaining access to information and resources in the network. The stronger the relationship embeddedness is, the closer the connection is and the more frequent the communication will be, which will form a more efficient way of knowledge exchange and promote a good cycle. It can be seen that relational embedding is conducive to collaborative innovation.

2.2.2 Structural embedding and collaborative innovation

Structural embedding refers to the position and "role" of enterprises in collaborative innovation network. The position of each enterprise has its advantages. When it plays the role of "bridge" or "hole" in the network, it is easier to obtain heterogeneous resources and invisible knowledge. The greater the network density, the more frequent the connections between innovation entities. The larger the network scale, the more diverse the types of innovation subjects. When an enterprise is located in a structural hole, it connects two "groups" that are not directly connected to facilitate the transfer of knowledge, thus promoting collaborative innovation.

2.2.3 Cognitive embedding and collaborative innovation

Cognitive embedding refers to the extent to which members of a network are able to think and process transactions in similar ways. Cognitive embedding represents that the members of the network share common goals, norms, beliefs, and experiences without disagreement when making major decisions. Common system and vision enhance mutual understanding, which is an opportunity for collaborative innovation. It is easy to integrate resources among network members to promote the realization of common aspirations.

2.3 Network embedding and enterprise innovation performance

2.3.1 Relationship embedding and firm innovation performance

Relational embedding is conducive to the construction of social capital, the acquisition of resources and the effective transfer of complex knowledge. Through investigation and research, Zuo Anbin found that the two dimensions of trust and information resource sharing in the relationship embedding of circulation enterprises have significant positive effects on the technological innovation performance of enterprises [4]. Through empirical data, Zhu Qing et al. verified the hypothesis that the more embedded the relationship between enterprises and university researchers, the better the performance of industry-university-research cooperation [5]. Therefore, the promotion effect of relationship embedding on firm innovation performance.

2.3.2 Structural embedding and enterprise innovation performance

The overall form of network structure and the position of enterprises in the network affect the quality of information and resources obtained by enterprises through the network. Enterprises located in structural holes are easy to obtain heterogeneous resources and have a controlling effect on resource acquisition of other enterprises. The more embedded the structure of the enterprise in the network, the more location advantage, the stronger the centrality, the higher the status in the network structure. Wang Chongfeng et al. found through patent application data in the field of new energy vehicles that structural hole characteristics have a significant positive impact on organizational innovation performance [6]. The centrality and network scale of enterprise network embeddedness have positive influence on innovation performance. Therefore, structural embedding is conducive to the improvement of innovation performance.

2.3.3 Cognitive embedding and firm innovation performance

Cognitive embeddedness represents the shared representations, goals, cultures, norms, beliefs and experiences among network members and can directly influence the development of social capital and organizational relationships. When members have a short cultural distance, it will facilitate the exchange of key innovative knowledge among the members of the internal network. Relationships that develop around shared norms and values are stronger. Strengthening the cognitive embedment degree of enterprises to their partners is conducive to reducing friction or conflict in the process of cooperation, reducing the cost of maintaining or

coordinating cooperative relationship, and laying the foundation for enterprises to obtain more resources and information. Therefore, cognitive embedding is conducive to the improvement of enterprise innovation performance.

3. Research Design

3.1 Sample selection and data sources

This paper chooses the electronic information manufacturing industry, because it is both capital intensive and knowledge intensive industry. In this paper, 20 enterprises are randomly selected from the list of Top 100 electronic information manufacturing Industries in Guangdong Province in 2021. In view of the fact that intellectual property protection has become an important form of technological innovation of enterprises, this paper obtained the patent data of 20 enterprises from the IPTOP patent information service platform database from 2017 to 2021, and used the obtained relational data to build a collaborative innovation network. Ucinet6.0 was used to measure the quantitative indicators. The 0-1 code was carried out according to whether there was a joint patent application between organizations. 1 indicated that there was a cooperative R&D relationship between organizations, while 0 was the opposite. Sample data were collected by means of questionnaire survey. The respondents of the questionnaire were mainly middle and senior managers and innovative personnel in the enterprise. A total of 100 questionnaires were distributed and 87 questionnaires were collected. In this paper, 5-point Likert scale was adopted, and the mean value of the questionnaire collected by each enterprise was used as the indicator data.

3.2 Construction of innovation performance evaluation index system of electronic information manufacturing enterprises in Guangdong Province

Similar to a large number of existing literatures, this paper uses the annual number of valid patent applications to measure innovation performance. This paper collected the annual patent applications of sample enterprises in the electronic information manufacturing industry from 2017 to 2021. Reference is made to the indicators of relational embedding by Zuo Anbin et al. [4] Learn from Wang Chongfeng [6] to measure the index of structural embedding. The selection of knowledge embedding index is completed by referring to the research results of Zhu Qing et al. [5]

4. Entropy weight method - grey relational degree evaluation method

Specific methods refer to previous literature. The results show that the scale of network, the degree of relationship continuity, the degree of reciprocity and the degree of cognitive pattern similarity have great influence on the innovation performance of enterprises.

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