Research on Structure Characteristics of Cooperative Network of Intelligent Networked Automobile Industry

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Abstract: Based on the theory of cooperative innovation, this paper uses the social network analysis method to analyze the structural characteristics of the cooperation network by using the data of joint patent applications of the intelligent networked automobile industry from 2012 to 2020 and the software of UNICET. The results show that the cooperation network of intelligent networked automobile industry has begun to take shape, but the overall network density is small, and the degree of cooperation is not high.

1. Introduction

In March 2021, the state promulgated "Outline of the 14th Five Year Plan and outline vision goals for 2035",which made it clear that a number of forward-looking strategic science and technology projects should be implemented during the 14th Five Year Plan period to strengthen strategic emerging industries. As one of the strategic emerging industries, intelligent networked automobile industry has high-end cutting-edge technology and cross-border integration industry chain. "Made in China 2025" lists automobile as one of the ten key fields. As the commanding point of future automobile technology, the development of intelligent networked vehicle is an inevitable trend. It is of great significance to study the cooperation network of intelligent connected automobile industry for the country to plan the future industry, implement the demonstration project of industrial cross-border integration, and innovate the decision-making and management in the field of intelligent connected automobile in China.

2. Research method and data sources

2.1 Research method

In this paper, the social network analysis method is used to study the structure characteristics of the cooperation network of the intelligent networked automobile industry. Social network analysis is a quantitative analysis method developed by sociologists based on mathematics, graph theory and other disciplines. In recent years, the application of social network analysis in the field of economic management emerges in endlessly. The application of social network analysis method to the analysis of cooperation network structure can directly reflect the mechanism and characteristics of innovation cooperation.

Social network is composed of a series of nodes and edges. The analysis of network relations by social network analysis method includes the overall attributes of the network and the individual attributes. The overall attribute is mainly measured by Network Scale, Network Density, Average Distance, Degree Centrality, Co-hesive Subgroup and other indicators. Network Scale is the total number of nodes in the network in a certain period of time. Network Density refers to the density of connecting edges between nodes in the network. Average Distance refers to the average length of the shortest path. Degree Centrality refers to the average degree centrality of each node in the network. Co-hesive Subgroup is a subset of actors, in which the actors are closely related. Individual attributes are mainly measured by Closeness Centrality, Betweenness Centrality and Structural Holes. Closeness

Centrality reflects the close degree of communication between the node and other nodes. Betweenness Centrality refers to the ability of a node to appear on the shortest path of any two nodes in the network. Structural Holes refers to the gap between the unconnected nodes in the network.

2.2 Data sources and processing

Patent is the most intuitive presentation form of scientific and technological innovation achievements. Based on the cooperative patent data, it is more accurate and objective to study the cooperative network structure of intelligent networked automobile industry. The data source of this paper is the patent data retrieved from the patent database of China Intellectual Property Office. The retrieval time is from January 1, 2012 to December 30, 2020, and the priority country is CN. Patent applications in China include invention patents, utility model patents and appearance design patents. This paper only takes the invention patents with higher innovation level as the research object. Statistics of patent application data of key technologies, basic support and information interaction technology for intelligent networked automobile industry vehicles are made, the patent applications of the same family are merged, and 3226 patents are collected.

In the retrieved patent data, the data of two or more units of patent applicant are screened out, and the patent data applied for by individuals, individuals and units and cooperative applications of branches affiliated to the same company are excluded. Finally, the data of 63 cooperative patents are obtained.

3. Results

3.1 Analysis of cooperative network structure characteristics

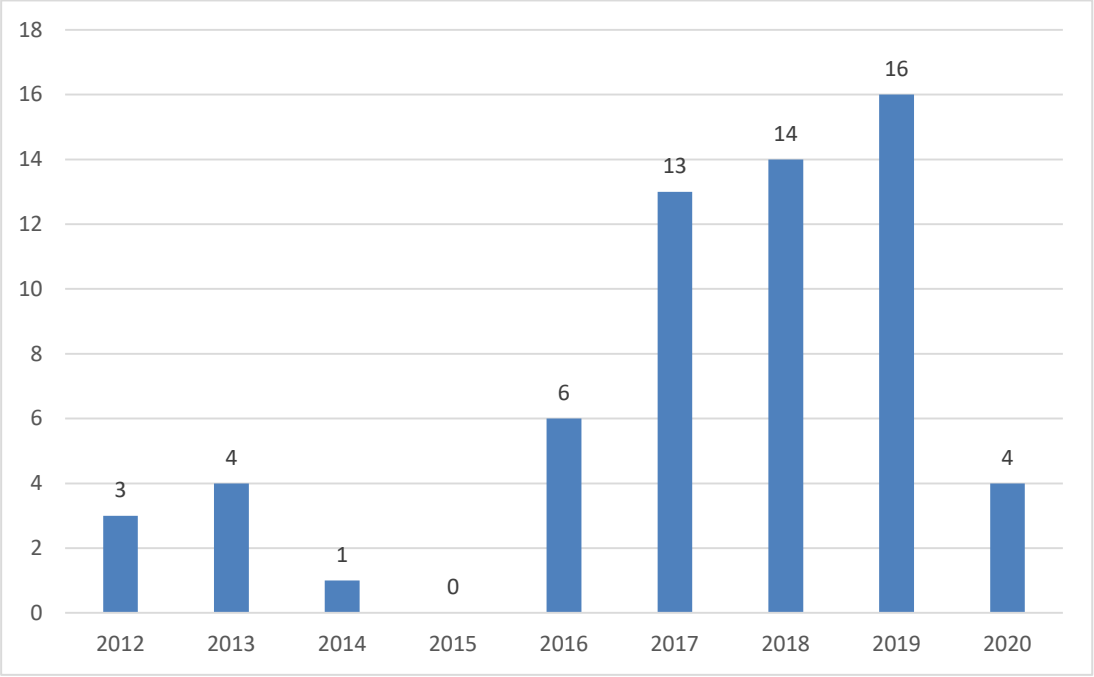

Figure 1 Number of patent cooperation applications of China's intelligent networked automobile industry from 2012 to 2020

Figure 1 describes the changes in the number of patent cooperation applications for China's intelligent networked automobile industry from 2012 to 2020. It can be seen that the overall number of patent cooperative applications in China's intelligent networked automobile industry is relatively small, with less than 7 patent cooperative applications per year, indicating that the patent cooperative application capacity of China's intelligent networked automobile industry is relatively weak. It is worth noting that from 2012 to 2020, the overall number of patent cooperation applications in China shows an increasing trend. Since 2017, the number of patent cooperation applications has made a big

breakthrough, with the annual number of patent cooperation applications exceeding 10 each year. Combined with its industrial policy, in 2017, for the implementation of the "Made in China 2025", the ministry of released "National car networking industry standard system construction guide (intelligent made cars) (2017) ", the lead of policy promotes the development of China's intelligent networked automobile industry, plays a technical standard of guidance, standardizes the development of the industry and promotes cooperative innovation among various entities. The state attaches great importance to the development of China's intelligent networked automobile industry, which promotes the cooperative innovation of various subjects

3.2 Overall Network Density analysis

Network Density refers to the closeness of connections among members in the network. The more connections among members, the more dense the network is. Corresponding to the cooperative network graph of the intelligent networked automobile industry, it reflects the close degree of cooperative innovation among various units (schools, enterprises or research institutions). The greater Overall Network Density is, the higher degree of connection between units, and the greater influence of the network on the attitude and behavior of its actors.

Table 1 Overall Network Density table of the intelligent networked automobile industry from 2012 to 2020

Year	Overall Network Density
2012	0.2000
2013	0.6667
2014	1.000
2015	0
2016	0.3810
2017	0.3611
2018	0.0822
2019	0.0394
2020	0.1667
Total	0.0241

Table 1 shows the Overall Network Density of the intelligent networked automobile industry from 2012 to 2020. Snatched from the whole, network density of the intelligent networked automobile industry is only 0.0241, the innovation of the industry cooperation is less, the cooperation between each other is not close, the level of the cooperation is low, cooperation innovation network is extremely sparse, at the same time also shows that there is a big room to improve cooperative innovation of intelligent networked automobile industry. Through integrating utilization of resources, strengthening communication and exchanges, the main body’s cooperation can be deepen. In terms of years, the network density of the intelligent networked automobile industry from 2013 to 2017 is much higher than that from 2018 to 2020. The reason is that before 2017, the state did not attach great importance to the development of the intelligent networked automobile industry, and the number of subjects carrying out cooperative innovation was small, so the network density was high. However, after 2017, the industrial policies related to the intelligent networked automobile industry have been introduced successively, and the technologies are relatively mature. The number of subjects carrying out cooperative innovation has been greatly increased, while the cooperative innovation between various units is only limited to two units or within the same region, resulting in a small Overall Network Density of cooperative network. Therefore, in order to improve the overall network density, on the basis of encouraging schools, enterprises and scientific research institutes to carry out cooperative innovation, we should also emphasize going out, carrying out more cooperation and exchanges with various subjects, broadening the geographical scope of cooperation, and achieving multi-agent cooperation.

4. Conclusions

The results show that the cooperation network of intelligent networked automobile industry has begun to take shape, but the overall network density is small and the cooperation degree is not high. In the cooperation network of intelligent and connected automobile industry, the enterprise is a very important part and plays a supporting role in the whole cooperation network, the school plays an irreplaceable role and an "intermediary" role in the whole cooperation network.

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