

# Research on the Impact of Innovation Ecosystem on the Upgrade of Automobile Industry

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**Abstract**—Facing fierce international competition, improving the ability of independent innovation is a major problem that China needs to solve urgently. Therefore, it is necessary to build a good innovation ecosystem. In this paper, we construct the automobile industry innovation ecosystem and analyze automobile industrial upgrading from two perspectives: the influence of innovation environment and the interaction between various entities in the industrial innovation ecosystem, which is analogous to the two dimensions of environmental synergy evolution and Co-evolution between species in the biological field. Finally, some suggestions which are connected with problems in the automotive industry are put forward.

**Keywords**—innovation ecosystem; industrial upgrading; automobile industry

## I. INTRODUCTION

With the continuous development of global economy, the automobile industry is playing an increasingly prominent role in the world economic development. As one of the highest earning manufacturing industries, the automobile industry creates a huge output value every year. China's total output value of automobile industry increased by 23.25% per year on average from 2004 to 2008, and later China became the world's largest automobile production and marketing country in 2009. With the rapid development of China's automobile industry, it's total output value has reached 5.3 trillion by 2018, and the industrial added value has exceeded 800 billion yuan. The automobile industry has gradually become a pillar industry in China, which has a profound impact on economic development and social progress. Although the development of China's automobile industry has been very rapid in the past two decades, there are still many problems that restrict the future development. China is gradually opening to the outside world and transforming into a free trade country. At the Boao Forum for Asia in 2018, President Xi Jinping indicated that the share ratio limit of the joint venture car company will be released, which is both a challenge and an opportunity for China's automobile enterprises, therefore, it puts forward higher requirements for the development of China's automobile industry. In the open competitive environment, China's auto companies must improve product performance and quality, enhance brand competitiveness, develop core technologies, and increase innovation research. Therefore, the study of the automobile industry innovation ecosystem and its impact

mechanism on industrial upgrading has both theoretical and practical significance for the further development of China's automobile industry.

## II. LITERATURE REVIEW

### A. Innovation Ecosystem

The introduction of "ecosystem" into the field of innovation originated from the study of Silicon Valley in the United States. A series of studies published in 2004, *Consolidating National Innovation Ecosystem* [1], pointed out that the future technology and innovation in the US will be based on a new system- Innovation Ecosystem. R. Adner[2] believes that innovation ecosystem is a synergistic integration mechanism, which integrates the innovative achievements of one enterprise and others in the ecosystem. R. Adner and R. Kapoor[3] through research on the global semiconductor lithography equipment industry, proposed that the industrial innovation ecosystem increases the interdependence of industries. The challenges of innovation comes not only from the enterprise, but also from the upstream suppliers, downstream customers. At the micro level, J. Lan, G.L. Yan and Q. Wang[4] made an empirical analysis based on the data of 463 companies in the New Over the Counter(OTC) Market to explored the role of heterogeneous resources in innovation activities of enterprises in the innovation ecosystem. At the meso level, Y.C. Yan[5] analyzed the competitive co-evolution mechanism, the symbiotic co-evolution mechanism and the predator co-evolution mechanism among the members of the industrial clusters in the innovation ecosystem, and gave the equilibrium conditions. At the macro level, L.C. Huang[6] introduced of constraints and flexibility of the ecosystem to analyze the constraints of the innovative subject in the technological innovative ecosystem and propose coping strategies. He[7] also analyzed the stability adjustment mechanisms of regional technological innovation ecosystems, including feedback, diversity and robust regulation.

### B. Innovation and Industrial Development

H.R. Duan, X.Z. Wei, Y.X. Sheng[8] took Ning Zhenyang area as an example to demonstrate the synergistic development relationship among the scientific and technological resources, innovation ability and industrial development. L.S. Li, Q.L. Gu,

X. Zhu[9] analyzed the optimized A-U model and reviewed the research methods, this paper studies the technological innovation and industrial upgrading of China's textile industry, and conducts empirical analysis.

### III. PROBLEMS IN THE UPGRADING OF CHINA'S AUTOMOBILE INDUSTRY

Firstly, there are still some problems in China's automobile industry, for example, the ability of independent R&D is weak and technology level is low. Over the years, many domestic auto enterprises heavily relied on foreign enterprises, whose main profits come from their joint ventures. Secondly, China's existing independent brand auto enterprises have little influence on domestic and international markets, and their international competitiveness is poor. Among the well-known auto companies in China, only Geely, Great Wall and BYD are independent brands. Many auto companies that eager for quick success in the process of development addicted to the huge profits from joint ventures, which lead to neglecting the cultivation of independent brands and the weakness of China's own brand auto companies. Thirdly, the development of vehicle and auto parts technology in China is disproportionate. At present, the global auto parts industry is dominated by the developed countries such as the US, Germany, France and Japan. The strength of domestic auto parts enterprises still have low competitiveness in the international market.

### IV. THE IMPACT MECHANISM OF INNOVATIVE ECOSYSTEM ON THE UPGRADING OF AUTOMOBILE INDUSTRY

Although the innovation ecosystem of different industries will have common characteristics. But due to the environment, development status and complexity of industry chain of different industries are discriminate, only construct the innovation ecosystem with industrial characteristics can have practical guiding significance.

#### A. Characteristics of Automobile Industry

First of all, the auto industry has a complex industrial chain. The upstream involves steel, machinery, rubber, petrochemical, electronics, textile and other industries, and the downstream involves insurance, finance, sales, maintenance, gas station, logistics and so on. Second, the environment of the automobile industry is changing. It can be seen from the relaxation of the share ratio restriction of joint ventures, Tesla's factory construction in China and the reduction of subsidies policy. China is adopting the strategy of open competition, which will bring great challenges and opportunities to the development of China's automobile industry. Third, the automobile industry is strongly dependent on the infrastructure network. Whether traditional fuel vehicles or new energy vehicles need gas stations, charging stations (piles) or other supporting facilities.

#### B. Theoretical Model of Automobile Industry Innovation Ecosystem

Innovative ecosystem is based on the theory of ecosystem in biology. Analogous to the ecosystem, the innovation ecosystem mainly includes the innovation environment and the

innovation population. The innovation environment system can be divided into the innovation survival factors and the external environment. Innovative survival factors include government organs, financial institutions, intermediaries, and infrastructure systems. The innovation external environment includes innovation resources, innovation risks, innovation culture, innovation incentive mechanisms and so on.

Innovative populations in innovative ecosystems, that is, innovation entities, can be divided into innovative producers, innovative consumers, and innovative decomposers. Innovative producers mainly include colleges and universities, scientific research institutions and various types of R&D organizations. Innovative producers carry out independent innovation and provide original technology through the support of various innovative resources. Innovative consumers refer to enterprises in the auto industry chain, which transform innovative technologies into new products. Innovative decomposers refer to the consumer groups in the market, including private consumers, business consumers, public sector consumers and so on, through the purchase of innovative products into capital flows. These innovators rely on the utilization and transformation of capital flow, material flow, information flow, knowledge flow, talent flow and policy flow to maintain the balance and stability of innovation ecosystem. Therefore, this paper establishes a theoretical model of the automobile industry innovation ecosystem as shown in Fig. 1.

The evolutionary process of individuals is carried out under the pressure of environmental selection, and the broad environmental factors include not only abiotic factors but also other biological factors. Therefore, species evolution not only exists coevolution between species and environment, but also exists coevolution between closely related species.

In the *Through the Looking-Glass* by the British writer Luis Carroll, the Red Queen said, "You have to run as hard as you can to keep you in place." The same is true in the economic society. In the long run, the winners of competition are not conditional on the current adaptability, but on evolutionary capabilities beyond those of other competitors. Usually, the winners in competition are those enterprises that have acquired more innovative capabilities. Therefore, innovation is an extremely important driving factor in the industrial transformation and upgrading.

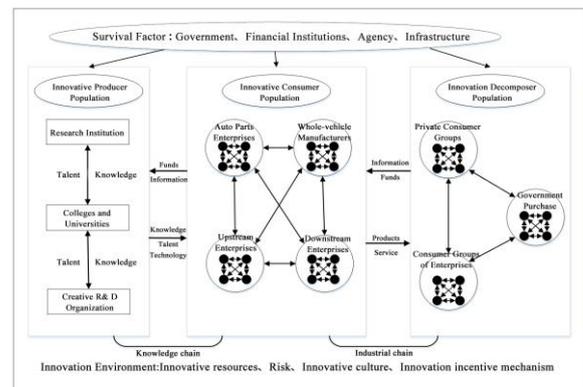


Fig. 1. Theoretical model of innovative ecosystem in automobile industry

Analogous to the coevolution of biology, the upgrading of the auto industry in the innovation ecosystem can be analyzed from two dimensions: the impact from innovation environment and the impact of the relationship among the main bodies in the innovation ecosystem of automobile industry on the upgrading of automobile industry.

Firstly, the impact of innovation environment on the upgrading of automobile industry is analyzed. Innovation environment includes the external innovation environment and innovation resources. The external innovation environment refers to the social, cultural and natural environment. A sound policy environment and legal framework, such as the protection of intellectual property rights, can stimulate the intention to innovative of innovative talents. A good ecological environment can improve the vitality of innovation and maintain the sustainability of innovation activities. Therefore, the positive external environment of innovation can promote the healthy growth of innovation, and then promote industrial upgrading. Innovation resources include funds, talents and infrastructure. Adequate research funds, a large number of high-quality innovative talents, sound innovative infrastructure and information network are essential. On the contrary, in the process of industrial innovation and industrial transformation and upgrading, higher demand will be put forward for the innovation environment and better output will be provided for the innovation environment. Once an industry's innovation and upgrading is successful, other industries and enterprises will be more active, which can improve the social and cultural innovation external environment. At the same time, the industry transformation and upgrading promotes the improvement of added value of products, which can generate more innovative resources.

Secondly, from the perspective of the impact from the interaction among main innovation bodies in auto industry ecosystem. The innovation bodies include innovative producers, innovative consumers and innovative decomposers. As innovative producers, scientific research institutes, universities and innovative R&D organizations carry out independent innovation and research and development, and produce innovations that can improve production efficiency, reduce costs or ameliorate industrial structure. Enterprises in the industrial chain can cooperate with innovative producers to absorb and apply innovative achievements to actual production, commercialize innovative achievements and provide new commodities. Innovation decomposers, such as private buyers and corporate buyers, transform innovative commodities into capital flows through consuming. At the same time, consumers will feed information back to enterprises, which can help enterprises to improve their products. Enterprises can integrate these information flows and put forward new demands to scientific research institutions.

## V. AN EMPIRICAL ANALYSIS OF THE RELATIONSHIP BETWEEN AUTOMOTIVE INDUSTRY ECOSYSTEM AND AUTOMOBILE INDUSTRY UPGRADE

### A. Model Setting and Numerical Description

Based on the analysis of the above two dimensions, this paper constructs the basic function model of industrial upgrading in the innovation ecosystem.

$$\ln UI_t = \beta_0 + \beta_1 \ln EC_t + \beta_2 \ln IC_t + \varepsilon_t \quad (1)$$

In the formula,  $t$  represents the year,  $\beta_0, \beta_1, \beta_2$  is the parameter to be estimated;  $UI$  represents the industrial upgrading;  $EC$  and  $IC$  respectively represent the impact of the relationship between the innovation environment and the agents in the innovation ecosystem on the upgrading of the automobile industry; and  $\varepsilon_t$  is random disturbances.

Explained Variable: Choose  $UI$  as the explanatory variable to express the industrial upgrading index over the years. Industrial upgrading can be reflected in the improvement of the value of the whole industry. This paper uses the added value of the total output value of the automobile industry  $IAV$  to measure.

Explanatory variable: The co-evolutionary part of the innovation environment for industrial upgrading is selected  $EC$  as a measurement index, including the innovative external environment and innovative resources. The innovative external environment includes China's economic development level, humanity environment and intellectual property protection degree. This paper selects per capita GDP to measure China's economic development level, chooses the per 10,000 people science and technology cultural infrastructure to measure the humanistic environment, and uses the IPR strength index given by the Global Competitiveness Report to measure the degree of IPR protection in China. Innovation resources mainly include innovative talents and innovative funds. In this paper, R&D funds ( $RDK$ ) is used to measure the investment of innovative funds, and R&D personnel full-time equivalent ( $RDL$ ) is used as the index to measure the investment of innovative talents.

$$EC_t = \alpha + \beta PGDP_t + \varepsilon_i \quad (2)$$

$$EC_t = \alpha + \beta_1 RDK_t + \beta_2 RDL_t + \varepsilon_i \quad (3)$$

$$EC_t = \alpha + \beta TCI_t + \varepsilon_i \quad (4)$$

$$EC_t = \alpha + \beta IPP_t + \varepsilon_i \quad (5)$$

In the dimension of the relationship among the main bodies in the industrial innovation ecosystem, this paper uses  $IC$  as a measurement index, which can be divided into the output of innovative producers, the "innovation transformation" between innovative producers and innovative consumers, and the "decomposition role" of innovative decomposers.

The data of China's automobile industry from 1995 to 2018 were selected, whose sources were National Bureau of Statistics and Guotai Junan Database. The original data of

innovation-related indicators were derived from China Science and Technology Statistical Yearbook and Global Competitiveness Report. The difference method is used for data processing and the measurement software used is Eviews 7.2.

### B. Empirical Analysis Results

$$IAV = 121.10 + 0.19 PGDP$$

(0.70) (3.33)

$$IAV = 33.49 + 1.85 RDK - 21.13 RDL$$

(0.25) (5.59) (-3.06)

$$IAV = -1201.24 + 46263.43 TCI$$

(-2.82) (4.32)

$$IAV = -821.89 + 420.37 IPP$$

(-2.51) (4.49)

$$\ln(IAV) = 7.28 + 0.0058 TMT(-1) + 0.00032 NPSR$$

(40.21) (3.41) (3.43)

$$IAV = 424.23 + 0.013 NPG$$

(3.17) (2.17)

From the regression results, we can see that the innovation environment and the relationship between the main bodies in the innovation ecosystem have a tremendous impact on the industrial upgrading of the automobile industry. In terms of innovation environment, the developed social infrastructure, adequate science and technology and cultural infrastructure, sound intellectual property protection system and policy environment, and high investment in innovation are conducive to promoting the transformation and upgrading of the automotive industry. In terms of the main bodies of the innovation ecosystem, the close cooperation between universities, research institutes and other innovative R&D institutions and enterprises in the automotive industry, the close links between upstream and downstream enterprises in the industrial chain, and the good relationship between enterprises and consumers can effectively promote the upgrading of the automotive industry.

## VI. COUNTERMEASURES AND SUGGESTIONS BASED ON INNOVATION ECOSYSTEM

Through the analysis of the two dimensions of species evolution in the ecosystem, this paper proposes the following suggestions from the innovation environment and the synergy between the various entities in auto industry innovation ecosystem.

### A. Innovative Environment Perspective

a) It is necessary to construct a sound policy environment and strengthen the intellectual property protection system. Our country should strengthen the legal protection of intellectual property protection and the popularization of intellectual property protection knowledge. Only when intellectual property rights are fully protected can we arouse the enthusiasm of social innovation.

b) It is necessary to enhance the scientific literacy of citizens and increase the per capita ownership rate of science and technology and cultural infrastructure. China should pay attention to the balanced development of science, technology

and cultural infrastructure in all regions, so that the people of the whole country can acquire knowledge more easily, thereby improving the innovative humanistic environment and strengthening social innovation ability.

c) In terms of innovation resources, it is necessary to increase investment in research funding, improve the efficiency of innovation funds. We should strengthen the supervision and management of innovative funds and avoid such violations as false reimbursement, misappropriation and illegal transfer. At the same time, we should pay attention to the cultivation of innovative talents and improve citizens' innovative consciousness and ability.

### B. Bodies in the Innovation Ecosystem of Automobile Industry

a) Market-oriented automobile manufacturing technology marketing institutions should be established to encourage independent innovation of scientific research institutes, universities and innovative R&D organizations. Specialized institutions should be established to coordinate between enterprises and R&D institutions to promote the industrialization of innovative achievements.

b) In the auto industry chain, we should strengthen the coordination of enterprises at all stages, improve the matching relationship between auto parts enterprises and automobile manufacturers and strengthen cooperation among the upstream and downstream companies. In addition, in order to improve industrial concentration, the government should formulate policies to promote cross-regional, cross-provincial and cross-enterprise cooperation, so as to avoid duplication and waste in innovation and R&D.

c) Improve the international competitiveness of China's independent automobile brands. Technological innovation must be market-oriented. China's independent brand car companies can establish a clear domestic and international customer base, and carry out different product innovations according to the different needs of domestic and foreign customers.

## REFERENCES

- [1] PSCT. Sustaining the Nation's innovation Ecosystems, Information Technology Manufacturing and Competitiveness. 2004.
- [2] R. Adner, "Match Your Innovation Strategy to Your Innovation Ecosystem," Harvard Business Review, 2006, vol. 84, no. 4.
- [3] R. Adner and R. Kapoor, "Value Creation in Innovation Ecosystems: How the Structure of Technological Interdependence Affects Firm Performance in New Technology Generations," Strategic Management Journal, 2010, vol. 31, no. 3.
- [4] J. Lan, G.L. Yan, Q. Wang, "Research on the Impact of Heterogeneous Resources of Small and Micro Enterprises on Innovation Performance from the Perspective of Innovation Ecology," Science of science and management of S.&T., 2019, vol. 01, pp. 137-149.
- [5] Y.C. Yan, "Research on the Construction and Governance of Industrial Cluster Innovation Ecosystem," Wuhan University of Technology, 2013.
- [6] L.C. Huang, "Characteristics of regional technology innovation ecosystem," China Science and Technology Forum, 2003, vol. 01, pp. 23-26.
- [7] L.C. Huang, "Stabilization mechanism of regional technology innovation ecosystem," R&D Management, 2003, vol. 04, pp. 48-52, 58.
- [8] H.R. Duan, X.Z. Wei, Y.X. Sheng, "Research on Science and Education Resources, Innovation Capability and Industrial Development- Based on

Moore value,” *China Collective Economy* *China Collective Economy*  
*China Collective Economy*, 2019, vol. 14, pp. 30-31.

- [9] L.S. Li, Q.L. Gu, X. Zhu. “Technological innovation and upgrading of  
China’s textile industry,” *Journal of Textile Research*, 2007.