

Study on High Quality Development Path of Manufacturing Industry Based on Innovative Ecosystem

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Abstract

Innovation-driven is the cornerstone of high-quality development, and innovation for development has gradually become a social consensus. Building an excellent innovation ecosystem is the right thing to achieve high-quality development. Through combing domestic and foreign literature and theoretical foundation, on the basis of analyzing the components of manufacturing innovation ecosystem, we analyze the mechanism of high quality development of manufacturing industry, which is innovation-driven being the development strategy, comprehensive innovation being the means to achieve, and innovation ecosystem being the role platform to promote high quality development of manufacturing industry through achieving all-round innovation.

Keywords

Manufacturing Industry; Innovation-driven; Comprehensive Innovation; Innovation Ecosystem; High-quality Development.

1. Introduction

Achieving high-quality development is the essential requirement of Chinese-style modernization. The 20th Report in China points out that high-quality development is the primary task of comprehensively building a modern socialist country, and that the new development concept must be implemented completely, accurately and comprehensively. We must adhere to the theme of promoting high-quality development and promote the economy to achieve effective quality improvement and reasonable quantitative growth. Innovation is the first driving force to lead development. Systematically promoting comprehensive innovation reform is the key to break the bottleneck of innovation-driven development. As an emerging innovation paradigm and management concept, innovation ecosystem means to manage innovation participants so that innovation can more effectively meet the strategic needs of ecological development and user demands [1]. Therefore, this paper intends to analyze the mechanism of high-quality development of manufacturing industry from the perspective of innovation ecosystem, so as to promote the realization of the goal of manufacturing power in China.

2. Literature Review

2.1 Research on Manufacturing Development

The innovative development of manufacturing industry is an important task to promote China's economy towards high-quality development, and is the key to the implementation of the strategy of strengthening the country with quality. From the existing literature, the current relevant research mainly focuses on two the construction and measurement of manufacturing development evaluation system. Y.L. Zhao and J.J. Gu (2018) measured and compared the quality of manufacturing development in China and the United States from three perspectives: production efficiency, value acquisition ability and technological content [2]. X.Z. Li (2022) constructed an evaluation index system for high-quality development of manufacturing industry from eight aspects, including

industrial foundation and innovation capacity [3]. Secondly, the way of manufacturing development. T. Lv and D. Liu (2019) pointed out that on the basis of clarifying the development of manufacturing industry, the basic idea of promoting the high-quality development of manufacturing industry in China should be further clarified [4]; N. Li, H. Wang and Y. Wang (2022) combined the analysis of digital economy and high-quality development of manufacturing industry is also a new direction to explore [5]. Q. Yan, B.Q. Yin and Y. Liu (2022) pointed out that energy-saving effect and emission reduction effect are effective green technological innovation to promote the high-quality development of manufacturing industry [6]. some other scholars suggested the development of manufacturing industry in western, central and eastern regions [7-9].

2.2 Connotation of Industry Quality Development

The existing research results focus on the connotation of high-quality industrial development, and generally agree that high-quality development research expands the connotation of quality and involves the improvement of the quality level of economic and social development, which is a comprehensive system project. High-quality development is a coordinated and integrated development and sustainable development [10]. High-quality development is understood from the industrial level, which refers to the optimization of industrial layout and structure adjustment, efficient operation of industrial ecosystem, and significant improvement of industrial quality and efficiency [11]. D. Shi, et al (2018) point out that to promote the change of industrial high-quality development must realize the change of growth momentum from factor-driven to innovation-driven, and realize comprehensive innovation in science and technology, culture, theory and other fields [12]. T.E. Liu, et al (2019) believe that the essence of industrial high-quality development is the value judgment made on the consensuality of industrial development, which requires the formation of new development concepts, development goals and dynamics, and evaluation systems [13]. H. Li (2019) believes that the practical orientation of the high-quality development stage includes cultivating new dynamic energy, developing new industries and forming new models [14]. Focusing on the manufacturing industry, Z.Y.Zhang (2020) believes that high-quality development of manufacturing industry is to promote the improvement of total factor productivity through quality change, efficiency change and power change [15].

2.3 Research on Innovation Ecosystem

The industrial innovation ecosystem is a new field of innovation research based on the bionic theory, formally proposed by the President's Council of Advisors on Science and Technology (PCAST) in December 2004[16], whose core behavior is interactive learning. B.A. Lundvall (1985) integrated innovation system and ecology theories, which can form symbiotic competition and dynamic evolution of open complex system to help manufacturing development[17].

Some studies focus on the strategic level of business ecosystems. A. Radziwon, et al (2017) combine business models and ecosystems to provide guidance for SMEs in innovation ecosystem model development [18]. P. Ritala, et al (2013) argue that an innovation ecosystem is essentially a business ecosystem that aims to create value and derive value from innovation activities[19]. Some other studies focus on high-tech industries. J. O. Guang, et al (2021) proposed the ecological development of innovation chain in high-tech industries based on the positive effect of KRV coupling on innovation ecology[20]. H.Y. YI , et al (2021) pointed out that the dissipative evolution of innovation ecosystem in high-tech industries can promote innovation-driven high-quality development and alleviate the problem of unbalanced regional innovation development[21]. Y. Y. Fang, et al (2022) focus on the internal innovation ecosystem of high-tech industries and examine the relationship between the innovation environment and innovation efficiency within the system from an open innovation perspective[22]. Some studies also focus on manufacturing industry. K. Wen, et al. (2020) take manufacturing industry as the research object, and empirically analyze the operation status of China's industrial innovation ecology, further project the development potential of industrial innovation ecology and summarize the categories of industrial innovation ecology[23]. T. Meng, et

al (2022) explored the core mechanism of manufacturing enterprises to build a meaning-oriented innovation ecosystem from the perspective of green innovation[24].

In summary, domestic and foreign research has made a lot of theoretical and practical achievements, but there are still the following shortcomings: (1) most of the literature focuses on the evaluation index system and countermeasures in the field of industrial development, and there is less research related to the high quality development of manufacturing industry; (2)the research on the high quality development of industry focuses on the role of technology, science and technology and institutional innovation for the improvement of industrial quality, and there is less research to explore the comprehensive innovation as the means to achieve; (3)the research on the high quality development of manufacturing industry is still in the preliminary stage, and few scholars combine the innovation ecosystem with the high quality development of manufacturing industry.

3. Analysis of the Mechanism of High-quality Development of Manufacturing Industry under the Innovation Ecosystem

3.1 Theoretical Support for Innovation Ecosystem

The 13th Five-Year Plan of National Economic and Social Development issued by the Central Committee of the Communist Party of China recommends innovation as the first driving force to lead development, while clearly pointing out that science and technology innovation should play a leading role in overall innovation. The manufacturing industry is the core of China’s manufacturing industry, which is influenced by the ability of independent innovation and the degree of mastery of key technologies, and its high-quality development is inseparable from the support of innovation.

Innovation was first introduced by the Austrian economist, who considered that innovation is not only a technological innovation in the field of science, but also emphasizes the application of new science and technology in the processes of manufacturing enterprises to obtain a new productive capacity, and pointed out that innovation in the field of economics has a key role in explaining total factor growth[25]. Scholars have continued to link innovation to economic growth, further enriching innovation theory and gradually forming the neoclassical school, the neo-Schumpeterian school, the institutional innovation school and the national innovation system school (see Table 1).

Table 1. Main views of the four major schools of thought

| School Classification | Main points |
|-----------------------------------|--|
| Neoclassical School | Technological innovation, together with capital and labor, determines the rate of economic growth. |
| Neo-Schumpeterian School | Technological innovation and progress play a central role in economic growth. Technological innovation is considered to be a complex and interactive process, focusing on the internal operation mechanism of the <i>black box</i> . |
| Institutional Innovation School | The development of the world economy is a reciprocal cycle of institutional innovation and technological innovation, promoting each other. |
| National Innovation System School | The national innovation system plays a leading and driving role in technological innovation. |

In addition, modern management science advocates that there are two main types of innovation: technological innovation and social innovation, which have obvious driving effects on economic growth, and R&D and innovation play an engine-like driving role in the process of economic growth[26-27]. Michael Eugene Porter, the famous professor of Harvard Business School and the father of competitive strategy, firstly proposed the concept of innovation drive in *National Competitive Advantage*, which once again enriched the innovation theory. He analyzed the different

stages of national economic development by using the theory of national competitive advantage, and divided them into factor-driven stage, investment-driven stage, innovation-driven stage and wealth-driven stage. Among them, the competitive advantage formed through innovation is the basis for establishing a high-end position in the international industrial division of labor.

As we can see above, innovation theory has well explained the importance of innovation drive to enhance competitive advantage and promote economic growth. The essence of innovation-driven high-quality industrial development is to promote China's manufacturing industry from the low end of the global value chain to the high end by continuously improving scientific and technological innovation capabilities, which is the only way to transform *Made in China* into *Created in China*. Manufacturing enterprises for scientific research, testing and development, promotion and application of each link need innovation, innovation-driven independent innovation as the engine of economic growth can effectively promote scientific and technological innovation[27]. Driving other aspects of innovation is a multi-disciplinary and comprehensive innovation.

3.2 Composition of Manufacturing Innovation Ecosystem

Innovation ecosystem refers to the benign symbiotic system formed by the complex innovation environment in which the innovation subjects and the communities among the subjects play their respective functions by participating in the exchange, conduction or sharing of information, material, energy, capital and other socialized activities. Considering from the perspective of organizational ecology, innovation ecosystem is composed of innovation community and innovation environment, and heterogeneous innovation subjects assemble to form innovation community, thus manufacturing innovation ecosystem is mainly composed of innovation subject, innovation community and innovation environment.

3.2.1 Innovation Subject

Innovation subject is the basic element in the innovation ecosystem of manufacturing industry, and the quality of innovation subject determines the quality of the system. It mainly includes scientific research institutions or universities, public service institutions, government, financial institutions, public, manufacturing enterprises and enterprise R&D departments, which correspond to the system functions of scientific and technological innovation, service innovation, system innovation, financial innovation, demand innovation, benefit innovation and design innovation, respectively. Among them, science and technology innovation has an important status and role, and is the core of the manufacturing innovation ecosystem. We should strengthen the concept of science and technology-based innovation, put into practice the requirement of comprehensive innovation with science and technology innovation as the core, and maximize the utility of innovation-driven.

(1)The main body of science and technology innovation. In the manufacturing innovation ecosystem, scientific research institutions and universities are the main body of scientific and technological innovation. Science and technology innovation needs to realize the transformation from basic research to applied research and from applied research to technological innovation. As the birthplace of new knowledge, new ideas and even new technology generation, scientific research institutions or universities are vigorous and have high initiative of innovation activities. Under the active innovation environment, the existing resources are used as the basis to improve or create new things, stimulate the transfer and transformation of technical achievements, establish a science and technology innovation results base, and provide scientific and technological reserves for the manufacturing innovation ecosystem.

(2)Service innovation subject. In the innovation ecosystem of manufacturing industry, the service innovation main body is public service organization, mainly including management consulting service organization, patent firm, accounting firm, law firm, manufacturing industry association, professional association, information service center, and so on. In order to meet the demand of manufacturing industry to provide technical to the national economy and national security, public service institutions to improve the quality of supply services as the main direction. Targeted

professional guidance to promote public services should be provided so as to achieve precision supply for high, medium and low-end manufacturing industry,.

(3)System innovation main body. In the manufacturing innovation ecosystem, the main body of institutional innovation is the government. Institutional innovation is a reasonable guarantee to maintain a comprehensive innovation prosperity symbiosis in the system, and each innovation subject effectively cooperates under the standardized institutional design. A good institutional environment itself is also product of innovation. As a key link in the ecological chain, the government should give full play to the coordination and synergy ability in the process of system design, and seek the optimal allocation of resources to mobilize innovation vitality.

(4)Financial innovation subject. In the manufacturing innovation ecosystem, the main body of financial innovation is financial institutions, mainly providing financial services for manufacturing enterprises and solving financing problems. Financial innovation plays a positive role in optimizing resource allocation, meeting market demand and serving the real economy, but at the same time, it also brings problems such as risk dispersion, irregular investment behavior and risk accumulation, violent fluctuations in financial market, capital flight and illegal fund raising. China's financial sector reform is deepening, and good financial innovation should balance the relationship between financial development and risk control, so as to achieve a sound financial supervision system and guard the bottom line without systemic financial risks.

(5)Demand innovation subject. In the innovation ecosystem of manufacturing industry, the demand innovation subject is the public, and the scale and quality of demand determine the scale of the system. Demand innovation to the new requirements of the development of the manufacturing industry, must quickly adapt to the new trend of consumer upgrading, accelerate the conversion of development momentum, improve the quality of supply, and effectively solve the structural contradictions between the ineffective supply formed by the precipitation of resources and the incompatibility of consumer demand.

(6)Benefit innovation subject. In the manufacturing innovation ecosystem, the main body of benefit innovation is the manufacturing enterprises, mainly for the system to create economic benefits and social public benefits, build the intergrated ecological benefits. High-quality development requires the optimization of the system to upgrade the structure of the elements, promote the manufacturing industry efficiency change. Manufacturing industry and related enterprises in the deeply understanding of market demand and public demand, based on the effective integration of production, marketing and after-sales service, to achieve the whole process of benefit creation.

(7)Design innovation main body. In the manufacturing innovation ecosystem, the main body of design innovation is the enterprise R&D department, which needs to make comprehensive use of technology propulsion, design-driven and demand-pull innovation activities. Design activities belong to the main activities during enterprise new product development, and have an important role in determining the future product form and properties. Design innovation is an internal R&D activity in the manufacturing industry and related enterprises, which transforms scientific and technological innovation results into concrete product form and gives them new semantics to meet or lead the market consumer demand changes through product feature processing.

3.2.2 Innovation Cluster

Innovation subjects interact, influence and promote each other to jointly promote comprehensive innovation development and form innovation communities. The concept of innovation communities was first introduced in 1996, when innovation communities were considered to have distinct social characteristics. Cluster members are deeply rooted in a dense network of social and economic relationships, while undergoing a socialization process that facilitates a learning process with knowledge flow and knowledge sharing among members, producing a synergistic evolutionary effect. In the innovation ecosystem of manufacturing industry, according to different functions, the innovation community can be divided into substructure organization and superstructure organization.

The substructure organizations are the direct participants of innovation activities, referring to scientific research institutions or universities, manufacturing enterprises and their R&D departments. In addition to cooperating with each other to undertake major research projects, scientific research institutions or universities also act as a bridge to transfer technology to the business community, but not engaging in production. Manufacturing enterprises are the ultimate demanders of technology, which link with research institutions or universities, sign contracts, and through the R&D department design the technology results in products with new vitality, give a new carrier for technology and new semantics for products. In addition, manufacturing enterprises also provide some financial support to scientific research institutions or universities, constituting a solid lower-level organizational structure.

The superstructure organization is the main body that plays a coordinating role, mainly referring to the government, public service agencies, financial institutions and the public. The government should not only optimize the relevant policies and regulations, to promote the development of manufacturing industry and try out the new system; but also allocate innovation resources reasonably and improve the infrastructure for the orderly development of innovation activities. Public service institutions aim to promote knowledge and technology transfer and maintain effective communication of the system by providing information, financial, legal advice and technology transactions. Financial institutions provide financial support for the manufacturing industry by implementing business integration and specialization. The public is the consumer of the manufacturing innovation ecosystem, which can discover system loopholes and deficiencies in time, provide new perspectives on the research direction of innovation activities, and form a market-oriented approach with public demand as the main criterion.

3.2.3 Innovation Environment

The innovation environment focuses on the institutional environment, market environment and cultural environment in the manufacturing industry, which are interrelated and interact with each other and have the characteristics of complexity, dynamics and uncertainty, etc. Continuously optimizing the innovation environment helps to guarantee the healthy operation of the system. The change of innovation environment often breaks the status quo of the innovation ecosystem of the manufacturing industry, and makes it transmute and form a new state for the purpose of adapting to the innovation environment.

In the manufacturing innovation ecosystem, a good institutional environment can reduce transaction costs and improve the situation of enterprises to invest in productive areas and maintain high quality economic growth rates. A vibrant market environment can deliver accurate production and consumption signals to manufacturing enterprises, increase innovation investment at the right time to improve the efficiency of enterprise production and R&D, and maintain market power. The cultural environment is broad in scope and can be either a specific cultural environment outside the manufacturing industry and related companies, or the mission or management's philosophy and preferences within the company. The deterioration of the innovation environment can lead to the development of the innovation ecosystem being hindered.

3.3 Analysis of the Mechanism on High-quality Development of Manufacturing Industry Based on Innovation Ecosystem

At present, China pursues the innovation-driven development strategy, aiming to promote the internal development of economy through comprehensive innovation. Innovation drive, comprehensive innovation and innovation ecosystem are different perspectives of the same path, and the ultimate purpose of the three is the same, that is, to promote the high-quality development of manufacturing industry by achieving all-round innovation in science and technology, service, system, finance, demand, efficiency and design. Among them, innovation-driven is the development strategy, as an important theoretical pillar of high-quality development of the manufacturing industry, constantly enriching and expanding the knowledge and understanding of innovation, and indicating the direction for practical promotion. Comprehensive innovation is the means of realization, emphasizing the

recombination of various production factors related to the production process, which is reflected in the profound understanding of the innovation process from specific production, circulation, sales and services, etc. To realize the needs of society, finance, government and other related fields to actively adapt to scientific and technological innovation, constantly open the innovation paradigm, actively cultivate new dynamic energy, construct new high ground, deeply participate in and even lead new technology in certain fields revolution. Innovation ecosystem is the role platform, its openness, diversity, growth, synergy, and dynamic characteristics, so that science and technology innovation subjects as well as non-technology innovation subjects in the system to communicate and reach symbiotic coupling, competition and cooperation and other interactive relations become possible, the formation of a sustainable and stable dynamic ecological network, innovation ecosystem to become the manufacturing industry to promote comprehensive innovation Habitat.

As can be seen from Figure 1, comprehensive innovation is an important measure to implement the innovation-driven development strategy, which helps the manufacturing industry to innovate technology application, production methods and management modes on the original basis and lay the foundation for the benign operation of the innovation ecosystem. Each innovation subject in the innovation ecosystem of the manufacturing industry has comprehensive processing of its own information as well as information of other subjects, which can promote the reform process of comprehensive innovation in the manufacturing industry, so as to achieve the goal of innovation-driven strategy and finally promote the high-quality development of the whole manufacturing industry.

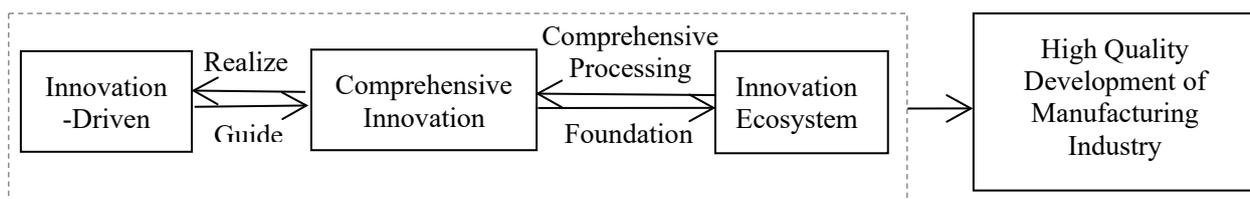


Figure 1. The interaction between innovation-driven, comprehensive innovation and innovation ecosystem

4. Conclusion

In response to the changes of the times and the challenges of the new economy, the traditional path of scale expansion and low-quality growth is unsustainable, and the high-quality development of manufacturing industry is a systemic change process with profound significance. Innovation-driven, comprehensive innovation and innovation ecosystem aims to promote the high quality development of manufacturing industry by realizing all-round innovation in science and technology, service, system, finance, demand, benefit and design. Innovation-driven is an important development strategy and main path for high-quality development of manufacturing industry, comprehensive innovation is the main measure to implement innovation-driven. Systematic promotion of comprehensive innovation reform is the key to break the bottleneck constraints of innovation-driven development. Manufacturing innovation ecosystem is a dynamic network system that can coordinate the development of the manufacturing industry itself and the changes with the internal and external environment. Realizing the the goal of high-quality development of the manufacturing industry need regard innovation-driven as a strategic direction, comprehensive innovation reform as the basis, the use of multiple means to improve the innovation subject, innovation communities and innovation environment, improve the utilization of innovation subject, enhance the cohesion of innovation communities, continuous optimization of innovation environment, in order to promote manufacturing innovation ecosystem to a high level of evolution, and the pursuit of more competitive development trend.

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References

- [1] D.L. Liu, Q. Wang. A new paradigm for innovation management research: innovation ecosystem management [J]. *Science and Technology Management*, vol.42(2021) No.10, p.20-33.
- [2] Y.L. Zhao, J.J. Gu. Measurement and comparative study on the quality of manufacturing development in China and the United States [J]. *Quantitative Economic and Technical Economics Research*, vol.35(2018) No.12, p.116-133.
- [3] X.Z. Li. A comparative study on the evaluation of high-quality development of China's manufacturing industry and regional differences [J]. *Social Scientist*, (2022) No.4,p.17-25.
- [4] T. Lv, D. Liu. High-quality development of manufacturing industry: gaps, problems and initiatives [J]. *Learning and Exploration*, (2019) No.1, p.111-117.
- [5] N. Li, H. Wang, Y. Wang. Research on the non-linear heterogeneous impact of digital economy on the high-quality development of manufacturing industry [J]. *Technology Economics and Management Research*, (2022) No.10, p.10-15.
- [6] Q. Yan, B.Q. Yin, Y. Liu. Green technology innovation, energy conservation and emission reduction and high-quality development of manufacturing industry [J]. *Science and Technology Management Research*, vol.42(2022) No.18, p.190-198.
- [7] Z.G. Mao, Y.M. Wu. Manufacturing distribution pattern, formation motive and development path in western region of China [J]. *Quantitative Economic and Technical Economics Research*, vol.36 (2019) No.3, p.3-19.
- [8] Y. W. Su. Research on the evaluation of high-quality development of manufacturing industry in the central region--analysis based on data from 2007-2018[J]. *Economic Issues*, (2020) No.9, p.85-91.
- [9] Y. Qu, X. Zhao. Analysis of regional upgrading and evolutionary path of China's manufacturing industry based on the change of regional industrial agglomeration level and its impact on total factor productivity [J]. *Industrial Economics Review*, (2022) No.2, p.37-58.
- [10] J.H. Chen, Y. Chen, M. M. Chen. Dynamic evolution of China's economic quality development level, regional differences and distribution [J]. *Quantitative Economic and Technical Economics Research*, vol.37(2020) No.12, p.108-126.
- [11] Y.J. Li, P. Han. Mechanisms and paths of high-quality development of manufacturing industry in the digital economy [J]. *Macroeconomic Management*, (2021) No.5, p.36-45.
- [12] D. Shi, J. Zhao, Z. Deng. Change mechanisms and policy measures for promoting high-quality development [J]. *Research on Finance and Economics*, (2018) No.9, p.19-27.
- [13] T.E. Liu, Y.Q. Wu. Connotation requirements, key difficulties and strategic initiatives for the high-quality development of industry in Xiongan New Area [J]. *Western Forum*, vol.29(2019) No.4, p.116-124.
- [14] H. Li. The theoretical mechanism, practical basis and policy options for big data to promote high-quality economic development in China [J]. *The Economist*, (2019) No.3, p.52-59.
- [15] Z.Y. Zhang. The basic logic and realistic path of high-quality development of China's manufacturing industry[J]. *Theoretical exploration*, (2020) No.2, p.87-92.
- [16] Pcast. *Sustaining the Nation's Innovation Ecosystems: Information Technology Manufacturing and Competitiveness*[R]. Washington D C Washington D C : Executive Office of the President, 2004.
- [17] B.A. Lundvall. *Product Innovation and User-producer Innovation* [M]. Alborg: Alborg University, 1985.
- [18] A. Radziwon, M. Bogers, A. Bilberg. *Creating and Capturing Value in a Regional Innovation Ecosystem: a Study of How Manufacturing SMEs Develop Collaborative Solutions*[J]. *International Journal of Technology Management*, vol.75(2017)No.1,p.73.

- [19] P. Ritala, V. Agouridas, D. Assimakopoulos, et al. Value Creation and Capture Mechanisms in Innovation Ecosystems: a Comparative Case Study [J]. *International Journal of Technology Management*, vol.63(2013) No.3-4, p.244-267.
- [20] J.O. Guang, Z. Li, Q. Shi, T.W. Huang. Research on the ecological construction path of high-tech industry innovation chain based on KRV coupling [J]. *Journal of Hangzhou Normal University (Social Science Edition)*, vol.43(2021) No.6, p.124-133.
- [21] H.Y. YI, Z.M. Zeng. Study on the evolution of dissipation of innovation ecosystem in high-tech industries--an empirical analysis of provincial regions in China using Brusselator model [J]. *Western Forum*, vol.31(2021) No.6, p.81-95.
- [22] Y.Y. Fang, J.J. Liu, X.Y. Feng. Spatial correlation, innovation ecological environment and innovation efficiency of high-tech industrial innovation ecosystem--an empirical study based on 23 provinces in mainland China [J]. *Science and Technology Progress and Countermeasures*, vol.39(2022) No.3, p.59-68.
- [23] K. Wen, G. G. Zhan, X.Y. Zhang. The operation status, development potential and categories of industrial innovation ecology [J]. *Science and Technology Management Research*, vol.40(2020) No.4, p.179-190.
- [24] T. Meng, D.X. Li, F.F. Zhao. The construction of meaningful innovation ecosystem for manufacturing enterprises in the context of double carbon [J]. *Science and Technology Management*, vol.43 (2022) No.7, p.156-166.
- [25] Y.A. Zhang. *Theory and practice of regional economic integration* [M]. Shanghai: Gezhi Press, 2010.
- [26] P.M. Romer. Endogenous Technological Change [J]. *Journal of political Economy*, vol.98 (1990) No.3, p.71-102.
- [27] M. Wei, C. Wang. Research on innovation-driven transformation and upgrading of manufacturing industry in Shaanxi Province from the perspective of information ecological balance [J]. *Science and Technology Progress and Countermeasures*, vol.32(2015) No.21, p.48-53.