The Reality, Risk and Governance of Regional Innovation Ecosystems under Digital Transformation Background

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Abstract. The digital transformation of regional innovation ecosystems is received by the extensive attention from academia and practical communities. This paper uses China's regional innovative ecosystem as a research object, explores changes in information flow, resource flow, capital flow and technical flow direction and flow rate within the context of digital transformation. The study found that digital transformation will change the flow direction and structure of the information flow; The flow rate of resource flow, capital flow and technology flow is accelerated is increased, but the flow direction is unchanged. Finally, the potential risks of innovative ecosystem under digital transformation background have been analyzed, and the countermeasures and recommendations for relevant management departments and enterprises are put forward, providing a theoretical reference for further improving digital construction for China's regional innovation ecosystems.

1. Introduction
In recent years, many regional innovation centers have emerged in the process of economic and technology globalization, and many developed innovative ecosystems such as Silicon Valley, London Tech city have taken a lead in international competition. The global competitive situation is no longer limited to the competition between countries and countries, and gradually closer to the regional strategic level [1]. At the same time, many Chinese strategies also promoted the development of regional innovation ecosystems, and the government has repeatedly emphasized the importance of constructing the innovative ecosystem system of collaborative development, and issued a series of policies to actively promote the construction of innovative ecosystems in all provinces. However, there is currently an imbalance in the development of innovative ecosystems in various regions, and the symbiotically of various elements within the system is relatively weak, leading to significant differences in economic development and scientific and technological innovation capabilities in different regions, which is not conducive to the high quality transformation of China's economy.

At the same time, digital transformation has brought opportunities and challenges in the global scientific and technological development, which has significant impact on China's scientific and technological strategy, indicating that China's development is rapid; In addition, COVID-19 in 2020 has accelerated the digital transformation process of China's economy and industry. Take into account this, digital transformation has caused different degrees of influence on China's innovative ecosystem, and accelerated industrial structured transformation and adjustment, and created potential opportunities for the improvement of technology research and technological innovation capabilities for all innovative
ecosystems. It also brings potential difficulties to formulate and implement development strategies and policies for relevant management departments. At present, China's digital transformation is still in the primary exploration stage, and the size of the digital economy and development has a definite gap between other developed countries. There is a further improvement space, so how to improve the construction of innovative ecosystems under the trend of digital transformation is highly concerned with the academic community and practical.

Take into account this, this paper passes through the status of innovative ecosystems and digital transformation in China. Based on bionic perspective and logic analysis of digital transformation on information flow, resource flow, capital flow and technology flow from regional innovation ecosystems in China, this paper further explores the potential risks in China's innovative ecosystem under digital transformation, and proposes relevant recommendations and countermeasures.

2. Connotation of Innovative Ecosystems and Digital Transformation

2.1. Innovative Ecosystem

The connotation of the innovative ecosystem is first made by Moore (1996). He believed that the group organization of the innovation enterprise is based on certain rules, which are an innovative ecosystem [2]. Iansiti and Levin (2004) believed that every individual of the innovative ecology had its own position in the entire ecosystem, that is, ecological position, and the change of the ecological position will cause a change in the entire system[3]. Therefore, from the perspective of the ecological position, the innovative ecosystem consists of various innovative units, and each innovative unit is constrained by the macroeconomic environment, and the interoperability and coupling of information flow, resource flow, capital flow, and technical flow are formed[4], to meet user and public need,[5] and has the ability to affect industry technical standards[6]. In addition, innovative ecosystems are also aggregates of colleges, research institutions, high-tech enterprises, and social public, which are based on the flow technologies, information, capital and resources. The innovation results are provided to the public and other departments, which in turn will promote the development of socio-economic and science and technology [7].

![Fig 1. Innovative ecosystem based on bionic perspective](image-url)
into innovative main communities, upstream communities and downstream communities. Innovative main communities are mainly focused on technological creation, such as high-tech enterprises and R&D institutions, etc. The main role of the upstream community is to provide basic material resources and talent resources, including the organization of raw materials suppliers and colleges. The downstream community is the sales terminal, mainly responsible for selling or promoting innovation results enhanced by innovative main communities.

2.2. Digital transformation

In recent years, the economic digital era has given birth to a new type of production factor represented by big data, and the national governance and business management of the company's operation relying on massive data. Data are different from traditional production factors, which have the characteristics of shared, replicated, large, fast flow rate, and an unlimited supply, can upgrade the company to digital transformation, and achieve economic development. During the digital transformation process, China's industrial and innovation systems have undergone a multi-angle transformation, and improve the digitalization and intelligent development level of various industrial and technological innovations.

At the same time, enterprises can use artificial intelligence, block chain, cloud computing, big data and other digital technology to build a digital interaction ability of enterprise multi-layer contacts, build data-driven business management capabilities, and realize enterprise digital, intelligent transformation and upgrading. And user-based digitization is combined with the product and service supply end, effectively reduces the innovation cost of the company, and the innovation efficiency of the company. With digital transformation, use of intelligent products and personalized products to improve organic balance between supply and demand.

3. Development Status of Regional Innovation Ecosystem and Digital Transformation

3.1. Development status of regional innovation ecosystem

Proposed from China's innovation-driven development strategy to the regional coordinated development strategy, in the established macro environment, each community conducts organic cooperation, which can effectively promote the close combination of innovation and commercial, science and technology and economy, and further stimulates the creation and value added in regional innovation ecosystems[8]. Therefore, the digital transformation of regional innovation ecosystem has gradually become a key force in shrinking regions, implementing innovative national strategies, achieving the coordinated development, and linkage growth[9].

The development level of regional innovation ecosystem in the eastern part of China is higher, and the development of the central and western regions is relatively lag. This is primarily due to the geographical advantages in the eastern region, and can make full use of open innovation to conduct numerous innovative activities. At the same time, communities in the innovative ecosystem have closely cooperated, accelerating the flow rate of information flow, resource flow, capital flow, and technical flow, and the synergy of innovative ecosystems. Relatively speaking, there are a relatively backward economic development, technical level and technological innovation capabilities, scarcely innovative talents, and technical support, such as China’s central and western regions, which have loaned innovative collaboration in innovation ecosystems. The effect of value creation is not significant, hindering system development. Due to digital transformation, the interconnection of information and knowledge, open sharing of data and technology can enhance the collaboration capacity of regional innovation ecosystems, and improve the development status of economically backward in the central and western regions.

At the same time, differences of innovation ecosystems between regions in China gradually shrink. Although the eastern region has a higher innovative ecological level, the development process is slow, most of the development of deterioration, can use digital technology to accelerate the development process, improve the development status; The central and western system's benign development is strong,
and the ability to collaborate in the system is gradually strengthened, which is conducive to cross-regional synergistic development of overall technology level in China.

3.2. Development Status of Digital Transformation

With the development of Internet, big data, artificial intelligence, digital economy is becoming an important engine for global economic and social development. According to data released by China Information Communications Research Institute(Fig.2), China's digital economy scale presented a year-on-year increasing trend, from ¥2.6 trillion in 2005 to ¥35.84 trillion in 2019, a growth rate of more than ten times. In the early days of digital transformation, China had a wide range of routine improvement in the traditional industries, and the average annual growth rate was even more than 100%, and in 2014, the annual growth rate was higher than 50%. Since 2015, the yearly growth rate remained stable, and was basically between 15% and 20%, which also presented a higher growth situation. In addition, the data of the Ministry of Industry and Information Technology showed that China had improved the production efficiency of 305 demonstration projects by building a group of digital workshops, reducing operational costs, shortening the development cycle, and the application of digital technology had greatly improved the production efficiency of enterprises and saved the operating cost of the company. From another perspective, China's digital transformation is mainly focused on production links and business models. It is limited to basic innovation, and is lacking on digital technology applications based on inventive nature and basic development.

![China Digital Economic Size](image)

**Fig 2.** China’s 2005-2019 Digital Economic Size and Growth

Digital economics include digital industrialization and industrial digitalization, namely digital technology innovation and industrialization and enterprises use digital technology to improve management levels and apply them to products, services [10]. As showed in Fig.3 and Fig. 4, China's digital industrialization and industrial digitalization had shown an upward trend. In 2005, the size of the two was nearly 1.3 trillion yuan, and the gap was not huge. By 2017, the size of industrial digitalization had reached 21 trillion and the digital industrialization was only 6 trillion yuan, and the industrial digitalization scale was 3.4 times that of digital industrialization, and the gap presented was substantial. From the digital economy to China's GDP proportion (Fig.5), the digital economy accounted for 32.9% from 14.2% between GDP in 2005 to 2017, presenting a year-on-year tendency. The trend of industrial digitization accounted for the proportion of GDP was in line with the overall digital economy, and the digital industrialization is always around 7% of GDP, which is relatively stable. However, the
regional innovation ecosystem in China faced the problem of development imbalance, considerable inter-regional gap, and the power of overall innovation. It can be seen that although China's digital process is continuously advanced, the digital economy is gradually become an important factor in determining China's economic development situation, but there is still large lifting space in digital technology in regional innovative ecosystems.

**Fig 3.** Digital scale and growth rate of industries in 2005-2017

**Fig 4.** Digital industrialization scale and growth rate in 2005-2017
4. Analysis of the effect of digital transformation on the ecological stream in the innovative ecosystem

4.1. Influence of digital transformation on information flow
On the one hand, the digital transformation causes a change in the flow direction of the information flow (Fig.6). In the traditional innovative ecosystem, the information flows from the downstream community to the main community of the innovative ecosystem, and then from the main community flow to the top community, it is a bottom-up direction; With the continuous advancement of the digital transformation process, the flow direction of information stream gradually transitions towards the top of the top. Specifically, before China's official implementation of digital transformation policies, China's market mainly focused on product function orientation, consumers paid more attention to functionality, use and durability, etc, and consumers' functional appeal was far more than experienced demands. The entire market environment presented "Buy what has been produced", that is, upstream community as the supply of resources, the existing material resources and human resources were passed to the main community or downstream community. The main community directly developed a suitable innovative product in accordance with existing resources, providing the product to the downstream community, entered the market through the sales link of the downstream community, consumers considered the functionality of existing products, and judgment if it was necessary to purchase products. In the context of digital transformation, further strengthening the consumer-centric market orientation, paying attention to the differentiation and diversification of the product, the entire market environment is transformed into a personalized demand, showing "Produce what is needed". Consumers pay more attention to the convenient and flexible experience and delivery, and feedback to the downstream community through the data sharing platform for information on the needs of future products and future products. The downstream group can promptly pass market information to the main community, which is conducive to the main community more clear market demand, and develop the corresponding products according to market demand, reducing the creative costs and the risks of entering market. At the same time, the main community provides information about the resource demand to the top community, which is efficient and convenient to obtain the resources required by the R&D investment, accelerate the R&D speed of the main community, and reduce R&D costs. Therefore, the digital transformation causes the flow direction of the information flow from"top-down" to "bottom-up ".

Fig 5. Overall digital economy, industry digitalization and digital industrialization account for the proportion of China's GDP
On the other hand, the digital transformation will make the chain structure of the information flow become a network structure that interacts. Due to the widespread use of digital technology such as block chains, cloud computing, big data, information gradually presents the trend of opening and sharing. Main, upstream and downstream community can promptly get accurate information, realize the community optimization and collaboration. For example, Baidu has attracted a large number of R&D collaborators from all over the world to jointly launch a series of solutions. In addition, the Android system adopts open source strategy to attract global technically to participate in application development, accelerate the update of the system, win a large number of smart phone users, accounting for 85.1% of the market share of smart phone market in 2018, reaching the world leading level [11].

In summary, the interconnection of information makes the unidirectional flow of the information flow in the traditional innovative ecosystem become circulating reciprocating flow, and the chain structure becomes a net structure.

4.2. Influence of digital transformation on resource flow

In the innovative ecosystem, the upstream community is a resource supply party. It is responsible for providing limited resources to the innovative main and downstream community. The main community uses resources to develop innovation; downstream community uses resources to achieve product sales links, so that the products and services are circulated in the user's hand, the digital transformation affects the flow and flow direction of the resource flow in the ecosystem (Fig. 7).

First, the digital transformation will speed up the flow rate of the resource flow. The data of each community can be interconnected by the construction of the data sharing platform and the wide application of the block chain technology. When the R&D resources of innovative main community and the sales resources of the downstream community are lacking, the community can use relevant digital technology to make resources, and achieve the precision supply of resources. In the innovative ecosystem before digital transformation, the upstream community tended to be a state of passive supply resources. Only when the main community or downstream community delivered information about demanding resource, the upstream community would supply resources, in addition, this passive supply often led to the occurrence of resource supply, and the resource flow was slow. In the context of the digital economic era, the upstream community can promptly understand the application of digital technology and even pre-proportional subjects and downstream groups to resource demand, to achieve the active supply of resources, save the intermediate link of purchase department, ordering department and other relevant departments, reducing the cost of enterprise, and improves the efficiency of resources, avoiding the stagnation of R&D, sales and other links due to the timely supply of resource supply. For
example, after COVID-19, research institutions such as the Chinese Academy, Peking University, Global Health Drug Research Center, Alibaba and Baidu Institute and universities, social organizations and enterprise, actively mobilize the resources that can be integrated, and rapidly built a relatively complete digital infrastructure system covering the data base, storage space and transport network to finish timely and effective resource supply and deployment[12], reducing the problems of resources shortages and uneven distribution[13]. At the same time, it has increased innovative input and investment, enhancing intelligence and convenience of COVID-19 prevention and control.

Fig 7. Effect of digitized transformation on resource flow

Second, digital transformation increases the flow of resource flow and increases the quality of resources. Digital technology can allocate a limited resource to the desired place, so that the resources flow are more targeted, reduce waste, which will enable the main community and downstream community to get more effective resources. As an important part of the innovative ecosystem, talent provides the intellectual capital required for R&D innovation. In recent years, companies have more strongly demand for high quality digital talents. Beijing Qihu Technology Co., Ltd. (referred to as 360) as China’s top technology company, in order to address digital transformation, recruits a large number of innovative talents and forms more than ten attack and defense experts who represent the world's top technology level. At the same time, China’s colleges and universities have also opened a series of courses related to digital technology, cultivating digital talents needed by society, such as Nankai University in recent years has added "Intelligent Science and Technology", "Data Science and Big Data Technology", Tianjin University has added "Intelligent Medical Engineering", "Intelligent Performance Engineering", and the lessons related to big data. Colleges and universities provide more professional researchers for main community. Therefore, the digital transformation will significantly improve the number and quality of resource supply.

Based on the above analysis, in the background of digital transformation, the flow direction of the resource flow has not changed, but the number, quality and flow rate of resources have improved significantly.

4.3. The influence of digital transformation on capital flow

The capital flow is an essential basis for establishing a good collaborative relationship between the communities, and is also a supportive resource for the synergy of the entire innovative ecosystem. In the entire innovative ecosystem, the main, upstream and downstream community need the capital to support. The downstream community has obtained funds from the market by selling products, and then
funded back to the main and upstream community. The flow direction of capital flow and product flow is opposite. Therefore, the capital flow is an integral part of the entire innovative ecosystem.

Fig 8. Effect of digitized transformation on capital flow

With the continuous advancement of digital transformation, China's credit rating mechanism slightly tends to be intelligent. The credit rating agency is primarily responsible for the credit extent of the capital demand, the credit party's credibility, and the more accurate evaluation of funding requirements, and the information is forwarded to the capital supply party in time. Before digitizing, credit information of each community was not easy to obtain. In the purchase of resources, a large number of research work needed to be carried out to determine the object of funds, which seriously hinder the flow rate, input and cost of capital flow. In the context of digital transformation, platform-based digital technology enables capital provider to obtain credit records related to capital demander in a timely and accurate, helping funds supplies to reduce bad debts risk, improve capital input and efficiency.

In order to promote digital transformation, China has introduced a series of preferential policies to increase the loan line, accelerate the speed of grants and loans, enabling more capital into innovative ecosystems at the faster speed and increase funds. Compared to no digital transformation, more financial support can be achieved with more policy support by main communities and downstream communities. The main community uses capital to increase R&D investment, increasing the need for resources, buying corresponding resources from upstream communities; The downstream community uses capital to obtain resources from the upstream community, product from the main community. Capital flow to the upstream and main community becomes huge.

Built on the above analysis, the digital transformation makes the flow of capital flow increase, and the flow rate is accelerated.

4.4. Influence of digital transformation on technology flow

In the innovative ecosystem, the main community is mainly responsible for the development of innovation, improving the technical level, and providing technical support to the upstream community and downstream community, improving the innovation capacity and the development level of each community. In addition, the development of the digital economy increases the flow rate of technology flow and increases the flow of technology flow.
Fig 9. Effect of Digital Transformation on Technology Flow

Digital transformation promotion technology sharing improves the flow rate of technology flow. Innovation units in ecosystems such as enterprises, R&D institutions, and universities are an important part of main communities, upstream communities and downstream communities, and there are structural relevances in the three communities. Before digitizing, the internal relevance of each community was not robust, and the contact was not close enough, and the efficiency of cooperation with each other was low. After digital transformation, the shared platform formed in each community has improved the overall efficiency between communities and promoting the synergy of innovative ecosystems. For example, Ningbo Bobi Board Co., Ltd. through data sharing with other R&D companies, cleans their data and calculates simulation with data, which has increased its R&D efficiency by 35%, and the lifecycle of innovative products is shortened by more than 50%, so that innovative products that meet the need quickly enters the market, improving market share and competition. Therefore, with the development of digital technology, The main community is internally shared with the technical achievements and constantly developing new innovative products to improve innovative efficiency. In addition, the problems in each community can be reacted through the digital technology, such as low product quality, high manufacturing cost, low production efficiency. At the same time, in the context of digital transformation, the main community can quickly obtain “signal” in the upstream and downstream community, developing targeted technology innovation, accurately and quickly conducting corresponding R&D innovation activities.

Based on above analysis, digital transformation increases the flow rate and flow of technology flow.

5. Potential risks faced by regional innovation ecosystem digital transformation

5.1. Digital transformation due to cost and resource issues, more applications in large enterprises, the digital process of small and medium-sized enterprises lag. The innovation "the gap between rich and poor" is further expanded

In the background of the digital economy, digital transformation means an optimized upgrade of the company's extensive industry chain. If you want to maintain a competitive advantage in the current market, you need to adjust the strategy, promoting innovation links such as digital research and
development, digital manufacturing, digital marketing. The digital transformation of enterprises requires higher human capital and material capital, that is, more resources and funds. However, compared to large enterprises have strong financial capital and more financing channels, the amount of funds within SMEs is poor, the external loan quota is depleted, limited, and most of the capital flow and resource flow go into the big enterprises, leading to the gap of digital transformation between SMEs and large enterprises is huge, which is not conducive to the development of the overall market economy.

5.2. The relative shortage of digital talents, the level of employees is uneven, resulting in low or loss of technical transformation
As China's digital economy has gradually increased, the number of employed people is increasing, the digital foundation of digital transformation is weak, and many problems with relatively insufficient platform capabilities and shortages of talents are gradually exposed. As an important part of the resource flow in the innovative ecosystem, talents, from the upstream community falling to the main community and downstream group. In recent years, most of our higher colleges have opened relevant course related to digital technology, targeted cultivating digital talents. However, China's cultivation of digital talents is still in the primary exploration stage, and the curriculum system and training model of digital technology are not perfect. The transformation of the resource capability of the main community and the downstream community can be relatively insufficient, so the digital transformation of the innovative ecosystem has a barrier. In addition, since China has a gap in the demand for digital talents, a large number of employees who do not have digitally knowledge have entered the field of digital technology research and development, making the professionalism between digital technology R&D staff have gaps, increasing the risk of failure of corporate technology change, leading to the amount of resource flow in the ecosystem increases but the quality is significantly reduced.

5.3. There is a large vulnerability of data security issues, and the trust is lower during advance.
The application of digital technology enhances data acquisition channels, and each data source can generate a lot of data in a short time, including a large number of data related to corporate internal confidentiality, public personal information, etc., therefore, the compliance, legitimacy issues are increasing, and the safety hazards of information leaks have not been resolved in the digital transformation process. In the innovative ecosystem, each community is competitive but collaborative, data loss or leakage will seriously damage the fairness and collaboration of competition, and reduce the degree of trust of the communities in digital technology. It is conducive to the development of digital transformation.

6. Countermeasures and recommendations of digital transformation of regional innovation ecosystem

6.1. Providing digital transformation subsidies and incentive policies, optimizing the protection measures for digital transformation of small and medium-sized micro enterprises.
In recent years, China's government has introduced a series of policies to promote the development of scientific and technological innovation and digital economy, but the subsidy policy and incentive policy of digital transformation of small and medium-sized enterprises have relatively small, leading to insufficient driving force for digital transformation of small and medium-sized micro enterprises. China can further improve the support policy of digital technology research and development and application of small and medium-sized enterprises, and encourage large-scale enterprises with high digitization to provide technical support and talent introduction to small and medium-sized enterprises, realizing the common development of digital economy of large and medium-sized enterprises, and promoting digitalization communityization and systematization of transformation. At the same time, all innovative units in innovative ecosystems should also make full use of existing preferential policies, rationally use the industrial guidance fund of government, carry out digital investment, and further improve the overall innovation ability and level of the ecosystem.
6.2. **Accelerate the construction of resource supply systems in innovative ecosystems, and focus on solving the problem of digital innovation talents.**

The upstream community mainly provides talent resources and material resources to innovative main communities and downstream communities. Talent resources are indispensable intellectual capital in digital transformation. Relevant departments can cultivate basic disciplines closely related to digital technology, and improve the reserve of China's outstanding talents for digital knowledge, and also need to establish a further improved digital talent training system to strengthen the internal training of digital talents. For example, General Electric Co., Ltd. has started digital transformation in 2011, and rapidly recruits 7,500 digital talents from the outside, especially Silicon Valley in 2012 ~ 2016. In June 2016, in 307,000 employees, 28,000 people were engaged in digitally related business, which prompted universal electrical achievements to the successful transformation of "digital manufacturing".

6.3. **Strengthening national digital technical safety construction and promotion, enhancing the digital transformation consciousness of innovation units.**

At present, China is in a critical period of digital transformation, the public's emphasis on data security and privacy protection has gradually increased. It is recommended that the applicable departments improve the "National Data Security Law" and the "Privacy Protection Law" to improve the requirements of data normative and legitimacy. At the same time, it can also establish a social data sharing platform to form a "data public pool" to ensure the safety use of data in laws, regulations and technical means, and improve the level of trust in digital technology and accelerate digital transformation process. What’s more, communities in the innovative ecosystem should make full use of the opportunities brought by the economic digital era, strengthen the digital transformation awareness, enhance the competitiveness between the community, and improve the innovation capability of regional innovation ecosystems. According to the data released by Boston Consulting, only 25% of China Manufacturing Enterprises will put forward the construction of smart plants, but also in the U.S. 54% manufacturing enterprises began to transform. China Manufacturing Enterprises are behind the U.S. in the same type of enterprise in human-machine collaboration, intelligent connection, wisdom decision and data integration [11]. It can be seen that the digital transformation process of China's innovative ecosystem is slow to develop in developed countries in the same period. Therefore, all innovative units in the innovative ecosystem need to strengthen the awareness of digital transformation, formulate and implement relevant measures related to digital transformation as soon as possible, and improve the overall technological level and innovation capabilities in China.

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