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Study on the Influence Mechanism of Science and Technology Finance on the Technological Innovation of High-tech Industry

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ABSTRACT

High-tech industries are leaders in technological innovation. Their high innovativeness, high investment, and high risk make the contradiction between capital supply and demand a key factor constraining industrial development. Science and technology finance is an open system composed of various financial entities and institutional environments. As a crucial guarantee for technological innovation and a critical link in enhancing financial services to the real economy, it will provide the strongest support for the development of high-tech industries. This paper delves into the direct impact mechanisms of science and technology finance on technological innovation in high-tech industries from five aspects: government, banks, venture capital, capital markets, and technology insurance. It also discusses the indirect impact mechanisms of science and technology finance on technological innovation in high-tech industries from two perspectives: competitive effects and spatial spillover effects. Finally, it proposes policy recommendations aimed at promoting technological innovation and the development of science and technology finance in high-tech industries across regions, improving the science and technology finance system, strengthening the role of science and technology finance, focusing on spillover effects between different regions, and facilitating the free flow of resources.

KEYWORDS

Science and technology finance; High-tech industry; Technological innovation; Spillover and competition effect

1. INTRODUCTION

Innovation in science and technology cannot do without financial support. On one hand, finance provides risk diversification and value discovery for technological resources, promoting technological development; on the other hand, the productivity generated by technology offers high returns to financial capital, incentivizing financial institutions to innovate for the sake of technology. The two aspects interweave and promote each other, giving rise to tech finance. High-tech industries, being both technology-intensive and knowledge-intensive, aim at technological innovation, characterized by high investment, high risk, and rapid growth. They are among the leading industries for achieving high-quality economic development. In the process of research and development as well as industrialization, these industries have an urgent need for funds, but the high risk has become an obstacle to corporate financing. The contradiction between funding demand and supply is also the biggest bottleneck constraining the development of high-tech industries. Therefore, tech finance, as a booster for technological innovation, can provide financial support and professional services at various stages of high-tech enterprises. Thus, the development of high-tech industries cannot do without financial support. The emergence of tech finance organically combines technological resources with financial resources, providing strong support to high-tech enterprises at different

stages; meanwhile, it focuses on the development of high-tech industries, accelerates the construction of an innovation system, promotes the optimization and upgrading of industrial structures, and facilitates the integration of technology and finance.The long-term integration of science and technology, the improvement of the science and technology financial system, the improvement of the regional science and technology financial development level, so that science and technology finance can better serve the innovation and development of regional high-tech industries, is also an important part of building an innovative country.

2. LITERATURE REVIEW

Ang (2010) found through the study of time series data that financial innovation is conducive to promoting technological progress and then promoting economic growth[1].Gustav M (2010) shows that the market-oriented financial system plays a more significant role in supporting enterprise technological innovation[2].Kubra S and Nihan Y (2016) used the credit scale of 100 communication technology companies in Turkish industrial parks to find that financial innovation is conducive to the development of high-tech industries in industrial parks[3].

Research on technology finance in China started relatively late, but it has also produced a wealth of academic achievements. At the theoretical level, Zhao Changwen (2009) first proposed the definition of technology finance, arguing that it is a systematic arrangement of a series of financial instruments, policies, systems, and services that promote technological development and facilitate the transformation of outcomes[4].Fang Hanting (2010) studied the connotation of science and technology finance from three perspectives: theory, policy and practice[5].Wang Hongqi and Xu Yulian (2012) believe that science and technology finance has many subjects, including government departments, science and technology industry institutions, financial institutions and other innovation institutions, which is a new type of investment and financing system[6].Wang Yuan (2014) pointed out that science and technology finance is an important part of the current financial system, rather than a completely independent new system[7].Xue Li and Ye Lingfei (2016) believe that science and technology financial services serve scientific and technological innovation activities and science and technology enterprises, and a main bank science and technology financial system should be established with government as the leader, banks as the main body, capital market and venture capital as supplements[8].

Research on the relationship between science and technology finance and innovation is also a hot topic at present. Wang Zhengren (2014) showed that regional technological innovation ability and science and technology finance have strong spatial dependence, and science and technology finance has regional spillover effect on technological innovation[9].Zhang Yuxi (2015) showed that there was a significant positive correlation between science and technology financial input and scientific and technological innovation in the short term, but not significant in the long term[10].Cheng Xiang (2018) found that the role of science and technology financial policies in Beijing, Tianjin and Hebei has not been fully utilized[11].Wang Weibin (2012) established an evaluation index system and model for promoting the development of high-tech industry by science and technology finance, and found that there is still a large space for improvement in the efficiency of promoting the development of high-tech industry by science and technology finance[12].Chen Ruixue (2014) found that the development of technology finance and high-tech industry showed a high degree of coupling and coordination[13].Li Junxia (2016) found that science and technology finance has a significant positive effect on high-tech industry based on system dynamics[14].Jin Hao et al. (2017) found that investment in science and technology finance helps the development of high-tech industries, and then promotes the upgrading of industrial structure[15].Liu Xiangyun et al. (2018) empirically shows that the co-evolution of science and technology finance and high-tech industry is a complex aggregate, and the two achieve optimal steady state solution through interactive learning, sharing and sharing, so as to realize the synergistic effect of "1+1>2" between science and technology finance and high-tech industry[16]. Chen Shan(2019) Using DEA method and generalized Cobb-Douglas production

function, this paper analyzes the influence of science and technology finance on regional innovation efficiency of high-tech industry. The results show that the continuous development of science and technology finance makes the innovation efficiency of high-tech industry continuously improve[17].Zhou Caiyun et al. (2021) showed that financial investment in science and technology, scientific and technological loans and investment in scientific and technological human resources directly promoted the performance of technological innovation, and financial investment in science and technology also indirectly improved the technological innovation ability of high-tech industries by improving the operating conditions of enterprises[18].Fang Xianming et al. (2023) showed that the innovation development of science and technology finance and high-tech industry in the Yangtze River Economic Belt showed a positive growth, but there were significant differences in the demand for science and technology finance among the upstream, middle and downstream high-tech industries[19].Ding Yong et al. (2023) empirically shows that government investment and human capital investment have a significant effect on the improvement of Chinese high-tech industry innovation ability and level, while enterprises own investment and financial institutions investment support are relatively low, and there is still a large space for development in the capital market investment[20].

3. THE MECHANISM OF TECHNOLOGY FINANCE ON TECHNOLOGICAL INNOVATION IN HIGH-TECH INDUSTRIES

The mechanisms by which technology finance influences technological innovation can be summarized into four main aspects: Technology finance helps raise funds for technological innovation activities, providing financial support to enterprises; the technology finance system processes information for technological innovation, reducing information asymmetry and lowering transaction costs, thus allocating resources for technological innovation; the technology finance system assists enterprises in establishing incentive and supervision mechanisms; the technology finance system helps enterprises control and reduce risks associated with technological innovation. Different forms of technology finance have varying impacts on technological innovation activities. Moreover, technology finance not only directly affects the technological innovation of high-tech industries in its own region but also indirectly influences neighboring regions through spatial effects. Below, we will discuss the direct impact mechanisms of government, banks, venture capital, capital markets, and technology insurance on technological innovation, as well as the indirect impact mechanisms of technology finance on the technological innovation of high-tech industries, primarily including competitive effects and spatial spillover effects.

3.1. The Direct Influence Mechanism of Science and Technology Finance on the Technological Innovation of High-tech Industry

3.1.1. The Role of Government in Technological Innovation

The complexity, uncertainty, high risk, and information asymmetry inherent in technological innovation make it indispensable for government support to drive its development. Government support for technological innovation is reflected in fiscal expenditures on enterprises, research institutions, and other tech entities. These fiscal expenditures can reduce the R&D costs and risks for businesses, universities, and research institutions, thereby stimulating their motivation for scientific innovation. Moreover, government funding can guide financial institutions to provide loans, venture capital, and other social funds into the field of technological innovation. Additionally, government fiscal spending can help companies upgrade equipment, introduce new technologies, launch new products, incentivize researchers, and promote the output of technological innovation outcomes. Through policy-based finance, the government can fully leverage the multiplier effect of fiscal funds to support technological activities, such as issuing policy documents to encourage the development of technology finance, promoting pilot projects for technology finance, establishing technology

financial service platforms, providing comprehensive financial services to tech companies, expanding the overall scale of corporate R&D funding, and reducing the risks associated with technological innovation activities, thus incentivizing the development of innovative activities.

3.1.2. The Role of Banking Financial Institutions in Technological Innovation

The banking financial system has always held a pivotal position in Chinese existing financial system. Evaluating the prospects and returns of innovative projects is a highly specialized task with high information costs. Leveraging their advantages in acquiring and processing information, banks and other financial intermediaries efficiently aggregate and process this information to comprehensively assess companies financial conditions, operational capabilities, and development potential. They also assess innovative projects, selecting those with more promising investment prospects, higher returns, and lower uncertainties, providing strong financial support for these potential stocks. The information on bank investments spreads, mobilizing social capital and guiding resources toward these high-tech, high-return enterprises. Moreover, the financial intermediary market dominated by banks, lacking specific disclosure requirements for innovative projects, does not lead to externalities in project information, thus incentivizing companies to engage in innovative activities.

But the high-risk nature of technological innovation activities fundamentally conflicts with the prudence principle of commercial banks. Loans for technological innovation activities of small and medium-sized enterprises (SMEs) are mainly short-term working capital loans, making it difficult to predict loan turnover periods and overdue risks. The characteristics of these loans short-term, urgent, and risky lead to common issues such as high costs, low efficiency, and information asymmetry when commercial banks lend to these tech companies. Therefore, commercial banks tend to favor large enterprises with larger asset scales and higher credit ratings. For SMEs with smaller assets and the "four highs" characteristics (high technology, high investment, high growth, and high risk) that fail to meet the credit requirements of commercial banks, banks often cannot satisfy their financing needs for technological innovation.

3.1.3. The Role of Venture Capital in Technological Innovation

Venture capital primarily invests in high-tech enterprises, focusing on the knowledge, technology, and business models owned by entrepreneurs and their teams. Through specialized operations, venture capital provides financial support to companies, offering much-needed funds for technological innovation activities, enhancing the competitiveness of high-tech enterprises in the market, and promoting the development of the high-tech industry. Typically, venture capital supports small and medium-sized tech companies through equity investments in the early stages, and later exits by helping these companies go public or merge with others, taking on high risks while reaping high returns. During the process of investing in companies, venture capital formulates different investment strategies based on the development status of the invested company, controlling the amount of investment at various stages to impose financial constraints on the company, which can motivate it to operate more efficiently and enhance its drive for technological innovation.

At the same time, venture capital provides a series of value-added services to high-tech companies, offering continuous supervision and guidance to meet the investors pursuit of high returns. These services primarily include managing working capital, providing relevant policy and legal information, risk prevention services, guiding quality technology, nurturing excellent management teams, and formulating plans for listing or acquisition. These services are particularly crucial for innovative startups that excel in technology. In short, while providing capital support and value-added services to high-tech companies, venture capital enhances their ability and efficiency in utilizing innovation resources through mechanisms such as risk sharing and incentive supervision. Ultimately, this promotes the successful commercialization of technological achievements and achieves industrialization.

3.1.4. The Role of Capital Market in Technological Innovation

The capital market serves as a direct channel for financing for technology innovation companies and also acts as an exit route for venture capital. It imposes strict requirements on corporate information disclosure, which helps to alleviate the information asymmetry between investors and financiers, indirectly enhancing the companys financing capabilities. In addition, capital market financing can reduce the companys debt-to-asset ratio, optimize its financial structure, significantly boost the companys reputation and credibility through public stock and bond markets, and guide high-quality talent into the company. This plays a crucial role in mergers and acquisitions, strengthening the companys power and expanding its market reach.

Technological innovation enterprises primarily use two methods for direct financing in the capital market: stock market financing and bond market financing. Stock financing involves listed companies raising funds directly through methods such as stock allocation, issuance, and additional convertible bond offerings on the securities market. For startups in the technology sector, the Growth Enterprise Market can help them access larger and longer-term funding, which is beneficial for their industrial development. For companies in the mature stage of technological research and development, the property rights trading market can assist them in effectively converting technical achievements into practical applications. Bond issuance is another major method of financing in the capital market. In the early stages of establishment, high-tech enterprises face significant investment risks and require substantial capital investment, often unable to secure funding support through channels like the stock market or bank loans. Bond financing features low issuance costs, fixed yields, and free tradability, allowing these companies to raise funds by issuing bonds to attract idle capital from social investors, thereby dispersing risks among a wide range of public investors. From this perspective, issuing bonds can bear and disperse more risks compared to bank loans.

3.1.5. The Role of Science and Technology Insurance in Technological Innovation

Xie Kefan (1995) argues that technological risks in scientific research and development activities, especially during the process of converting science and technology into productive forces, arise from the uncertainty of external environments, the complexity of projects themselves, and the limitations of researchers capabilities. These factors can lead to project failures, terminations, or under performance. Internal risks include high technical challenges, substantial research funding and personnel investment, as well as management issues within the research project itself. External risks involve information asymmetry in technology transfer, inadequate incentive mechanisms, and changes in market demand. Therefore, high-tech enterprises need specific insurance to disperse, transfer, and mitigate high risks associated with basic R&D, production activities, and management operations, thereby promoting risk management and control and enhancing the level of technological innovation. Since 2007, when the Ministry of Science and Technology issued the "Notice on the Pilot Work for Innovation in Science and Technology Insurance," major cities across the country have actively advanced science and technology insurance financial services. This has gradually formed a "government + market" operational model involving the participation of the government, insurance regulators, the Ministry of Science and Technology, enterprises, and insurance companies, establishing a risk management mechanism for scientific and technological innovation activities to manage and control risks and disperse technical risks.

3.2. The Indirect Influence Mechanism of Science and Technology Finance on the Technological Innovation of High-tech Industry

Technology finance not only has a direct impact on the technological innovation of high-tech industries in this region, but also has an indirect impact on the high-tech industries in neighboring regions.

3.2.1. The Competitive Effect of Science and Technology Finance on the Technological Innovation of High-tech Industries

The uneven distribution of economic activities has led to competitive dynamics across regions. The varying levels of economic development, geographical locations, and policy support in different areas of China result in significant spatial heterogeneity and imbalance in technological financial resources. On one hand, resources tend to flow from less efficient regions to more efficient ones, leading to a concentration of technological financial resources from impoverished areas to affluent ones, further exacerbating the poverty in these resource-poor regions. On the other hand, high-tech companies prefer to locate in areas rich in technological financial resources to secure substantial funding support. Due to the competitive relationship between local high-tech industries and those in neighboring areas, this competition often manifests as agglomeration. This agglomeration effect promotes economies of scale, reduces transaction costs and innovation costs, and encourages high-tech companies from neighboring areas (with lower levels of high-tech industries) to enter the high-tech market in their home regions (with higher levels of high-tech industries). Consequently, the number of high-tech companies in neighboring areas decreases, hindering the development of high-tech industries in these regions. It is evident that technological finance can impede the development of high-tech industries in neighboring regionscompetition effects.

3.2.2. Spillover Effect of Science and Technology Finance on Technological Innovation in High-tech Industries

Another area of focus in spatial economics is spillover effects, which are mainly the result of one economic activity

It will produce the expected effects and also have a promoting effect on other economies. First, through various forms of financial support, tech finance entities promote technological innovation, improve technology, and launch new products, which is beneficial to the development of high-tech industries within the region. High-tech industries exhibit both knowledge spillover effects and market spillover effects. The former refers to how high-tech enterprises spread new products, production methods, and technologies to neighboring regions through exchanges and mutual visits, leading to learning in these areas, improving production efficiency, and driving the development of high-tech industries. The latter involves high-tech enterprises disseminating technological goods to neighboring regions, which then attract high-level scientific and technological talents from developed areas. Local tech finance entities leverage their information collection advantages to gather technological information from developed regions, promoting the development of high-tech industries in their own regions. Thus, tech finance will have a promoting effect on the development of high-tech industries in neighboring regions, i.e., it has spillover effects.

4. COUNTERMEASURES AND SUGGESTIONS

Science and technology finance is an important factor affecting the high-tech industry. Therefore, the state should ensure the rapid and effective development of science and technology finance, improve the science and technology finance system, so as to promote the development of high-tech industry, achieve the purpose of high-quality economic development, and realize the construction of an innovative country. Based on the above analysis, the following suggestions are put forward:

4.1. Improve the Science and Technology Financial System and Strengthen the Role of Science and Technology Finance

4.1.1. Increase Financial Investment in Science and Technology

In the seed and start-up period of high-tech enterprise development, the government should guide government funds to enter and lay a foundation for the entry of private capital such as venture capital.

4.1.2. Improve the Services of Banks and Other Financial Institutions

Banks and other financial institutions should set up special science and technology loan departments to comprehensively improve the ability of science and technology financial services and open up a green channel for the development of high-tech industries.

4.1.3. Improve the Venture Capital Investment Mechanism

Focus on seed-stage and start-up enterprises, establish a sound legal system to support the development of high-tech industry, and actively participate in the early operation of high-tech enterprises, so as to realize the common development of venture capital institutions and high-tech industry.

4.1.4. Promote the Development of Science and Technology Insurance

On the one hand, insurance institutions should set up a special science and technology insurance department to support high-tech enterprises through insurance funds; on the other hand, insurance institutions should formulate targeted insurance products for high-tech enterprises and improve the insurance and reinsurance system for high-tech enterprises.

4.1.5. Establish a Multi-level Science and Technology Capital Market

Focus on improving the GEM market of high-tech enterprises, continue to strengthen the construction of the main board market, improve the property rights trading market, improve the issuance efficiency of high-tech enterprises, strengthen the information disclosure of high-tech enterprises, build a perfect capital market, give play to the value of the capital market, and provide good financing channels for high-tech enterprises.

4.2. Pay Attention to the Spillover Effect between Regions in China, and Promote the Flow of Resources and Coordinated Regional Development

4.2.1. Building Regional Innovation System

Establish regional innovation collaboration centers in key areas nationwide, formulate integrated regional collaborative innovation strategies to boost overall innovation efficiency and capability; strengthen joint innovation among enterprises, government, and research institutions, leveraging their respective strengths for mutual benefit; establish an open mechanism, combining the introduction of enterprises and R&D institutions with external expansion, to break through technological lock-in and rigid innovation phenomena, achieving a technological leap for enterprises.

4.2.2. Deepening Regional Exchanges and Cooperation

Strengthen exchanges and cooperation between high-tech enterprises, scientific research institutions and universities in different regions, improve the transmission path of knowledge and technology, accelerate innovation incubation and technological iteration; encourage enterprises to carry out open innovation, strengthen exchanges and cooperation with other industries in different places, and create effective and smooth channels for technical exchange.

4.2.3. Promote Cross-regional Mobility of Talents

Local governments should establish and improve talent service platforms to provide comprehensive information services for all types of talents, successfully building a communication bridge between enterprises and talents to achieve precise matching of supply and demand; local governments need to remove institutional barriers to talent mobility, promoting smooth and rational flow of talents; underdeveloped regions can attract and gather high-end talents through measures such as talent introduction and incentives, encouraging and guiding talents to flow towards less developed areas.

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