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Original Paper

Rethinking the Development of Science and Technology Finance in China

Xin Dong[1]

[1] The University of Shanghai For Science And Technology, Shanghai, China

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Abstract

Technological innovation and financial development are mutually reinforcing.The financial system alleviates the financing constraints faced by technological innovation by providing services such as information incentives, risk management, and intertemporal resource allocation. This paper first reviews the interactive relationship between technological progress and financial innovation during the three industrial revolutions, clarifying the connotation and functional positioning of science and technology finance. Subsequently, by analyzing the structural characteristics of China's financial system, it points out the limitations of the government-dominated credit system and bank-dominated financing structure in supporting technological innovation. Finally, it proposes policy recommendations for improving China's science and technology finance system, including unblocking the circulation bottlenecks between science, technology, and finance, enriching the ecosystem of science and technology finance supply, and establishing a national-level science and technology finance support institution.

Keywords

Science and technology finance, Financial system, Technological innovation

1. Introduction

After more than four decades of reform and opening up, the sustainability of China's economic growth increasingly relies on technological innovation capabilities.Innovation-driven development has become an inevitable choice for economic development patterns. Technological innovation cannot be separated from financial support. A stable and efficient financial system can effectively respond to the financing constraints faced by technological innovation and promote its stable and sustainable development by providing services such as information production, incentive mechanisms, risk management, and intertemporal allocation.

Throughout human history, each industrial revolution has begun with a technological leap, subsequently driving changes in commercial organizational forms, posing new demands for capital, and promoting reforms in the financial sector. Financial innovation, in turn, acts as a catalyst for commercial and technological progress.

As technological iterations become more frequent, the demand for financial innovation from technological progress continues to increase, and the interactive model between the two is constantly evolving. Against this backdrop, in-depth research on the development patterns of science and technology finance and the design of policy systems tailored to China's national conditions are of great significance for promoting an innovation-driven development strategy.

2. Evolution of Financial Innovation During the Three Industrial Revolutions

2.1 The First Industrial Revolution (18th Century 60s to Mid-19th Century)

With the widespread application of the steam engine, societal productivity underwent a breakthrough transformation, making large-scale production possible and significantly increasing capital demand.

To meet the urgent funding needs of industrial expansion, the modern banking system gradually emerged. The Bank of England was established in 1694. By 1825, the number of banks in Britain exceeded 700, basically achieving the effective conversion of household savings into industrial capital. In 1817, the New York Stock Exchange Committee (now the New York Stock Exchange) was established, and the emergence of railway stocks around 1830 marked the initial formation of the early capital market.

The most representative financial innovation during this period was the formation and operation of commercial bank credit mechanisms.

Banks absorbed idle social funds and provided long-term financing support for emerging industries such as textiles, steel, and railways, playing a key role in promoting enterprise expansion and industrial development. Although the stock market was still in its infancy, it began to function as a channel for supplementing enterprise long-term capital.

2.2 The Second Industrial Revolution (19th Century 60s to Early 20th Century)

The widespread application of electricity drove industry further towards intensification and organization, leading to the emergence of large-scale monopolistic organizations such as cartels and syndicates, and deepening enterprises' reliance on financial resources. Financial innovation during this period focused on the rise of investment banks.On the one hand, with the rapid development of capital-intensive industries such as railways, manufacturing, and mining, commercial bank credit struggled to meet their enormous financing needs, and enterprises increasingly turned to issuing stocks and bonds to expand their funding sources, driving demand for securities underwriting services. On the other hand, commercial banks were unable to meet the demands of numerous mergers and acquisitions; from 1895 to 1904, the United States experienced its first merger wave, with a significant trend of integration between industrial capital and financial assets. The emergence of investment banks,

specializing in securities underwriting, corporate mergers and acquisitions, and project financing, filled the gap in commercial bank services in the capital market, significantly enhancing the financial system's ability to support the real economy and promoting the increasing maturity of the capital market.

2.3 The Third Industrial Revolution (Mid- to Late 20th Century)

The new round of technological revolution, represented by atomic energy, electronic computers, aerospace technology, and biotechnology, profoundly changed social production methods and economic organizational forms.Simultaneously, the rapid development of information and communication technologies accelerated the globalization of economic activities, leading to structural changes in the financial system.Financial innovation during this period was mainly reflected in two aspects: First, the internationalization process of financial services accelerated. The rapid expansion of multinational corporations and sustained growth in global trade posed higher requirements for cross-border capital allocation and risk management. The establishment of multilateral economic and trade organizations such as the International Monetary Fund, World Bank, and World Trade Organization provided an institutional basis for a global financial coordination and support system. Second, the venture capital mechanism gradually took shape. Rapidly growing technology enterprises became important drivers of economic growth, but traditional financing models struggled to adapt to their high-risk and highly uncertain characteristics. Therefore, governments around the world successively established small business investment companies, introduced venture capital funds (such as Sequoia Capital), and promoted the construction of a multi-level capital market system (such as NASDAQ), effectively promoting the commercialization and industrialization of technological achievements and providing crucial financial support for the formation of technological innovation clusters.

3. Connotation and Functional Positioning of Science and Technology Finance

The development of technology financing often lags behind enterprise and societal needs. On the one hand, technological achievements possess characteristics such as specificity, dependency, virtuality, monopoly, spillover, timeliness, and optionality, making them difficult to scientifically measure and trade. On the other hand, technology enterprises are characterized by intangible asset lightness, high risk, information asymmetry, small scale, and high growth potential, leading to severe market failures in their financing.

Science and technology finance is a systematic and innovative arrangement of various financial tools, institutions, policies, and services aimed at promoting technology development, achievement transformation, and high-tech industry development. Governments, enterprises, markets, social intermediary organizations, and other entities provide financial support in the technological innovation financing process, making it an important component of the national technological innovation system and financial system. Science and technology finance is the organic integration of "the primary

productive force" and "the primary driving force", embodying the fusion of technological and financial innovation. The main functions of science and technology finance are reflected in the following aspects:

Resource Allocation Function:

From a macro perspective, science and technology finance must provide an effective resource allocation mechanism for society, optimizing social output and welfare with limited resources.Society needs to direct resources towards the technology sector and the real economy to prevent excessive economic virtualization. China's economic development once relied excessively on infrastructure construction and real estate investment, which not only caused overcapacity to a certain extent but also triggered an economic virtualization tendency, insufficiently supporting consumption and innovation. This phenomenon indicates that there is still room for improvement in China's macro-level resource allocation efficiency. Resource allocation efficiency is the result of the combined effects of market mechanisms, government intervention, and institutional environments.

Information Production Function:

From a micro perspective, science and technology finance first needs to address the issue of information asymmetry.Information asymmetry refers to a situation where transaction parties (such as borrowers and lenders) possess different quantities or qualities of information, leading one party to potentially exploit its information advantage to harm the other party's interests, thereby distorting resource allocation, reducing market efficiency, hindering transaction completion, and even triggering systemic risks. Information production is an important means to address information asymmetry, but this is not the responsibility of a single financial institution; it requires collaboration from all parties in society to establish a cooperative mechanism among banks, equity investment institutions, guarantee institutions, the government, and technology enterprises, forming an information-sharing pattern and reducing transaction costs.

Incentive and Constraint Function:

Moral hazard is one of the core issues in the financial system. The existence of moral hazard distorts market incentive mechanisms, leading to resource misallocation and increasing systemic risks. Science and technology finance needs to form reasonable incentive mechanisms through scientific contract design, strict market discipline, necessary financial regulation, and even cutting-edge technological means to overcome moral hazard. For example, various forms of financial contracts and tools can alleviate and reduce adverse selection and moral hazard, such as the company control market formed by equity capital and bonds in direct financing, debt constraints in indirect financing, and common betting agreements in venture capital that incentivize entrepreneurs while guarding against moral hazard.

Risk Management Function:

The process of technological innovation and achievement transformation is highly uncertain, and science and technology finance must achieve effective risk management. Risk management aims to

identify, assess, control, and transfer potential risks during the investment process, optimizing the risk-return balance of relevant parties. Science and technology finance needs to optimize the risk-return structure through financial innovation, developing a multi-level risk-sharing system and diversified risk management tools. Only in this way can the extremely high risks of technological innovation be effectively shared, attracting more capital to participate in technological innovation.

Value Enhancement Function:

Science and technology finance needs to provide value-added services for start-up enterprises and technological innovation.Science and technology finance should not only meet the funding needs of technological innovation but also possess strategic vision, resource integration capabilities, and value creation wisdom, emphasizing intellectual empowerment, network effects, and long-term value orientation behind capital. In addition to providing funds, various financial institutions should also assist technology entrepreneurial teams in team building, governance structure design, market development, and marketing network construction. Venture capital and private equity institutions play important roles in this regard, as they can efficiently identify opportunities, avoid risks, and achieve excess returns through active management.

4. Characteristics of China's Financial System and the Current State of Science and Technology Finance Development

4.1 Structural Characteristics of China's Financial System

Driven by deepening reforms and financial openness, China's financial system has initially formed a multi-level, multi-entity, and multi-tool development pattern, but it still exhibits two core characteristics overall:

Government-Dominated Credit System:

China's credit system is centered around government credit, while market-based credit mechanisms are relatively weak. The government not only serves as a regulator but also directly participates in market credit allocation through implicit guarantees for state-owned enterprises, credit endorsements for major projects, and approval-based listing review arrangements, substantially influencing market credit assessment and risk pricing. This model was beneficial in mobilizing social resources and concentrating efforts to support infrastructure and key industry construction during the early stages of economic development. However, it has also led to excessive bank capital flowing towards government-dominated projects and state-owned enterprises, resulting in inefficient allocation and insufficient financial support for small and medium-sized enterprises (SMEs) and the private economy, with prominent resource misallocation issues.

Bank-Dominated Financing Structure

China's current financing system is still dominated by bank credit-based indirect financing, while the direct financing system remains immature.From the perspective of financing structure, bank loans account for approximately 80% of external financing for non-financial enterprises, indicating limited

functionality of the capital market in serving the real economy. Although the stock market has made progress in institutional construction and market size, it primarily served state-owned enterprise reforms for a long time. Government intervention in the secondary market has created expectations of a "policy-driven market", leading to irrational behaviors such as "speculating on policies" and hindering effective support for front-end technological innovation. The bond market has developed relatively slowly, and the long-standing expectation of guaranteed repayment has affected the bond market's risk pricing function.

4.2 Structural Limitations in Supporting Technological Innovation

China's existing financial system faces multiple constraints in supporting technological innovation:

Mismatch Between Risk Appetite and Innovation Needs

Under the government-dominated credit mechanism, the risks of various financing entities are mostly covered by government credit guarantees or collateral.The capital market lacks a benign interaction between liquidity and risk. Investors generally prefer low-risk or risk-free assets and tend to support projects with "implicit guarantees", with a pervasive "rigid payment" mentality in the market. However, technological innovation projects generally possess high-risk and highly uncertain characteristics. Existing financial institutions lack the ability and incentive to identify, assess, and bear such risks, leading to difficulties in effectively channeling funds into the technology sector.

Relatively Simple Financing Instrument System

The bank-dominated system, centered on debt financing, focuses on traditional models such as fixed income and collateral guarantees, which are incompatible with the financing characteristics of technology enterprises, which are characterized by "light assets, weak collateral, and long cycles".

Credit products are still mainly traditional working capital loans, lacking customized financial tools tailored to the long research and development cycles of technology enterprises. The popularity of new tools such as equity investment, convertible bonds, and intellectual property securitization remains low. An effective cooperation mechanism between banks and venture capital institutions has not been established, making it difficult to match investment and credit cycles and inhibiting banks' enthusiasm for participating in early-stage technology investments.

Insufficient Capability of the Capital Market to Support Technological Innovation

Although China's capital market has continuously improved in terms of scale and institutional construction, a multi-level capital market system oriented towards technological innovation is still underdeveloped. The financial system provides weak support for the front end of technological innovation. Financial institutions are unwilling to undertake high-risk projects with uncertain technological paths and provide insufficient financial support for the concept verification and pilot testing stages. Financial institutions still mainly rely on traditional financial indicators to evaluate technology enterprises, making it difficult to quantify technological value and hindering small technology enterprises from obtaining loans. Platforms such as the Science and Technology Innovation Board and NEEQ are still in their early stages, with market liquidity, exit mechanisms, and risk pricing

capabilities needing improvement, limiting the ability of technology enterprises to configure resources through direct financing. The construction of the science and technology finance ecosystem lags behind, lacking an integrated collaborative platform for multiple entities such as venture capital, investment banks, commercial banks, insurance institutions, and guarantee institutions. The services provided by various institutions are fragmented and difficult to form a closed loop.

Inadequate Risk-Sharing and Management Mechanisms

Financial institutions lack the ability to effectively identify and price technological risks and market risks, as well as effective risk mitigation tools.In some cutting-edge technological fields, due to a lack of sufficient data, it is difficult to develop corresponding insurance products. Policy tools such as fiscal subsidies and guarantees have not formed effective linkage with market-based venture capital. The failure risks of technology projects are almost entirely borne by financial institutions, lacking a multi-party collaborative risk-sharing mechanism involving the government, insurance, guarantees, and guide funds. This leads financial institutions to tend to avoid rather than support technology-based enterprises when facing them, constraining the sustainable development of the science and technology finance service system.

5. Basic Principles of Designing Tech-Finance Policies

5.1 Basic Principles of Policy Design

Adhering to Market-Oriented Principles

Government support policies and measures must respect market laws and achieve policy goals through the combined efforts of government support and market mechanisms. It is essential to leverage the decisive role of the market in resource allocation, guiding financial resources toward high-potential tech sectors through price signals. Meanwhile, the government should “act where necessary and refrain where not,” intervening in areas where market failures occur, such as basic research and early-stage projects, to prevent resource misallocation and moral hazards caused by excessive policy intervention.

Maintaining Fair Competition

Maintaining fair market competition is crucial for optimizing the business environment and stimulating innovation vitality. Government intervention should focus on creating a level playing field, ensuring transparency in policy formulation and execution, reducing information asymmetry and rent-seeking opportunities, and ensuring equal access to resources and participation in competition for all market entities, avoiding policy biases or hidden barriers. It is also important to balance efficiency and fairness, strengthen intellectual property protection, break administrative monopolies and local protectionism, and prevent excessive competition or monopolies from stifling innovation.

Promoting Equal Opportunities

Tech-finance policy design should lower support thresholds and steadily increase support intensity to promote social equity and inclusive economic growth. It should create a relaxed and regulated institutional environment to enhance the success rate of entrepreneurial innovation among small and

medium-sized tech enterprises. Simultaneously, regional disparities should be considered to increase development opportunities for small and medium-sized tech enterprises in underdeveloped regions and promote balanced regional technological innovation.

Focusing on Sustainable Development

Sustainable development should be ensured by guaranteeing the commercial viability of financial institutions in supporting technological innovation, providing sufficient innovation incentives for tech innovators to foster a positive interaction between finance and technology, and ensuring the government's financial sustainability. This involves continuously improving the endogenous mechanisms of management and services to ensure that the long-term direct and indirect benefits of policy-based finance or other forms of fiscal support can cover related costs.

5.2 Urgent Issues in Current Tech-Finance Policies

Currently, while China's tech-finance sector is developing rapidly, it still faces a series of issues that require government-level coordination. Firstly, there is a lack of effective linkage between government fiscal tools and market-based financial instruments, with inadequate institutional mechanisms for collaborative support of technological innovation. Policy funds and social capital struggle to form synergies in resource allocation. Secondly, information asymmetry is prevalent among tech enterprises, with the professionalism and uncertainty of their R&D activities increasing the difficulty for financial institutions to identify risks and hindering the effective flow of funds. Thirdly, the entrepreneurial integrity constraint mechanism is relatively weak, with inadequate credit evaluation systems and integrity education mechanisms, increasing the moral hazards associated with financial support. Fourthly, against the backdrop of an imperfect exit mechanism, venture capital faces incentive imbalances and adverse selection issues while pursuing high returns. Especially in the "user-centric" internet ecosystem, some enterprises prioritize short-term user growth over long-term benefits, giving rise to new moral hazards. Fifthly, with increasingly fierce market competition and a shortened overall enterprise lifecycle, financial support faces higher uncertainty and timeliness pressures, demanding greater professionalization and refinement in tech-finance services.

6. Policy Recommendations for Improving China's Tech-Finance System

6.1 Unblocking the Circulation Between Technology and Finance

There are still certain obstacles in the circulation mechanism between technology and finance, necessitating institutional-level unblocking and optimization. On one hand, indirect financing methods dominated by bank credit have limitations in supporting the early-stage development of tech enterprises, particularly in meeting the financing needs of high-risk, asset-light projects. The function of direct financing has not been fully leveraged, and the channels for tech innovation enterprises to access capital markets need to be broadened. On the other hand, the motivation and capacity of financial institutions to support technological innovation need to be strengthened, especially in terms of professional services, resource integration, and project identification by key entities such as investment

banks and venture capital firms. Additionally, there is room for further optimization of the performance evaluation mechanism for policy-based tech-finance. The existing evaluation mechanism, to some extent, reinforces risk aversion tendencies, which is not conducive to government-backed financial institutions participating in high-uncertainty tech innovation projects. In the future, it is necessary to promote the establishment of a more scientific and reasonable evaluation system that incentivizes financial institutions to reasonably undertake innovation risks while preventing moral hazards, gradually enhancing the circulation efficiency between technology and finance.

6.2 Enriching the Tech-Finance Supply Ecosystem

Under the current financial service system, tech enterprises face practical issues such as limited financing channels and mismatched product tools, necessitating improvements from the supply side. Various financial institutions, including banks, insurance companies, funds, and securities firms, can further focus their efforts on the key challenges faced by tech enterprises in their development, precisely targeting product design and service models to enhance service precision and effectiveness. Specifically, firstly, a more diversified tech-finance market system can be promoted, such as the Science and Technology Innovation Board and university financial markets, to provide differentiated financing tools for tech enterprises at different stages and of various types. Secondly, the organizational models of financial institutions can be optimized to adapt to the characteristics of tech enterprises, such as establishing tech branches, tech insurance subsidiaries, and professional venture capital platforms, to enhance their understanding and responsiveness to tech projects. Thirdly, in terms of risk protection, more professional insurance products targeting specific industries and technological directions (e.g., biotechnology, artificial intelligence, and new energy) need to be explored to reduce the uncertainty of enterprise financing and operations through risk compensation and reinsurance mechanisms. Strengthening incentives and support for these innovative services in terms of institutional construction will help enhance the adaptability and inclusiveness of the financial system to technological innovation.

6.3 Strengthening the Tech-Finance Support Institution System

In the process of promoting the improvement of the tech-finance system, some policy-based support institutions can play an active role in filling market gaps and guiding social capital. Firstly, a specialized national-level tech bank can be considered to provide low-interest or interest-free loans to small and medium-sized tech enterprises and key innovation projects, while also undertaking public financial functions to provide necessary support for credit reporting systems, intellectual property evaluation systems, etc., and enhance the overall level of financial infrastructure. Secondly, a national-level reinsurance mechanism can be constructed to disperse the systemic risks faced by tech enterprises in terms of technology, market, and talent, alleviating the risk concerns of financial institutions during capital deployment. Especially in specific regions or industries, risk matching mechanisms can be utilized to mitigate resource misallocation caused by risk homogeneity. Thirdly, a national-level strategic investment fund can be established, adopting a master fund operation model and focusing on strategic emerging industries. This will not only enhance the supply of long-term capital

but also serve as a demonstration and driving force for local guidance funds, gradually forming a benign structure where policy guidance and market mechanisms work in tandem.

7. Conclusion

Tech-finance is an eternal theme in the financial sector. The development of new quality productive forces requires continuous transformation of the financial system. Tech-finance is not merely a financial issue but a transformation of the entire societal resource allocation mechanism, involving institutional improvements and cultural construction across multiple dimensions, including laws and regulations, fiscal and tax policies, monetary policies, organizational structures, education systems, and the application of digital technologies.

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