RESEARCH ON POLICY-BASED FINANCIAL SUPPORT FOR TECHNOLOGY INNOVATION OF CHINESE ADVANCED MANUFACTURERS

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ABSTRACT

Through literature research, theoretical research and empirical research, this paper focuses on key issues such as what role policy-based finance can play in enterprises' technology innovation, how to play the role, and existing shortcomings and constraints. Policy-based finance refers to the financial means adopted by a country's government in order to achieve specific policy objectives such as industrial policies, that is, giving preferential treatment in terms of interest rates, loan terms, guarantee conditions, etc., and selectively funding with a view to cultivating specific strategic industries. In 2015, in order to promote the development of the manufacturing industry, China released the 2015-2025 Strategic Top-level Plan for China's Manufacturing Industry (the "Made in China 2025" strategy). According to the ten key areas in the "Made in China 2025" strategy, this paper selects listed companies in the advanced manufacturing industry on China's RMB common stock market during 2011 to 2019 as a sample, and empirically analyzes the role of policy-based finance in supporting enterprise technology innovation input and output. Meanwhile, this paper examines whether enterprise heterogeneity, including property right nature, enterprise size, and enterprise age, significantly impacts policy-based financial support for enterprise innovation, so as to analyze policy-based financial support for different types of enterprises.

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INTRODUCTION

In China, manufacturing industry is the core of the national economy and the real economy. From 2012 to 2021, the added value of China's manufacturing industry increased from RMB16.98tn to nearly RMB31.4tn, with global share increasing from 22.5% to nearly 30%. In order to accelerate China's transformation from a large manufacturing country to a manufacturing power, China has proposed the "Made in China 2025" strategy to promote innovation-driven development and the transformation and upgrading of the manufacturing industry. Since Chinese manufacturers are generally external financing-based enterprises, the scale and efficiency of financial support are important factors that affect enterprise technology innovation. However, the transformation and upgrading of China's manufacturing industry currently face a series of problems, such as the financial industry's low support for enterprises in the core equipment, core components, industrial software and other industrial underlying technology fields, the restriction on technology innovation in the manufacturing industry by financing constraints, information asymmetry, and market failures, and huge risks to technology innovation activities brought by the long cycle and insufficient funds. In such case, the Chinese government has repeatedly require financing support for the upgrading and development of the manufacturing industry to improve the quality and efficiency of financial services in the manufacturing industry and has proposed to give full play to the advantage of synergy between the government and the market and between treasure and finance. Policy-based finance is a resource allocation method between

the direct investment of financial funds and commercial financing and an important means to promote structural reforms and implement national development strategies. Under this policy-based financial system arrangement, social funds are raised in reliance upon national credit to support specific national strategic goals, and a market-oriented approach is adopted to support key areas, weak links and specific groups of the state, which helps to reduce the impact of market failures in technology development caused by long development cycles, information asymmetry and underinvestment in the private market.

This research will ask two main questions. The first is how China can use the advantage of synergy between public finance and finance to effectively support the technology innovation of advanced manufacturing amid increasing pressure of fiscal deficit and imperfect resource allocation capability of the financial market faced by the Chinese government? In this part, this paper will explore the role of policy-based finance in manufacturing innovation input and output and clarify the mechanism of policy-based financial support for enterprise innovation through a theoretical analysis or empirical test.

Second, why does policy-based finance significantly and positively impact the technology innovation for some manufacturers, but have little or no effect on others? In general, policy-based finance should promote innovation input and output of advanced manufacturers. However, with respect to technology innovation of different types of enterprises, policy-based financial support is still insufficient and unbalanced and needs to be improved. For example, policy-based financial support for private

enterprises, small and medium-sized enterprises (SMEs) and young enterprises is insufficient. At the same time, policy-based finance provides significant resources for state-owned enterprises (SOEs), but has not helped increasing innovation of SOEs.

For the problems that need to be tested empirically, this study puts forward research hypotheses by combining the theory of enterprise innovation and the theory of policy-based finance. This paper specifically divides the measurement of enterprise technology innovation into enterprise innovation input and output, and proposes relevant research hypotheses from the impact of policy-based financial support for enterprise innovation input and output, and the impact of enterprise heterogeneity on the role of policy-based finance and makes statistical analysis of the research sample. Based on the Hausman test, this study selects the fixed-effect model to verify the role of policy-based finance as an independent variable on enterprise technology innovation as a dependent variable, and the impact of enterprise heterogeneity on this effect. In the empirical analysis of enterprise heterogeneity on policy-based financial support for enterprise innovation, this study analyzes the impact of enterprise heterogeneity on policy-based financial support for enterprise innovation input and output from the perspectives of property right nature, enterprise size, and enterprise age, so as to further analyze whether there are differences in the role of policy-based finance in supporting SOEs and private enterprises, large enterprises and SMEs, young enterprises and mature enterprises, and whether there are some problems and deficiencies in the supporting role and coverage of policy-based finance.

It is found in the study that (1) policy-based financial support is significantly

and positively correlated with innovation input and output of advanced manufacturers, indicating that policy-based finance can support Chinese advanced manufacturers to increase innovation input by providing targeted financial support and exerting an inducing effect and help them achieve innovation results. (2) The nature of state-owned property rights can significantly strengthen the role of policy-based finance in enhancing enterprise innovation input, while the role of policy-based finance in enhancing enterprise innovation output is insignificant; enterprise size growth cannot significantly enhance policy-based financial support for enterprise innovation input, but significantly impacts policy-based finance in enhancing enterprise innovation output; enterprise age growth is not conducive to policy-based financial support for enterprise innovation, and has a more significant inhibitory effect on innovation input.

CHAPTER 1

POLICY-BASED FINANCIAL SUPPORT FOR TECHNOLOGY NOVATION OF CHINA'S ADVANCED MANUFACTURERS

1. Research background

As the main body of industrial economy and the support for service economy, manufacturing is the main body of national economy. It plays an important role in enhancing the comprehensive strength and modernization of countries and regions. Its size, level and position in the international division of labor directly reflect the competitiveness of a country or region. Since the beginning of industrial civilization, history has proved that strong manufacturing is an important cornerstone of the prosperity of a country or nation. Developing internationally competitive manufacturing is the only way for China to enhance comprehensive national strength, safeguard national security and build itself into a world power.

1.1 China is a large manufacturing country, not a manufacturing power

Both the 14th Five-Year Plan and the Long-Range Objectives Through the Year 2035 propose to further implement the manufacturing power strategy. Manufacturing is not only the main body of real economy but also a strong engine of economic and social development. The Report on the Work of the Government 2021 proposes to raise the proportion of loans to the manufacturing sector and increase investment in the equipment upgrades and technology transformations of manufacturers. China has made a series of achievements in current domestic construction and development: China is a country with the largest poverty reduction in the world and has become the

first developing country to accomplish the United Nations Millennium Development Goals in poverty reduction, contributing to over 70% of global poverty reduction; economically, China's economic aggregate ranks second in the world, making China's economy a main stabilizer and power source of the world's economic growth; in terms of market size and product supply capacity, China provides the world with a huge market demand from 1.4bn people and a market supply of various commodities.

However, China's manufacturing industry has faced "large but not strong" problems for a long time: (1) At present, China has become a worldwide large manufacturing country. Comparable to the U.S., China's manufacturing industry has added value of USD2.08tn in 2012, accounting for about 20% of the added value of global manufacturing; but in the same year, the added value rate of China's manufacturing industry was only 21.5%, while that of each industrial developed country was greater than 35%; the added value of manufacturing industry accounted for about 32.6% of China's GDP, but energy consumption for manufacturing accounted for 58.0% of the national energy consumption (Yu Donghua, 2015). (2) China's manufacturing industry relies on foreign imports for core technologies and components, has insufficient independent innovation capacity, faces serious product quality problems, and experiences low resource utilization efficiency. Moreover, traditional manufacturing, which is resource intensive and labor intensive in the industrial structure, still accounts for a relatively high proportion and lacks technology-intensive industries and productive service sectors. (3) There are significant differences in regional development levels. Compared with eastern coastal

areas, manufacturing sectors in central and western regions are mostly resource-intensive and labor-intensive sectors with many low-end downstream products, and lack support in infrastructure, science and technology, information and industrial coordination and agglomeration. (4) China's manufacturing industry faces dual challenges from developed countries in Europe and America and developing countries. Judging from external factors, on the one hand, developed countries in Europe and America are promoting the "re-industrialization" strategy, seeking to continue to lead in technology and industry and seize the high end of manufacturing. The U.S. has formulated strategic plans such as "re-industrialization strategy," "manufacturing revival plan," "advanced manufacturing partnership plan" and "framework for reorganizing the U.S. manufacturing industry. Germany, Britain, France and Japan have also announced new plans to vigorously promote manufacturing revival. On the other hand, developing countries such as India, Indonesia and Vietnam undertake the transfer of labor-intensive industries with lower labor costs to seize the middle-and low-end market of manufacturing (Zhou Ji, 2015). This constitutes a "sandwich attack" on China's manufacturing.

1.2 "Made in China 2025" strategy promotes the transformation and upgrading of manufacturing Currently, challenges and opportunities coexist in China's manufacturing. Through the transformation and upgrading of manufacturing, it is an inevitable requirement for economic development in the new era to transform the conditions and foundation of a large manufacturing country into the competitive advantages of a manufacturing power, and to make manufacturing the main battlefield

of the "innovation-driven development and transformation and upgrading" of China's economy. Since 2013, General Secretary Xi Jinping has pointed out that "a strong country depends on real economy not bubble economy;" "China will deeply implement the innovation-driven development strategy and enhance the core competitiveness of industry;" and "China is changing its image from being a manufacturer to an inventor, from being a speed manufacturer to a high quality producer, and from being a country of products to a country of brands." On March 5, 2015, Premier Li Keqiang pointed out in his Report on the Work of the Government that the "Made in China 2025" program should be implemented to accelerate the transformation of China from a large manufacturing country to a manufacturing power. On May 8, the State Council issued the "Made in China 2025" program, which deploys the comprehensive promotion of the manufacturing power strategy.

The implementation of the "Made in China 2025" strategy calls for the transformation of manufacturing to an innovation-driven direction and all-round transformation and upgrading of manufacturing: towards the high end of the global value chain, towards a resource-efficient, environment-friendly and innovation-driven sustainable development model, and towards improving production efficiency, technology innovation and international competitiveness. In the context of globalization and new industrial revolution, China's manufacturing is facing challenges such as fierce competition in the international market, rising factor prices due to limited resources, accelerated development of science and technology, extensive distribution of information and application of big data, increased knowledge

content of products and technologies, and increasingly import intellectual property rights and technical standards. It is necessary to make breakthroughs in intelligent manufacturing, interconnected manufacturing, personalized manufacturing and green manufacturing to promote revolutionary progress in the way technological and market factors are allocated.

In summary, the "Made in China 2025" program includes the following specific content: (1) Accelerate the development of strategic emerging industries and advanced manufacturing. (2) Manufacturing undergoes transformation and upgrading through the transformation of production modes. (3) Improve the independent innovation capability of manufacturing with the help of intelligent, digital and information technology. (4) Adapt to the global market and improve international competitiveness. In the "Made in China 2025" strategy, technology innovation occupies an important and even core position, especially when the current new generation of information technology innovation wave is in the ascendant, and the new generation of broadband network, Internet of Things, system-level chips, big data, 3D printing, new materials, new energy and other new technologies, new applications are driving modern industry to make a new, qualitative leap and spawn a series of new manufacturing systems, new production equipment and emerging industries, all of which provide a good technical environment for China's manufacturing to catch up with developed economies and achieve leapfrog development.

1.3 Insufficient endogenous power and support for technology innovation in manufacturing At present, China lacks strategic emerging industries such as new

energy, new materials, advanced major equipment manufacturing and electronic information, and China's traditional manufacturing is also at the low end of the global industrial chain. Under this situation, China's industrial structure may be "locked" in the low load: low end of high-tech industries and low-tech traditional industries, resulting in poverty-like growth (Liu Zhibiao, 2007; Zhang Jie, 2007).

The 19th National Congress of the Communist Party of China (CPC) puts forward that innovation is the primary engine of development, and firmly implementing the innovation-driven development strategy is an inevitable requirement of market environment and economic development. Internationally speaking, in the process of globalization, international political and economic environment is becoming increasingly complex as some countries have seen the rise of "trade protectionism" and developed countries have entered the process of "re-industrialization." Domestically speaking, factor price rise and resource and environmental constraints are intensified. As the largest foreign direct investment (FDI) inflow country among developing countries and the global contract manufacturing outsourcing base, the large-scale export-oriented strategy of cutting into the global value chain division system in the form of contract manufacturing has enhanced China's scale-expanding middle and low-end manufacturing capacity, but it will negatively impact the independent innovation activities of China's manufacturers and the development of the national innovation system. Competition based on low prices will inhibit enterprise innovation input (Zhu Hengpeng, 2006). These situations require China's manufacturing industry to accelerate the pace of technology

innovation.

However, the reality is that at present, most of China's manufacturers have insufficient endogenous power and insufficient support for technology innovation. Here, endogenous power refers to the spontaneous power generated by the internal survival and development needs of enterprises.

First, due to the lack of a knowledge isolation mechanism and a technical threshold, there is a widespread phenomenon of "rushing up" in China's real environment: A manufacturer develops a new product through a large amount of capital, technology and other R&D investment, or absorbs and draws on international advanced experience to produce a new product in China. When its industrial prospects and profit margins are tested by the market, there will be a large number of enterprises that imitate or even copy such new product, or master its key technologies through the introduction of core talent of that manufacturer so as to conduct low-cost market competition (Zhang Jie, 2007). Then a unique "imitation—low-cost competition" pattern with technology spillover and diffusion has been formed in China. In this case, most enterprises can only rely on cost-reducing scale expansion to obtain profits, but lack the motivation for continuous innovation.

Secondly, there is insufficient external support for technology innovation overall, and insufficient policy supply to support technology innovation of manufacturers. Compared with developed countries, the investment in technology development and innovation of Chinese enterprises is relatively less. In 2013, the intensity of R&D investment (proportion of R&D expenditure in GDP) was only 2%,

while that of the world's manufacturing powers was 4%. In the new economic normal period, the growth rate of fiscal revenue in China has declined; the resource allocation capacity of capital market is not perfect and the pressure on fiscal deficit is increasing day by day; the scarcity of financial resources and the ceiling effect of fiscal policy are obvious (Wan Dongcan, 2019). During the 12th Five-Year Plan period, the proportion of fiscal and S&T expenditure in total expenditure and the growth rate of S&T expenditure fluctuated greatly, showing an overall decline tendency (as shown in Table 1-1).

Thirdly, local governments will restrain the innovative development of enterprises to some extent by means of administrative intervention. For a long time, GDP growth has been the most important indicator of the performance of local governments in China. The promotion of local officials has been linked to economic performance (Zhou Li'an, 2004). Inspired by the promotion tournament, local government officials have shown a strong willingness to promote local economic growth (Ding Congming et al., 2015). However, during the transition period of imperfect financial system construction and imperfect allocation of financial resources, local governments, by plundering and interfering in the allocation of credit funds of banks, local governments made funds flow to industries that could boost GDP in a short period of time, thus generating fund supply for R&D enterprises with long-term effectiveness and slow income. This led to the development of market mechanism being hindered and funds being concentrated in low-end traditional industries with fast effectiveness, thus inhibiting the innovation activities of

enterprises (Liu Haifei and He Xiaoyu, 2017). At the same time, compared with private enterprises, local governments will lead more financial resources to flow to SOEs. Although this tendency increases SOEs' R&D investment and helps them expand their scale, they produce relatively low innovation output and efficiency, and there is no effective evaluation standard for innovation performance.

Table 1-1 Fiscal Expenditure and S&T Expenditure in China from 2010 to 2018

Year	Fiscal expenditure	Growth rate of fiscal expenditure	S&T expenditure	Growth rate of S&T expenditure	Proportion of S&T expenditure
2010	89874	17.79	3250	18.42	3.62
2011	109248	21.56	3828	17.78	3.50
2012	125953	15.29	4453	16.32	3.54
2013	140212	11.32	5084	14.19	3.63
2014	151786	8.25	5314	4.53	3.50
2015	175878	15.87	5863	10.31	3.33
2016	187755	6.75	6564	11.96	3.50
2017	203085	8.17	7267	10.71	3.58

Source of data: CEI Data

1.4 Policy-based financial support for advanced manufacturing is an important institutional arrangement for common prosperity. China's manufacturers have been facing the problem of insufficient funds for technology innovation for a long time (Zhang Jie, 2012). It is difficult for them to meet the demand for R&D investment in technology innovation by relying only on their own funds and market forces. It is necessary to give play to the supporting role of policy-based financial strategy. Regarding the impact of government subsidies on enterprise technology innovation, there are promotion, inhibition and irrelevance viewpoints in academic circles. On the one hand, the financial support of the government can directly increase enterprise innovation input, reflect the government's

recognition of the development prospects and potential of the enterprises, and to a certain extent will induce other investors and financial institutions, thus increasing the innovation output of enterprises (Wu Yanbing, 2006). On the other hand, government subsidies will also crowd out enterprise innovation input (Montmartin, 2015), which will affect the long-term innovation development of enterprises.

Since November 14, 1993 when the CPC Central Committee made the Decision on Several Issues Concerning the Establishment of a Socialist Market Economy System, China has begun the practice of common prosperity under the principle of giving priority to efficiency while considering fairness. On December 25 of the same year, the State Council made the Decision on the Reform of the Financial System, pursuant to which China will explicitly set up three policy banks to coordinate with the reform of the socialist market economy. This became the historical logical starting point for promoting common prosperity. After the end of targeted poverty alleviation, the policy-based finance strategy will focus more on the following six key points (Du Yankun, 2022): linking poverty alleviation and rural revitalization; supporting industrial innovative development; increasing efforts to build infrastructure and public facilities; giving overall support for the national regional coordinated development strategy; supporting ecological environment construction; and strengthening the development and utilization of human capital.

Under the strategic background of common prosperity, policy-based finance is an important institutional arrangement. The practice of reform and opening-up has shown that promoting common prosperity requires a correct handling of the

relationship between government and market, fairness and efficiency. We should not only improve the mechanism of market-oriented allocation of factors and stimulate market vitality, but also give play to the role of government in regulating and controlling the society and promote social equity and justice through institutional arrangement. Policy-based finance relies on national credit to raise social funds and adopts market-oriented methods to support key areas, weak links and specific groups of the state. It is a special financial institutional arrangement for the state to implement specific strategies and compensate for market failures. It has dual attributes of finance and is a bridge connecting the government and the market. In a market economy, the market mechanism plays a fundamental role in resource allocation, making funds flow from inefficient areas and low-yield fields to efficient areas and high-yield fields, so as to more effectively use limited funds. However, this capital allocation method under the market mechanism will also bring some problems due to "market defects". For example, underdeveloped regions need financial support to develop, and the risk-adjusted rate of return in the use of funds in underdeveloped regions is obviously lower than that in developed regions, so funds naturally flow from underdeveloped regions to developed regions, causing a "Matthew effect" in capital allocation. As a result, developed regions obtain more adequate capital supply, while underdeveloped regions that are in urgent need of funds lose their funds. In addition to regional differences, this is true for the capital allocation relationship between large enterprises and SMEs in some specific economic sectors. In order to solve this "market defect" or "market failure" problem, the government needs to

actively and appropriately participate in the funds allocation in these areas according to the overall needs of social and economic development. The normative way for the government to participate in the funds allocation is to develop policy-based financial institutions, to mobilize and guide more social funds into the fields supported and encouraged by the government through some financial investment arrangements or preferential government policies, and with the help of market-oriented operation mechanisms. Especially to support the innovative development of advanced manufacturing, policy-based finance will help to implement the manufacturing power strategy, help to implement intelligent manufacturing and green manufacturing projects, and promote high-end, intelligent and green manufacturing. Policy-based finance focuses on scientific and technology innovation in strategic emerging industries such as new generation information technology, biotechnology, new energy, high-end equipment, green environmental protection, and aerospace. At the same time, it strongly supports the integration and development of productive services and the quality development of life services, helps to build a modern industrial system with coordinated development of real economy, scientific and technology innovation and modern finance, and builds industrial support for economic growth and social wealth accumulation.

To sum up, there are many problems in the transformation and upgrading of China's manufacturing industry: inefficient resource utilization, dependence on foreign imports of core technologies and components, insufficient independent innovation capability, unreasonable industrial structure, disorderly market competition, local officials' short-term preference for and intervention in GDP growth, insufficient investment in technology research and development, etc. The state policy-based finance is trying to address these issues.

2. Problems of the research

Based on the above research background, this paper tries to focus on researching, discussing and solving the problems mainly include the following two parts:

1.At present, China has seen increasing fiscal deficit pressure and imperfect financial market resources allocation ability, how can China use the fiscal and financial synergies to effectively support technology innovation in advanced manufacturing? In this part, this paper will explore the role of policy-based finance in enterprise innovation input and output and clarify the mechanism of policy-based financial support for enterprise innovation through a theoretical analysis or empirical test.

2.On the basis of making it clear that enterprise innovation needs market synergy and policy-based financial support, this paper further explains the shortcomings of policy-based financial support for technology innovation in advanced manufacturing, measures to improve the quality, efficiency and effectiveness of

technology innovation, analyzes the external constraints, and puts forward corresponding improvement plans for better promoting technology innovation in advanced manufacturing.

3 Reference review

There are four kinds of literature related to the research herein, including literature on factors influencing technology innovation of enterprises, literature on financial development influencing technology innovation of manufacturing, literature on government finance influencing technology innovation of manufacturing, and literature on policy-based finance.

3.1 Literature research on enterprise technology innovation

3.1.1 Concept of innovation. The concept of innovation first came from the discussion of innovation by Schumpeter (1934): Competitive market is not an ideal market structure to promote innovation. On the contrary, if an enterprise's innovation can quickly obtain the protection of its patent monopoly right, it will be conducive to the development of innovation activities, stimulate the enterprise and other enterprises to conduct independent innovation rather than simply imitate others (Shi Yupeng and Gu Quanlin, 2013). The neoclassical economic growth theory (Solow, 1956) holds that only technological progress can lead to long-term and stable economic growth. The new growth theory of the mid-late 1980s (Romer, 1990) points out that the long-term low growth in some countries is caused by the lack of investment in knowledge-producing sectors and low rate of technological progress, and that technological progress plays a key role in economic growth. At the same time, the

experience of economic development in developed countries and emerging industrialized countries has shown that innovation and technological progress are the core drivers of economic growth.

3.1.2 Factors influencing innovation. What factors impact the technology innovation ability of manufacturers in China's economic transformation and its transformation from a large manufacturing country to a manufacturing power? How does the structure of property right of different nature affect technology innovation and other factors? How to create a market and policy environment conducive to innovative development and accumulation of knowledge and technology? In the research of the influencing factors of innovation, Ma Ning and Guan Jiancheng (2000), through the regression analysis of 12 variables, concluded that the key factors affecting the technology innovation of Chinese industrial enterprises are: R&D investment, culture of recognition of the role of innovation, industrial policy, innovation strategy, technical cooperation, personnel quality, foreign investment introduction and competitive impact. According to the research of An Tongliang et al. (2006), three factors, namely industry, enterprise size and ownership characteristics, are the most important factors affecting Chinese enterprises' innovation activities. Among others, differences in industry characteristics are the most important factor affecting China's manufacturers at the current stage of development. Large enterprises classified by the number of employees will carry out more continuous R&D activities than small enterprises, and tend to establish independent regular and specialized R&D departments. A common classification method is to divide the factors that affect

enterprise innovation into internal factors and external factors. In this paper, the existing research is summarized into three levels: macro, meso and micro levels (as shown in Figure 1-1).

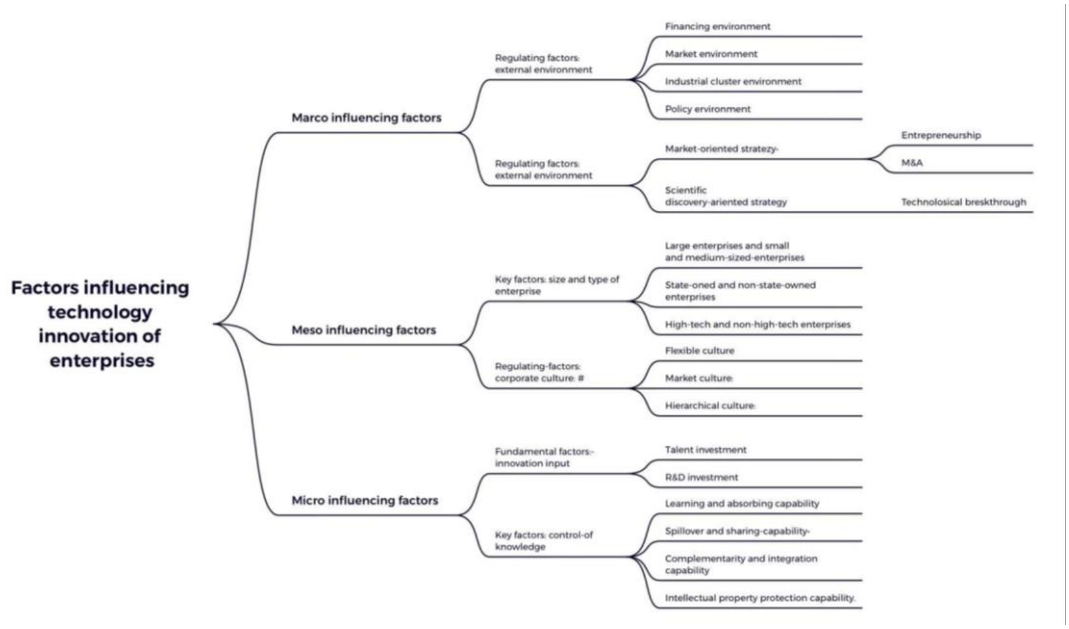

Figure 1-1 Influencing Factors of Enterprise Technology Innovation

From the macro level, the external environment of technology innovation of enterprises includes financing environment, market environment, industrial cluster environment and policy environment. In terms of the financing environment, there is a general consensus that investment in technologies promotes innovation and adoption of new technologies (Hicks, 1969). Allen and Gale (1999) argued that highly risky and instable new technologies were more likely to be supported by the financial market, while bank-oriented structures were more suitable for supporting more mature, stable and promising technologies. In addition, micro and small enterprises (MSEs) will be more obviously affected by venture capital. Compared with

non-technology-based MSEs, venture capital plays a greater role in promoting the technology innovation of technology-based MSEs (Feng Ruoyang et al., 2020). In terms of market environment, the study found that it is not the case that greater market demand implies higher intensity of technology innovation of enterprises. Technology innovation of enterprises will be most active when the market demand scale is stable near a certain higher threshold. Moreover, technology innovation of large-scale enterprises is driven by both demand and competition, while that of small-scale enterprises is more obviously driven by competition (Kong Lingwen et al., 2022). In terms of the industrial cluster environment, the diversification and specialization generated by industrial agglomeration are conducive to the exchange of information and the improvement in innovation efficiency. Regions with high levels of industrial synergy will have large inflows of financial capital, which can promote technology innovation by easing the financing constraints on enterprises (Arizala et al., 2013). Moreover, the spatial agglomeration of heterogeneous industries can promote economic transformation and technology innovation through sharing, matching and learning effects (Marshall, 1890). In terms of policy environment, government subsidies, credit, taxation, industry access and other policies directly impact technology innovation of enterprises. Shang Hongtao et al. (2020) analyzed the data of 129 private technology enterprises in China from 2010 to 2017, and concluded that, from the short-term incentive effect, government subsidies have a greater role in promoting technology innovation output of enterprises. Chang Xi et al. (2020) found that local industrial policies can ultimately promote technology innovation by

strengthening financial subsidies, stabilizing financial risks and increasing R&D investment. However, this role is more obvious for enterprises in the mature stage, but insignificantly impacts enterprises in the growth stage.

In addition to external factors, the innovation strategy of enterprises is the direct orientation of technology innovation, including market-oriented or scientific discovery-oriented (Hong Yinxing, 2012). You Lei (2021) pointed out that when an enterprise develops to a certain stage, it will adopt the technology breakthrough innovation strategy, that is, the non-continuous and non-linear technology R&D activities carried out for potential market users or cutting-edge technologies, which will bring great changes to the enterprise. If the new technology R&D is successful, the enterprise will form a technological leap, and may also reshape or lead the industry rules and standards.

From the meso-level, the main factors that affect enterprise technology innovation are enterprise size, type and culture. In terms of size and type, enterprises are divided into SOEs and private enterprises, multinational enterprises and domestic enterprises, and large enterprises and SMEs. Based on the analysis of data on 1,385 high-tech enterprises in Shanxi Province, Wang Penghui et al. (2021) found that promoting technology innovation of non-publicly-held enterprises and large and medium-sized enterprises is less positively affected by government subsidies. Government R&D subsidies significantly promote micro-enterprises, but had significantly inhibite publicly-held enterprises and small enterprises. In general, SOEs have better innovation input and output performance due to their size and financial

resources, but their marketization degree is not lower than private enterprises. Private enterprises are relatively more efficient in technology innovation. Due to the integration with the international market, facing a wider range of competitive pressure and the demand for higher quality products, multinational enterprises have a stronger driving force for technology innovation and need to strive to occupy more high-end links such as product design, R&D and channel control in the industrial chain.

Corporate culture is important in regulating enterprise technology innovation. Technology innovation is the source of sustainable competitiveness of enterprises, and today technology innovation requires corresponding changes in corporate organization and culture (Zhang Gang et al., 1997). At the same time, Liu Mingming et al. (2012) found that team spirit and social responsibility culture significantly impact enterprise innovation performance and economic benefits, but technology innovation, customer orientation and organizational learning have insignificant impact. This phenomenon reflects the current tendency of Chinese enterprises to flat management, pay more attention to the cohesion of enterprises as a community and the responsibility of enterprises in society, while the culture of "innovation for innovation" and "innovation for superior tasks" cannot achieve practical results.

From the micro level, the fundamental factor of enterprise technology innovation is innovation input, including talent input and R&D investment. There is no doubt about the role of talent in innovation. You Lei (2021) classified talent into four categories: directors, executives, technical employees and ordinary employees by hierarchy. It was pointed out that directors with technical expertise positively impact

technology innovation performance of enterprises. Higher remuneration of executives and overseas experience usually promote the technology innovation performance (Gao Ling et al. 2020). In addition, technical employees and ordinary employees are more likely to be paid incentives. In terms of R&D investment, Xie Weimin et al. (2009) and Wang Jun (2010) concluded through an empirical analysis that the governments' R&D subsidies have incentive effect on enterprise R&D investment, but have no obvious effect on enterprise innovation. Sun Zao and Song Wei (2012) research on manufacturing shows that in strategic industries with high capital intensity, the positive effect of enterprise R&D investment on industrial innovation performance is not significant, and the positive correlation between R&D investment and industrial innovation performance of private enterprises is more significant than that in case of SOEs.

Control of knowledge, as a key factor affecting innovation at the micro level, includes the enterprises' knowledge and information learning and absorbing capability, spillover and sharing capability, complementarity and integration capability, and intellectual property protection capability. Wang Jianjun et al. (2020) found, through an empirical test of sample data of 239 knowledge-intensive enterprises, that both control of knowledge and influence of knowledge had significant positive effects on enterprise innovation performance. Boundary-spanning technical knowledge search and boundary-spanning market knowledge search played an intermediary role between knowledge power and enterprise innovation performance. Moreover, the stronger the knowledge reconstruction capability was, the stronger the positive effects

of knowledge power had on enterprise innovation performance through boundary-spanning search.

3.1.3 Technology innovation of manufacturers. The agglomeration of enterprises or industries is widely considered to be an organic carrier conducive to diffusion and spillover of technology innovation (Freeman and Rothwell, 1991; Christian DeBnesson, 1999). The new economic geography proposed by Krugman and Venables (1995) emphasizes the regional diffusion effect and spillover effect of agglomeration effect on certain technology innovation, and discusses key factors influencing independent innovation power of manufacturers from the perspective of cluster or agglomeration. The mechanism of agglomeration effect on the innovation behaviors of enterprises is complex. On the one hand, agglomeration is conducive to the spillover and diffusion of innovation information within clusters and the formation of an innovation network (Chi Renyong, 2007), and can encourage enterprises within clusters to implement more innovation activities. On the other hand, low-cost spillovers of innovation information within clusters may encourage enterprises to adopt more copying and imitation strategies in the absence of intellectual property protection systems, thus inhibiting innovation activities of enterprises within clusters.

Most of China's current industrial agglomeration is only in a low-level "pile-up" stage and in the low-road of industrial cluster development (Wang Jici, 2004). Cluster competitive advantage is mainly concentrated on the support from low-cost factors, cost-reducing technology innovation, external scale increment and other low-level competitive factors. However, as the core competitive advantage of

the industrial cluster specialization, innovation network, brand reputation and network cooperation and other high-end competitive advantages have not been reflected. As a result, cluster or agglomeration at the current development stage cannot become a benign carrier to stimulate the innovation power of Chinese enterprises. Due to the excessive low-cost competition, enterprises have too small size and thus unable to accumulate enough "Schumpeter-type" monopoly profits, and to develop their sustainable technology innovation capability.

The research of Zhang Xianfeng and Hu Cuiqun (2013) shows that manufacturing agglomeration improves resource utilization efficiency, thus promoting the growth of total factor productivity (TFP) in manufacturing. Based on the externalities of agglomeration, Gornig and Schiersch (2019) argued that, with differences in strength and direction, the economic utility of manufacturing agglomeration positively impacts technology innovation of high-tech manufacturers, but insignificantly impacts low-tech manufacturers. The research of Wei et al. (2020) shows that there is a significant negative relationship between manufacturing agglomeration and manufacturing innovation efficiency at the county level in China, and the negative effect on manufacturing in developed regions is higher than in that in less developed regions.

3.2 Literature research on the impact of financial development on enterprise technology innovation

3.2.1 Impact of financial agglomeration on enterprise technology innovation.

Financial agglomeration is the combination of financial resources such as financial

institutions, talent and capital flows with specific regional conditions under the support of policies or driven by market demand to form the agglomeration of the financial industry in a certain scale and density in spatial geography (Cai Xuemin, 2021). The characteristics of financial resources clustering in a certain geographical area are becoming a new research focus. The academic focus includes the impact of financial geography and financial agglomeration on industrial structure, financial agglomeration and regional economic growth, spatial structure of financial resources, uneven distribution of financial resources and income gap between urban and rural areas. Financial industry's agglomeration also falls within the research scope of industrial agglomeration. Research on the relationship between industrial agglomeration and economic growth really began with Krugman, an important figure in the new economic geography school, who established in 1999 the relationship between industrial agglomeration and economic growth indirectly by constructing a model. In China, Zhu Yingming (2009) found that the co-agglomeration effect caused by regional manufacturing agglomeration in China significantly reduced the growth of regional manufacturing economies of scale, while the urbanization agglomeration effect of industrial agglomeration promoted its growth.

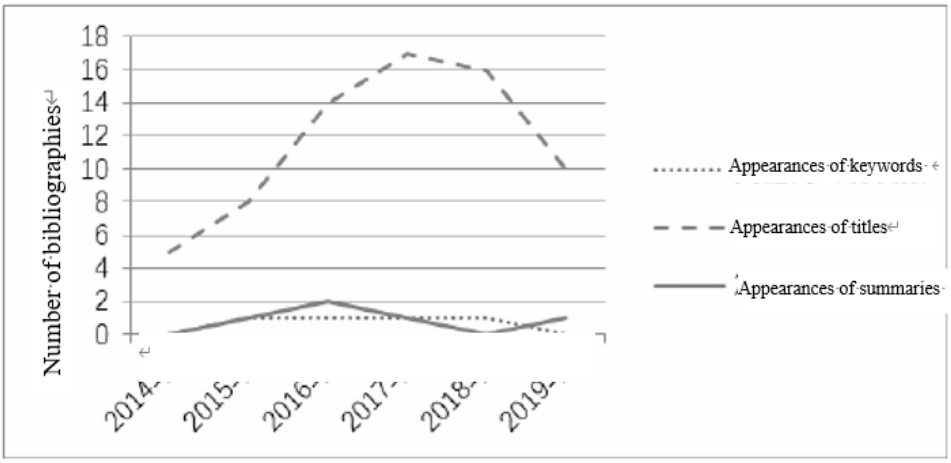

Figure 1-2 Trend Chart of the Number of Literature Combing Financial Agglomeration and Enterprise Innovation

On the "China National Knowledge Infrastructure" search platform, "financial agglomeration" and "enterprise innovation" are counted according to appearances of keywords, abstracts and titles. The search results are shown in Figure 1-2.

At present, domestic and foreign scholars' researches focus on the economic effect of financial agglomeration. Liu Haifei and He Xiaoyu (2017) applied the panel's fixed effect model to empirically study the manufacturers in the industrial enterprise database from 2005 to 2007. They found that the higher the financial concentration, the stronger the willingness of enterprises in the region to innovate, and the greater the investment in R&D innovation. Xuan Yang (2019) studied 30 provinces and cities from 2011 to 2016 and found that financial agglomeration positively impacted the innovation efficiency of enterprises. This effect was influenced by the heterogeneity of different financial sub-sectors.

In foreign research, few scholars carry out positive research on the impact of financial agglomeration on enterprise innovation. Scholars mainly discuss the relationship between the two from the aspects of geographical distribution of banks, credit accessibility and geographical distance between enterprises and financial institutions. Cornaggia et al. (2015) examined the background of deregulation of interstate banking in the U.S. and found that it promoted agglomeration and competition in the banking sector, which resulted in more innovative financing for small businesses. However, innovation in SOEs has been negatively impacted by the reduction of credit availability to them. Adegboye and Iweriebor (2018) found that innovation in Nigerian SMEs was significantly driven by the degree of bank credit facilities through empirical research on SMEs in Nigeria.

In the research on the impact of financial agglomeration on enterprise technology innovation, the intervention and influence of local government is an important variable which is often neglected. The institutional background of financial decentralization and centralization distorts the innovation-driven effect of financial agglomeration to some extent. The promotion of local officials is linked to economic performance. Thus, GDP growth becomes the most important indicator of local government performance evaluation (Zhou Li'an, 2004), leading local officials to use government actions to interfere in economic development. During the transition period when China's financial reform was not complete and its institutional construction was not perfect, local governments plundered and interfered in the allocation of credit funds by banks, so that funds flowed to industries that could boost

GDP in the short term, while crowding out funds for R&D enterprises with long-term results and slow returns. Yang Ye et al. (2015) found that the form of direct financial subsidies has a negative regulatory effect on enterprise R&D investment.

On the whole, financial agglomeration can promote enterprise innovation mainly through two aspects: First, when financial resources are concentrated, it can form a "strong and efficient" financial system, thus easing the credit constraints of enterprise innovation, reducing the innovation risk and providing long-term incentives, and finally making the innovation activities of enterprises long-term, stable and sustainable. Levine (1998) pointed out that the uncertainty of innovation results makes enterprises face intertemporal risks when they innovate. Financial markets can diversify the risks and improve the enthusiasm of enterprises to innovate. Sanit Paul (1992) argues that the financial risk diversification function weakens the concern of risk-averse enterprises about the lack of liquidity of innovation investment, and prompts enterprises to realize technological progress through innovation. Second, financial agglomeration is conducive to the optimal allocation of innovation resources. Financial agglomeration reduces the cost of information acquisition by financial intermediaries, enables financial institutions to collect investment information more quickly, and improves the efficiency of resource allocation (Yu Yongze et al., 2013). As for the innovation behavior of enterprises, the competition effect of financial agglomeration can improve the efficiency of financial resources, reduce the financing cost of enterprises, and the innovation cost of enterprises is greatly reduced.

3.2.2 Impact of financial development on enterprise technology innovation.

Financial development mainly refers to the dynamic development process of the whole financial system and the financial industry, including the increase of financial functions and the improvement of financial system. Through the diversification of functions and the improvement of system, financial efficiency is promoted. The market-oriented index compiled by Fan Gang is often used to measure the degree of financial development in each region.

Academics agree that financial development plays a key role in promoting GDP growth through technology innovation. Theoretically, financial development overcomes high information search costs through specialization and learning by doing effect, and reasonably discovers the value of enterprise innovation (Chowdhurya and Maung, 2012); overcoming liquidity risk and non-systemic risk through effective risk management and diversification, making innovation investment more attractive (King et al., 1993); reduce agent and monitoring costs by creating contractual incentives (Morales, 2003). At the macro level, Meierrieks (2014) examined data from 51 countries from 1993 to 2008, providing macro evidence linking financial development and national innovation.

Domestic research on technology innovation of enterprises in support of financial development is mainly carried out from three levels: country, industry and enterprise. The research content includes: research on the mechanism of combining technology and finance (fintech) to promote technology innovation; research on support for technology innovation of SMEs; research on financing mode, financing mechanism, financing performance and financing development of high-tech

enterprises; research on the relationship between direct financing and indirect financing; research on venture capital model and mechanism; and discussions on the second board market.

Li Jianwei (2005) studied the mechanism of financial arrangement on the development of technology innovation and promoted mechanism, and established a theoretical model of technology innovation operation mechanism from the perspective of real option theory. Yin Jianfeng (2006) and Wang Li (2007) both studied the role of finance on technology innovation from the perspective of financial structure. Among them, Yin Jianfeng explained the role of financial structure on economic growth through the different roles played by different financial structures in the long wave of technology, and concluded that different financial structures play different roles in the promotion, dissemination and improvement and maturity of new technologies. Wang Li compared the differences between the two financial structures in promoting innovation activities at micro, meso and macro levels based on three dimensions: information, risk and corporate governance. She argues that there is no absolute difference in advantages between banks and markets in supporting innovation. What a country needs for innovation and economic growth is a more diversified financial structure and higher overall financial development.

The development and innovation of manufacturing, especially high-end manufacturing, need to be supported by financial capital. In a market economy, the development of financial markets significantly impacts the ability of manufacturing to obtain financial capital and ease financing constraints. In addition, the improvement

of total factor productivity in manufacturing requires a lot of innovation investment, so as to realize the transformation from the extensive model of quantitative growth to the intensive model dominated by the efficiency of allocation of capital and technological resources. This process needs the support of a mature and perfect financial system (Zhang Xu et al., 2017). The research of Liang Bang et al. (2018) shows that different financial scale and efficiency brought by financial development will have a heterogeneous impact on the optimization and upgrading of manufacturing structure.

3.2.3 Impact of enterprise heterogeneity on financial promotion of technology innovation.

It is necessary to fully analyze the heterogeneity of enterprises to play the role of finance in supporting the technology innovation. On the one hand, the theoretical analysis of enterprise heterogeneity can explore the internal texture of enterprise innovation, distinguish which internal factors will promote the financial support effect and which will inhibit the support effect; on the other hand, through the comparison of different types of enterprises, it is helpful to evaluate the effect and insufficiency of financial support for the technology innovation of various enterprises. The research of Zhang Jie et al. (2012) shows that the development of China's financial system has significantly inhibited the innovation of small-scale enterprises, private enterprises and young enterprises. Therefore, among the factors of enterprise heterogeneity, the more important are enterprise size, property right nature and life cycle.

The first is the size of the enterprise and the nature of the property rights. In terms of innovation input, existing studies have found that the competitive market structure of the banking industry significantly and positively impacts innovation input of SMEs, because SMEs are inferior to large enterprises in their ability to obtain resources, their operational and financial risks are higher, and financial support can ease their financing constraints (Cai Jing and Dong Yan, 2016). In addition, the different types of ownership of enterprises affect the role of finance in investment in innovation. Non-SOEs perform better in this regard. This is due to the preference of government and banks for SOEs and the propensity of government subsidies, so that SOEs would otherwise be able to obtain more financing. Therefore, financial development will allow private enterprises to obtain more financing. Secondly, in terms of enterprise innovation output, Dai Jing and Zhang Jianhua (2013), taking China's industrial sector panel data from 2001-2010 as a sample, found that financial development is conducive to reducing factor gains for SOEs by virtue of their political status, and promoting SMEs and private enterprises to increase innovation output.

The supporting role of finance for enterprises with different life cycles is different. Yuan Zeming et al. (2016) took Tianjin science and technology enterprises as the research object and found that for enterprises in the start-up stage and growth stage, the supporting role of financial development and relevant policies will be more significant. However, enterprises in the mature stage have little dependence on this

and mainly rely on internal management and scale efficiency to improve innovation output. Wang Xueyuan et al. (2017) through the research of China's high-tech enterprises, found that the reason why finance has a more significant effect on innovation promotion of start-up and growth-stage enterprises is that such enterprises have small scale, financing availability and low-cost financing difficulties, are difficult to obtain financing from banks or capital markets due to insufficient social relations, and lack of accumulation and innovation ability. Financial structure and environment should be optimized to help them ease financing constraints.

3.3 Literature research on policy-based finance

3.3.1 Concept of policy-based finance. Resource allocation is an eternal proposition based on the two foundations of modern economics and finance: the finiteness of resources and the infinity of human needs. However, the two idealized goals of economic effectiveness and social rationality often contradict each other in practice. Resource allocation to achieve economic efficiency may destruct social equity and equality, while resource allocation focusing on social rationality may lead to inefficient resource allocation. Policy-based finance thus emerged. The concept of policy-based finance was first put forward by Bai Qinxian (1994). He believed that policy-based finance is the combination of national fiscal policies and finance, taking into account the dual attributes of administration and market, macro-economic and micro-market, gratuitous allocation and gratuitous lending. In the market mechanism, policy-based finance appears to supplement the defects and deficiencies of commercial finance mechanism. It plays an auxiliary role and acts as an economic

regulation or management means. Policy-based finance exists widely in both developed and developing countries. It is a universal economic and financial phenomenon in the sense of time. Even in the U.S., its agricultural policy-based financial institutions are statutory permanent institutions.

Jia Kang and Meng Yan (2013) believed that policy-based finance had two important responsibilities -- solving market failures and promoting the implementation of "catch-up" development strategy. On the one hand, through the operation of policy-based financial institutions, we can solve the market failures of social resources allocation, so that social funds can support areas with low short-term benefits but vital to social development; on the other hand, especially in developing countries, policy-based finance is usually combined with national strategies, including export-oriented strategies, independent innovation strategies, support for key industries and development strategies for backward regions.

3.3.2 Effect of policy-based financial support for economic development.

The research on policy-based financial support for economic development originated very early. Dietrich (1935) studied the Export Credit Insurance Scheme established in 1919 and considered that the scheme, as a typical policy financial instrument, provided convenient short-term and medium-term loans to exporters, and promoted British trade exports. Fergusson (1948) took the Industrial Development Bank of Canada, which was founded in 1944 as the research object, and found that the medium-and long-term loans provided by the bank to industrial enterprises promoted the production transformation of SMEs, and laid the foundation for post-war economic recovery and industrial transformation and upgrading.

Compared with foreign research, the domestic literature pays more attention to the support of policy-based finance for industrial upgrading, urbanization and poverty alleviation. Du Yankun (2022) traces back to Marx and Engels, and points out from the theoretical level that policy-based finance shoulders the responsibility of reflecting the national will, balancing the market and serving the strategic needs, and is an important institutional arrangement to achieve China's goal of common prosperity. Zhang Shaohui (2019) research on Jiangsu manufacturing shows that under the current situation of huge manufacturing scale, low emerging industries and high external dependence, in order to promote higher-level industrial development, the services provided by policy-based financial institutions are an important path for manufacturing transformation and upgrading.

In terms of agriculture and poverty alleviation, Luo Qiong (2016) took China's urbanization development level from 1998 to 2012 as a sample, and found that policy-based finance is more helpful than commercial finance to promote the development level of new urbanization from three aspects: environment, economy and society, but has less effect on the development level than commercial finance. As for the research on policy-based finance supporting industrial upgrading, Zeng Kanglin (2004) believed that the essence of policy-based finance was the government's intervention in financial activities, featuring overall, directive and low interest. The research of Gu Haifeng (2011) establishes the policy-based financial support system for the evolution of strategic emerging industries, and the researcher believed that the process of policy-based financial support for strategic emerging industries needed to form a coordination system with commercial banks and capital markets.

3.3.3 Policy-based finance and manufacturing. In the sense of the national strategy, advanced manufacturing is the key development direction of the country, and it is becoming more and more important in promoting the transformation and upgrading of manufacturing and even enhancing national competitiveness. The main service objects of policy-based finance are industries or fields with "strong status but weak position" (Bai Qinxian, 2010). Zhang Kun (2015) believed that the areas in which policy-based finance played a role were those in which commercial finance tended to avoid disadvantages and was unwilling to enter, such as agricultural and manufacturing R&D innovation. In particular, the military and high-precision

manufacturing sectors directly determine the fate of the country and international competitiveness, and involve national security. Commercial sectors rarely make a difference in these industries.

Zhang Yuxi and Duan Jinlong (2016) studied the mechanism of policy-based finance to support scientific and technology innovation, and found that its ways mainly include direct and indirect financing, venture capital, financial services, etc., and its role is mainly reflected in mobilizing and allocating resources, disclosing information and diversifying risks. Zhuo Lihong et al. (2016) hold that China's policy-based finance should learn from the experience of developed countries and promote policy-based finance to support enterprises in "going global"; Wang Yungui and Lin Yanhong (2017) proposed that policy-based finance should drive the orderly export of industry capital, play a leading role in the regional strategy of supporting enterprises to "go global", and shift from supporting trade to supporting capital to go global.

3.4 Literature review

3.4.1 Review of literature on enterprise technology innovation. On the research of enterprise technology innovation, going back to Schumpeter, there have been very full research and discussion in academic circles. Whether from the overall perspective of what factors are working, or from the perspective of a single factor to analyze its specific mechanism, the relevant literature is quite rich. But there are still some concerns.

First, the previous literature mainly focused on the direct effect of various factors on enterprise innovation, but few studies on the indirect effect of factors on enterprise innovation. For example, the government supports enterprise innovation by injecting capital into industrial investment funds or taxing investment income.

Second, the factors that affect enterprise technology innovation can be broadly divided into organizational external environmental factors and organizational internal factors, which derive the understanding of the technology innovation performance of enterprises (TIP) by domestic and foreign scholars can be summarized into two main points of view: one is the efficiency of technology innovation input and output, the other is the output of technology innovation activities and the impact on enterprises, including economic benefits, social news, technical benefits, etc. However, technology innovation is a multi-stage process, each stage has a phased objective, and all the phased inputs and achievements are aggregated into activities that reflect the quality of innovation of an enterprise. However, the current evaluation system is more about calculating the input-output ratio, focusing on output rather than process.

3.4.2 Review of literature on finance affecting enterprise technology innovation.

Academics are generally positive about financial support for enterprise innovation. More disputes focus on what kind of financing method is more conducive to enterprise innovation, or what kind of construction finance should focus on to serve enterprise innovation. Summarizing the past literature, we can find that the advantages of capital markets lie in efficiency and flexibility. However, the main point is that developing countries have weak capacity to allocate resources and are prone to

speculation, which is detrimental to innovative enterprises and SMEs that need a long time to show their value. While bank credit can alleviate capital market problems to some extent, it is vulnerable to government intervention, benefiting large SOEs. How will China choose to develop capital markets and bank credit to support enterprise innovation requires prudent decision-making.

In addition, previous studies tend to study the impact of some aspects of finance on enterprise innovation from the macro perspective, such as regional financial structure, financial agglomeration, financial policy, etc., but less research from the micro-finance perspective. Because macro factors such as financial agglomeration play a relatively indirect role in enterprise innovation, there is a transmission process from external to internal, such as the availability of enterprise loans or the contribution of enterprise R&D financing to technology innovation performance, and this process will also be affected by other internal and external factors.

3.4.3 Review of literature on policy-based finance. The research on policy-based finance is closely related to the development of China's market economy and the implementation of major national strategies. Most of the relevant literatures focus on theoretical aspects, especially on the nature and position of policy-based finance in strategies such as targeted poverty alleviation and common prosperity. In the new economic period, China's strategy of insisting on the market-oriented operation of policy funds and the national development strategy has been fully recognized in theory and practice. But at present, there is little research on

policy-based financial support for real industries, and there is no empirical evidence on its support for infrastructure construction, manufacturing power strategy and Belt and Road strategy.

4. Conceptual basis

4.1 Enterprise innovation theory The theoretical investigation into innovation began with Schumpeter's pioneering research, followed by many influential theoretical schools and various innovation models, such as the A-U innovation process model proposed by Abernathy and Utterback (1975). One of the core problems of enterprise innovation theory is that, from the perspective of innovation process and result, is enterprise innovation uncertain or path dependent? The existing research shows the path dependence and evolution characteristics from linear innovation view to ecological innovation view and from uncertain innovation to path dependence and evolution characteristics of innovation.

First, the linear mode of innovation. Schumpeter's innovation theory holds that innovation is the heroic and adventurous activity of entrepreneurs; the opportunity of innovation exists in the external environment; and the innovation behavior is an individual's random flash of inspiration. Based on this, Rothwell (1992) called technological development-driven enterprise innovation as the first-generation innovation model and market demand-driven enterprise innovation as the second-generation innovation model, both of which were enterprise innovation under a linear mode. The linear mode means that the factors influencing enterprise innovation are very limited, and policy tends not to intervene. This view is the starting point of innovation research.

Second, the innovation ecosystem mode. In the 1980s, the enterprise innovation has changed correspondingly under the background of the new tendency of division of labor. Academic circles have put forward the concepts of "innovation network" and "innovation ecology" successively (Freeman, 1991; Adner, 2006), and introduced the viewpoint of ecology into the research of enterprise innovation, thus emphasizing the complexity and system of enterprise innovation. Under this concept of innovation ecology, effective innovation should be a collaborative integration of ecosystem, and each enterprise integrates its own innovation activities into a set of coordinated programs. If an individual enterprise leaves the ecosystem, it will face project risk, dependency risk and integration risk.

Finally, the evolution mode of enterprise innovation. Evolutionary economics represented by Nelson and Winter (1982) holds that firms have path dependence in technology innovation. In many cases, scientists and technologists clearly know that technological development can steadily improve along a certain direction and path. In this sense, technologically, the innovation of enterprises is constrained by the achievements and direction of the past. Support policies based on innovation evolution are usually autonomous, closed and technology-oriented.

Nowadays, the innovation activities of enterprises are often complex, organized and systematic. Traditionally, the independent and closed innovation theory cannot provide guidance. Knowledge is the foundation of innovation and has the characteristic of accumulation, so it also provides a certain path choice for the innovation of enterprises. At the same time, the innovation activities of enterprises and the external environment are mutually coordinated, and the resources used by individual enterprises in the process of innovation have broken through the boundaries of individuals.

4.2 Policy-based finance theory Classical economics holds that in a completely free competitive market, everyone will choose the optimal strategy according to the principle of maximizing their own interests. Market mechanism is the only way to allocate resources efficiently. However, with several economic crises and market failures in reality, people realize the need for government's macro-intervention in market economy. This is the basis of policy-based finance theory. In China, policy-based finance theory is inherited from the planned economy system in practice.

The state controls economic activities by administrative means. Since the reform and opening-up, commercial financial system and policy-based finance have been separated, and both have been developed accordingly.

In terms of the operation of policy-based financial business, foreign developed commercial banks can provide the foundation for the policy-based financial system, but all Chinese commercial banks started in the form of policy banks and undertake both the business of policy banks and the business of professional banks. Policy banking is supported by government finance, which can lead to a series of problems such as rent-seeking. At the same time, China's economy is mainly investment-oriented, micro-economic lack of development potential, the general environment restricts the development of policy-based finance, easy to form a "capital pot rice" situation, affecting the efficiency of capital use and innovation.

In essence, policy-based finance is a financial instrument, which obeys the law of the market and functions according to the market mechanism, including market-based financing, market-based investment and market-based management, and cannot be as gratuitous as finance. At the same time, it is also a special finance, its particularity is reflected in the government's allocation of resources with the principle of maximizing public interests, but not pursuing profit maximization. It is mainly located in weak industries and bottleneck areas. Therefore, policy-based finance has both financial and public nature.

In terms of functions, policy-based finance, as a financial instrument for allocating resources by the government, has three main functions: firstly, improving

financing constraints in bottleneck areas and leading the high-quality development of industry; secondly, we should play and demonstrate the role of commercial finance and guide social capital to invest in projects or industries that conform to the national strategy. Finally, improve the market financing system and business philosophy, help bottleneck enterprises reduce their dependence on financial funds, and give full play to the role of market mechanism.

The carrier of policy-based finance is the policy-based financial institution, which carries its main functions and systems. According to the classification of financial industry, it can be divided into policy banks, policy insurance companies, government industrial funds, policy asset management companies, etc. Policy banks are the core of policy-based financial system. China's policy-based financial system is dominated by policy-based financial institutions, supplemented by some commercial financial institutions that undertake policy-based financial business. Policy-based financial institutions are mainly three policy banks established in 1994: China Development Bank (CDB), Export-Import Bank of China (EIBC) and Agricultural Development Bank of China (ADBC). The CDB serves basic industries, builds strategic industries and coordinates regional development; the EIBC promotes the "going global" of Chinese enterprises' products and services and international economic and trade cooperation; and the ADBC serves the commercialization of agriculture and support farmers to increase their incomes. In addition, there are some commercial financial institutions that undertake policy-based financial business in China, including commercial banks that undertake student loans, poverty alleviation

loans, and loans to MSEs, and commercial insurance companies that undertake agricultural insurance and municipal government bonds.

4.3 Characteristics of policy-based finance On the basis of identifying the essential attributes of policy-based finance, this section further analyzes the characteristics of policy-based finance. This paper believes that policy-based finance has four characteristics, which can be summarized as governmental basis, public function, financial nature and professional service. The specific analysis is as follows.

(1) Governmental basis. Policy-based finance is established by the government, represents the government's will, implements the government's intention, and is a tool for the government to allocate resources and implement economic and industrial policies. The operation of policy-based finance and the giving of continuous play to its role need the support and guarantee of the government as the foundation. Specifically, take policy banks as an example. All capital of a policy bank is allocated by the government, and the policy bank financing from the financial market is guaranteed by the government and enjoys the national sovereign credit. The losses incurred in the operation of the policy bank ultimately need to be subsidized by the government finance.

(2) Public functions. Policy-based finance is responsible for serving the national development strategy and supporting weak links and bottleneck fields. The goal of policy-based finance is to maximize public interests, ensure that the country's basic industries, agriculture, advanced manufacturing industry and other weak industries with strong positions can obtain due capital supply and financial services,

and ensure the access to financial resources in strategic and bottleneck fields. Meanwhile, policy-based finance does not aim at maximizing its own profits, and does not step into the industrial fields where the market mechanism can play its full role and commercial finance can better cover because it is profitable to do so.

(3) Financial nature. As a tool of the government, although policy-based finance has certain attributes of fiscal investment and financing, its essence is finance, and it is a financial behavior of paid lending, not a financial behavior of free appropriation. Take policy banks as an example. The main fund source of policy banks as financial intermediaries is the issuance of bonds where social funds are used. Policy banks have the obligation to repay the principal and interest of the bonds they issue. Meanwhile, policy banks grant loans to the weak links and bottleneck fields in the country. Such loans are for paid use, and the borrowing enterprises need to undertake the obligation to repay the principal and interest. In a word, no matter how big the public mission of policy-based finance is, it must follow the laws of the market and the operating mechanism of the financial industry, and abide by the relevant laws and regulations of the financial industry, including the banking industry and the fund industry.

(4) Professional services. Professionalism is not only an important guarantee for policy-based finance to effectively play its public functions and serve the country's bottleneck industries, but also a necessary condition for sustainable development. On the one hand, the business of policy-based finance is more focused, and the division of labor is clearer than that of commercial finance, and can provide specialized

financing and services for key fields such as infrastructure, regional development, agricultural development, and advanced manufacturing. On the other hand, in order to achieve sustainable development, policy-based finance must realize professional operation and management on the basis of following the market mechanism.

Since policy-based finance neither aims at maximizing profits nor competes with commercial finance, it must optimize the construction of systems and mechanisms through professional means, improve operational efficiency, and reduce management costs, so that they can surrender part of the profits to enterprises while preserving their own capital with meager profits. Since private enterprises aims at making profits, they make investment for reproduction and expand the scale of production to continue to increase profits. So this cannot be supported by policy-based finance, nor can this play the role of policy-based finance.

CHAPTER 2

RESEARCH PLAN

1. Empirical analysis ideas and research hypotheses

1.1 Empirical analysis ideas The aforementioned analysis demonstrates the role and advantages of policy-based finance in supporting technology innovation of advanced manufacturers from a theoretical perspective. Based on the data, this chapter empirically tests whether policy-based finance plays a significant role in supporting and promoting technology innovation of advanced manufacturers, and whether enterprise heterogeneity significantly impacts the supporting role of policy-based finance. Thereby, from an empirical point of view, this chapter verifies the role and advantages of policy-based finance and the problems and shortcomings of policy-based finance in supporting enterprise technology innovation.

The empirical analysis ideas of this chapter are as follows.

First, for the problems that require empirical test, research hypotheses are put forward in combination with the aforementioned theoretical analysis. The author divides the measurement of enterprise technology innovation into enterprise innovation input and output, and proposes five research hypotheses from the impact of policy-based financial support for enterprise innovation input and output and the impact of enterprise heterogeneity on the effects of policy-based finance.

Second, research samples and variables are selected, and preliminary statistical analysis on the research samples are conducted. This chapter selects the

listed advanced manufacturing companies that conform to the "Made in China 2025" strategy as a sample, selects the listed companies with high profitability, high growth and low valuation from the advanced manufacturing-related industries in Shanghai and Shenzhen markets, and conducts statistical analysis on the market capitalization and industry distribution of the sample enterprises. At the same time, this chapter selects explained variables, explanatory variables and control variables required for the empirical test, and makes pre-processing of the variable data.

Third, an empirical model is built. In order to verify the relevant research hypotheses, it is necessary to construct a multiple linear regression model according to the sample variables. Based on the Hausman test, the author selects a fixed-effect model to verify the role of policy-based finance (independent variable) in enterprise technology innovation (dependent variable), as well as the impact of enterprise heterogeneity on this effect.

Fourth, empirical results are analyzed. This chapter analyzes descriptive statistics and empirical regression results, and analyzes whether policy-based financial support can effectively improve the innovation input and output of advanced manufacturers from the perspective of regression coefficient and significance level.

Fifth, an empirical analysis of enterprise heterogeneity on policy-based financial support for enterprise innovation is carried out. This chapter analyzes the impact of enterprise heterogeneity on policy-based financial support for enterprise innovation input and output from the perspectives of property right nature, enterprise size and enterprise age, so as to further analyze whether there are differences in the

effects policy-based financial support for state-owned and private enterprises, large enterprises and SMEs, young enterprises and mature enterprises, and whether there are some problems and shortcomings in the effect and coverage of policy-based financial support.

Sixth, robustness test is carried out. This chapter analyzes whether the above empirical test results are robust by replacing the core variables and changing the regression method.

1.2. Source of data Considering that listed companies represent high-quality enterprises in China whose information is relatively standard and transparent, this paper selects the listed advanced manufacturing companies that conform to the "Made in China 2025" strategy as a sample, selects the listed companies with high profitability, high growth and low valuation from the advanced manufacturing-related industries in Shanghai and Shenzhen market, and conducts statistical analysis on their market capitalization and industry distribution.

At present, the listed companies included in the CSI Made in China 2025 theme index are the backbone enterprises in the ten key areas of Made in China 2025. The method of selecting sample stocks is as follows: Firstly, the companies that have been listed for less than 3 months and have not completed the share split reform and ST are excluded; then the sum of the average daily capitalization and average daily turnover in the past year is used as a comprehensive ranking to select the top listed companies in their respective fields in the ten key areas. Thus, the selected sample stocks have better representativeness and activity. Listed companies under the CSI

Made in China 2025 theme index include advanced manufacturing companies listed on the Shanghai Stock Exchange and Shenzhen Stock Exchange.

CSI Advanced Manufacturing 100 Strategy Index selects listed public securities with high profitability, high growth and low valuation from advanced manufacturing-related industries in Shanghai and Shenzhen as a sample of the index. The method for selecting sample stocks is as follows: the securities in advanced manufacturing-related industries are ranked from high to low according to their average daily turnover and latest total capitalization in the past year, and the securities in the bottom 20% are excluded; then the profitability and efficiency improvement indicators of the company are standardized from high to low, the valuation level is standardized from low to high, and the simple arithmetic mean of the three indicators is standardized as the comprehensive score. Select the top 100 enterprises by the comprehensive score.

There is some overlap between the companies under the two indexes. In this paper, sample companies included in both the "CSI Made in China 2025" and "CSI Advanced Manufacturing 100 Strategy Index" are combined to avoid double counting. The sample selected in this paper is the latest adjusted public companies as of December 2021.

After collection, the latest samples include a total of 246 enterprises, with data from the Wind database. Details of enterprises in various fields are as follows.

Table 1-2 Listed Companies under "CSI Made in China 2025" and "CSI Advanced Manufacturing 100 Strategy Index"

Industry	Number of entrepreneurs	Total market value (RMB 100mn)	Average market value (RMB 100mn)	Representative enterprise
New generation information technology	22	9809	445	iFlytek Kingsoft Office Yongyou
Machinery and equipment, home appliance industry	20	11193	559	Haier Smart Home Gree Electric Sany
Aerospace equipment	16	6397	399	Aviation power AVIC Shenyang Aircraft AVIC Xi'an Aircraft
Transportation equipment and shipbuilding, logistics industry	10	4665	424	CRRC China Shipbuilding Industry CSSC
Biological and chemical products	15	11481	765	Wanhua ZFSW TINCI
Energy saving and new energy vehicles	40	30637	766	CATL BYD Energy New Materials
Power equipment	29	10706	369	NARI Inovance Jonhon

Table 1-2 Listed Companies under "CSI Made in China 2025" and "CSI Advanced Manufacturing 100 Strategy Index"(continue)

Industry	Number of entrepreneurs	Total market value (RMB 100mn)	Average market value (RMB 100mn)	Representative enterprise
General equipment, communication equipment	14	2187	156	CIMC Group CSICP Yiheda
New materials	18	10206	567	Western Superconducting CISRI-Gaona Xinjiang Joinworld
Medical devices and services	16	9845	615	Mindray Wantai BioPharm IMEiK
Semiconductors, photovoltaic equipment, optical optoelectronics	21	24165	1098	LONGi SMIC Tongwei
Special equipment/professional services/ instruments and apparatus	25	2785	111	Jiechang YTO Himile

According to the statistics, the capitalization of the 246 sample enterprises as of December 31, 2021 was RMB 13,320.2bn, with an average capitalization of RMB 54.1bn. Among them, the number of enterprises belonging to the field of energy conservation and new energy vehicles is the largest, with the highest total capitalization. The average capitalization of semiconductors, photovoltaic equipment and optics and optoelectronics is higher, all exceeding RMB 109.8bn.

To sum up, this paper selects all listed companies in the China A-share "CSI

Advanced Manufacturing 100 Strategy" and "CSI Made in China 2025" theme index from 2011-2020 as a sample. Data are from CSMAR database and Wind database. Some missing data are collected and supplemented manually.

1.3 Research hypotheses

1.3.1 Policy-based financial support and enterprise innovation input.

Serving the national development strategy, supporting strategic, weak and cutting-edge technology innovation and the systematic cultivation of bottleneck industries are the positioning and important mission of policy-based finance. Policy-based finance does not aim at maximizing profits. It can provide large, long-term and low-cost preferential loans for technology innovation of advanced manufacturers, or provide enterprises with funds and services in key links of technology innovation, including from general technology research to the early stage of industrialization through policy-based equity investment, guarantees and consulting services, so as to help enterprises reduce financing costs, diversify private and public risks in the innovation process, and alleviate information asymmetry, financing constraints and market failures in the innovation process. In addition, the involvement of policy-based finance can play the role of signal transmission and guidance and demonstration, and diversify commercial financial risks by forming syndicated loans, thereby leading commercial finance to provide further financial support for enterprise innovation. For key projects in weak links and key areas, policy-based finance can enable enterprises to communicate with government departments, and strive for R&D support such as subsidies and interest discounts for enterprises. The above measures

help enterprises to internalize the externality of innovation to a certain extent, reduce the innovation cost and innovation risk of enterprises, and promote enterprises to invest more resources in technology innovation. In addition, policy-based finance can investigate, screen and supervise relevant enterprises, so that policy-based funds can be invested in enterprises under financing constraints instead of those with excess funds, to achieve precise support. It can also promote enterprises to invest funds obtained by them in innovation through continuous supervision of capital flow. Therefore, Hypothesis 1 is put forward:

H1: Given that other conditions remain unchanged, policy-based financial support is positively correlated with enterprise innovation input.

1.3.2 Policy-based financial support and enterprise innovation output.

Following with the laws of the market and realizing policy goals in accordance with the market-oriented mechanism are the operating principles of policy-based finance in the new era. Compared with financial funds that are purely from the government, one-way and under restraint mechanism, policy-based financial institutions can fully communicate with enterprises from pre-loan investigation and project review process, conduct on-site research, and hire experts in related fields for demonstration and evaluation, collect, sort out and identify information on project situation, capital demand, and risk management in the R&D innovation activities of enterprises, so as to reduce information asymmetry and provide financial support with appropriate cost and time limit for enterprise innovation.

At the same time, policy-based financial institutions will sign loan contracts or

investment contracts with enterprises, specifying the use of funds and repayment (dividend) obligations, so as to restrict the use of funds by enterprises and increase enterprises' cost of default. In the subsequent links such as loan granting and post-lending management, policy-based finance can check the capital flow and operating financial situation of enterprises, so as to supervise and restrain the use of funds by enterprises and the effects thereof, and urge enterprises to invest the funds in R&D innovation in a timely and effective manner, which will help to promote enterprises to improve innovation efficiency and output, and minimize moral hazard and adverse selection problems.

In addition, policy-based finance is strongly professional in supporting enterprise technology innovation. Policy-based financial institutions are relatively focused on business areas, and have relatively rich talent and resource reserves in supporting advanced manufacturing. For example, with accumulated domestic and foreign resources, policy-based financial institutions can help enterprises communicate with leading upstream and downstream enterprises in the industry, strive for better raw materials and equipment resources for their R&D innovation, or assist enterprises in securing domestic and foreign orders for their new products.

All in all, policy-based finance can improve the innovation efficiency and innovation output of enterprises by virtue of its public attribute, market-oriented operation mechanism and professional resource advantages. In addition, the long-term nature of policy-based funds can also reduce the short-term behavior of enterprises

and provide a time guarantee for the final formation of innovative results. Therefore, Hypothesis 2 is proposed:

H2: Given that other conditions remain unchanged, policy-based financial support is positively correlated with enterprise innovation output.

1.3.3 Impact of property right nature on policy-based financial support for enterprise innovation. First, property right nature has an important impact on the enterprise technology innovation. On one hand, SOEs generally possess more innovation resources, and have more advantages than private enterprises in terms of talents, capital, and technical reserves (Xu Wei et al., 2017). At the same time, SOEs have the mission of implementing the national strategy and the transformation and upgrading of the real economy, and receive more government support in respect of major projects. In general, the problem of market failure in innovation is more serious for private enterprises. On the other hand, due to the uncertainty of the tenure of agents and executives, and the fact that SOEs undertake certain social and public functions, the technology innovation efficiency and motivation of SOEs are lower than that of private enterprises (Yao Yang and Zhang Qi, 2001).

After comprehensive analysis of the impact of policy-based financial support and property right nature on enterprise innovation, the author believes that in terms of the impact of property right nature on policy-based financial support for enterprise innovation input, since both policy-based finance and SOEs have government backgrounds, they are similar to a certain extent in terms of operation and management, target assessment and other aspects, and the degree of information

asymmetry between SOEs is lower than that between private enterprises. In addition, SOEs have more innovative resources such as talent and technology, and their innovative behaviors, especially major projects, are more likely to be supported by the government. It is relatively easier for policy banks to approve loans to innovation projects of SOEs, so that there are more adequate financial support for innovation input of SOEs. Compared with private enterprises, SOEs are operated in a more standardized manner in general, and are relatively less involved in capital misappropriation. The investment of policy-based financial funds can be better transformed into enterprise innovation input.

However, in terms of the impact of property right nature on policy-based financial support for enterprise innovation output, due to the relatively inefficient operations, the principal-agent problem, the short-term behavior caused by the uncertain tenure of the actual controller, and the imperfect assessment mechanism, not all the innovation behaviors of SOEs are aimed at enhancing their own market competitiveness. Specifically, such innovation behaviors place more emphasis on input than effects and output.

Moreover, the contradiction between the intertemporal duration from innovation input to innovation output and the uncertain tenures of the actual controllers of SOEs has exacerbated the problem that SOEs place more emphasis on innovation input than innovation output. At the same time, compared with private enterprises, policy-based finance may be less devoted to post-loan inspection and innovation achievement evaluation for SOEs. Therefore, Hypothesis 3 is proposed:

H3a: Given that other conditions remain unchanged, the nature of state-owned property rights positively impacts policy-based financial support for enterprise innovation input.

H3b: Given that other conditions remain unchanged, the nature of state-owned property rights insignificantly impacts policy-based financial support for enterprise innovation output.

1.3.4 Impact of enterprise size on enterprise innovation with policy-based financial support. First, enterprise size impacts the decision-making, mechanism and effect of enterprise technology innovation. In China, due to the imperfect factor market and financing constraints, it is difficult for SMEs to carry out R&D innovation activities, and excessive innovation risk and insufficient innovation input make it hard to bring considerable innovation output. Therefore, enterprise size positively impacts technology innovation. (Wu Yanbing, 2007). On the other hand, the growth of enterprise size and hierarchy will make large enterprises inflexible in terms of market response, innovation decision-making and incentives, and thus inhibit innovation activity, innovation efficiency and entrepreneurship, resulting in "large enterprise's disease" and "innovator's dilemma" (Boone et al., 2000).

After comprehensive consideration of the impact of policy-based financial support and enterprise size on enterprise innovation, the author believes that in terms of the impact of enterprise size on policy-based financial support for enterprise innovation input, enterprises of larger sizes generally have stronger financing ability and more abundant funds, and are under lighter financing constraints. When large

enterprises invest in innovative projects, they have more innovative elements at their disposal and can choose funds from a wider range of sources. Therefore, policy-based financial support insignificantly impacts the alleviation of information asymmetry and financing constraints in technology innovation of large enterprises.

In terms of the impact of enterprise size on policy-based financial support for enterprise innovation output, since China's policy-based finance mainly supports large scientific and technology innovation projects in line with national strategies and key weak areas, policy-based financial support for such projects is more targeted and professional and is of more resource advantages, while large innovation projects are mainly invested by large enterprises which have the advantages of talents, technologies and other innovation resources and scale effects in innovation. In recent years, large enterprises have created independent business sectors, business units and business divisions, and improved the assessment mechanism, improving the innovation efficiency to a certain extent. Therefore, Hypothesis 4 is proposed:

H4a: Given that other conditions remain unchanged, growth of enterprise size insignificantly impacts policy-based financial support for enterprise innovation input.

H4b: Given that other conditions remain unchanged, enterprise size growth positively impacts policy-based financial support for enterprise innovation output.

1.3.5 Effect of enterprise age on policy-based financial support for enterprise innovation. Enterprise age is an important factor affecting enterprise technology innovation. Young enterprises in the start-up and growth stages, as latecomers, have stronger innovation motivation, more sensitive sense of innovation,

more flexible incentive mechanisms, and lower cost of change. However, inertia and improved market control of mature enterprise have inhibited their innovation willingness and input. On the other hand, young enterprises face more serious information asymmetry in innovation, innovation resource constraints and financing constraints, and greater innovation risks (Zhang Jie et al., 2012). Taking into account the impact of policy-based financial support and enterprise age on enterprise innovation, the author believes that with enterprise age growth and the development of enterprises from the start-up stage to the mature stage, enterprises have gradually increased financing capacity and gradually weakened innovation resource constraints. Policy-based financial support plays a more significant role in easing the financing constraints of young enterprises and increasing their innovation input, but for mature enterprises, their innovation input is less affected by financial constraints, and enterprise age growth will reduce the promotion of policy-based finance on enterprise innovation input.

In terms of the impact of enterprise age on policy-based financial support for enterprise innovation output, although with its age growth and stabilization of technological strength and market size, an enterprise's innovation motivation declines, but it has increasingly rich innovation resources and innovation experience, stronger anti-risk ability, and closer cooperation with policy-based financial institutions, and since policy-based financial support is more effective for mature enterprises, it can ensure that the innovation success rate and output of an enterprise will not decline significantly due to the enterprise's declined willingness to innovate. Therefore, Hypothesis 5 is proposed:

H5a: Given that other conditions remain unchanged, enterprise age growth inhibits policy-based financial support for enterprise innovation input.

H5b: Given that other conditions remain unchanged, enterprise age growth insignificantly impacts policy-based financial support for enterprise innovation output.

2. Selection and measurement of variables

2.1 Explained variables To measure the status and level of technology innovation in advanced manufacturers, this paper describes innovation input and output. This paper uses the R&D investment density of enterprises to express innovation input, and the specific calculation method is the R&D expenditure of enterprises divided by the net profit of enterprises in the current year. In terms of innovation output, patents are the most direct results of technology innovation activities of enterprises, applying for patents for innovation output is an important

way for enterprises to protect innovation achievements, and patent indicators are also a common practice in academic circles to measure enterprise innovation output. Therefore, this paper draws on the method of Yu Minggui et al. (2017), and uses the number of patents applied for by enterprises in the year plus 1 to represent innovation output.

2.2 Explanatory variables This paper sets virtual variables for policy-based financial support. China's policy-based financial institution system is mainly composed of policy banks and government industry guidance funds, with policy banks as the core. As industry guidance fund has only gradually emerged in recent years, it is inferior to policy banks in terms of size, support areas and history. Therefore, this paper mainly makes empirical test of the role of policy-based finance in enterprise innovation from the perspective of policy banks. In addition, because it is hard to obtain data on policy banks' annual loans to a certain enterprise, most enterprises do not disclose such data. Considering the limitation of data availability, this paper constructs a virtual variable based on whether an enterprise obtains loans from policy banks (including loans from CDB, EIBC and ADBC) in the current year. If yes, the value is 1, otherwise the value is 0.

2.3 Control variables Taking into account the important internal and external factors that affect the enterprise technology innovation, and drawing on previous literatures on enterprise innovation, this paper selects relevant control variables, including internal and external factors of enterprises. The internal factors of an enterprises include its equity structure and business development level, and external

factors of an enterprise include the location, government subsidies and market recognition. The control variables are as follows.

First, property right nature and ownership structure of an enterprise may significantly impact management's innovation decision-making, paths and motivations, which in turn affect the enterprise innovation input and output. The virtual variable soe is set to control the impact of property right nature on enterprise innovation. In terms of equity structure, the shareholding ratio of the largest shareholder (top 1) is set to control the impact of equity structure and equity concentration

Secondly, the operating and financial status, development prospects and marketpower of enterprises are the material basis and power source of enterprise technology innovation. Among them, the current asset quality, life cycle, solvency, profitability and cash position of enterprises will have an important impact on technology innovation, so size, age, cash, property, plants and equipment (pp&e), financial leverage (lev), growth, and return on assets (roa) are under control. In addition, an enterprise's business growth prospects and marketpower have an important impact on its innovation decision-making and innovation revenue, so growth and marketpower are under control.

Thirdly, external factors, including the enterprise location, the market and the government, will impact enterprise innovation. In terms of regional factors, the difference of the regional environment in which the enterprise is located will impact the decision-making, motivation and effect of innovation, and the regional virtual

variable region is set here. The market factors mainly include the market's recognition of the business development of the enterprise, and the market-to-book ratio mb is under control. The government factors mainly include the government's support for the enterprise, and the government subsidy received by the enterprise is under control here. Finally, annual virtual variables and industry virtual variables are added to control annual fixed effects and industry fixed effects.

To sum up, this paper selects all listed companies in the China A-share "CSI Advanced Manufacturing 100 Strategy" and "CSI Made in China 2025" theme index from 2011-2020 as a sample. Data are from CSMAR database and Wind database. Some missing data are collected and supplemented manually. Based on the original data, we adopt the following processing methods: (1) sample enterprises included in both the "CSI Made in China 2025" and "CSI Advanced Manufacturing 100 Strategy Index" are combined to avoid double counting; (2) the samples with missing data after manual supplementation are eliminated; (3) in order to reduce the adverse effect of outliers on the research results, this chapter uses the Winsorization method to Winsorize continuous variables in the model at 1% and 99% percentiles.

3. Model Design

Based on past research and the Hausman test, this paper constructs a multiple linear regression model of innovation input and output of enterprises with policy-based financial support under a fixed-effect model and a regression model of enterprise heterogeneity affecting enterprise innovation with policy-based financial support, to test the research hypotheses.

Firstly, the model (5-1) is used to test Hypothesis 1, that is, whether policy-based financial support can effectively increase enterprise innovation input.

$$r\&d_{i,t}=\beta_0+\beta_1\ policybank_{i,t}+\gamma control\ variables_{i,t}+\varepsilon_{i,t} \quad (5\text{-}1)$$

Where, $r\&d_{i,t}$ denotes the R&D investment intensity of enterprise i in year t; $policybank_{i,t}$ denotes whether enterprise i receives loan support from a policy bank in year t; and control $variables_{i,t}$ is a control variable group.

Secondly, the model (5-2) is used to test Hypothesis 2, that is, whether policy-based financial support can effectively enhance the innovation output of enterprises. Considering that it takes some time from policy-based financial support to enterprises producing results through R&D innovation and applying for patents, this paper draws on the practice of Chen Mingming et al. (2016) to examine the impact of policy-based financial support for innovation output of enterprises in the coming year.

$$patent_{i,t+1}=\beta_0+\beta_1\ policybank_{i,t}+\gamma control\ variables_{i,t}+\varepsilon_{i,t} \quad (5\text{-}2)$$

Where $patent_{i,t+1}$ represents the number of patent applications filed by enterprise i in year t+1.

Finally, a regression model for the impact of enterprise heterogeneity on the innovation of an enterprise with policy-based financial support is constructed. Property right heterogeneity, size heterogeneity and age heterogeneity are included. The specific models are as follows.

The cross term between policy-based financial support and property right nature is added to models (5-3) and (5-4) to test Hypothesis 3, that is, whether the innovation input and output of enterprises with policy-based financial support are

different for enterprises with different natures of property rights.

$$r\&d_{i,t}=\beta_0+\beta_1\ policybank_{i,t}+\beta_2 policybank_{i,t}*\ soe_{i,t}+\ \gamma\ control\ variables_{i,t}+\varepsilon_{i,t} \quad (5\text{-}3)$$

$$patent_{i,t+1}=\beta_0+\beta_1\ policybank_{i,t}+\beta_2 policybank_{i,t}*\ soe_{i,t}+\ \gamma\ control\ variables_{i,t}+\varepsilon_{i,t} \quad (5\text{-}4)$$

Where $_{i,t}$*$soe_{i,t}$ is the cross term of policy-based financial support and the nature of enterprise property rights.

The cross term between policy-based financial support and enterprise size is added to models (5-5) and (5-6) to test Hypothesis 4, that is, whether different enterprise sizes have different effects on innovation input and output of enterprises with policy-based financial support.

$$r\&d_{i,t}=\beta_0+\beta_1\ \ policybank_{i,t}+\beta_2 policybank_{i,t}*\ size_{i,t}+\ \gamma\ control\ \ variables_{i,t}+\varepsilon_{i,t} \quad (5\text{-}5)$$

$$patent_{i,t+1}=\beta_0+\beta_1\ policybank_{i,t}+\beta_2 policybank_{i,t}*\ size_{i,t}+\ \gamma\ control\ variables_{i,t}+\varepsilon_{i,t} \quad (5\text{-}6)$$

Where, $policybank_{i,t}$* $size_{i,t}$is the cross term of policy-based financial support and enterprise size.

The cross term between policy-based financial support and enterprise age is added to models (5-7) and (5-8) to test Hypothesis 5, that is, whether different enterprise ages have different effects on the innovation input and output of enterprises with policy-based financial support.

$$r\&d_{i,t}=\beta_0+\beta_1\ policybank_{i,t}+\beta_2 policybank_{i,t}*\ age_{i,t}+\ \gamma\ control\ variables_{i,t}+\varepsilon_{i,t} \quad (5\text{-}7)$$

$$patent_{i,t+1}=\beta_0+\beta_1\ policybank_{i,t}+\beta_2 policybank_{i,t}*\ age_{i,t}+\ \gamma\ control\ variables_{i,t}+\varepsilon_{i,t} \quad (5\text{-}8)$$

Where, $policybank_{i,t}$* $age_{i,t}$is the cross term of policy-based financial support and enterprise age.

To construct a multiple linear panel regression model, it is necessary to decide whether to choose a fixed-effects model or a random-effects model. Here, the Hausman test is carried out on the panel data model of policy-based financial support for enterprise innovation input and output. The results of Hausmann test show the P-value of 0.0034, rejecting the original hypothesis that there is no significant difference between the coefficients of the fixed effect model and the random effect model, that is, the fixed effect model should be selected.The results of the Hausman test reject the null hypothesis that the coefficients of the fixed-effects model and the random-effects model are not significantly different, that is, the fixed-effects model should be selected.

4. Analysis of Empirical Results

4.1 Descriptive statistical analysis Table 2-1 is a table of descriptive statistics of all variables. Among them, the mean value of R&D investment density is 631.45, and the standard deviation is 764, which indicates that different sample enterprises have and sample enterprises in different years have certain differences in their R&D investment. The median of R&D investment density is lower than the mean, which means that more than half of the sample enterprises have R&D investment below the average level. The standard deviation of patent applications is small, indicating that the differences in enterprise innovation output in the sample data are small.

The mean value of policy-based financial support is 0.08, and the standard deviation is 0.27, indicating that policy banks have a certain coverage of support for advanced manufacturers in the sample, and there are certain screening and differences in support for different enterprises or in different periods.

In terms of enterprise property rights and organizational structure, the mean value of property rights is 0.31, indicating that in the sample data of advanced manufacturers, the number of SOEs and that of private enterprises are relatively close, and they are both important components of advanced manufacturing. The sample number of private enterprises is slightly higher than that of SOEs. The mean value of the shareholding ratio of the largest shareholder is 35.29, and the standard deviation is small, indicating that the difference in equity concentration among the sample enterprises is small and the distribution is relatively even.

In terms of enterprise operation and development, the standard deviation of size, age, cash, pp&e and financial leverage of the enterprise are all smaller than the mean, and the mean value of the two variables of enterprise size and enterprise age is similar to the median, indicating sample data has small difference and is relatively evenly distributed. The mean value of lev is 3.36, indicating that the asset-liability ratio of advanced manufacturers in the sample is generally reasonable. The coefficient of variation of enterprises' income growth rate, roa and marketpower is relatively large, indicating that the sample enterprises have certain differences in growth, profitability and market monopoly ability.

In terms of external factors, enterprises in the eastern region account for the

majority. The overall market recognition of the sample enterprises by the capital market is not very different, showing a left-biased trend. The standard deviation of government subsidies is relatively small, indicating that government subsidies to advanced manufacturers in the sample are relatively average, with small differences.

Table 2-1 Table of Descriptive Statistics Results

Variable	Observed value	Mean value	Standard deviation	Median	Maximum value	Minimum value
R&d	1452	48.82	76.4	45.2	137.45	0.04
Patent	347	4.46	1.6	4.11	9.63	0.69
Polictbank	2214	0.06	0.27	0	1	0
Soe	2214	0.31	0.46	0	1	0
Top1	2214	35.29	14.96	35.1	77.97	3.39
Size	2214	19.68	7.79	0.04	39.59	-0.61
Age	2214	19.53	5.14	19	33	5
Cash	2214	0.19	0.14	0.11	0.85	0.01
Pp&e	2214	0.19	0.12	0.10	0.63	0
Lev	2214	3.36	7.41	0.28	25.91	0.03
Growth	2214	0.72	11.4		422.97	-1.65
Roa	2214	0.32	1.43	0.04	39.39	-0.76
Marketpower	2214	1.65	2.37	1.14	34.54	0.04
Region	2214	0.72	0.44	1	1	0
Mb	2214	0.27	0.16	0.13	0.79	-0.27
Subsidy	1492	11.44	8.08	15.7	21.52	0

4.2 Empirical analysis of policy-based financial support and enterprise innovation input According to the model (5-1), this subsection takes enterprises R&D investment density as the dependent variable and the policy-based financial support as the independent variable to conduct multiple regression to explore whether the policy-based financial support can effectively increase the innovation input of advanced manufacturers. At the same time, in order to test the robustness of the model regression, the control variables are included in the model according to the internal factor control variables, external factor control variables and all control variables in turn, and the regression results are shown in Table 2-2.

Table 2-2 Regression Results of Policy-based Finance and Enterprise Innovation Input

	(1)r&d	(2)r&d	(3)r&d
intercept	0.47*** (0.54)	1.14*** (3.26)	1.64 (2.75)
Policybank	1.31*** (2.41)	0.09*** (0.16)	0.73*** (1.34)
Age	-0.04* (-2.00)		-0.06* (-2.66)
Region		0.81 (2.52)	1.19 (4.12)
Soe	0.61 (2.04)		0.68 (2.28)
Lev	-0.08*** (-0.98)		-0.01*** (-0.40)
Roa	-0.55*** (-4.66)		-0.55*** (-4.72)
Mb		0.51*** (0.57)	3.05*** (2.94)
Growth	-0.01 (-0.14)		-0.01 (-0.13)
Size	0.16 (7.59)		0.10* (2.97)
Marketpower	1.26*** (19.09)		1.22*** (18.53)
cash	4.89*** (4.31)		4.88*** (4.34)
Pp&e	-2.92*** (-2.22)		-2.89*** (-2.21)
Subsidy		0.31*** (14.81)	0.15*** (4.12)
Top1	-0.01*** (-1.72)		-0.01*** (-1.99)
Year	Control	Control	Control
Industry	Control	Control	Control
N	1452	1452	1452
R-squared	0.32	0.14	0.33
Adj R-squared	0.31	0.14	0.32
F	84.43	91.93	71.37

Note: data in parentheses are t values, data *** in the table is significant at the 1% level, data ** is significant at the 5% level, and data * is significant at the 10% level.

Regression (1) is the empirical result using the internal factors of enterprises as the control variable, regression (2) is the empirical result using the external factors of enterprises as the control variable, and regression (3) is the empirical result adding both the internal and external factors of enterprises as the control variable .

All empirical results of regressions (1) to (3) show that policy-based financial support is significantly and positively correlated with technology innovation input of advanced manufacturers, and both are significant at the 5% level. The empirical results are consistent with Hypothesis 1. The results show that policy-based finance has obvious incentive effect on promoting advanced manufacturers to increase innovation input, rather than crowding out effect. By providing low-cost, long-term credit and other financial support for enterprises, policy-based finance can effectively enhance enterprises' willingness to innovate and risk tolerance, enabling them to invest more funds in innovative projects. After advanced manufacturers obtain funds from policy-based financial institutions, the problem of profit spillover in their R&D process is alleviated, and innovation costs and innovation risks are reduced. At the same time, obtaining policy-based financial support can be used as an important signal of an enterprise's innovation capability, thereby effectively alleviating the problem of information asymmetry between it and external stakeholders in the innovation process, and can further ease its financing constraints. In addition, the fund compensation and screening and supervision functions of policy-based finance can effectively urge enterprises to use the funds obtained for technology innovation. For enterprises with sufficient funds whose own funds can cover innovative projects,

policy-based finance can grasp their actual situation by pre-loan investigations or other means, and appropriately reduce the capital investment to avoid crowding out effect.

In terms of control variables, the empirical results of regressions (1) to (3) are generally consistent. In terms of internal factors of enterprises, cash and marketpower are significantly and positively correlated with enterprise innovation input, indicating that capital is an important factor and guarantee to promote enterprises to increase R&D investment. On the contrary, financing constraints and lack of funds will negatively impact enterprise R&D investment. At the same time, enterprises increase investment in innovation in order to obtain monopoly advantages and excess profits. Enterprises with strong marketpower have more ability and motivation to increase investment in innovation and maintain their market position and competitiveness. The shareholding ratio of the largest shareholder, enterprise age, pp&e, lev and roa are significantly and negatively correlated with enterprise innovation input, indicating that mature enterprise with too concentrated equity and good profitability, and established for long lack motivation in transformation and upgrading and increasing R&D investment. In addition, it is difficult for enterprises with heavy assets and high asset-liability ratios to increase investment in R&D innovation. Enterprise size is insignificantly and positively correlated with enterprise innovation input, and property right nature and enterprise development ability are insignificantly and negatively correlated with innovation input.

In terms of external factors of enterprises, the regional environment, market recognition and government subsidies of enterprises are significantly and positively correlated with enterprises' innovation input, indicating that a good government and market environment is an important factor to promote enterprises to increase innovation input, or technology innovation of advanced manufacturers needs to be more motivating in a good environment. Enterprises located in the eastern region of China, with high market recognition and abundant government subsidies, have more strength and motivation to increase investment in R&D innovation.

4.3 Empirical analysis of policy-based financial support and enterprise innovation output According to the model (5-2), this subsection uses the number of enterprise patent applications as the dependent variable and the policy-based financial support as the independent variable to conduct multiple regression to explore whether the policy-based financial support can effectively improve the innovation output of advanced manufacturers. The regression results are shown in Table 2-3.

Table 2-3 Regression Results of Policy-based Finance and Enterprise Innovation Output

	(1)r&d	(2)r&d	(3)r&d
intercept	0.47*** (0.54)	1.14*** (3.26)	1.64 (2.75)
Policybank	1.31*** (2.41)	0.09*** (0.16)	0.73*** (1.34)
Age	-0.04* (-2.00)		-0.06* (-2.66)
Region		0.81 (2.52)	1.19 (4.12)
Soe	0.61 (2.04)		0.68 (2.28)
Lev	-0.08*** (-0.98)		-0.01*** (-0.40)
Roa	-0.55*** (-4.66)		-0.55*** (-4.72)
Mb		0.51*** (0.57)	3.05*** (2.94)
Growth	-0.01 (-0.14)		-0.01 (-0.13)
Size	0.16 (7.59)		0.10* (2.97)
Marketpower	1.26*** (19.09)		1.22*** (18.53)
cash	4.89*** (4.31)		4.88*** (4.34)
Pp&e	-2.92*** (-2.22)		-2.89*** (-2.21)
Subsidy		0.31*** (14.81)	0.15*** (4.12)
Top1	-0.01*** (-1.72)		-0.01*** (-1.99)
Year	Control	Control	Control
Industry	Control	Control	Control
N	1452	1452	1452
R-squared	0.32	0.14	0.33
Adj R-squared	0.31	0.14	0.32
F	84.43	91.93	71.37

Note: data in parentheses are t values, data *** in the table is significant at the 1% level, data ** is significant at the 5% level, and data * is significant at the 10% level.

Regressions (1) to (3) are the empirical results of using enterprises' internal factors, external factors, and internal and external factors as control variables, respectively. All the empirical results show that policy-based financial support is significantly and positively correlated with the technology innovation output of advanced manufacturers, and both are significant at the 5% level. The empirical results are consistent with Hypothesis 2. It shows that policy-based finance can coordinate the respective advantages of the government and the market, fiscal and finance. The market-oriented operation, professional investment and management of policy-based funds can realize the unity of public nature and efficiency in improving the innovation efficiency of enterprises and promoting the innovation output and income of enterprises.

First, policy-based finance can help enterprises make scientific decisions through pre-loan investigation, project review, risk identification and management, etc. Even in a period of continuous decline in the macroeconomic environment, it can provide enterprises with sufficient financial support with appropriate cost periods and prudent consulting advice, and reduce enterprises' internal innovation risk and external market risk. Secondly, through post-loan inspection, continuous supervision, risk warning and other methods, improve the efficiency of enterprise capital use. In addition, there are many subordinate industries in advanced manufacturing, and advanced manufacturers have high technical level and large differences, so it is necessary to implement classified policies for them. With strong professionalism and resource reserves, policy-based finance can deeply understand the innovation level

and development prospects of enterprises, as well as the degree of matching with national strategies, so as to formulate effective support plans for them, and take multiple measures to help enterprises obtain innovative resources and improve innovation output and success rate.

In terms of control variables, the empirical results of regressions (1) to (3) are generally consistent. In terms of internal factors of enterprises, the size, cash, and profitability are significantly and positively correlated with innovation output of advanced manufacturers, indicating that large enterprises have more abundant innovation resources and financing channels, stronger anti-risk capabilities, and have the basis for obtaining innovation results . Cash is an important guarantee for enterprises to increase innovation output. Pp&e and marketpower are significantly and negatively correlated with enterprise innovation output. It shows that the innovation ability of traditional heavy-asset enterprises is insufficient, and the innovation of advanced manufacturing requires the reserve of light assets and intangible assets such as R&D strength and human capital. Generally, property right nature, ownership concentration, enterprise age, lev and growth insignificantly impact enterprise innovation output.

In terms of external factors, enterprise location in the eastern region and government subsidies significantly and positively impact enterprise innovation output. It shows that good location environment can provide advanced manufacturers with better innovation resources and innovation channels and perfecter innovation achievement protection mechanism, helping them to better obtain innovation output.

The government subsidy mechanism has a sound effect in promoting advanced manufacturers to increase innovation output. Generally, market recognition insignificantly impacts enterprise innovation output.

4.4 Analysis of the impact of enterprise heterogeneity on policy-based financial support Enterprise heterogeneity is an important factor affecting the decision-making and effect of policy-based financial support for technology innovation of advanced manufacturers. There are a large number of advanced manufacturers with large differences. Different property rights, enterprise size, enterprise age, internal control, management characteristics and other factors will impact the support strength, mechanism and supporting role of policy-based finance. Studying the impact of enterprise heterogeneity on policy-based financial support can help us analyze the operational principle and characteristics of policy-based finance more clearly. In addition, policy-based financial funds are based on finance and are valuable national resources. Studying the effects and differences of policy-based financial support for innovation input and output of different types of enterprises is important to help policy-based finance accurately support technology innovation of advanced manufacturers, discover the shortcomings of support, and improve the decision-making and supporting role of capital investment. Combined with the main internal factors of enterprises that affect enterprise technology innovation in academic research, and the basic elements of enterprises that policy-based financial institutions focus on in due diligence in practice, the author selects three factors: property right nature, enterprise size and enterprise age to empirically study the impact of enterprise

heterogeneity on policy-based financial support for technology innovation of advanced manufacturers.

5. Impact of property right nature on policy-based financial support for enterprise innovation

5.1 Data description Based on property right nature, the final sample enterprise data is divided into SOEs and private enterprises, and their innovation input, innovation output and policy-based financial support are shown in Table 2-4.

Table 2-4 Data Description of Enterprises with Different Property Right Natures

Variable	SOEs			Private Enterprises		
	Observed value	Mean value	Standard deviation	Observed value	Mean value	Standard deviation
R&D	577	43.63	47.62	875	52.25	57.35
Patent	134	3.6	1.78	213	4.99	1.81
Policybank	577	0.10	0.30	1639	0.04	0.28

It can be seen from the table that the mean value of innovation input and output of SOEs is smaller than that of private enterprises. It can show to a certain extent that private enterprises have more innovation resources than SOEs, especially in terms of R&D funds. After comparing the mean value of innovation input divided by the mean value of innovation output, the author finds that for each unit of innovation output obtained by an enterprise, the innovation input required by private enterprises is greater than that of SOEs. It can show to a certain extent that the innovation efficiency of SOEs is higher than that of private enterprises. In terms of policy-based financial support, policy-based finance supports SOEs more strongly than private enterprises. On one hand, it shows that SOEs undertake more innovation

projects in line with national strategies and in weak areas. At the same time, policy-based finance inclines towards SOEs to a certain extent in supporting technology innovation in advanced manufacturing and the difference in support for different SOEs is smaller than that for different private enterprises.

5.2 Empirical analysis According to models (5-3) and (5-4), the interactive terms of property right nature and policy-based financial support are added to explore whether the difference in property right nature will significantly impact policy-based financial support for the innovation input and output of advanced manufacturers. The regression results are shown in Table 2-5.

Table 2-5 Regression Results of the Impact of Property Right Nature on Policy-based Financial Support for Enterprise Innovation

	(1)r&d	(2)patent
intercept	1.78 (3.01)	0.35*** (2.00)
Policybank	1.84*** (2.54)	1.35*** (1.62)
Soe	0.21 (3.90)	0.34 (3.75)
Policybank*Soe	0.56 (1.53)	0.41 (1.28)
Region	0.48* (0.96)	0.08* (0.97)
Age	-0.05* (-2.37)	-0.01* (-0.92)
Lev	-0.08*** (-0.98)	-0.01* (-0.59)
Roa	-0.54*** (-4.68)	1.06* (1.82)
Mb	0.86*** (3.17)	-0.03 (-1.43)
Growth	-0.01 (-0.15)	0.01 (0.77)
Size	0.11* (3.29)	0.01*** (1.31)
Marketpower	1.22*** (18.55)	-0.04* (-2.26)
cash	4.78*** (4.29)	1.41*** (4.21)
Pp&e	-3.32*** (-2.25)	-0.54*** (-1.39)
Subsidy	0.15*** (1.90)	0.01* (1.30)
Top1	-0.01*** (-0.72)	-0.01 (-0.84)
Year	Control	Control
Industry	Control	Control
N	1452	347
R-squared	0.32	0.07
Adj R-squared	0.31	0.06
F	77.44	11.37

Note: data in parentheses are t values, data *** in the table is significant at the 1% level, data ** is significant at the 5% level, and data * is significant at the 10% level.

The results of regression (1) and (2) show that the nature of state-owned property rights can significantly enhance the role of policy-based finance in promoting the innovation input of advanced manufacturers, but insignificantly enhance the role of policy-based finance in promoting enterprise innovation output. The empirical results are consistent with Hypothesis 3. This shows that compared with private enterprises, policy bank loans play a more significant role in enhancing innovation input of SOEs. Considering the small information asymmetry between policy banks and SOEs, they are jointly responsible for the national strategy of adjusting structure and promoting transformation. In addition, policy banks have more convenient project approval and loan granting procedures for the financial support for the innovation of SOEs, and the institutional cost is lower, which can better reduce the innovation cost of SOEs and promote their increased investment in innovation. For the technology innovation of private enterprises, policy banks have stricter approval process, and require higher risk protection measures, which increases the cost of loan application and loan use of enterprises to a certain extent, as a result of which the advantage of policy-based funds in reducing the innovation cost of enterprises is not played well in private enterprises.

The nature of state-owned property rights has an insignificant role in promoting policy-based financial support for enterprise innovation output. It shows that the SOEs have the problems of low innovation efficiency and placing more emphasis on innovation input than innovation output. The principal-agent problem of

SOEs, the contradiction between the intertemporal duration of innovation output and the uncertain tenures of executives, and the imperfect incentive mechanism will lead enterprises to place more emphasis on innovation input than innovation output. At the same time, after the policy banks grant innovation loans to SOEs, the evaluation of their funds use efficiency, especially innovation achievements, are not effective. The work still focuses on assessing the repayment risk of enterprises, rather than further making in-depth inspection of the quality of innovation achievements of SOEs. As SOEs are the main force in China's manufacturing power strategy and the development of heavy equipment for a powerful country, the technology innovation and application of achievements of state-owned advanced manufacturers play a pivotal role in the breakthrough development of key areas and core links in China. Therefore, why policy-based finance plays an insignificant role in improving the innovation output of SOEs, and how policy-based finance can better improve the innovation output of SOEs, are important issues. This paper will make further analysis in the case part of the next chapter.

6. Impact of enterprise size on enterprise innovation with policy-based financial support

6.1 Data description Among the listed companies in China, the size of companies listed on the main board is significantly larger than that of companies listed on the SME board and the ChiNext board. Taking this sample data as an example, during the sample period, the average asset size of the sample enterprises listed on the Shanghai Stock Exchange and the Shenzhen Stock Exchange

(RMB28.9bn) is significantly larger than the average asset size of the sample enterprises on the SME board and the ChiNext board (RMB7bn). Therefore, according to the different listed boards, the author divides the final sample enterprise data into large enterprises (composed of main board enterprises) and SMEs (composed of enterprises on the SME board and the ChiNext board). Their innovation input, innovation output and policy-based financial support are shown in Table 2-6.

Table 2-6 Data Description of Enterprises of Different Sizes

Variable	Large enterprises			SMEs		
	Observations	Mean value	Standard deviation	Observations	Mean value	Standard deviation
R&D investment density	740	50.21	33.12	712	47.45	42.13
Number of patent applications	177	4.61	2.18	170	4.37	3.21
Policy-based financial support	1128	0.08	0.42	1085	0.07	0.28

It can be seen from the table that the mean value of innovation input and output of large enterprises is higher than that of SMEs. Comparing the mean value of innovation input divided by the mean value of innovation output, it is found that for every unit of innovation output obtained by an enterprise, large enterprises require less investment in innovation than private enterprises. It shows that large enterprises have more innovation resources and higher level of innovation, and have certain scale benefits in technology innovation. In addition, the coefficient of variation of innovation input of large enterprises is higher than that of SMEs, indicating that different large enterprises have greater differences in R&D investment density, and

SMEs have overall smaller difference in R&D investment density, further indicating that SMEs commonly face financing constraints and insufficient risk tolerance in innovation. In terms of policy-based financial support, policy-based financial support for large enterprises is stronger and more common. However, the coverage of support for SMEs is smaller, and the support for different SMEs is more different.

6.2 Empirical analysis According to the models (5-5) and (5-6), the interaction terms of enterprise size and policy-based financial support are added to explore whether the difference in enterprise size will significantly impact policy-based financial support for the innovation input and output of advanced manufacturers. The regression results are shown in Table 2-7.

Table 2-7 Regression Results of the Impact of Enterprise Size on Policy-based Financial Support for Enterprise Innovation

	(1)r&d	(2)patent
intercept	1.61 (2.71)	0.34** (1.93)
Policybank	0.18*** (0.54)	0.19*** (0.33)
Size	0.10 (2.91)	0.01*** (1.17)
Policybank*Size	0.56 (1.53)	0.15*** (0.63)
Region	0.09* (0.96)	0.08* (0.76)
Age	-0.06* (-2.64)	-0.01 (-0.99)
Lev	-0.01*** (-0.39)	-0.01* (-0.53)
Roa	-0.06*** (-1.81)	0.54* (4.76)
Mb	2.99*** (2.89)	-0.42 (-1.37)
Growth	-0.01 (-0.17)	0.01 (0.78)

Table 2-7 Regression Results of the Impact of Enterprise Size on Policy-based Financial Support for Enterprise Innovation (continue)

	(1)r&d	(2)patent
Soe	0.71 (2.41)	0.38 (4.33)
Marketpower	1.23*** (18.61)	-0.04* (-2.19)
cash	4.75*** (4.23)	1.41*** (4.23)
Pp&e	-2.88*** (-2.20)	-0.60*** (-1.55)
Subsidy	0.14*** (4.10)	0.01* (1.32)
Top1	-0.02*** (-0.82)	-0.01 (-0.80)
Year	Control	Control
Industry	Control	Control
N	1452	347
R-squared	0.33	0.07
Adj R-squared	0.32	0.06
F	71.23	11.30

Note: data in parentheses are t values, data *** in the table is significant at the 1% level, data ** is significant at the 5% level, and data * is significant at the 10% level.

The results of regression (1) and (2) show that enterprise size growth insignificantly impacts policy-based financial promotion of innovation input of advanced manufacturers, but it can significantly improve the effect of policy-based financial support for enterprise innovation output. The empirical results are consistent with Hypothesis 4. It shows that for large enterprises, due to their strong financing ability, relatively abundant self-owned funds, richer innovation resources, and higher tolerance for the risk of innovation failure, their innovation behavior and innovation input are mainly affected by the financial demands for innovation projects, and are

less restricted by external financing and capital costs. Therefore, the impact of policy-based financial support for large enterprises' increase in innovation input is relatively small. In the process of innovation, SMEs have more serious financing constraints and market failures, are more sensitive to innovation funds and innovation costs, and are more likely to be restricted by insufficient funds in innovation input. Therefore, policy-based financial support is more needed to promote them to enhance technology innovation.

In terms of innovation output, policy-based finance has a more obvious role in promoting the innovation output of large enterprises. On one hand, with the size growth of China's advanced manufacturers, they gradually accumulate more innovation resources, have higher effect of economies of scale and higher ability to digest the sunk costs of innovation and participate in and lead large technology innovation projects related to national strategies, have lower information asymmetry in policy-based financial support for large enterprises, especially large technology innovation projects. Policy-based finance can make better use of its professional and experience advantages, thereby further bringing suitable innovation resources to enterprises and promoting enterprises to obtain more innovation achievements. For SMEs, the investment in policy-based finance is relatively small, and there is no targeted support models and experiences for SMEs, resulting in a relatively general support for the innovation output of SMEs.

7. Effect of enterprise age on policy-based financial support for enterprise innovation

7.1 Data description The average age of the sample advanced manufacturers is 19.53 years. Here, the average is used as the dividing point. Enterprises with an age of less than or equal to 19 years are classified as young enterprises, and enterprises with an age of more than 19 years are classified as mature enterprises. The innovation input, innovation output and policy-based financial support for young and mature enterprises are shown in Table 2-8.

Table 2-8 Data Description of Enterprises of Different Ages

Variable	Mature enterprises			Young enterprises		
	Observations	Mean value	Standard deviation	Observations	Mean value	Standard deviation
R&D investment density	920	50.11	47.62	531	45.68	47.53
Number of patent applications	220	3.6	1.78	127	4.04	1.53
Policy-based financial support	829	0.20	0.30	810	0.01	0.15

It can be seen from the table that the mean value of innovation input of young enterprises is higher than that of mature enterprises, indicating that young enterprises have stronger innovation willingness and motivation to innovate, and hope to improve their business scale and competitiveness through innovation, while mature enterprises have had relatively mature technology and market, and thus have lower willingness to invest in innovation than young enterprises. However, mature enterprises have higher innovation output and innovation output efficiency than young enterprises.

Considering that mature enterprises generally have technological advantages and more innovation resources and innovation experience, they have stronger innovation ability than young enterprises. Policy-based financial support for mature enterprises is stronger than that for young enterprises, which proves that mature enterprises have more innovative resources and low-cost financing sources.

7.2 Empirical analysis According to the models (5-7) and (5-8), the interaction terms of enterprise age and policy-based financial support are added to explore whether the difference in enterprise age will significantly impact policy-based financial support for the innovation input and output of advanced manufacturers. The regression results are shown in Table 2-9.

Table 2-9 Regression Results on the Impact of Enterprise Age on Policy-based Financial Support for Enterprise Innovation

	(1)r&d	(2)patent
intercept	1.79 (2.98)	0.41*** (2.26)
Policybank	5.31*** (2.11)	1.47*** (1.95)
Age	-0.07* (-3.09)	-0.01 (-0.61)
Policybank*age	-0.26** (-2.43)	-0.09 (2.72)
Region	1.15* (3.97)	0.05* (0.62)
Soe	0.61 (2.28)	0.39 (4.42)
Lev	-0.01*** (-0.23)	-0.01* (0.71)
Roa	-0.55*** (-4.78)	0.06* (1.73)
Mb	0.31*** (0.34)	-0.47 (-0.52)
Growth	-0.01 (-0.18)	-0.01 (-0.79)

Table 2-9 Regression Results on the Impact of Enterprise Age on Policy-based Financial Support for Enterprise Innovation (continue)

	(1)r&d	(2)patent
Size	0.11* (3.16)	0.01*** (1.47)
Marketpower	1.23*** (18.63)	-0.04* (2.22)
cash	4.64*** (4.14)	1.38*** (4.13)
Pp&e	-3.11*** (-2.28)	-0.52*** (-1.34)
Subsidy	0.15*** (4.03)	0.01* (1.23)
Top1	-0.02*** (2.00)	-0.02 (-0.83)
Year	Control	Control
Industry	Control	Control
N	1452	347
R-squared	0.33	0.07
Adj R-squared	0.32	0.06
F	71.81	11.81

Note: data in parentheses are t values, data *** in the table is significant at the 1% level, data ** is significant at the 5% level, and data * is significant at the 10% level.

The results of regression (1) and (2) show that enterprise age growth significantly inhibits policy-based financial promotion of innovation input of advanced manufacturers, but insignificantly inhibits policy-based financial promotion of enterprise innovation output. The empirical results are consistent with Hypothesis 5. It shows that with enterprise age growth and the development of enterprises from the start-up stage to the mature stage, their innovation motivation and willingness to invest in innovation gradually decrease, their financing constraints are gradually eased and they have relatively sufficient funds for innovation investment. Therefore, the role of policy-based financial support in reducing the innovation cost and innovation risk of mature enterprises and increasing their innovation input is weakened. But young

enterprises have not yet fully established their technological and market advantages, so their innovation motivation is stronger, and they face more serious constraints on innovation resources and financing. Therefore, policy-based finance has a more obvious role in promoting innovation input of young and growing enterprises.

In terms of innovation output, enterprise age growth insignificantly inhibits policy-based financial support for the technology innovation output of advanced manufacturers. It shows that mature enterprises generally have better innovation ability, innovation resources and innovation experience, and have longer time of contact with financial institutions. Policy-based finance has lower information asymmetry in supporting the technology innovation of mature enterprises, and has a better understanding of technology innovation. Therefore, it can provide efficient and appropriate financial support to the innovation projects of mature enterprises, so as to ensure that enterprises' declined innovation willingness will not significantly and negatively impact innovation output.

8. Robustness test

On the basis of the above empirical tests, in order to further verify the robustness of the empirical results, this section conducts robustness tests by replacing the core variables and changing the regression method.

First, the measurement of innovation input and output is the key to this variable selection and empirical regression. Different measurement methods for innovation input and output may produce certain differences in empirical results. Therefore, the author draws on relevant research and adopts the ratio of enterprise

R&D personnel to total employees (R&DSTAFF) as a measure of innovation input. Considering enterprise innovation output, especially the knowledge achievements will be transformed into the intangible assets of enterprises. The accounting of intangible assets is composed of a combination of patents, non-patented technologies, and land use rights. Here, the logarithm (IA) is taken as a measure of the innovation output of enterprises after excluding the land use rights from the net intangible assets of enterprises. Other variables and regression models are kept unchanged. Table 2-10 uses the replaced innovation measurement indicators to test the impact of policy-based financial support for enterprise innovation input and output.

Table 2-10 Robustness Test Results of Policy-based Finance and Enterprise Innovation

	(1)r&dstaff	(2)ia
intercept	0.89** (0.51)	0.64*** (0.88)
Policybank	0.84*** (0.58)	0.54** (0.75)
Age	-0.09*** (-1.57)	-0.08 (-3.06)
Region	2.46*** (3.24)	1.83 (5.13)
Soe	0.41*** (0.52)	0.83 (2.26)
Lev	-0.16*** (-0.69)	-0.01 (-0.03)
Roa	0.17** (0.56)	0.02 (0.14)
Mb	1.64*** (2.07)	0.15*** (1.35)
Growth	-0.04 (-0.16)	0.01 (0.15)
Size	0.15 (1.67)	0.05*** (1.28)
Marketpower	0.12*** (0.70)	0.08 (1.09)

Table 2-10 Robustness Test Results of Policy-based Finance and Enterprise Innovation (continue)

Cash	0.32*** (0.11)	2.14*** (1.54)
	(1)r&dstaff	(2)ia
Pp&e	-1.03*** (-0.29)	-2.76* (-1.71)
Subsidy	0.12*** (1.28)	0.06*** (1.44)
Top1	-0.13*** (-3.97)	-0.01 (-1.79)
Year	Control	Control
Industry	Control	Control
N	771	1352
R-squared	0.01	0.02
Adj R-squared	0.01	0.01
F	2.13	3.88

Note: data in parentheses are t values, data *** in the table is significant at the 1% level, data ** is significant at the 5% level, and data * is significant at the 10% level.

The results of regressions (1) and (2) show that, after adopting a new measurement method for explained variables, policy-based financial support is still significantly and positively correlated with innovation input and output of advanced manufacturers. The effects of relevant control variables and the fitting of the model basically remain unchanged. Therefore, the empirical results of the role of policy-based finance in promoting enterprise innovation input and output are robust.

Secondly, a new measurement method for explained variables is adopted to conduct a robustness test on the empirical results of the impact of enterprise heterogeneity on policy-based financial support for enterprise innovation. The explanatory variables, control variables, and model remain unchanged. Tables 2-11 to 2-13 respectively show the effects of property right nature, enterprise size and enterprise age on policy-based financial support for enterprise innovation input and output.

Table 2-11 Robustness Test Results of the Impact of Property Right Nature on Policy-based Financial Support for Enterprise Innovation(Interaction Item Regression)

	(1)r&dstaff	(2)ia
intercept	6.08** (1.55)	0.78*** (0.89)
Policybank	3.31** (1.74)	2.28** (1.92)
soe	0.36 (0.46)	0.21 (1.16)
Polictbank*soe	3.75*** (1.35)	0.94 (4.52)
Age	-0.09** (-1.68)	-0.04 (-9.87)
Size	0.42 (1.45)	0.05*** (2.37)
Year	Control	Control
Industry	Control	Control
N	771	1352
R-squared	0.01	0.96
Adj R-squared	0.01	0.95
F	2.20	21.93

Table 2-12 Robustness Test Results of the Impact of Enterprise Size on Policy-based Financial Support for Enterprise Innovation(Interaction Item Regression)

	(1)r&dstaff	(2)ia
intercept	7.15** (1.63)	0.78*** (0.92)
Policybank	2.59** (0.52)	0.39** (0.65)
soe	0.66*** (0.88)	0.21 (1.16)
Polictbank*size	0.19 (0.87)	0.74*** (2.52)
Age	-0.10*** (-1.83)	-0.04 (-3.72)
Size	0.04 (1.33)	0.16*** (7.19)
Year	Control	Control
Industry	Control	Control
N	771	1352
R-squared	0.01	0.96
Adj R-squared	0.01	0.95
F	1.98	21.93

Table 2-13 Robustness Test Results of the Impact of Enterprise Age on Policy-based Financial Support for Enterprise Innovation (Interaction Item Regression)

	(1)r&dstaff	(2)ia
intercept	8.23** (0.92)	-8.14*** (-6.92)
Policybank	6.13*** (2.64)	1.39** (2.26)
soe	3.14*** (3.02)	0.27 (1.34)
Polictbank*age	-0.23*** (-3.15)	-0.07 (-1.52)
Age	-0.03*** (-2.11)	-0.05 (-1.47)
Size	0.36 (0.59)	1.12 (7.29)
Year	Control	Control
Industry	Control	Control
N	771	1352
R-squared	0.33	0.93
Adj R-squared	0.32	0.92
F	21.43	32.93

Note: data in parentheses are t values, data *** in the table is significant at the 1% level, data ** is significant at the 5% level, and data * is significant at the 10% level.

The regression results show that the nature of state-owned property rights can significantly strengthen the role of policy-based finance in enhancing enterprise innovation input, but insignificantly impacts policy-based financial promotion of enterprise innovation output; enterprise size growth cannot significantly enhance policy-based financial support for enterprise innovation input, but significantly impacts policy-based financial promotion of enterprise innovation output; enterprise age growth is not conducive to policy-based financial support for enterprise innovation, especially for innovation input. The results of the robustness test are consistent with the original empirical results, indicating that the empirical results of

the impact of enterprise heterogeneity on policy-based financial support for enterprise innovation are robust.

Regarding the impact of enterprise heterogeneity on policy-based financial support for enterprise innovation, the author changes the said method of adding interaction terms for regression test to the grouping regression method. Variables remain unchanged. The sample enterprises are divided into SOEs and private enterprises, large enterprises and SMEs, young enterprises and mature enterprises, respectively, according to property right nature, size and age, for grouping regression. The robustness test results of grouped regression are shown in Tables 2-14 to 2-16.

Table 2-14 Robustness Test Results of the Impact of Property Right Nature on Policy-based Financial Support for Enterprise Innovation(Group Regression)

	SOEs		Private enterprises	
Variable	(1)r&d	(2)patent	(1)r&d	(2)patent
intercept	1.02 (0.79)	0.94*** (2.35)	1.45 (2.78)	0.13 (1.07)
Policybank	1.52*** (3.17)	0.48* (2.18)	0.85** (2.58)	0.51*** (2.83)
Age	-0.03** (-0.58)	-0.01 (-0.82)	-0.02** (-0.68)	-0.01 (-1.48)
Size	0.12 (0.74)	0.02*** (2.85)	0.25 (9.17)	0.16** (4.95)
Year	Control	Control	Control	Control
Industry	Control	Control	Control	Control
N	875	134	577	213
R-squared	0.05	0.03	0.19	0.03
Adj R-squared	0.05	0.02	0.18	0.02
F	11.13	5.05	25.89	15.65

Note: data in parentheses are t values, data *** in the table is significant at the 1% level, data ** is significant at the 5% level, and data * is significant at the 10% level.

The regression results show that the role of policy-based finance in promoting innovation input of SOEs is more significant than that of private enterprises and the

role of policy-based finance in promoting innovation output of private enterprises is more significant than that of SOEs. This further indicates that SOEs have the problem of attaching importance to input and ignoring output in the innovation process, while private enterprises have higher innovation efficiency. The results of grouping regression are consistent with the regression results after adding the interaction term of property right nature, indicating that the empirical results of the effect of property right nature on policy-based financial support for enterprise innovation are robust.

Table 2-15 Robustness Test Results of the Impact of Enterprise Size on Policy-based Financial Support for Enterprise Innovation(Group Regression)

	Large enterprises		SMEs	
Variable	(1)r&d	(2)patent	(1)r&d	(2)patent
intercept	0.97*** (1.19)	0.36*** (2.54)	0.23 (0.60)	0.10 (0.74)
Policybank	0.87* (1.16)	0.05*** (2.64)	0.90*** (0.72)	0.93** (2.23)
Age	-0.06*** (-1.56)	-0.02 (-1.84)	-0.04*** (-2.28)	-0.02 (-3.27)
Soe	0.05 (1.01)	0.41 (3.18)	0.09 (0.30)	0.40 (3.63)
Size	0.53 (3.11)	0.05*** (3.60)	1.31 (5.67)	0.06** (0.77)
Year	Control	Control	Control	Control
Industry	Control	Control	Control	Control
N	740	177	712	170
R-squared	0.02	0.04	0.04	0.03
Adj R-squared	0.01	0.04	0.04	0.03
F	7.74	11.95	10.80	8.59

Note: data in parentheses are t values, data *** in the table is significant at the 1% level, data ** is significant at the 5% level, and data * is significant at the 10% level.

The classification criteria for large enterprises and SMEs are consistent with the above classification. The regression results show that the role of policy-based

finance in promoting innovation input of SMEs is more significant than that of large enterprises, and the role of policy-related finance in promoting innovation output of large enterprises is more significant than that of SMEs. This further shows that policy-based finance has a stronger role in supporting the innovation input of SMEs, and has a better role in promoting the innovation output of large enterprises. The grouping regression results are consistent with the regression results after adding the interaction term of enterprise size, indicating that the empirical results of the effect of enterprise size on policy-based financial support for enterprise innovation are robust.

Table 2-16 Robustness Test Results of the Impact of Enterprise Age on Policy-based Financial Support for Enterprise Innovation(Group Regression)

	Young enterprises		Mature enterprises	
Variable	(1)r&d	(2)patent	(1)r&d	(2)patent
intercept	0.49 (0.79)	0.53*** (1.84)	0.27 (0.65)	0.15** (0.44)
Policybank	0.56*** (1.85)	0.02*** (0.08)	0.63* (0.81)	0.77*** (4.13)
Age	-0.09 (-2.33)	-0.03 (-1.48)	-0.02*** (-4.88)	-0.02 (-1.73)
Soe	0.94 (2.42)	0.69 (4.38)	0.38 (1.77)	0.33* (3.08)
Size	0.23** (1.76)	0.03*** (6.76)	0.19 (9.27)	0.04*** (2.17)
Year	Control	Control	Control	Control
Industry	Control	Control	Control	Control
N	920	220	531	127
R-squared	0.32	0.11	0.09	0.03
Adj R-squared	0.32	0.10	0.08	0.03
F	10.77	27.61	30.58	11.09

Note: data in parentheses are t values, data *** in the table is significant at the 1% level, data ** is significant at the 5% level, and data * is significant at the 10% level.

The classification criteria for young enterprises and mature enterprises are consistent with the above classification. The regression results show that the role of

policy-based finance in promoting innovation input of young enterprises is more significant than that of mature enterprises, indicating that enterprise age growth will inhibit policy-based financial support for enterprise innovation input. Meanwhile, policy-based finance plays equal role in promoting innovation output of young enterprises and mature enterprises, and enterprise age growth will insignificantly impact policy-based financial support for enterprise innovation output. The grouping regression results are consistent with the regression results after adding the interaction term of enterprise age, indicating that the empirical results of the impact of enterprise age on policy-based financial support for enterprise innovation are robust.

Finally, for the issue of endogeneity, considering the fact that enterprises with greater innovation input and output are more likely to attract policy-based financial support, this paper needs to test the endogeneity of the model. This paper draws on the method of Ma Guangrong et al. (2014) to construct instrumental variables for testing. In this paper, the average value of policy-based financial support in the industry in which a company is located is used as an instrumental variable. Whether an enterprise can obtain policy-based financial support is closely related to the industry in which the enterprise is located, and the average level of policy-based financial support obtained by enterprises in the industry has nothing to do with the unobservable characteristics of an enterprise. Therefore, the average value of policy-based financial support in the industry in which the enterprise is located can be used as an instrumental variable. Table 2-17 shows the two-stage regression results of instrumental variables. It can be seen that after considering endogenous factors, the

relationship between policy-based finance and enterprise innovation input and output is still significantly positive.

Table 2-17 Regression Results of Instrumental Variables

	(1)r&d	(2)patent
Policybank	3.31** (2.41)	2.07*** (1.25)
Age	-0.12* (-2.17)	-0.02 (-0.46)
Soe	0.19 (2.31)	0.36 (3.42)
Size	0.21 (0.76)	0.11 (1.27)
Year	Control	Control
Industry	Control	Control
N	1452	347
R-squared	0.33	0.32
Adj R-squared	0.29	0.26
F	8.34	5.21

Note: data in parentheses are t values, data *** in the table is significant at the 1% level, data ** is significant at the 5% level, and data * is significant at the 10% level.

To sum up, after conducting the robustness test of the empirical results by replacing the measurement methods that characterize enterprise innovation, grouping regression, and two-stage regression of instrumental variables, it is found that the robustness test results are basically consistent with the original empirical results. This indicates that the empirical research results of policy-based financial support for enterprise innovation input and output, and the effect of enterprise heterogeneity on policy-based financial support for enterprise innovation are robust.

CHAPTER 3

IMPACT AND CONTRIBUTION

The empirical results of this study show that:

(1)Po licy-based financial support is significantly and positively correlated with innovation input of advanced manufacturers. It shows that policy-based finance can alleviate market failure, share innovation risks, and encourage enterprises to increase innovation input by providing low-cost and targeted financial support;

(2)Policy-based financial support is significantly and positively correlated with innovation output. It shows that policy-based finance can adhere to the market-oriented operation of policy-based funds, improve the use efficiency of enterprise R&D funds by virtue of its professionalism and resource advantages by means of ex ante information mining and ex post supervision and restraint, so as to help enterprises achieve innovation results;

(3)The nature of state-owned property rights can significantly enhance the role of policy-based finance in promoting innovation input of advanced manufacturers, but can insignificantly impact improving policy-based financial support for enterprise innovation output. This shows that policy-based finance has more information symmetry and closer cooperation with SOEs, and provides more adequate support for SOEs' R&D investment. However, due to the relatively low operating efficiency of SOEs, they have the problem of placing more emphasis on innovation input than innovation output; and since the relatively loose post-loan inspection and innovation achievement evaluation of SOEs by policy-based finance, state-owned property rights cannot effectively promote policy-based financial support for innovation outputs;

(4)Enterprise size growth insignificantly impacts policy-based financial promotion of enterprise innovation input, but can significantly improve the effect of policy-based financial support for enterprise innovation output. It shows that with enterprise size growth, their innovation resources are more abundant, their financing

constraints are eased, and size growth is difficult to strengthen the role of policy-based finance in promoting enterprise innovation input. At the same time, large enterprises have stronger innovation capability, and the policy-based finance is more professional in supporting the innovation of large enterprises and large projects, making the role of policy-based financial support for the innovation output of large enterprises more obvious;

(5) Enterprise age growth significantly inhibits policy-based financial support for innovation input of advanced manufacturers, but insignificantly inhibits policy-based financial promotion of enterprise innovation output. It shows that as with enterprise age growth, their innovation motivation decreases and their financial strength increases, and the role of policy-based financial support in reducing the innovation cost of mature enterprises and increasing their innovation input is weakened. However, mature enterprises are relatively rich in innovation resources and experience, so that enterprise age growth will not significantly weaken policy-based financial support for their innovation output.

Through sample analysis and empirical results, we find that: Generally speaking, policy-based finance can give full play to the fiscal and financial synergies, and plays an effective role in promoting the innovation input and output of advanced manufacturers. However, with respect to technology innovation of different types of enterprises, policy-based financial support is still insufficient and unbalanced and needs to be improved. For example, policy-based financial support for private enterprises, SMEs and young enterprises is not strong and wide enough, and needs to be optimized in terms of methods and effects. At the same time, policy-based finance provides great support for SOEs, but has not satisfactory effect of supporting their innovation output. Policy finance needs to strengthen precise support to improve the quality of support. As SOEs play a key role in promoting the high-quality development of advanced manufacturing in China, it is necessary to study the reasons and countermeasures for the poor role of policy-based finance in improving the innovation output of China's SOEs.

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