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Does the Nation Innovation System in China Support the Sustainability of Small and Medium Enterprises (SMEs) Innovation?

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Received: 12 February 2020; Accepted: 21 March 2020; Published: 24 March 2020



Abstract: To maintain sustainable economic growth, China has created a national innovation system (NIS) and strengthened the central status of firms. Our data show that the effect of turnover growth in small and medium-sized enterprises (SMEs) on China's aggregate Gross Domestic Product (GDP) growth is significant, but the status of SMEs in the NIS and related policies is not significant. To determine whether there is a correspondence between the sustainability of innovation in SMEs and the support of China's NIS, we developed a framework for China's innovation policy under the NIS framework, taking into account its transition characteristics, to examine the texts of SME innovation policies and reveal the sustainability of SMEs' innovation. The relevant national government policy texts were collected from the yearbooks of Chinese SMEs between 1999 and 2017 and government notices between 1994 and 2017. On this basis, we also compared with some other countries' innovation systems. The findings indicate that China's NIS pays little attention to the sustainability of SMEs' innovation activities for two reasons. First, the scope of the NIS is very narrowly defined. Second, the top-down, government-oriented Research and Development (R&D) system that focuses on large state-owned firms leaves little room for innovation policies in SMEs.

Keywords: SME innovation; national innovation system; sustainability

1. Introduction

With the globalization of the knowledge economy, national economic growth depends ever more on the efficiency of innovation systems in stimulating the creation, dissemination, and use of knowledge. Innovation has become the main motivation for the evolution of economic structures and for promoting economic development around the world. Schumpeter's theory of innovation [1] has led to the development of national innovation systems (NIS) [2] at the macro level and the concept of creative small and medium-sized enterprises (SMEs) at the micro level [3]. The NIS concept is widely used in practice as a policy framework in many countries. In addition, SMEs have become more dynamic and the main engine of economic growth. Lundvall [4] explicitly pointed out that firms have a central status within the NIS and underlined the importance of innovation in SMEs.

Since the 1950s, SMEs have played a more important role in promoting technological innovation efficiency. Governments around the world have established policies encouraging SMEs to innovate and cultivate innovation environments, which is an important focus for scholars studying innovation policies and the sustainability of innovation in SMEs. Some studies have investigated the contents of innovation policies from a systemic perspective. For instance, Zhang [5] found that there are too many environment-oriented, supply-side policy innovation tools, while demand-side policy innovation tools

are insufficient. However, increasingly more research focuses on public procurement for innovation as a relevant demand-side instrument. Edquist and Zabala-Iturriagoitia [6] provided clarification on what should (and should not) be considered innovation procurement. While the producer price index (PPI) is efficient as a demand-side instrument, resource constraints prevent SMEs from accessing innovation procurement contracts. Therefore, SMEs should focus on their networks with other firms rather than on public or private R&D actors [7]. Moreover, some studies focus on comparing the technological innovation policies of SMEs across nations and regions, such as Europe, the the United States (US), Japan, and other developed countries, or different regions in one country [8,9]. Most of these studies seek to explore useful policy implications for the sustainability of innovation in SMEs and SMEs' development using case studies. Recent studies, however, have paid attention to the characteristics and trends of China's innovation policy during its transition period, such as the Organization for Economic Co-operation and Development (OECD) and the Ministry of Science and Technology in China, referring to the government innovation support system for SMEs [10,11]. Some highlight the shortcomings of China's innovation system [12–14], arguing that the government should provide more indirect service support rather than direct intervention and should improve the legal system.

Other studies have examined the level of assessment and the factors influencing sustainable innovation in SMEs. Cao et al. [15] proposed an improved Dynamic Function Quality Function Deployment (DFQFD) based on Quality Function Deployment (QFD), providing a good theoretical basis for evaluating the sustainable innovation capabilities of SMEs. Regarding the factors affecting innovation, some studies investigate the sustainability of SMEs' innovation from different perspectives, such as ownership concentration and social responsibility. Li et al. [16] found that fierce competition in the product market strengthens the negative relationship between ownership concentration and the sustainability of SMEs' innovation. In addition, SMEs can improve the positive effect of social responsibility on their sustainable development through personnel training and innovation activities [17]. Industrial SMEs may have fewer Research and Development (R&D) activities, but the proportion of non-R&D innovation is higher. Therefore, some studies have focused on the effect of non-R&D innovation activities on sustainable SME innovation. Their results have shown that non-R&D innovation activities have a negative effect on the SMEs' performance, which is only reduced to a minimum within an appropriate threshold [18]. Recent studies have also focused on China's open innovation (OI), especially its effect on the innovation capabilities or performance of firms. Zhang et al. [19] conducted a survey of 119 firms in South China and concluded that introverted and extroverted OI activities have positive effects on firms' innovation performance. However, firms' potential absorptive capacities have negative effects on their introverted OI activities but positive effects on their extroverted OI activities. Nevertheless, government policy plays a different role in the process of OI affecting firm performance. Fiscal and tax policies have a more significant effect on introverted OI, while property rights policies have a greater effect on extroverted OI [20].

In terms of research methods, in addition to qualitative and comparative research, some quantitative research methods have been used to analyze policy texts. Zheng [21] analyzed the characteristics of China's policymaking on high-tech industries since the reform and opening up in 1978, using quantitative analysis of the number of policy texts, topic distributions, and issuing bodies. Liu [22] divided the internationalization process of China's NIS into four stages and analyzed all relevant policy texts between 1978 and 2012 to determine the characteristics of policy development at different stages. While quantitative research methods help understand how policymaking processes can influence the rate and direction of socio-technical changes towards sustainability, we need to extend the research scope from individual policies to policy mixes, to explain how policy mixes influence socio-technical changes and how changes in the socio-technical system affect the sustainability of innovation activities in SMEs [23]. Ossenbrink et al. [24] provided an analytical framework for policy mixes with two archetypal methodological approaches: Top-down and bottom-up. The policy mix evaluation should be made in the regional context [25] and the implementation context [26].

Although much research investigates the NIS and SMEs' sustainable innovation, few studies explore whether the NIS is appropriate to SMEs. In previous studies, both empirical methods and text analysis methods have been used. Empirical analysis methods are mostly used to test the impact of some innovation policies on the performance of enterprises. Text analysis methods are usually used to analyze the evolution of the national innovation system and types of innovation policies. Few studies focus on the innovation policies aimed at SMEs under the framework of NIS to analyze whether they support the sustainable innovation and development of SMEs. Hence, this thesis uses publicly issued SME policy texts between 1994 and 2017 in China as a research sample and analyzes Chinese SME policies under the NIS framework, to describe the sustainability of innovation in SMEs. Different with previous studies, we conclude that although the continuous improvements of these policies surely promote the innovation of SMEs since the open and reform in 1978, the NIS is still not effective in supporting SMEs' sustainable innovation activities and it lacks complete legal system and an independent system to support innovation of SMEs, and the policy tools are not very appropriate and need to be enriched. Further, we seek to determine how differences between generally and narrowly defining the scope of the NIS, together with an understanding of China's economic evolution, can partly explain this situation. We also draw on the findings to propose improvements.

The remainder of this paper is organized as follows. Section 2 describes the components of China's innovation policy under the NIS framework, providing a basis for classification and analysis for the subsequent policy text analysis. Section 3 presents the text sources, policy analysis, and simple international comparison. Section 4 discusses the results. Section 5 concludes the paper.

2. NIS Innovation Policy and the Economic Contribution of SMEs in China

2.1. Innovation Policy under the NIS Framework

According to Edquist and Hommen [27], innovation policy is the governmental behavior that affects technological and other types of innovation. Liu and White [28] further explained that innovation policy is an integrated concept that gradually forms a comprehensive policy system with specific aims and certain references derived from previous economic policy or technology policy. The Chinese Science and Technology Committee defined innovation policy as the synthesis of direct and indirect policies and measures that governments use to regulate and promote innovative behavior [29]. In short, there is no uniform definition of innovation policy. Therefore, we argue that innovation policy is a comprehensive policy system that includes policies that directly and indirectly affect technological innovation activities.

The NIS concept appeared and became popular as a way of meeting the needs of innovation policymakers and researchers. Lundvall [30] suggested that the excessive specialization of policy institutes and policy analysts is a practical problem. Thus, the development of concept that helps analyze and solve problems is important, especially those that can be applied to the analysis of innovation policy and science policy. The NIS provides such an institutional framework for policy formulation and an analytical framework for the study of innovation policy. Innovation policy, in turn, affects the NIS. That is, it affects the operations of innovation actors in the NIS and their exchanges and cooperation through specific policy tools or methods, thus affecting the performance of the NIS, and therefore, the performance of the whole country. In other words, the NIS and innovation policy are interdependent.

With the evolution of the national political economy, China's innovation policy has undergone complex and significant changes. In addition, the NIS has gone through a period of transition. Huang et al. [31] pointed out that innovation policy in a transition period may not involve the typical policy factors of a mature market economy. Assuming the active shift of the NIS from actor-oriented to activity-oriented, we used a policy analysis method with multiple actors and multiple activities to identify the components and characteristics of China's innovation policy under the NIS framework. The position and role of SMEs in the NIS were examined through an exploratory investigation of

innovation policies for SMEs. As the core of China's innovation policy, the NIS' composition includes financial policies, business innovation support system, human resource (HR) policies, and legal policies. The main content and concise descriptions of these items are listed in Table 1. All of the categories contain government policy decisions at the national level, relative responsibilities for innovation policy, and policy formulation and implementation.

Table 1. The composition of China's innovation policy.

Policy Composition	Content	Description
Organizational structure	Policymaking and executive institution	
Financial policies	<ul style="list-style-type: none"> a. Current science and technology projects (1) b. Tax policy and Foreign Direct Investment (FDI) policy c. Venture Capital (VC) and stock market 	(1) Including the National Natural Science Fund, the 973 Program, the National Science and Technology Support Plan, the 863 Program, the Science and Technology Condition Platform, policy guidance for science and technology projects and other special projects (the Spark Program, the Torch Program, the National New Key Product Plan, the National Soft Science Research Plan), other (the key international technology cooperation plan, SME innovation fund)
Business innovation support system	<ul style="list-style-type: none"> a. Science parks, experimental areas and incubation centers b. China's high-tech fair c. Productivity promotion centers 	
Human resource policies	<ul style="list-style-type: none"> a. Developing a basic education plan b. Project 211 on higher education c. Human resource projects of the Ministry of Education (2) 	(2) Including rewards and funded projects for teachers, student awards and student projects, international cooperation and exchange
Legal policies	<ul style="list-style-type: none"> a. Intellectual property law and competition law b. Science and technology law and education law 	

In 1978, China's national science and technology policy launched a market-oriented, multilayered management reform, involving several government departments and organizations. In 1998, the National Science and Technology Leading Group was founded by the State Council and became the top-level coordinating institute for innovation policy, coordinating important issues between the departments of the State Council and national and local departments. It studies and designs China's medium and long-term science and technology development programs with the Ministry of Science and Technology. The Ministry of Science and Technology is currently one of the main institutes that design and implement China's innovation policy, together with the National People's Congress, the State Council, the National Development and Reform Commission, the Ministry of Commerce, the Ministry of Finance, the State Taxation Administration, the Ministry of Education, the Ministry of Industry and Information Technology, the Ministry of Human Resources and Social Security, the Chinese Academy of Sciences, the National Natural Science Fund, the State Intellectual Property Office and other departments, which are parts of China's innovation policy system. As one of the most influential research institutes in China, the Chinese Academy of Sciences, an important part of the innovation policy framework, after years of market reform, remains the largest beneficiary of government technology funding. Statistics show that in 2008, the Chinese Academy of Sciences undertook 21% of all nationally funded projects (representing 82% of all national scientific research), 42% of the 973 Program, and 65% of the scientific support program for tracking key problems [32,33].

With regard to the components of financial policies, the priority of the Chinese government is to use grants, loans, interest subsidies, and planning grants to encourage scientific and technological innovation activities. Current science and technology projects are mainly financed through appropriation, such as the National Natural Science Fund, the 973 Program, the National Science and Technology Support Plan, the 863 Program, and the Science and Technology Condition Platform [32,33]. Policy guidance for science and technology projects and other special projects are mainly financed by state loans and self-financed with a supplementary state allocation. Since the reform and opening

up policy in 1978, China's economic growth and the development of national innovation capacity have benefited from FDI to some extent, and the Chinese government has continuously improved its investment promotion policies. For example, the Ministry of Science and Technology and the Ministry of Commerce issued the catalog of industries for foreign investment and introduced a foreign investment transition from low-tech and labor-intensive industries to high-tech manufacturing and service industries using financial and tax policies, to encourage and support technological innovation, technology diffusion, and international technology transfer. One of the important components of China's financial policies is the financial support system, especially its risk investment support for innovative SMEs. However, the technological base and the necessary legal conditions of the risk investment system are incomplete. In addition, although the scale of the SME Boards, Sci-Tech innovation board (STAR Market), and the Growth Enterprise Market (GEM) is limited, the Chinese stock market has, to some extent, supported the growth of listed high-tech companies.

A country's business innovation support system can best reflect the dynamic development of an innovation system, including the innovation activities of firms, the emergence of new firms, and the diffusion and absorption of knowledge and technology. Through the Torch Program in China, a wide range of high-tech development zones and business incubation centers have been established. In recent years, National Agricultural Science and Technology Parks, National Sustainable Development Pilot Zones and National University Science and Technology Parks have been created to coordinate with China's long-term science and technology development planning. Since 1999, the national hi-tech fair, held once a year, has been an important window for China's high-tech sector in foreign markets and is also the high-end platform of high technology industrialization. Productivity promotion centers are science and technology intermediary service institutes, which aim to promote technological innovation in firms, especially SMEs.

Human resource policies involve education, higher education, and special human resources awards, a funding and training plan, the latter consisting of rewards and funding for teachers and students, and international cooperation and exchange programs. In recent years, the Chinese government has greatly expanded its human resource policies and paid particular attention to scholarships and the creation of businesses by scholars returning from overseas.

China has had great success in developing related laws. The fields of science and technology and innovation have Trademark Law (1982, revised in 2019), Patent Law (1984, revised in 2008), Copyright Law (1990, revised in 2010), Regulations on The Protection of Computer Software (1991, amended in 2001), the law of Science and Technology Progress (1993), the Law of Agricultural Technology Extension (1993, revised in 2012), Regulations on The transfer of Research and Achievement (1996, revised in 2015) and the Promotion of Small and Medium-sized Enterprises (2003, revised in 2017), among others. The field of education includes, among others, the Compulsory Education Law (1986, revised in 2006), the Teachers' Law (1994), the Education Law (1995, revised in 2015), the Vocational Education Law (1996) and the Higher Education Law (1999, revised in 2018). The field of firm management involves the Bankruptcy Law (2007) [34], among others. In addition, many rules and laws are enacted to strengthen supervision and enforce the law. Currently, the legal system for innovation in China is still under construction, and law enforcement needs to be further strengthened.

The above analysis shows that China's innovation policy involves multiple activities, including innovation, commercial and social applications from multiple actors, such as firms, universities, research institutes, government bodies and others, and the interaction between different participants. In addition, the financial and legal environments support these activities, reflecting the key elements of the NIS. Figure 1 illustrates the five parts of China's innovation policy under the NIS framework. Each oval represents a part, with the part of the organizational structure being located in the center surrounded by the other four equally independent parts.

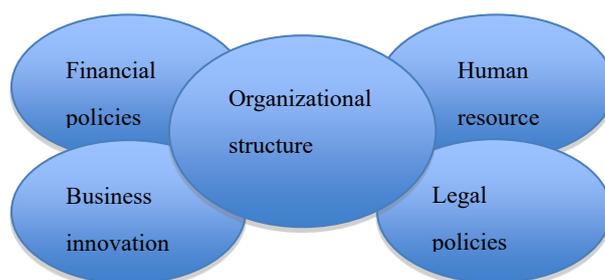


Figure 1. Five components of China’s innovation policy under the national innovation system (NIS) framework.

2.2. SME Performance in China’s Macroeconomy

According to the Regulations on the Classification of Small and Medium-sized Enterprises and Measures for the Classification of Statistically Large, Medium-sized, Small and Micro-enterprises (2017) [35], entrepreneurs in China are divided according to three indicators: The number of employees, business income, and total assets. For medium-sized entrepreneurs, the standards are as follows: The number of employees must be between 300 and 1000, and business income must be between 20 and 400 million yuan. For small-sized entrepreneurs, the standards are as follows: The number of employees must be between 20 and 300, and business income must be between 3 and 20 million yuan.

SMEs play a very important role in the development of the economy, and their development status has a great impact on the operation of the macroeconomy. Data adapted from the National Bureau of Statistics Database of China suggest that SMEs have a significant effect on China’s aggregate economic growth. By the end of 2017, there were about 363,000 industrial SMEs in China, contributing 85% to the growth of the total number of enterprises in China. All SMEs contribute more than 50% of China’s tax revenue, more than 60% of its GDP, more than 70% of its technological innovation achievements, and more than 80% of its labor force employment. In 2017, the industrial SMEs’ main business income was 6.81 trillion yuan, accounting for 60.1% of all industrial enterprises above designated size, and the total profit was 4.22 trillion yuan, accounting for 56.33% of all industrial enterprises above designated size. Figure 2 shows that the increase in annual sales revenue in industrial SMEs above designated size significantly affects the GDP growth rate during the sampling period. The growth pattern of these two variables is essentially similar. In 2008, the annual growth rate in sales revenue in SMEs above designated size decreased slightly (from 29% to 28%), while that of large firms decreased more significantly (from 25% to 19%). In addition, China’s GDP growth rate declined. In 2017, the opposite scenario can be observed: The increase in the GDP growth rate seemed to be driven by the strong recovery in sales growth in SMEs. The variation in the gap in the annual sales growth rate between SMEs and large firms shows the same pattern as the annual GDP growth rate when we eliminate the significant time lag effects in certain years. To maintain the sustainability of economic growth in China, the government has focused on strengthening the construction of its NIS and has emphasized the central status of firms in the NIS, with the implementation of an independent innovation development strategy. However, in practice, the contribution of SMEs to China’s macroeconomic growth and their status in policy supply and the NIS are not proportionate. At times, the actual status of SMEs has even deteriorated, with a lack of financial support and limited market access in, for instance, times of financial crisis and tight monetary policy.

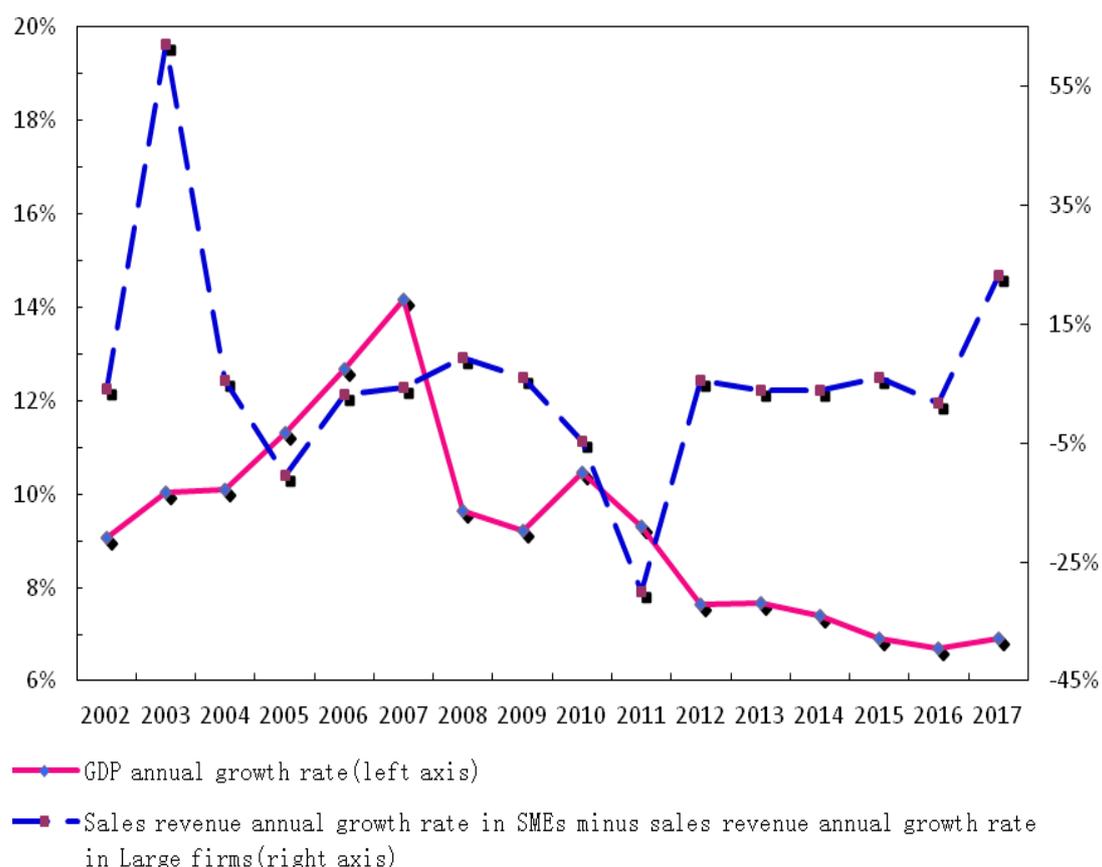


Figure 2. Gap in sales growth rate between industrial SMEs (above designated size) and large firms and the annual GDP growth rate between 2002 and 2017.

3. Policy Text Sources, Analysis, and Comparison

We studied policy texts for SMEs at the national level in China between 1994 and 2017. Some policies were issued for all firms rather than being limited to SMEs or their innovation activities. However, we did not separate them as they would have little influence on the results despite the increase in the quality of policy texts. All policy texts collected were classified, analyzed, and compared with relatively similar practices in selected countries.

3.1. Types of Policy Texts

The types of policy texts and their distribution are shown in Table 2. The distribution pattern can be easily identified: Fewer laws, more regulations, etc. Low stability, wide variability, and strong guidance imply that the understanding, management, and supervision by the Chinese government of sustainable development and innovation in SMEs are still in the early exploratory and progressive stage.

Table 2. Distribution of the types of policy texts.

Type	Law	Regulation	Provision	Opinion	Method	Decision	Assessment Indicator
Quantity (Qt.)	5	2	1	45	9	2	1
Type	Rules	Notices	Reply description	Declaration	Guidance	Development plan	Total
Quantity (Qt.)	3	216	2	2	5	1	294

For the last 20 years, the SME Promotion Law has been a unique law for SME operations, called the ‘constitution’ for the development and innovation of SMEs. Other laws, such as the Government Procurement Law, the Cleaner Production Promotion Law, and the Law of the People’s Republic of China on Partnership, do not clarify the objects of intervention. Moreover, the SME promotion law is the only law executed in legal form, while other laws related to SMEs, such as Opinions on Strengthening the Construction of the Technological Innovation Service System of Small and Medium-sized Enterprises, Provisional Regulations on the Technology Innovation Fund for Small and Medium-sized Enterprises, Notice on the Announcement and Management Methods for the Development of Special Funds for Small and Medium-sized Enterprises, are all executed in the form of opinions, provisions, and notices. Overall, SMEs’ innovation activities lack legislative support. Current policy texts, such as opinions, regulations, and notices, are likely to have a negative effect on the actual encouragement and support of sustainable innovation and development in SMEs.

Therefore, in terms of the types of policies, despite the large number, China’s policy system to support innovation and sustainable development of SMEs is fragmented. Many policies are scattered in various opinions and notices, and they lack a specialized legal system. It is also easy to make various policies discontinuous and non-relevant. Compared with China, developed countries have more specific laws for SMEs. In the 1940s, the US (the United States) promulgated a series of laws supporting technological development and innovation in SMEs, such as basic law, investment, R&D, innovation and development, and taxation. In 1982, the US enacted the Small Business Innovation Development Act, then the Small Business Research and Development Enhancement Act in 1992. In addition to these laws, the US has developed many research plans, such as the Small Business Innovation Research Program and the Small Business Technology Transfer Research Plan. Japan also established a legal system. Since the 1950s, Japan has formulated and promulgated over 30 laws and regulations to create a relatively comprehensive legal system for SMEs, such as Business-industry Cooperative Law in 1946, Basic Laws for SMEs in 1963, SME Modernization Promotion Law in 1967. The implementation of these laws established the legal status of Japanese SMEs and ensured their stable development.

3.2. Issuing Bodies of Policy Documents

The main government bodies issuing policies are the National People’s Congress, the General Office of the State Council, various ministries (mainly the National Development and Reform Commission and the Ministry of Commerce) and agencies and institutes directly under the State Council (see Table 3).

Table 3. Distribution of bodies issuing policy documents.

Type	Joint Publication	National People’s Congress	The General Office of the State Council	Departments of the State Council
Qt.	117	5	24	106
Departments directly under the State Council	Business units directly under the State Council	National bureaus managed by the ministries and commissions of the State Council	Institute specifically created directly under the State Council	Other
25	9	1	1	6

Table 3 summarizes the categories of issuing bodies and the corresponding number of policies issued. The strength of the policies is directly linked with the hierarchy of the policy issuing bodies, which suggests that the management system of the Chinese government relies on stylized and top-down management. Most policy texts involve government ministers in the role of lawmakers, guides and supervisors, and a weaker coordinator providing fewer real services and specific guidance. The separation between policy design and implementation is common. As a result, the number of participants and the number of implementing bodies designated by the policy texts are limited.

Moreover, policies issued by joint bodies account for 40% of all policies issued (Table 4), among which the institutes of the State Council are involved in 45%. In addition, between 1994 and 2017, especially after 2010, joint publication became a trend, as shown in Figure 3. The number of policy texts issued by joint institutes exceeded that published by independent institutes in 2011, 2014 and 2017. This illustrates the idea of combining multiple powers and multiple resources to support the development of SMEs, but it also makes coordination between institutes more difficult. Policymakers in different ministries may face the problem of complex target functions due to overlapping policies and multiple purposes, which can lead to inefficient resource allocation and management.

Table 4. Distribution of joint publication of policy documents.

Joint Publication Bodies	Between the Institutes of the State Council										Within the Institutes of the State Council				Between the Institutes of the State Council and Other Departments	
	2	3	4	5	6	7	8	10	12	2	3	4	10	2	6	
Number of bodies	2	3	4	5	6	7	8	10	12	2	3	4	10	2	6	
Number of texts	35	8	4	3	2	1	1	2	1	45	3	3	1	6	2	
Total	57										52				8	

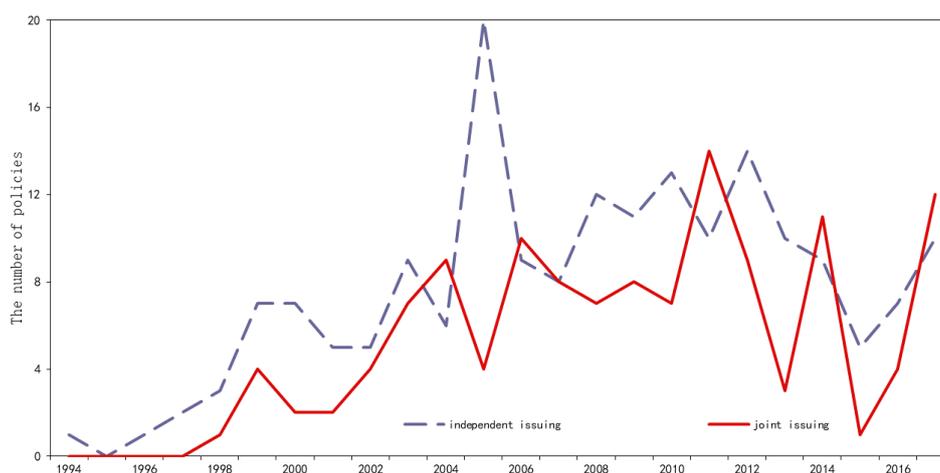


Figure 3. Trends in joint and independent publication of policy texts between 1994 and 2017.

At the end of 1998, a special SME department was created under the State Economic and Trade Commission of China, with the aim of managing the large number of SMEs and standardizing the market order. However, it has limited legal authority. In 2008, the SME department and most industry departments that were previously under the responsibility of the National Development and Reform Commission (the former State Economic and Trade Commission) were classified under the Ministry of Industry and Information Technology. The role of these bodies under the Ministry of Industry and Information Technology is to guide the development of SMEs, to coordinate the relevant aspects to draft policies and measures to improve the growth of SMEs and the non-state-owned economy, to promote foreign exchanges and cooperation, to promote the establishment of an effective service system, and to collaborate to solve major issues. The SME department includes the general office, the policy and legal office, the non-state-owned economy office, the financing guarantee office, and the service and innovation office. As one of the seven bureaus and 19 departments of the Ministry of Industry and Information Technology, the SME department has limited authority. In addition, its main governing body, the Ministry of Industry and Information Technology, is only responsible for industry administration, while decisions regarding state investment projects must be made in collaboration

with the National Development and Reform Committee. At the local government level, the creation of SME management institutes is still in progress, with certain measures and rules being currently tested. The situation of a large number of SMEs with scattered and limited regulations and low efficiency hinders their innovation activities, which explains the need to establish a special, independent, and approved organization, and management department for SMEs.

Therefore, from the perspective of the main issuing body of the policy, China lacks an independent and specialized management agency, which can strengthen cooperation between different departments and form a systematic development network. On this aspect, the United States seems to be more effective. Unlike China, the US created the Small Business Administration (SBA), an independent federal agency, to manage and coordinate certain government institutes to support the implementation of technological innovation projects for small businesses. The SBA not only has offices across the country but also manages a network system involving various fields to support small businesses. In addition, the White House Small Business Committee and the Congressional Small Business Committee were established to assist the SBA in its work. Therefore, the hierarchy of government management and support is stronger in the US, which not only emphasizes the strict grading system from central to local, guaranteeing the authority and independence of policies but also pays attention to the role played by the government at different levels, such as lawmakers, guides, coordinators, and participants, to ensure the prevalence and effectiveness of policy implementation.

3.3. Topics of Policy Texts

Based on the four components of China's innovation policy discussed above (financial policies, business innovation support system, human resource policies, and legal policies), we could further analyze the topics of policy texts for SMEs published between 1994 and 2017, as shown in Table 5 [32,33].

Table 5. Distribution of the topics of policy texts between 1994 and 2017.

Topic	Financial Policies	Supervision	Industry Innovation and Development	Social Services (Information)	Employment
Number	125	42	37	31	25
Percentage	43%	14%	13%	11%	8%
Comprehensive policy	Law	Business innovation structure	Legal enforcement	Human resource training	Total
16	5	5	4	4	294
5%	2%	2%	1%	1%	100%

Financial policies represent a dominant proportion (43%) of all topics. Among them, Table 6 shows that loan guarantee and credit guarantee (35%), tax (17%), financial development (14%) and financial services (11%) account for 77%, while the rest, such as venture capital (VC) and listing, represent a smaller proportion. In terms of capital support, the different forms of support for SMEs in China (mainly scientific and technical SMEs) are project funds, funds allocated to national science and technology plan projects, interest-free or low-interest loans, committee funds for high and new technology development zones and preferential tax. There are many free funds in the form of projects and traditional credit guarantee funds for financial support, ignoring the channel of social capital inflow and financial service innovation.

Table 6. Distribution of the topics of financial policies between 1994 and 2017.

Topic	Loan Guarantee and Credit Guarantee	Tax	Financial Development	Financial Services	Technology and Innovation Funds
Number	44	21	17	14	8
Percentage	35%	17%	14%	11%	6%
Topic	International market	Finance and investment	Venture capital	Listing	Total
Number	7	6	6	2	125
Percentage	6%	5%	5%	1%	100%

The business innovation support system for SMEs includes industry innovation and development (13%) and the business innovation structure (2%), accounting for a smaller proportion, around 15% of all topics. For industry innovation and development, for example, regulations promoting the development of the software industry and the integrated circuit industry have been promulgated by the State Council and the Development and Reform Committee. The Ministry of Culture and the Ministry of Railways have jointly released successive notices and opinions on encouraging non-state capital access to the culture industry and road construction notices have also been issued by the Ministry of Commerce to promote the reform and development of SMEs. Regarding the business innovation structure, there are only five policies. Although social service information is related to SMEs, it is not directly related to their innovation activities and is therefore eliminated from this category. As part of China's innovation policy discussed above, the business innovation support system, which supports business innovation, the creation of new businesses and the interaction between production, study, and research, mainly includes science and technology parks, experimental areas and incubation centers, China's high-tech fair and productivity promotion centers. In contrast, specific policies for SMEs in these areas are insufficient and focus mainly on industrial access and reform.

There are only four policy texts related to human resource training in all policies that apply to SME human resources. It seems that SME policies are still largely focused on increasing employment rather than professional training and investment in human resources, which are more important for the sustainability of SMEs' innovation activities. If they are limited to the traditional objectives of economic growth and increased employment, human resource policies cannot promote human capital investment in innovative SMEs.

There are five laws applicable to SMEs, representing 2% of all policy texts. Among them, the SME promotion law directly concerns SMEs, as discussed above, and the proportion of law enforcement provisions (1%) and related policies (5%) is 6%.

After analyzing the topics and counting the number of texts, each part of China's innovation policy and its relative proportion are illustrated in Figure 4, which is obviously a distortion of Figure 2. The four main components are unbalanced in this graph. Except for financial policies, in general, supervision and services or support for SME policies are unbalanced, with more supervision, less specific services and support, more policy objectives and less detailed measures. However, only practical measures or approaches can be implemented. Moreover, according to relevant studies, voluntary regulations positively affect the innovation efficiency of SMEs, while mandatory supervision has no significant effect [36]. The policy composition under the NIS framework involves little supervision and is more focused on the environment and the development of services. However, supervision represents 14% of all policy texts related to SMEs, including company name, classification, company confirmation, registration, standards, modification, accounting, contract acknowledgment, annual inspection, fees, files and statistics, and credit and security. Obviously, the laws and regulations applicable to major entities in a mature market economy still need to be improved, which is one important reason why the government should publish numerous policy texts to regulate SMEs.

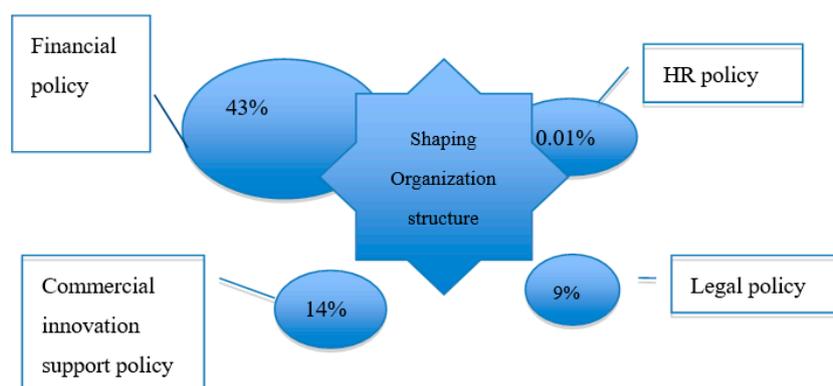


Figure 4. National innovation policy vs. SME innovation policies.

From the perspective of policy topics, China has a high proportion of financial policies, followed by business innovation support policies, and the rest are very low. However, although there are more financial policies, they have fewer policies to promote the participation of social capital, which is related to China's weak credit guarantee system. The lack of sufficient information support to facilitate the cooperation between entrepreneurs and research institutions is not beneficial to open innovation, but the US and Japan all have better policy systems in these aspects. Compared with China, the financial policies are also very effective in the US, but they mainly guide and mobilize social funds in the form of guarantees to provide broader and stronger financial support to businesses, especially innovative SMEs. While Japan pays more attention to public services and regulations, accounting for around 36% of all policies [37]. Another big difference between China and these countries is related to public procurement policy. There is currently no clear law in China to regulate public procurement to promote technological innovation in SMEs, but Japan and the US all attach great importance to public procurement, with a ratio of this type of policy of 7% and 7.6%, respectively [37].

In short, although SME innovation policies cover almost all subjects and key points involved in China's innovation policy, the overall policy strength is relatively weak. The relevance and independence of SME innovation policies are not strong. It can easily be seen that many policy ideas are direct applications and copies of the national innovation policy for SMEs and do not adequately reflect their characteristics and needs for innovation and development activities. From the viewpoint of innovation policy, the national innovation system does not support the sustainability of innovation in SMEs, which is evident in the organizational structure, legislation, financial resources, business innovation support system, and human resource policies. Moreover, in recent years, open innovation (OI) has been strongly encouraged, especially since Premier Li proposed the idea of Mass Entrepreneurship and Innovation in 2014. Entrepreneurial support policies, such as Construction of Innovation and Entrepreneurship Base, communication and cooperation promoting policies and information technology policies are growing rapidly. But there is no special law and regulation on OI in SMEs. Compared with large and micro-entrepreneurs, SMEs are more affected by property rights policies, but China still needs to improve its property rights protection. For OI, the talents and close relationships between entrepreneurs, universities and other research institutes are important and the framework for maintaining the flow of knowledge and talents during technology dissemination needs to be established. For example, the US has enacted a series of laws and regulations aimed at opening up information, such as Broadband Data Improvement Act (2008), American Recovery and Investment Act (2009). Therefore, there is room for improvement in China's innovation policy under the NIS framework. In the next section, this paper attempts to explain these results in terms of a narrow definition of the NIS and the evolution of China's innovation policy objectives.

4. Some Explanations: Narrow Definition of the NIS and the Evolution of China's Innovation Policy Objectives

4.1. *Narrow Definition vs. General Definition of the NIS*

In the narrow definition of the NIS, technological innovation and knowledge creation and production are important elements, which is consistent with Schumpeter's ideology of innovation linking the NIS with high-tech industries and placing businesses, the university system and national technical policies at the centre of the analytical framework. Related studies focus on R&D and innovation and investment in formal education, which are easier to quantify. Freeman and Lundvall developed the concepts of broader capacity building and innovative NIS. Lundvall argued that if we really want to link innovation and economic growth, we need a broader definition of the NIS, which includes individuals, organizational, and inter-organizational study [38]. The general definition of the NIS includes new product introduction and diffusion and the structures of all related processes and systems [39].

It is worth noting that due to intense global innovation competition and the convenience of evaluating and assessing knowledge innovation output, innovation policies in many countries are influenced by a narrow concept of the NIS, which emphasizes the creation of innovative knowledge, producing two types of misleading biases. The first bias is the focus on an innovation model based on science and technology and innovation, neglecting innovation based on learning by doing, learning by using and learning through interaction. The second bias is the focus on the competitiveness of high-tech industries, ignoring medium- and low-tech industries. China is no exception. In its plans for the long-term development of science and technology, China aims to become an innovative country with specific quantitative goals: By 2020, the R&D of the whole society should account for at least 2.5% of China's GDP, the contribution of the progress of science and technology should be above 60%, the reliance on foreign technology should be less than 30% and the number of Chinese patents granted each year and the number of cited scientific papers should be in the top five. The government pays more attention to the quantitative indicators of investment in R&D and knowledge creation (such as technology exports and patents) of public and private departments in policymaking. However, it ignores the diffusion and application of initiatives, which are difficult to quantify, although the latter is widespread in SMEs. In the real economy, SMEs do not choose innovation models based on science and technology and innovation, but models based on learning by doing, learning by using and learning through interaction. That is, SMEs play a key role in the diffusion and application of technological innovation and are the most active subjects of the technology application system. Similarly, innovation in medium and low-tech industries is not achieved through large investments in R&D and a large number of patent applications, but through extensive and highly efficient knowledge flows, sharing, and interactive learning. Innovation activities in these types of SMEs and innovation activities in medium and low-tech industries are not supported by the narrow conceptualization of the NIS, which focuses on innovation and knowledge production. Therefore, the narrow definition of the NIS undermines sustainable innovation in SMEs. In contrast, businesses (large firms, groups of firms, or even high and new technology firms), universities and scientific research institutes are the main actors, which can push innovation in R&D and knowledge at the center of the NIS. Innovation activities in SMEs are inevitably marginalized by the narrow definition of the NIS.

4.2. *The Evolution of China's Technology Policy Objectives*

Ergas [40,41] investigated the interaction between the technological systems and government policies in six industrial nations, arguing that different technology policy targets have different effects on the technical system and the industrial structure and its changes. Generally, US technology policy is closely linked with its national sovereignty target and focuses on radical innovation to achieve this key national target, while the supply of public goods related to innovation is only a minor consideration. In contrast, Germany's technology policy is focused on diffusion and is closely related to the supply

of public products and the diffusion of technical capacities throughout the industrial structure, thus promoting the adaptability of society to technological reform and innovation.

Since the reform and opening up in 1978, the objectives of China's technology policy have been to meet the demand for national economic survival, competition, and development and to provide an important technological base to improve China's national technological capability to achieve long-term economic catch-up. This technology policy would require R&D and an innovation mechanism guided by the government from the top down. However, the government generally sets its R&D objectives focusing mainly on industrial technology, with important strategies and R&D investments limited to specific parties, generally public research institutes, large state-owned enterprises (SOEs) or groups of firms, to achieve the optimal allocation of resources. Current policies are developed and implemented according to the size of the firm and its ownership, thus there are few policy texts for SMEs compared with large firms. Policy resources tend to support important large firms or SOEs and prefer market rules for SMEs. In addition, in the process of economic transformation, the immature market makes survival and development more difficult for SMEs, affecting the sustainability of their innovation activities. In fact, the policy preference of the government for large and medium-sized enterprises is likely to weaken support for SMEs.

Of course, the creation of technology objectives and a technological system in a country should adapt and comply with the requirements of economic development. Recently, China has made a big leap to become a major economy. To conform with the transition of the economic growth model from natural resources, demographic dividends and capital investment to technological innovation, the objectives of China's technology policy have shifted to provide support and a foundation for building an affluent society and a scientifically strong country, focusing on independent innovation while improving people's lives. These are the objectives of China's technology policy. However, adjusting the objectives of the policy requires a joint adjustment of technology policy and the technological system. The original policy system often involves inertia, and there will be many adjustment costs and risks. For example, early China's technology policy did not put self-innovation in a prominent position, and the stimulation of business participation and support was also weak. To build an innovative country, it will be essential to develop a group of firms with basic competitiveness, and SMEs are the root of a country [42]. In addition, technology policy should not only focus on innovation, but should also consider the diffusion of R&D and the sustainability of innovation activities. Therefore, the evolution and adjustment of the objectives of technology policy must take into account the different functions of different innovation models for firms of different sizes and types of ownership and pay attention to the functions performed by SMEs in the diffusion and application of innovation technology. When increasing investment in R&D, particular attention is paid to balancing the proportion of different R&D actors, stimulating the R&D potentials of all firms, balancing the proportion of basic research, application research and experimental development and balancing productivity enhancement in the short term with continuous dynamic technological improvement in the long term. To comply with the adjustment of policy objectives, it will be necessary to adjust the technology policy system, including related policies and detailed implementation rules.

In 2007, the US President signed the American Competition Act to push the Technology Innovation Project (TIP) to replace the Advanced Technology Plan (ATP). Under this new plan, the aid limits are not significantly increased, and it is clearly stated that large firms cannot obtain funds directly from the government. Small firms will receive more help and focus on a technological and business model, while considering demand-driven technology innovation. The features of policy adjustment for joint interdisciplinary application and flexibility in intellectual property rights show a flexible strategy for technological innovation in the US. Similarly, the Indian government introduced the India Innovation Bill to stimulate Indian technological innovation. To adapt to the demand for national competition under a new environment, many countries are currently adjusting their innovation policy. This will have important policy implications.

5. Conclusions

China's innovation policy includes organizational structure, financial policies, business innovation support system, human resource policies, and laws, which comprehensively reflect the key elements of the NIS. Under this analytical framework, we studied SME innovation policy texts between 1994 and 2017. We show that the current NIS does not effectively support the sustainability of SMEs' innovation because of these reasons: Incomplete law system especially for SMEs, lack of independent and specialized management agency and inappropriate policy tools, such as lack of guidance on social capital and financial services and weak business and human support. From the viewpoint of innovation policy, the NIS does not provide SMEs with sufficient national innovation resources in the absence of a sharing mechanism, including legal, capital, and business support and social services. This paper tries to explain this from two aspects: The narrow definition of the NIS and the evolution of China's innovation policy objectives.

China's innovation policy system has changed from including simple technological and economic policies to specific innovation policies, and the awareness of technological innovation, motivation, pressure, and capacities of firms, research institutes and individuals have been considerably strengthened. Moreover, significant progress has been made in the implementation of technological innovation regulations, and the development of the NIS has received considerable attention from the government. However, innovation policy still lacks a complete system and shows certain features of a transition period. Innovation activities in SMEs are situated between economic and technological policies and do not constitute an independent system. The formulation of innovation policies for SMEs still has the inertia logic of subject-oriented innovation, as a result of copying and applying the national innovation policy at the level of SMEs. As important actors in the national innovation system, the integrity of firms is not strong. SMEs and large firms are very different in terms of innovation model, dependence on government policy and environment, and risk management capabilities. It is urgent to develop independent innovation policies for SMEs under the NIS framework and thus help to develop an innovative nation adapted to the government's technology policy objectives. This would include the establishment of basic law and related specific laws for SMEs and a series of regulations adapting to the different phases or demands of SMEs. Given the limited access of SMEs to national innovation resources, the government should actively improve the Sci-Tech innovation board (STAR Market) system, providing SMEs with sustainable innovation potential direct docking capital markets, optimizing their capital environment, reducing their financing costs and risks and enhancing their core competitive capabilities. In addition, there is a need to ensure the authority and independence of policymaking bodies, the broad application of policy implementation and the development of an effective government management and support system. There is also a need for SMEs to have a practical innovation mode to adopt. Further, detailed finance, commercial services, and human resource development measures should not be ignored, especially in the background of the Chinese government's encouragement of mass entrepreneurship and innovation, with SMEs' open innovation increasing rapidly. The innovation policy needs to guide public R&D investment to build a public knowledge database.

Author Contributions: Conceptualization, C.J. and X.T.; methodology, C.J.; validation, X.T.; formal analysis, C.J.; investigation and resources, Z.K.; data curation, X.T.; writing—original draft preparation, C.J.; writing—review and editing, Z.K.; visualization, X.T. supervision, C.J. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Acknowledgments: We are indebted to the anonymous reviewers and editor.

Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

The following abbreviations are used in this manuscript:

ATP	Advanced Technology Plan
DFQFD	Dynamic Function Quality Function Deployment
GEM	Growth Enterprise Market
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
HR	Human Resource
NIS	National Innovation System
OECD	Organization for Economic Co-operation and Development
OI	Open Innovation
PPI	Producer Price Index
QFD	Quality Function Deployment
Qt.	Quantity
R&D	Research and Development
SBA	Small Business Administration
SMEs	Small and Medium-sized Enterprises
SOEs	State-owned Enterprises
STAR Market	Science and Technology Innovation Board
TIP	Technology Innovation Project
US	the United States
VC	Venture Capital

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