Comparison of Science and Technology Innovation Policies Among China, the United States and Japan and Improving Path of Science and Technology Innovation Policies in China

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Abstract. Policies play an important role in innovation and development. This paper makes a comparative study on innovation policies of the United States, Japan and China from the perspectives of supply, demand and environment. It is found that the innovation policy systems of the United States and Japan are relatively mature, and the system of China still needs to be improved. Based on the experience of the United States and Japan, corresponding improving path of science and technology innovation policies are put forward, targeting at solving the problems of innovation policies in China.

1. Introduction

A perfect policy framework is an important guarantee for innovation-driven development. In the background of technological innovation and industrial change becoming increasingly fierce, science and technology policies have been paid more attention in the world, and became important means to promote science and technology development and ensure national competitiveness. China has also formulated a series of laws and policies to promote scientific and technological innovation, but due to late start, the relevant policies are not perfect, and there is a big gap with the developed countries. The 18th National Congress of the Communist Party of China proposed strategy of innovation-driven development, and implementation of the strategy needs to be supported by corresponding policies, so improving China’s innovation and development policy system is the general trend. By comparing innovation policies among the United States, Japan and China, this paper analyzes problems existing in the operation of Chinese innovation policies and puts forward some countermeasures and suggestions to promote Chinese innovation policies based on the advanced experience of the United States and Japan.

2. A Comparison of Innovation Policies in the US, Japan and China

According to Rothwell and Zegveld’s innovation policy classification system [1,2], industry innovation policy is divided into 3 categories and 12 subcategories. The specific contents include: Supply policies, refer to policies directly supplied by the government, including public utilities, science and technology development, education and training, information services; Demand policies, refer to policies which affect the development of science and technology by providing technology demand by the government through analyzing the market, include government procurement, public services, trade controls and overseas institutions. Environmental policies, refer to laws, systems, policies and strategies which indirectly impact scientific and technological development environment, including finance, tax concessions, regulations and controls, and policy-based strategies. The whole policy system has an impact on industrial technology system and research and development activities from three aspects of supply, demand and environment.
2.1 Comparison from the supply level

Firstly, the US government provides huge research and development funding to enterprise, and increase year by year. In 2015, the research and development budget of the US federal government reached to 135.4 billion dollars, going up 1.2% comparing to 2014 [3]. Secondly, the government pays attention to introduction of the talented, especially the introduction of professional and technical personnel. H1B visa in US is specifically set to provide temporary work visa for foreign professional and technical personnel. Thirdly, implement STEM program to encourage students majoring in science, technology, engineering and mathematics, to develop their science and technology literacy. Fourthly, establishment of industrial cooperation centers in universities to implement strong consociation and integration of production and research. Fifthly, develop basic research relying on university laboratories and national laboratories, to cultivate high-level innovative talents [4].

Japanese innovation policies in supply level have the following characteristics. Firstly, establishment of technological innovation system of small and medium sized enterprises (SMEs), aiming to transform research and development investment from large enterprises to SMEs and encourage innovation of SMEs [5]. Secondly, focus on basic research to enhance innovative ability fundamentally. Thirdly, implement of industry-government-university integration mechanism to improve the efficiency of innovation system. Fourthly, introduce digestion, absorption and re-innovation to implement technology import to technological innovation [6].

China has also formulated a series of related policies in terms of financial support and human resources development. First of all, increasing research funding to scientific and technological enterprises to encourage innovation, and establish technology innovation fund for SMEs. The expenditure on research and development was 142.20 billion Yuan in 2015, going up by 9.2% over 2014, accounting for 2.1% of GDP, of which 67.1 billion Yuan was for basic research. Secondly, a series of personnel training programs were established to cultivate innovative talents, such as “Chang Jiang Scholars Program”, “One Hundred Person Project” and so on [7].

2.2 Comparison from the demand level

In US, the government is responsible for purchasing foreign advanced innovative products; this policy will improve the effectiveness of financial expenditure. At the same time, US government established social organizations to provide advice, personnel, technology and other services for SMEs to encourage the development of SMEs.

Japan promulgated the “New Business Creation Promotion Law”, the government selects and purchases innovative products, and establishes a special industrial structure investigation department - Industrial Policy Research Association to strengthen industrial policy research and policy legislation according to different periods of time.

China sets up a series of policy documents, and establishes the system of government procurement. All levels of government set up full-time institutions for the government procurement.

2.3 Comparison from environmental level

The United States established laws and policies such as “Investment Law for SMEs”, “Technology Diffusion Law” and so on, and “Small Business Risk Research Fund”, with a complete venture capital system. It also promulgated laws and regulations including “The Bayh-Dole Act”, “Technological Innovation Act”, and “Patent Law”, and so on to strengthen protection of intellectual property rights. Its principle is inventor priority. The US promulgated tax policies such as “Economic Recovery Tax Act” to implement tax allowance and exemption for R&D in enterprises [8].

By studying venture capital system of the US, Japan set up a series of venture capital laws and regulations such as “Law on Promotion of SMEs Creation”, “Law on Promotion of Technology Transfer from Universities” and so on, set up Venture Development Bank. “Patent Law” was enacted to strengthen protection of intellectual property rights. The principle of “register has the priority” encourages registering before inventing, so that enterprises can apply for all kinds of unique patents to promote the marketization of innovative products.
China established a government-led venture capital system, in which the government guided social capital, created commercial venture capital institutions, and set up laws and regulations for risk investments, such as “A number of views on the establishment of venture capital system”, “Promotion Law for SMEs” and so on. China also gave tax incentives for R&D in enterprises and research institutions, and implemented income tax, value-added tax, business tax and other tax incentives. At the same time, a series of laws and regulations for were set up according to principle of “inventor first”, including “Science and Technology Progress Law”, “Patent Law”, “Copyright Law” and so on, to protect rights and interests of inventors.

3. Problems and Defects in Operation of Science and Technology Innovation Policy in China

3.1 R&D investment is underfunded, and inputs for fundamental research are less than applied research

Annual R&D investment in China increases year by year, but international community generally believe that a country lacks innovation capacity if its R&D investment intensity is less than 1%, its R&D investment intensity is between 1% to 2% will make a difference, and a country may have relatively strong innovation capacity when its R&D investment intensity is more than 2% [9]. In 2012, the R&D investment intensity exceeded 2% for the first time to measure science and technology input level. Although in that year, China’s R&D expenditure reached more than a trillion, but it is only 46.4% of the US, and the gap is large between China and the developed countries.

Moreover, China’s social investment in R&D is still relatively small. In 2014, China’s R&D expenditures totaled 1301.56 billion Yuan, and the expenditure for fundamental research was 61.35 billion Yuan, going up by 10.6% comparing to 2013; the expenditure for applied research was 139.85 billion Yuan, going up by 10.2%; the expenditure for experimental development was 1100.36 billion Yuan, going up by 9.8%. Fundamental research, applied research and experimental development accounted for 4.7%, 10.8% and 84.5% of R&D total expenditure respectively. Fundamental research funding is significantly lower than applied research funding. Compared with the developed countries such as the US and some counties in Europe, China’s R&D investment, especially fundamental research from enterprises is still relatively small.

3.2 Outflow of the talented is serious, talent competitiveness is low

The talented is core competitiveness of a country. China has set up a series of human resources training policies, but since the reform and opening up, China’s brain drain is extremely serious. Table 1 is statistics of personnel studying abroad and returnees from 1978 to 2015. From the Table, we could see that, from 1978 to 2010, the total number of personnel studying abroad was 1.9 million, while returnees were only 632.2 thousand and 33% of total personnel studying abroad. After 2010, the number of personnel studying abroad and returnees both increased, and the proportion of returning has increased too.

Table 1. Statistics of personnel studying abroad and returnees from 1978 to 2015.

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<tbody>
<tr>
<td>Number of students studying abroad [million]</td>
<td>190.54</td>
<td>28.47</td>
<td>33.97</td>
<td>39.96</td>
<td>41.39</td>
<td>45.98</td>
<td>52.37</td>
</tr>
<tr>
<td>Number of returnees [million]</td>
<td>63.22</td>
<td>13.48</td>
<td>16.82</td>
<td>27.29</td>
<td>35.35</td>
<td>36.48</td>
<td>40.91</td>
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Data source: Investigation report on the trend of studying abroad from Ministry of Education and China Education Online.

3.3 R&D investment of SMEs is low and consciousness of innovation is not strong

In recent years, Chinese government set up a number of funds to SMEs to support their innovation and development, such as SMEs Innovation Fund. But due to fewer funds and decentralized support
object, effect was not good, resulting in low R&D investment of SMEs. At the same time, SMEs always pay insufficient attention on technological innovation, and they deeply rely on the government and research institutes in technology innovation. They often pay more attention on short-term benefits, lacking idea of sustainable development and awareness of scientific and technological research and development.

3.4 Awareness of property rights protection is not strong, protection of rights and interests for patent holders is not enough

China has established a series of laws and regulations for intellectual property protection and patent protection, but our citizens are generally not aware of intellectual property protection, fake and shoddy products emerge in an endless stream in the market. This kind of situation seriously not only hurts rights of consumers, but also hurts rights of patent holders.

3.5 Government intervenes in venture capital, market subject of capital investment needs to be cultivated

Chinese entrepreneur lack of adventure spirit, while the lack of a large number of high-quality venture capitalists with technical, management, marketing, finance and other aspects of knowledge. This made China could only use government-led investment model at present. Under this model, venture companies are funded by the government, operate in the model of state-owned enterprises. This improves the reputation of venture companies, and enhances confidence of public in venture capital. But in the long run, it violates original market-oriented operation law of venture capital.

4. Perfecting Path of Science and Technology Innovation Policies in China

4.1 To strengthen fundamental research investment, and to improve original innovation ability

R&D investment of central finance should be tilted toward fundamental research. Fundamental research has strategic, commonweal, and pilot characteristics. It is the duty of the government supporting fundamental research financially. It needs to increase the intensity of fundamental research investment for strategic emerging industries, to make universities and research institutions become the main body of fundamental research, to improve transformation efficiency of fundamental research, to promote industry-university-institute cooperation, so as to improve original innovation ability and gradually guide enterprises to take more seriously and increase investment to fundamental research [10].

4.2 To make welfare policies to attract the talented, and to promote competitive power of the talented

China should stress on the talented both in policies and activities to encourage students studying abroad come back to contribute the motherland. Through improving mechanisms of assessment, selection, use, incentives, and improving overall environment and supporting policies to retain our talents and attract outstanding talents.

4.3 To increase financial support for SMEs to promote technological progress

The government should increase the scale of special funds for SMEs, to encourage independent innovation of SMEs. The government should give tax concessions to SMEs, to give fully support to those enterprises which have good market prospects, or save energy, or protect environment. To provide free advisory services to relevant SMEs, and to build service agencies which can provide technological innovation services, entrepreneurial training services, market development services and management consulting services [11].
4.4 To improve intellectual property protection mechanism, and to promote public innovation

In our legal framework, the government should increase remediation efforts to fake and shoddy products, to strengthen judicial transparency. To improve public awareness of intellectual property protection from the source, make patent protection truly implemented to enhance enthusiasm of public innovation.

4.5 To enhance vitality of capital operation, and to form market-led venture capital system

The government should cultivate and develop advisory service market of risk investment, provide information and consultancy service for decision-making and operation of risk investment, try to reduce risk and raise the profit; at the same time, cultivate and develop project brokerage market and technology brokerage market of venture capital, select high-tech risk projects which can be industrialized and incubated, so as to further optimize investment portfolio, reduce opportunity cost of risk investment, improve risk investment efficiency [12].

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