

The Technology Diffusion Effect of International Intellectual Returnees

Li Shuyun

College of Economics and Management
Weifang University of science and Technology
Weifang City, China
e-mail: langdihua0554@163.com

Chen Shaozhi

SEM School of Electromechanical Engineering
Weifang Engineering Vocational College
Weifang City, China
e-mail: yuefeng0822@163.com

Abstract—By introducing returnees into the international R&D spillovers econometric model and using Chinese provincial panel data, we test the technological progress effects of returnees in various regions of China. The results show that returnees have played important roles in technological progress in various regions of China, but there are differences in the degrees of contribution, and the conclusions remain robust after the use of multiple tools to solve the endogenous problems of variables. Then, we set threshold models to measure the threshold levels of local fiscal revenue, economic development, etc., which can cause positive spillover effects of returnees.

Keywords—returnees; international; technology; diffusion; threshold regression

I. INTRODUCTION

Since the 1980th and 1990th, with globalization, new technology revolution and the deepening of industrialization process, the phenomenon of overseas talent returning emerged at great number. Asian tigers such as South Korea, whose outflow of talent began to return after entering 1980th especially after 1980th, with the personnel return rate of 60%. Relative to the domestic talents, we call those talents that have work or study experience abroad and then returned as returnees in China¹. According to CSC statistics, the total number of all kinds of returned overseas students in China has reached 49.74 million from 1978 to the end of 2009, and the scale of returning is expanding year by year. In the education and scientific research fields, about 77% of the principal institutions of higher schools, 84% of the Chinese Academy of Sciences, 75% of the Chinese Academy of Engineering, 62% of the PhD supervisor had study abroad experience; In the business world, more than 20000 high-tech enterprises in Zhong Guancun were founded by the foreign students, with the total registered capital up to more than 5.0 billion, and it has also attracted hundreds of billions of domestic and foreign funds. The same situation also occurred in Taiwan, India and China. Nowadays, the personnel returning from overseas is becoming an important force for many countries or regional's economic

development and technological progress, which raises the question: As the necessary form of factor mobility in the global economy, how is the technology diffusion effect of international intellectual returnees? How developing countries or regions should take full advantage of their intellectual status of the technology diffusion effect to promote their technological advances?

Taking China for example, this paper focus on the technology diffusion effect of international intellectual returnees. The rest of the paper is organized as follows: In the second part, we will make a theoretical analysis of the impact of returnees on China's technical progress and those factors that impact the technology spillovers of returnees on the basis of existing research; In the third part, by introducing returnees into the international R&D spillovers econometric model and using Chinese provincial panel data of 2000-2008, we test the technological progress effects of returnees in various regions of China; In the fourth part, we set threshold models to measure the threshold levels of local fiscal revenue, economic development, etc., which can cause positive spillover effects of returnees; Last part is the conclusion.

II. THEORETICAL ANALYSIS OF RETURNEES' THEORETICAL PROGRESS EFFECT

Scholars at home and abroad mainly study the international technology spillovers from the following three aspects: international trade, FDI and patent applications and patent citation, and it has formed a systematic theoretical framework. With the thoroughing research of international technology diffusion, people recognized that international human capital flows is also an important factor for one country's scientific and technological progress and also its economic growth. Returnees can bring their home countries with a wealth of human capital, physical capital and social capital. For example, Commander et al. (2004) made a study on India, and found that many new technology companies in India were founded by returnees, the Indian IT industry in the southern city of Bangalore has gathered 40000 IT industry professionals returned from the U.S. and UK to the end of 2007, and those returnees made the major force for India's IT technology development. By reviewing the existing research and each country's experiences in order, this paper summarized the mechanism of returnees on their home countries' technological progress as: human capital

¹ The intellectual reflux this article refers to is also known as international human capital return, the word returnees in the text means the return of international intelligence which is the specific application in China.

effects, competitive effects, the direct learning effect of inter-firm technological knowledge and network effects.

A. *The Effect of Human Capital*

Returnees have received higher education abroad or have foreign work experience in relevant technical areas, they generally have a high quality and master the key professional and technical knowledge, they are higher than the average technical level of domestic workers[1]. so, their reflux can promote China's accumulation and quality improvement of human capital. McCormick and Wahba (2001) found that, returnees in Egypt have higher levels of human capital than ordinary domestic scientific and technical personnel, and with the time of study and work abroad longer, the higher of their technology and spillover effects. As high-quality human capital, returnees can create a number of advanced technology, capital and professional networking group of high-quality human capital for China to build a huge senior human resource base. For example, among the 330 million migrants living in the United States in 2003, there are about three-quarters of scientists and engineers are from developing countries or regions (about 250 million people), but many of them from China[2]; According to statistics of the U.S. Center for Education Statistics, Chinese students studying in the United States accounted for 14% of the total international students in 2008, with the number reached 98235. The number of students from mainland to the United States accounted for second in the world, which formed the key driving force for the growing of its international students. According to the research of Docquier and Marfouk (2004), there are more than 93% overseas students from developing countries or areas return to their home country with foreign experience and advanced technology, which can bring their home countries with vast amount of market information .

B. *Competitive Effect*

As high-level human capital, the return of oversea students will reduce the employment opportunities of domestic high-tech fields to some extent, then the "jobs out effect" can stimulate domestic staffs to improve their career skills through in-service education and vocational skills training and other channels to meet the competitive domestic employment market, and this can finally improve China's overall level of human capital by enhancing its independent innovation capability and absorptive capacity of foreign technology. Second, the technological exchanges and development cooperation between returnees business enterprises or between enterprises and non-returnees and can promote the exchange of technical knowledge within the industry, narrowing the technology gap between enterprises and further exacerbate the competition between enterprises, which to some extent will encourage enterprises to increase the R&D investment and staff training, and this process could improve the technology of overall the industry. Furthermore, the speed of the new companies opened by the job-hopping returnees is often greater than the original company, which to some extent, will promote the competition of talent and technology between the new and old enterprises. Enterprises will accelerate their pace of

technological innovation by increasing their investment of R&D, seize the core talents in order to remain invincible in the highly competitive market, and this in turn will trigger a new round of talent flow, and ultimately form an virtuous circle including returnees, flow of talents, industry competition and technological upgrading. proceedings, and not as an independent document. Please do not revise any of the current designations.

C. *Direct Learning of Business and Technical Knowledge*

Technology diffusion between enterprises especially between returnees and non-returnees enterprises is one important way of the dissemination of knowledge and technology.

I) *Voluntary Transfer of Technology*

From their own business needs and future development of technology, Returnees often transfer technology to local enterprises by means of technical cooperation in R&D cooperation agreements or other forms, this two-way active technical exchanges and cooperation in R&D could reduce the technology gap between returnees and non-returnees enterprises, which can promote the overall technical levels of the industry.

II) *Non-voluntary Technology Diffusion*

Non-voluntary technology diffusion mainly include the demonstration effect of technology spillovers, staff mobility effect and industrial clustering effect.

a) *The demonstration effect.* Through imitation and learning from returnees enterprises, non-returnees companies can freely learn to adopt advanced technological knowledge by the demonstration effect of company, so the non-returnees companies can realize technological progress in type of "learning by doing"[3].

b) *Staff mobility effect.* The staff movement between returnees enterprises and between enterprises and non-returnees enterprises is an important channel of technology spillovers. When workers leave the returnees enterprises and to take their own business knowledge, knowledge spillovers will inevitably occur. On the one hand, mobile workers will apply their advanced technology accumulated before to the new enterprises, which will directly lead to the horizontal proliferation and spread of knowledge in the whole industry[4]; On the other hand, the staff training expenses by returnees enterprises could reduce the training expenses of local businesses, so that these companies can focus its major financial and material resources in R&D and innovation activities.

c) *The industrial cluster effect.* Human capital flows arising from sea turtles and re-configuration process will make the location choice of enterprises tend to focus on the geography, resulting in industry cluster 2 . Industrial

² For example, so far there have been more than 6000 enterprises in the Overseas Students Pioneer Park since it was first founded in 1994 by Chinese government, these enterprises have played a complementary advantage between industries and enterprises by

agglomeration can further drive the technological upgrading of local enterprises through labor mobility, association, demonstration and spillover effects. The relationship between returnees technological spillovers and industrial agglomeration are mutually reinforcing, showing the cumulative circular causation. In the endogenous movement conditions, the high level of technology will increase production efficiency and further promote the gathering, while the larger movement of persons provide more channels for the activities of knowledge spillover, then the technology exchange model is more specialized and highly efficient, and ultimately form a virtuous cycle of returnees business, mobility, agglomeration and technology spillovers.

D. Network Effects

Network of overseas returnees is a series of special economic, cultural, technological and other contact based on kinship with the motherland, friendship and relationships. Returnees can not only input the latest knowledge and technology to their home countries, but also form a certain business network, which can strengthen the cooperation of trade and investment ties with China, then the trade and investment ties can further amplification technology spillover effect of returnees by attracting more trade and FDI. Some scholars believe that within the standard framework of the trade theory, there exists complementary relationship between trade and human capital flows. For example, there are about 60% bilateral trade growth in the amount of heterogeneous products between the Southeast Asian countries and China are due to the ethnic Chinese business networks in Southeast Asia. The research of Rauch and Trindade (2002), Kugler and Rapoport (2006) on China also confirmed the complementary relationship between human capital and trade flows. In addition to trade leading mechanisms, scholars have also found that returning officers can help their home countries to attract FDI, and help their home countries further amplify returnees effect of technology diffusion by the mechanism of FDI technology spillover. Docquier and Lodigiani (2006) used the cross-country data for the FDI-dynamic model of capital accumulation, and he found that the human capital flows have significant FDI inducing effect with the elasticity of FDI capital growth rate of 2%. The Chinese government introduced about 622.4 billion U.S. dollars of foreign capital during 1978-2005, where Chinese investment accounts about 67%, and about 70% enterprises are foreign-funded among the 55 million approved enterprises. These FDI caused by returnees formed an important part in the whole FDI of China, and their positive technology spillover effect has been generally recognized by most scholars.

As an important form of human capital flows, the effect of personnel returning from overseas to developing countries or regional can be affected by many factors and conditions. From the above literature review we vaguely found that, the technology spillover effect of intellectual return could occur

in some developed regions with higher level of economic development, better infrastructure and some developing countries or regions. The study of Almeida and Kogut (1999) on Silicon Valley believe that, only the countries with adequate human resources, better infrastructure and stable economic environment could attract more talent and benefit from it. The reason of this phenomenon is that the technology spillover of international flow of talent is a complex system which faced a variety of factors and constraints. Only when a country's own conditions, such as economic development reaches a certain level can it form a pull for high-quality talents from overseas, and brought their advanced technology for effective learning and imitation, thus contributing to raising the level of the country's technology. Conversely, a country could neither effectively absorb the technology brought by returnees, nor form the pull of overseas talent, which is not conducive to their technological progress.

Therefore, the spillover effects of returnees may have obvious "threshold feature", with the improvement of China's technological base and integrated absorptive capacity, the technology spillover effect of returnees will also has a significant leap. There have been some scholars who studied the possible factors that impact returnees' technological spillovers, such as Lin Lin(2009) who summarized the factors that affect the return of overseas talents as follows: home countries' economic development trend, the domestic income levels, the policy environment and the thrust generated by overseas economic and social factors, while the local revenue can represent the economic situation and the ability of government support for technological progress. Sun Jian et al.(2005) select the GDP, scientific research, the number of college students and other macro variables etc. in the study of science and technology personnel rules, and they found that many factors have significant effects on returnees. Ocean University of China Research Group(2004) also found that there exists significant correlation between brain drain and national income and many other macroeconomic variables. In addition, The research of financial market factors made by Alfaro et al.(2003) suggests that financial market development is essential in encouraging human capital to learn and absorb advanced technologies. The formation of new enterprises by human capital will spread skills and knowledge into the real productivity, while the defects of capital market will limit the generation of new business technology, and thereby limiting the diffusion effect. The research of Wanghui Yao(2005,2010) on the Chinese returnees entrepreneurship suggests that the success rate in Chinese students docking projects and funds is only 3%3. Now, the problem of financing business in China returnees are increasingly prominent, and the improvement of the environmental situation in China's financial market is inevitable.

bring technology, human resources and management experience which are lack resources for domestic enterprises.

³ Wanghui Yao, "returnees era", Beijing: Central Compilation and Translation Press, 2005; "National Strategy-talent to change the world", Beijing: People's Publishing House, 2010.

III. CONCLUSION AND COUNTERMEASURES

Comprehensively along with the knowledge economy, the person with the high quality becomes the resources of strategic importance to the economic development and international competition in the 21st century for every country. In some way, whether a country can develop persistently and fleetly depends on whether the country have plenty of high-tech talents as well as whether these talents are properly developed, made use of, deployed and managed. Human capital, especially the high-quality human capital as an essential element of economic development for a country, is becoming a valuable resource for competing countries. World Migration Report shows that there are around 210 million people working outside their countries of birth on Earth as of 2010, where 1 in every 35 people is immigrant, and six people are from developing countries and regions among every 10 highly educated migrants. Adds in the global scope talented person's shortage, developed countries attract a lot of talented people from developing nations. This has become the "bottle-neck" that restricts the development of our country's economy and society.

On the basis of conclusions above, we think that international exchange of human talents is necessary and important. Only when we keep pace with the world in talents flow, can we walk in the forefront of the world. But for developing countries and developed countries, their

strategies are different. For developed countries, they should relax restrictions for talents in and out. They should not only attract talents from other developed countries, but also not set limit to intelligence outflow.

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