An Analysis on Technology Spillovers From Foreign Direct Investment in Chongqing

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Abstract

With China's accession to the WTO, the Chinese economy has involved in the process of globalization quickly. On the one hand, Foreign Direct Investment (FDI) has played an important role in Chinese economy, on the other hand, and foreign advanced technology comes along with the foreign capital. In order to explore whether FDI technology spillover has affection in Chongqing, this paper selects the 1999-2013 data of large and medium-sized industrial enterprises in Chongqing as the research object, and builds an estimating equations by introducing FDI as physical capital to have an empirical analysis of how FDI technology spillovers affect the technology innovation abilities of Chongqing enterprises. The conclusion shows that FDI has a significant effect in technological spillover.

Key words: Foreign direct investment; Technology spillovers; Chongqing city

INTRODUCTION

In order to speed up the economic growth, China has promoted the introduction of foreign capital and the scale of introduction has been increasing since reform and opening up. Especially, since China joined in the WTO, the Chinese economy has involved in the process of globalization quickly and has played an important role in the deepening continuously global division. There is a closer relationship among China and the nations of the world, which leads more and more foreign capital into China to invest. FDI, which is short for Foreign Direct Investment, is a win-win way to invest. On the one hand, FDI can realize high profits for developed countries; on the other hand, it is a convenient way to help developing countries to access to sources like capital and technology. So there is no doubt that FDI has a rapid development in recent years. From the *Global Investment Trends Report* published in the United Nations Council on Trade and Development, it's known that China has been the largest destination country in the world to attract foreign investment in 2014, and the amount of FDI is up to 128.6 billion dollars. That's to say, China has become one of the most attractive foreign direct investors in the world. Besides, according to the data from The National Statistics Bureau, it shows that China's actual use of FDI from 40.7 billion dollars in 2000 to 119.6 billion dollars in 2014. FDI's rapid development has indicated that China is accelerating to participate in the global economic integration process. FDI plays a very important role in promoting China's economy speedy development, especially in resolving employment and tax increases, etc. However, as with substantial amount of FDI coming into China, China's economic growth turns high speed to high-middle speed, and China needs more innovative products as a consequence of industrial upgrading. In terms of technical level, FDI enterprises have comparative advantage compared with domestic enterprises in China.

So Chinese people pay increasingly attention to FDI effect on China's economic and technological progress, and want to know whether FDI in China domestic enterprises have technology spillover effect. If there are, what are the characteristics? In recent years, foreign and domestic scholars have made some heated discussions on advantages and disadvantages of FDI to the local economic development. Some scholars think that successful foreign enterprises have a positive effect on domestic enterprises, which promotes the marketization process and also improve the competitiveness of products and enterprises in the host country. On the contrary, other scholars hold the opinion that FDI threaten the host country's economic security. Anyway, there is no doubt that FDI, as an important part of China economy, promotes a longstanding and sustained development.

Chongqing, located in the upstream of the Yangtze River's golden waterway, has so many fascinating advantages such as completed infrastructural facilities, abundant human recourses, convenient traffic condition and excellent investment environments, so it has attracted substantial amount of FDI. There were 312 FDI enterprises in Chongqing by 2013, and most of them were telecommunication equipment, computer, and electronics manufacturing as well as automobile manufacturing industries. In 2013, the proportion of total industrial output which was valued RMB328.4 billion in the GDP of Chongqing had risen to 28.8%, while the proportion of FDI valued 10.5 billion dollars in fixed assets gross investment of Chongqing had risen to 7.1%. There is no doubt that FDI has made an important contribution to Chongqing's economy.

Developing countries also can access to advanced technology by introducing FDI to improve the technology level of local enterprises. However, it is a difficult way to realize technology transfer and progress by making use of FDI, because it depends not only on the characteristics and nature of FDI technology, but also on the enterprises' absorptive capacity and the development level of social economy in host country. According to the above-mentioned analysis, we can know that a lot of scholars have studied on technology spillover from FDI, and have gotten some different conclusions. So how about Chongqing? Is there technology spillover from FDI, and what features it has? This paper based on the former analysis, selects the 1999-2013 data of large and medium-sized industrial enterprises in Chongqing as the research object, and build an estimating equations introducing FDI as physical capital to on how FDI technology spillovers affect the technology innovation abilities of Chongqing enterprises. In this paper, the 2nd part makes a literature review, and then it has an empirical analysis on the 3rd part, finally it provides some briefly policy suggestions.

1. LITERATURE REVIEW ON SPILLOVER EFFECTS

Many scholars have analyzed cross-section data, time series data and panel data from all over the world to know how FDI technology spillovers affect the economics development, for example, these empirical researches and experience analysis mainly focus on capital accumulation, direct economy growth and technology spillovers. However, the results are widely divergent. Some scholars hold the idea that FDI technology spillovers are obvious. Cavas (1974) selected the cross section data of manufacturing industries that had attracted substantial amount of FDI from Canada and Australia in 1962 and 1966 to inspect FDI technology spillovers. He found that FDI from multinational enterprises had no evident technology spillover effect on their domestic private sectors while effect on their subsidiaries in the two host countries. Cavas also found that by introducing FDI, Australia had improved its resource allocation efficiency and promoted technology progress, even Canada had produced the technology progress and technology transfer. Liu (2000) analyzed the panel data of British manufacturing industries from 1991 to 1995, and he made conclusion that there was a significant technology spillover effect in British manufacturing industries. Mi and Yum (2013) figured out in the *Asia Development Bank Report* that FDI introduced by China would make negative effects on the productivity of native firms in the same location, but it would make positive technology spillover effects on enterprises in the same area. In the long term, the positive effects would restrain the negative ones by the mechanism of the Labor Market. As contrasted to these studies, other scholars think that FDI technology spillovers are unobvious. Contrary to the above researches, some study says that the technology spillover effect form FDI is not obvious. When Blomstrom and Kokko (1998) had a study on the FDI technology spillover effects in Mexico, they found that for low productivity native firms, foreign companies did not significantly affect their labor productivity. Rafaelita and Fernando (2010) found that FDI introduced by Philippines had promoted the growth of domestic economy, but brought a limited effect on technology spillover, and to make a more significant spillover effect on host countries, need some more comprehensive measures, for example, related the foreign and domestic enterprises engaging in the same professional production, and also need encourage the domestic enterprises into high-end industrial chain, etc.. Ewert (2012) also found that the technology spillover effects on South Africa were limited by analyzing the data for manufacturing enterprises. What is more? The others believed that the spillover effect from FDI to be realized needs some certain conditions. Brian & Harrison by analyzing the panel data of manufacturing from Venezuela found that whether the enterprises

benefitted from the spillover effect of FDI mainly depends on the participation of the joint ventures. Cantwell (1989) systematic researched the response of European market to United States multination firms during 1955 to 1975, and he found that only the enterprises, which had competitive advantage before the foreign investment in, could benefit positive technology spillover effect.

There are also many scholars analyzing the FDI technology spillover effect of overseas-funded enterprises in China. Liu (2009) and Sha (2013) analyzed the technology spillover effect on domestic and foreign companies among different technology development level, and found that FDI produced the technology spillover effect and promoted the domestic enterprises to improve their innovation abilities, and the technology development level gap between foreign and domestic enterprises had a nonlinear effect on the knowledge overflow and innovation of domestic firms. Cheung (2004), Li (2007) found that FDI technology spillovers is regional different in China. Feng (2012) verified that China existed technology spillover from FDI in general, but this kind of effect was comprehensive and heterogeneous. His research figured out that FDI technology spillover effects mainly existed in eastern and central regions of China.

The above researches can be divided into three categories: (a) Measure the FDI technology spillover effects on TFP of the host country from a perspective of technological progress. (b) Measure the FDI technology spillover effects on economic growth of the host country from a perspective of output growth. (c) Measure the FDI technology spillover effects on innovation capacitive of the host country from a perspective of independent innovation. However, most of these studies regard the whole China as the research object, and few of them choose a certain area to analyze. Therefore, are these study conclusions applicable to Chongqing or not? Based on this background, this paper, considering the fact that innovation is the power of science and technology progress, selects the large and medium-sized industrial enterprises in Chongqing as empirical object to inspect how technology spillovers from FDI affect their technology innovation ability.

2. MODEL BUILDING, INDEX SELECTION AND DATA SOURCES ON TECHNOLOGY SPILLOVER EFFECTS

2.1 Model Building

Assuming the knowledge production function of the large and medium-sized enterprises of Chongqing is:

$$ZL = AK^{\alpha} L^{\beta}. \qquad (1)$$

ZL, A, K and L respectively represent knowledge production, technical progress rate, material capital and human capital. In order to inspect how technology spillovers from FDI affect Chongqing's economy, the model introduces *FDI* as a variable. Then lets the material capital stock is expressed as the weighted average of domestic capital and FDI, namely $K^{\alpha} = K_d^{\alpha 1} FDI^{\alpha 2}$, thus:

$$ZL = AK_d^{\alpha 1} FDI^{\alpha 2} L^{\beta}. \qquad (2)$$

And then takes the natural logarithm on both sides of the equation b):

$$LnZL = LnA + \alpha_1 LnK_d + \alpha_2 LnFDI + \beta LNl. \qquad (3)$$

However, it considers that FDI has time-lag effect on knowledge production, so the model introduces the lagging of the *FDI* variable in the equation c), thus:

$$LnZL = LnA + \alpha LnK_d + \theta_i LnFDI_{t-i} + \beta LNl. \qquad (4)$$

In the Equation (4), the model identifies i=1, 2, 3, 4. So the Equation (4) is the final estimated model.

2.2 Index Selection

In this paper, the model selects the time series data from 1990 to 2013 of the large and medium- sized industrial enterprises of Chongqing as the sample data. *ZL* is on behalf of patents authorization account of these enterprises. Considering the availability of the data, the model chooses the patents authorization account of mining enterprises as the proxy variable. The variable K, which can be worked out by using the index of intramural expenditure on R&D to deflate nominal R&D capital stock, is on behalf of real R&D capital stock of enterprises in Chongqing (regard 1999 as the base period). Nominal R&D capital stock is computed with Perpetual Inventory Method put forward by Goldsmith in 1951, the formula is:

$$K_t = K_{t-1}(1 - \delta) + I_t. \qquad (5)$$

K_t and K_{t-1} respectively represent the nominal R&D capital stock in year t and the year lag. δ is depreciation rate of the R&D capital, and the model assigns it 15% according to Bai (2007). I_t is nominal intramural expenditure on R&D in year t. R&D capital stock during the base period is computed with:

$$K_0 = I_0 / (g + \delta). \qquad (6)$$

K_0 is R&D capital stock during the base period; I_0 is intramural expenditure on R&D during the base period; and g is average growth rate of nominal intramural expenditure on R&D during the base period. The index of intramural expenditure on R&D is from weighted average of price index of investment in fixed assets (PIIFA) and consumer price index (CPI) according to Bai's research, and the weight respectively is 0.62 and 0.38, thus:

 Index of intramural expenditure on R&D =0.62* PIIFA+ 0.38*CPI.

$$\qquad (7)$$

The variable *L* presents number of persons for R&D in large and medium-sized industrial enterprises, and the model selects the number of science and technology institutions in scientific and technological activities of large and medium-sized industrial enterprise as the real assessment index considering the availability and consistency of the data. *FDI* is amount of real foreign

direct investment presented by the constant price in year 1999, and the model uses the annual average exchange rate to convert the unit of nominal FDI from dollar to RMB. Besides, price index is PIIFA in Chongqing (regard 1999 as the base period). This paper uses the data from 1999 to 2012, and the datum is from the website of the National bureau of Statistics (http://www.stats.gov.cn/) and *Chongqing Statistical Yearbook (2000-2013)*.

3. EMPIRICAL RESULTS ON TECHNOLOGY SPILLOVER EFFECTS

In this paper, the model analyzes the logarithmic type of data sample with the OLS method of Eviews 7.2. The results are as follows.

Table 1
The Test Results

	$i = 1$	$i = 2$	$i = 3$	$i = 4$
The constant term	-13.6045*** (-6.5844)	-12.5113*** (-5.3334)	-11.4806*** (-5.1444)	-12.3578*** (-5.3385)
LnL	-0.2266 (-0.1920)	-0.6100 (-0.4957)	-0.6866 (-0.6639)	-0.9213 (-0.1102)
LnK	1.0926** (2.3764)	1.0556** (2.3078)	0.8637* (2.1696)	0.4411 (1.1659)
LnFDI_{t-i}	-0.0480 (-0.2480)	0.1078 (0.4875)	0.2955 (0.2161)	0.5152* (2.3551)
AdjustedR^2	0.9413	0.9000	0.8975	0.9019
Durbin-Watson	0.8696	1.0027	1.5679	1.7355
F-statistic	48.1368	33.9926	30.1925	28.5692

Note. Figures in Table 1 present the correlation coefficient; value in parentheses is the t-statistic regression coefficient, *, ** and *** respectively represent they are significant at 10%, 5% and 1% level on a statistical basis.

Given a significant level, make the F statistical distribution, whose first freedom degree is 3 and second freedom degree is 14, and get the threshold value is $F_{0.01}(3,14) = 5.56$. We can obviously see that all the *F*-statistical values of four regression results is exceed 5.56, so it illustrates the linear relationship of this model was significant at 99% level on a statistical basis.

However, the values of *D. W.* are little deviation, so the model is in the presence of autocorrelation seriously. Besides, the coefficient of variable LnL does not pass the *t*-statistical test, which shows that there is a strong possibility that its coefficient value is likely to be zero. Then we delete the variable LnL from this model and have a linear regression analysis again, finding that all the variable coefficient are passed the t-statistical when $i = 4$, so the regression equation is :

$$\text{Ln}ZL = -12.3969 + 0.4046\text{Ln}K + 0.5138\text{Ln}FDI_{-4}. \quad (8)$$
$$\quad\quad (-5.8475) \quad\quad (2.3780) \quad\quad\quad (2.5386)$$

Adjusted R^2=0.9157   *F*-statistic=49.8880   D.W.=1.7410

The economical relation of this model is reasonable, and it passes the statistical and econometrics tests. So it is appropriate of this model for analyzing the technology spillover effects from FDI to large and medium-sized industrial enterprises in Chongqing.

From the analysis above, the following conclusions can be drawn. a) Human capital does not have significant effect on the total amount of patents for authorization. But in fact, the human capital is able to influence on the ability of absorbing technology spillovers even the spillovers from FDI of one certain country or district. According to the reality in Chongqing, it is speculated that the empirical results against the facts maybe are related to the current situation that the enterprises especially the large-scale enterprises are very lack of high-level professional and technical talents in Chongqing. Therefore, human capital cannot play a substantial impact as itself existing, and its technology spillover effect is very weak. b) R&D capital stock has a positive effect on the total amount of patents authorization; and 1% for each increase in R&D capital stock, the amount of patent authorization increases 0.4046 percentage points because of $\alpha = 0.4046$. As one of the most important factors of the ability of absorbing technology spillovers, it goes without saying that the importance of R&D investment. Only if one certain country or district satisfies the research and development material requirements could it have a fantasy ability absorbing of technology spillovers form FDI. Many studies are consistent with the result: stock of R&D investment has a positive effect on ability of technology spillovers of one certain country or district to promote the digestion of external technology and the improvement of internal innovation. c) FDI has a positive effect on the amount of patent authorization, but it needs 4 years lag to act. This may be due to the large technology gap between domestic and foreign enterprises, so it should take a long time for domestic enterprises to absorb foreign enterprises technology. The value $\theta_4 = 0.5138$ stands for that 1% for each increase in FDI, the amount of patent authorization increases 0.5138 percentage points, whose effect exceeds that of R&D capital stock.

CONCLUSION

The above analysis shows that the localization of product researches and the improvement of technical level driven by profits in foreign enterprises play an important role in promoting the technical innovation ability of Chongqing enterprises. Specific performance of this result in: Human capital does not have significant effect on the total amount of patents authorization, R&D capital stock has a positive effect on the total amount of patents authorization, and FDI has a positive effect on the amount of patent authorization, but it needs 4 years lag to act. However, at the same time, we should also pay attention to that domestic enterprises almost acquire non-core technology from FDI technology spillover effects through imitation,

competition, and industrial association ways. Besides, the strength of spillover effects is affected by many factors, such as the original level of technology and the importance to the enterprises as well as the absorption ability of the domestic enterprises. In other words, though the way of technology spillovers from FDI is various, the spillover effects are still potential and limited.

POLICY PROPOSALS

According to the above conclusions, this paper gives follow suggestions. a) Establish the construction of the independent innovation system, and improve the independent innovation ability. Although there are spillover effects from FDI, the domestic almost acquire non–core technology, and if the domestic enterprises want to master core technology they must increase the investment on R & D based on the construction of the independent innovation system and the independent innovation ability. In practical terms, first the government should provide stronger policy support to companies and research institutes in terms of capital investment, especially expanding the R&D investment input of the small and medium-sized enterprises. Secondly, Chongqing government need allocate the R&D funds rationally, for example, focus on promoting developing the industries which have comparative advantages, and take investing more for scientific research of basic research and applied research, especially the R&D activities about the ability of absorbing technology spillover effect from FDI. Thirdly strengthen Chongqing local enterprises. Through strengthening the support technology research and development of local enterprises, strive to make domestic enterprises' obtain technical ability to compete with foreign enterprises, and improve the quality of FDI fundamentally. b) Set up the sharing platform of knowledge and information, promoting the technology and knowledge spillover external benefits internalization. Aiming at the situation that nowadays technological innovation mainly relies on FDI technology spillover effects, Chongqing can set up a platform which can share information and knowledge, strengthen exchange and communication among enterprises to push the technology and knowledge spillover external benefits internalization quickly. c) Create a good investment environment. Chongqing government should create more favorable market and social conditions to introduce the foreign capital. What's more? Government should introduce more multinational enterprises with international level in advanced technology to promote the technology spillover effects from FDI. d) Improve the human capital development level. Chongqing government need do the macroeconomic regulation and control well, and publish the talent demand directory regularly to strengthen the introduction of domestic and overseas high-level talents. We need to be cautious that the most important thing is to retain talents instead of just attracting. Therefore, it is necessary to boost fiscal spending to support for education funds, and improve the education facilities and the education development level, in order to provide a steady stream of reserve talents for Chongqing.

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