An Empirical Study on Technological Spillover Effects from FDI in China

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Abstract

The purpose of this paper is to examine the effects of technology spillover of FDI on large-scale domestic manufacturing industries in China. Using the macro panel data of 27 Chinese manufacturing industries from 2001 to 2007, Based on Total Factor Productivity (TFP). The result indicates that FDI has positive effect of technology spillover on large-scale domestic manufacturing industries.

1. Introduction

Promoting foreign direction investment (FDI) has always been a primary concern for economic growth, especially in developing countries. The Chinese government has encouraged FDI in order to prop up backward industries since 1978. After 1992, Deng Xiaoping's southern tour of Shenzhen, encouraging a further and much more massive wave of foreign direct investment, which contributed towards acceleration in GDP growth of China.

China's Foreign Direct Investment (FDI) has exceeded about 60% in manufacturing industries in China since 1996, although the ratio has been downed to about 50% during Asian financial Crisis in 1997-1998. After China entered WTO in 2001, the ratio of FDI in Chinese manufacturing industries has increased up to about 70% in 2004. Chinese government made reform of the same income tax rate for the domestic and foreign firms in 2006. After that, the global financial crisis of 2008 forced FDI up to 50% in manufacturing industries in China. However, Function of FDI has not been disregarded in Chinese manufacturing industries. So, a lot of studies have taken up manufacturing industries in Chinese empirical study field.

FDI is expected to force domestic firms to improve their technical efficiency, and domestic firms can benefit from technology spillovers from foreign entrants. Because foreign firms are not able to extract the full value of these gains, they are often called involuntary technology transfer or spillover effect by Kokko (1994).

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Domestic firms' technological gain from foreign direction investment (FDI) generally results from two channels. First, there are a number of channels through which FDI affects productivity of domestic firms. The first, spillovers through demonstration effect take place when a domestic firm improves its productivity by simply observing nearby foreign firms and copying some technology. Second, another type of spillovers is through competition between foreign firms and domestic firms. The competition effect, unlike demonstration effect which is presumably positive, can be either positive or negative. FDI may toughen the competition faced by domestic firms, thereby forcing them to become more competitive. On the other hand, increase competition with inward FDI can also reduce productivity of domestically owned firms, particularly in the short run. If imperfectly competitive firms have to incur fixed costs of production, a foreign firm with lower marginal costs will have an incentive to increase production relative to its domestic competitor. In this environment, entering foreign firms producing for the domestic market can steal demand from domestic firms, forcing them to reduce production.

In this paper, we will examine the effects of technology spillover of FDI in China.

2. Literature Review

In the early 1990s, the Chinese surge in FDI has attracted the attention of economists. But in recent years, a lot of empirical studies have tended to take analysis of technology spillover effect of FDI in Chinese industries. Most of studies used a Cobb-Douglas production function of Feder (1982), which I also use, adding foreign capital which comes from FDI to domestic firms.

Feder (1982) provide a new econometric framework for analyzing the spillover effect of FDI, based on the Cobb-Douglas production function in Eq. (2.1)

$$Y = AL^{\alpha}K^{\beta} \tag{2.1}$$

Where Y is output, K and L denote fixed capital, labor, A is technology level. α is labor share and β is capital share.

Feder (1982) divided economics into foreign and domestic two sectors and added foreign capital into Cobb-Douglas production function as a factor of production.

$$Y = AL_H^{\alpha}K_H^{\beta}K_F^{\gamma} \tag{2.2}$$

If right and left in equation (2.2) is given natural log, Eq. (2.2) can be turned as follows:

$$LnY = LnA + \alpha LnL_H + \beta LnK_H + \gamma LnK_F + \varepsilon \qquad (2.3)$$

Where Y, K, L are the same to above Eq. (2.1), α is output elasticity of labor and β is output elasticity of domestic fixed capital. γ is output elasticity of foreign capital. If γ is significantly positive. It is concluded that the factor enhances spillover and it restricts spillover if γ is significantly negative.

The technological spillover effect of FDI means that capital embodies the technology in Eq.(2.3). The results showed that domestic firms benefit significantly from foreign firms.

The others studies use total factor productivity based on Cobb-Douglas production function (Todo, 2008; Li Xing, 2008; Li Li, 2010).

Li Xing (2008) in Chapter 4 estimate technological spillover of FDI in china, using panel data. Substitute Eq. (2.4)

$$Y_{it} = A_{it} L_{it}^{\alpha} K_{it}^{\beta} \qquad (2.4)$$

$$A_{it} = B_{it} e^{\eta share_{it}} \qquad (2.5)$$

Where Y_{it} denotes value- added for industry i in year t, A_{it} is total factor productivity for industry i in year t , and L_{it} ,K_{it} are labor and capital for industry i in year t, B_{it} is rate of foreign capital to industry capital for industry i in year t. η is technology Spillover effects factor of FDI. $Share_{it}$ is rate of foreign capital to total capital of Chinese manufacturing industries for industry i in year t.

For Eq.(2.5)and giving natural log, can be written as following:

$$LnY_{it} = LnB_{it} + \eta share_{it} + \alpha LnK_{it} + \beta LnL_{it} + \mu_{it} \qquad (2.6)$$

α is output elasticity of capital and β is output elasticity of domestic fixed labor. η is technology elasticity of foreign share. μ_{it} is error for industry i in year n.

If η is significantly positive, it is concluded that the factor enhances spillover and it restricts spillover if η is significantly negative. The result showed that domestic firms' productivity or technological growths by foreign firms enter.

In this paper, not only capital of foreign firms but also its technology affects Chinese firms.

We estimate technological spillover effect of foreign firms in Chinese large-scale firms of industry, using the macro panel data of 27 large-scale domestic manufacturing industries from 2001 to 2007.foreign firms, and taking effects of technology level of foreign firms.

3. Empirical Methodology

In this section, we estimate technological spillover effects by two steps. The First, to estimate technology level, we borrow Cobb-Douglas production function,. After that, we extend the previous studies to examine the effects of technology spillover of FDI on large-scale domestic manufacturing industries in China.

3.1 Estimating for technology level

The first, we consider research methodology to estimate technology level. As is well known, the Cobb-Douglas production function is used often when economists estimate productivity. We also borrow Cobb-Douglas production function as following:

$$Y = f(K, L) \tag{3.1}$$

or

$$Y = AL^{\alpha}K^{\beta} \tag{3.2}$$

where Y is output, K and L denote fixed capital, labor, A is technology level, the others studies name it total factor productivity, α is labor share and β is capital share.

For Eq. (3.2) with industry i and year t, and giving natural log and error, it can be turned as following:

$$lnY_{it} = lnA_{it} + \alpha lnL_{it} + \beta lnK_{it} + \varepsilon_{it}$$

$$\varepsilon_{it} \sim N(0, \delta^2) \tag{3.3}$$

Where Y_{it} denotes value-added for industry i in year t, A_{it} is technology level for industry i in year t, and L_{it}, K_{it} are labor and capital for industry i in year t, μ_{it} is error for industry i in year t. α is output elasticity of labor and β is output elasticity of domestic fixed capital.

When the constant returns to scale prevail or $\alpha+\beta=1$, Eq. (3.3) can be written as:

$$ln\left(\frac{Y_{it}}{L_{it}}\right) = LnA + \beta ln\left(\frac{K_{it}}{L_{it}}\right) + \varepsilon_{it}$$

$$\varepsilon_{it} \sim N(0, \sigma^2) \tag{3.4}$$

Using Panel Ordinary Least Square (OLS) estimator on Eq. (3.4), β, can be estimated. Because we supposed $\alpha=1-\beta$, so we also know α, Eq. (3.2) with industry i and year t, can be written as following:

$$A_{it} = \frac{Y_{it}}{K_{it}^{\beta} L_{it}^{\alpha}} \qquad (3.5)$$

Based on Eq. (3.5), using the data of β ,α ,and the origin data of Y_{it} , L_{it} , K_{it}, Y_{it}, K_{it}, L_{it}, we can estimate the technology level of foreign firms ($AFDI_{it}$) and technology level of Chinese large-scale firms (A_{it}).

3.2. Estimating for technological spillover effects

As the second step, we consider whether these factors have effects on technological spillover.

In this paper we consider affecting factors as following,

Maitaing the assumption that the foreign firms and domestic firms have the competitive effects, we extend the previous studies and take up technology level of foreign firms ($AFDI_{it}$). For domestic firms, we can consider the relationship between technology level in year *t* (A_{it}) and its t-1 (A_{it-1}), and finally add the foreign capital (FY_{it-1}) exactly the same as the previous studies. We provide a new econometric framework which is expressed as follows:

$$A_{it} = \alpha_1 + \alpha_2 AFDI_{i,t} + \alpha_3 FY_{it-1} + \alpha_4 A_{it-1} + \varepsilon_{it} \qquad (3.6)$$

where A_{it} is technology level of domestic firms for industry *i* in year *t* as a dependent variable. $AFDI_{it}$ is technology level of foreign firms for industry *i* in year *t*, ε_{it} is error for industry i in year *t*, FY_{it-1}, which be expressed as following:

$$FY_{it-1} = \frac{FDI_{it-1}}{GDP_{it-1}} \qquad (3.7)$$

It is the rate of foreign capital to output of domestic firms in industry level in year t-1, α_1 is constant, α_2 is technology level of domestic firms elasticity of technology level of foreign firms in industry level, α_3 is technology level of domestic firms elasticity of *FY*. α_4 is technology level of domestic firms in year t elasticity of its in year t-1. Considering time lag, we give time-lag 1 to *A* and *FY* as independent variable. α_2 means the technological spillover effects of FDI. Using OLS estimator, we can estimate α_2, if coefficient α_2 is significantly positive, it is concluded that the factor enhances spillover effects, and it restricts spillover if α_2 is significantly negative.

4. Data Set

The above literatures mainly use the time-series data, but panel data. To use Panel data we can control for individual heterogeneity, and give more information, design data collection problems (Hsiao, 2003). In this paper, in order to estimate technological spillover effect of foreign firms in Chinese large-scale firms of industry, we use the macro panel data of 27 large-scale domestic manufacturing industries from 2001 to 2007.

We use China statistical yearbooks (2002-2008) for foreign firms and large-scale domestic firms. Each variable is set as following:

1) Value added (Y)

We use value-added of large-scale industries to subtracted value added of foreign firms for value-added of domestic, and exchanged by good price index (2000 average=100).

2) capital stock (K)

We use fixed assets of large-scale industries for capital

3) labor(L)

Work time of employed personnel is not reported in China statistical yearbook, so we use annual average number of employed personnel.

5. Results and interpretation

Based on Eq. (3.3), the technology level of Chinese large-scale firms and foreign firms in industry level are estimated as following table1.

In econometrics, Wald test is the most widely accepted definition of coefficients limitation. The first, we test for $\alpha+\beta=1$, using EViews6.0 soft, Test result in table 1 show that F value is 2.25 in domestic firms case, and Probability is over 5%, then the Null hypothesis ($\alpha+\beta=1$) is not rejected. Similar process is used in foreign firms for testing the Null hypothesis ($\alpha+\beta=1$), we do not reject the null hypothesis too. Output elasticity of capital domestic firms is 0.619 and foreign firms' is 0.630, both of them are 1% of statistical significance level. Capital input is more Contribution degree to output than labor input. The same result is estimated by Fengyue's study (2008). using β, α can be estimated as following table 1:

Table 1 Result of output elasticity of capital

	Domestic firms	Foreign firms
β	0.619 (22.91)**	0.630 (52.57)**
constant	0.75 (9.90)**	0.815 (9.963)**
Wald test（F）(α＋β=1)	2.25 0.132	4.05 0.062
R-squared	0.741	0.674
F-statistic	265.57	387.33
α	0.381	0.370

Note: **and* indicate 1% and 5% of statistical significance level, respectively.

In order to determine whether the units root exist or not, Eq. (4.1) is estimated using OLS for *A, FY*, and *AFDI*. For example A as following:

$$\Delta A_{it} = \delta_i A_{it-1} + \sum_{j=1}^{L_i} \gamma_{it} \Delta A_{it-1} + \beta trend_t + \eta_i + \varepsilon_{it} \quad (4.1)$$

If the hypotheses is not rejected ,there is a non-year unit root in the series. Usually LLC(Levin,Lin, Chu(2002)), IPS(Im, Pesaran and Shin(2003))、ADF(Augmented Dickey-Fuller Unit Root Test) are used, in this paper we use LLC and IPS. Test result in table 2 show that A, AFDI, FY are stationary in first difference and AFDI and FY is stationary in level By LLC test.

Table 2 Result of Unit root tests for level and difference

	Level		First difference	
Variables	L L C	I P S	L L C	I P S
A	0.185	0.177	0.000	0.000
AFDI	0.000	0.636	0.000	0.029
FY	0.000	0.400	0.000	0.000

Summarizing the above test results, we conclude that all variable are integrated of order, I (1),

In econometrists, granger definition of causality is the most widely accepted definition of causality（granger ,1969). If the *F*-statistic is grater than a certain critical value and it's Prob is statistical significance level. For example, then we reject the null hypothesis that AFDI does not granger cause a, which means AFDI granger cause A.

After that, we also tested granger causality for *AFDI*, *A* and *AFDI* (1), *A* (1). The result in

Table 3 Result of Granger Causality Tests

Null Hypothesis	F-statistic	Prob
AFDI does not Granger Cause A	21.665	0.0000
AFDI(1) does not Granger Cause A(1)	14.76	0.0006

table 3 show that both of null hypothesis are rejected, we conclude that *AFDI* does granger cause *A* in level and first difference.

Finally, based on Eq. (3.6), we estimated technology spillover effects of FDI as following table 4:

Table 4 presents the result of the regressions analysis. The coefficient of AFDI is significantly positive at 0.165. But the coefficient of FY is minus. This is because there

Table 4 Effect ion of TFP of Chinese domestic firms

Dependent Variables : A(TFP)	OLS
AFDI	0.165
	(4.35)**
A(-1)	1.06
	(35.65)**
FY(-1)	-15.574
	(-2.62)**
constant	11.75
	(3.73)**
R-squared	0.982
F-statistic	2960.93
Prob(F-statistic)	0.000
Number of observations	189

Note: The figures in parentheses are t-statistics.
**and* indicate 1% and 5% of statistical significance level, respectively.

is less inflow of foreign capital into China than technology growth of Chinese firms during this period. The coefficients of A(-1) and constant are, as expected, 1% of statistical significance level.

The above results show Foreign presence does have positive effect big technological spillover effects on domestic productivity of industry in China in 2001-2007.

6. Conclusions remarks

FDI has been considered the key to the economic growth for developing countries. FDI has contributed a rapid growth of GDP and technological advances in China. This paper studies whether the technological spillover effects on the productivity of domestic firms in Chinese large-scale industries. We do an empirical study on using industry-level panel data of 27 industrial sectors during 2001-2007 based on Total Factor Productivity (TFP).The result indicates that FDI has positive effect of technology spillover on firms of large-scale domestic manufacturing industries. This result may be achieved by the purchasing of materials, the competition and effective demonstration of the foreign firms. This is a study on technological spillover effects, just during 2001-2007. After the world financial crisis in 2008, FDI inflows to China has grew steadily. Neither the impact, nor policy factor have been considered in this paper yet, these questions are left for further studies.

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