TOWARDS FDI AND TECHNOLOGY SPILLOVER:
A CASE STUDY IN CHINA

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**ABSTRACT.** Technology spillover has played an important role to promote technology innovation of indigenous firms in emerging countries. In this paper, the effects of technology spillover in Shanghai, the largest city attracting FDI in China were examined. Roll regression on the basis of panel data and co-integration on time series during the period from 1981 to 2004 are employed. The results from the two methods were compared. It is indicated that the increase of foreign direct investment (FDI) restrains, rather than promotes the technology increase of indigenous firms. The research has revealed that FDI has negative effects of technology spillover on indigenous firms in Shanghai, China.

**KEYWORDS:** FDI, technology spillover, emerging markets, China.

**JEL classification:** F21, P2, P33.

**Introduction**

Foreign direct investment (FDI) brings about double-edged effects on the indigenous firms. The entrance of foreign-invested enterprises will drive technology progress of indigenous firms through channels such as demonstration and intense competition. On the other hand, intensive foreign invested enterprises (FIEs) will lead to extrusion effect on indigenous firms. Technology spillover has played an important role to promote technology innovation of indigenous firms in emerging countries. In this paper, the effects of technology spillover in Shanghai, the largest city attracting FDI in China were examined. Roll regression on the basis of panel data and co-integration on time series during the period from 1981 to 2004 are employed. The results from the two methods were compared. It is indicated that the increase of foreign direct investment (FDI) restrains, rather than promotes the technology increase of indigenous firms. The research has revealed that FDI has negative effects of technology spillover on indigenous firms in Shanghai, China.

Foreign direct investment (FDI) has been widely recognized as a growth-enhancing factor in investment receiving (host) countries. FDI not only brings in capital but also introduces advanced technology that can enhance the technological capability of the host country firms (Demirbag et al., 2007). The technological benefit is not limited to locally affiliated firms but can also spread to non-affiliated ones. The latter benefit is usually referred to as technology spillover (Kohpaiboon, 2006). However, FDI brings about double-edged effects on the indigenous firms. The entrance of foreign-invested enterprises will drive technology progress of indigenous firms through channels such as demonstration and intense competition (Thompson, 2002). On the other hand, intensive foreign invested enterprises (FIEs) will lead to extrusion effect on indigenous firms.

Since implementing reform and open policies in 1978, China’s economy has grown rapidly. China has been one of the biggest emerging markets attracting FDI (Chen et al.,
1995; Liu, 2002). For example, the proportion of FDI on total capital formation reached over 25 percent in 2004 in Shanghai, the largest city in China (see Figure 1).

![Figure 1. FDI of Shanghai between 1981 and 2004](image)

However, research on technology effects from FIE to indigenous firms in the Chinese context is, to our knowledge, still of paucity, which is the focus of this article. This paper aims to examine the effects of FDI on technology spillover in Shanghai, using roll regression on the basis of panel data and co-integration on time series. The aim is to understand the challenges for emerging markets around the world in bringing positive effects of FDI on technology spillover.

1. Literature review

The expectation of gaining from technology spillover persuades many developing countries to offer various incentives in order to attract FDI (Sadik and Bolbol, 2001.). However, FDI spillovers depend on many factors (Crespo and Fontoura, 2007). The results of empirical research to test the validity of FDI spillover are far from conclusive (Koopaiboon, 2006). Some researchers confirmed that FDI has positive correlation with production efficiency of indigenous firms (Caves, 1974; Globerman, 1979; Blomstrom & Persson, 1983). A study conducted by Kim (1998) indicated that it’s a key factor for indigenous firms transforming from imitation to innovation to effectively promote and to make use of technology transfer of foreign invested enterprises. Liu et al. (2000) examines intra-industry productivity spillovers from foreign direct investment (FDI) in the UK manufacturing sector. The empirical analysis uses panel data for 48 UK industries over the period 1991-1995. The results indicate that the very presence of FDI has a positive spillover impact on the productivity of UK-owned firms.

Sinani and Meyer (2004) reveal that technology spillover has positive effect in Estonia. Positive technology spillover from FDI has only been found in some countries. Overall, the findings seem to suggest technology spillover is not automatic, but depends on both country-specific factors and policy environment.

Foreign direct investment (FDI) brings about double-edged effects on the indigenous firms. The entrance of foreign-invested enterprises will drive technology progress of indigenous firms through channels such as demonstration and intense competition. On the other hand, intensive foreign invested enterprises (FIEs) will lead to extirpation effect on indigenous firms (Reganati and Sica, 2007). Technology spillover has played an important role to promote technology innovation of indigenous firms in emerging countries. In this paper, the effects of technology spillover in Shanghai, the largest city attracting FDI in China.
were examined. Roll regression on the basis of panel data and co-integration on time series during the period from 1981 to 2004 are employed. The results from the two methods were compared. It is indicated that the increase of foreign direct investment (FDI) restrains, rather than promotes the technology increase of indigenous firms. The research has revealed that FDI has negative effects of technology spillover on indigenous firms in Shanghai, China.

However, some researchers presented their suspicious views on the positive effects of technology spillover (Haddad & Harrison, 1993; Djankov & Hoekman, 2000; Konings, 2001). For Morocco, Haddad and Harrison (1993) explored the effects of foreign presence on the relative productivity of local firms by comparing firm level productivity with that of the best practice firm in the industry and find no evidence of spillovers. For Venezuela, Aitken and Harrison (1999) found negative spillovers. They described that as a market stealing effect because foreign investment reduced domestic plant productivity in the short run by forcing domestic firms to cut production. Additionally, Aitken and Harrison (1999) test the possibility that spillovers are local and find no evidence to support this claim. For India, Kathuria (2000) revealed that local firms do not benefit from a foreign presence. Djankov and Hoekman (2000) find a positive significant impact of FDI on the growth of sales for their entire sample of Czech firms. However, contrary to what is predicted, spillovers have a negative impact on the growth of sales of domestic firms. Hence, growth of sales in the industry occurs in the foreign owned firms while the technological level of local firms may be too low to enable them to absorb new knowledge that they encounter, but only if local firms invest in R&D activities. Hence, R&D and spillovers may be complementary.

Konings (2001) explored negative spillovers to domestic firms in Bulgaria and Romania, which suggests that the crowding-out effect of competition dominates the positive effect of technology transfer. Also, Konings (2001) and Gryko and Kluzek (2008) revealed no evidence of any spillovers to domestic firms in Poland. Feinberg and Majumdar (2001) estimated production functions for foreign and domestic firms in India and found that multinational corporations gain from each others' R&D spillovers, although domestic firms do not. More recently, Duffield and Love (2007) developed a taxonomy that relates foreign direct investment (FDI) motivation (technology- and cost-based) to its anticipated effects on host countries' domestic productivity. By empirically examining the effects of FDI into the United Kingdom on domestic productivity, they find that different types of FDI have markedly different productivity spillover effects, which are consistent with the conceptual analysis. The UK gains substantially only from inward FDI motivated by a strong technology-based ownership advantage. However, inward FDI motivated by technology-sourcing considerations leads to no productivity spillovers.

The issue of evaluating effects of technology spillover in China has engaged researchers for a long time. Buckley et al. (2007) find that the nationality of ownership of foreign investors significantly impacts upon productivity spillover effects, revealing a curvilinear relationship with foreign direct investment on data for overseas Chinese (Hong Kong, Macau and Taiwan) multinational enterprises, but not for other (Western) firms. This relationship is most pronounced for low-technology host industries. Li and Yue (2005) examines the evolutionary processes of multinational corporations' R&D strategies in China in terms of two principal dimensions, i.e. geographic dispersion and functional focus. They find that the globalization of R&D through foreign centers of scientific and technological excellence enables multinational corporations to innovate closer to their product markets and manufacturing facilities in emerging markets. Based on a panel of more than 10,000 indigenous and foreign-invested firms for 1998–2001, Wei and Liu (2006) assesses productivity spillovers from R&D, exports and the very presence of foreign direct investment (FDI) in China's manufacturing sector. They find that there are positive inter-industry productivity spillovers from R&D and exports, and positive intra- and inter-industry
productivity spillovers from foreign presence to indigenous Chinese firms within regions. Moreover, OECD-invested firms seem to play a much greater role in inter-industry spillovers than overseas Chinese firms from Hong Kong, Macao and Taiwan within regions.

Using detailed cross-section data for 1995, Buckley et al. (2002) reveal that non-Chinese MNEs generate technological and international market access spillover benefits for Chinese firms, while overseas Chinese investors confer only market access benefits. State-owned enterprises reap no benefits, and indeed receive negative spillovers from overseas investors, in marked contrast to the positive spillovers gained by collectively-owned firms.

Using a set of panel data of 11,324 firms in China from 1996 to 1999, Tian (2007) finds that positive technology spillovers from FIEs to domestic firms occur through tangible assets rather than intangible assets, through domestically consumed products rather than exported products, through ‘traditional’ products rather than new products, and through FIEs employing unskilled workers rather than FIEs employing skilled workers. FIEs are found to generate negative spillovers through exports and through employment of skilled workers.

2. Methodology and Methods

As Görg and Strobl (2001) and Aitken and Harrison (1999) argue, panel data analysis is a more appropriate method to determine productivity spillovers. In this paper, two methods are employed for comparison. First, the relationship between FDI and economical increase is examined by using a roll-regression method to analyse panel data for Shanghai, the largest city in China between 1981 and 2004. Second, the effects of FDI on indigenous firms are investigated (Ramirez, 2000) using a co-integration method to analyse time series data for Shanghai between 1981 and 2004. In comparing the results conducted from the two methods, the effects of technology spillover of FDI on indigenous firms in Shanghai can be studied.

2.1 Roll-regression model of panel data

Based on the research by Feder (1983) and He (2000), a regression model is developed by introducing new variables.

Assume that

\[ Y = D + F, \]

where \( Y \) is the total output; \( D \) the local output; and \( F \) the FDI output;

\[ F = F(K_f, L_f), \]

where \( K_f \) is the capital of FDI; and \( L_f \) the labor force of FDI;

\[ D = D(K_d, L_d, K_f), \]

where \( K_d \) is the local capital; \( L_d \) the local labor force; and \( K_f \) the capital of FDI;

The element productivity ratio of \( F \) and \( D \) is constant:

\[ \frac{FL}{DL} = \frac{FK}{DK} = 1 + \theta, \quad \theta \in (-1, 1), \]

\[ FL = \frac{\partial F}{\partial L_f} K_f; \quad DK = \frac{\partial D}{\partial K_d} \]

Then, \( Y = D + F = F(K_f, L_f) + D(K_d, L_d, K_f) \).

By differentiating both sides, we obtain

\[ dY = FL \times dL_f + FK \times dK_f + DL \times dL_d + DK \times dK_d + DF \times dK_f, \]

where \( DF = \frac{\partial D}{\partial K_f} \) is the change of local output caused by addition of FDI.

From equation (4), \( FL = DL \times (1 + \theta), \quad FK = DK \times (1 + \theta). \) After being added to equation (6), one obtains
\[ dY = DL \times (1+\theta) \times dL_f + DK \times (1+\theta) \times dK_f + DL \times dL_d + DK \times dK_d + DF \times dK_f \]

\[ = DL \times (dL_f + dL_d) + DK \times (dK_f + dK_d) + \theta \times (DL \times dL_f + DK \times dK_f) + DF \times dK_f \]

\[ = DL \times dL + DK \times dK + \theta \times (DL \times dL_f + DK \times dK_f) + DF \times dK_f \]

\[ = DL \times dL + DK \times dK + DF \times dK_f + [\theta / (1+\theta)] \times [DL \times (1+\theta) \times dL_f + DK \times (1+\theta) \times dK_f] \]

\[ = DL \times dL + DK \times dK + DF \times dK_f + [\theta / (1+\theta)] \times [FL \times dL_f + FK \times dK_f] \]

Dividing both sides by \( Y \), we obtain

\[ \frac{dY}{Y} = \frac{DK \times dK}{K} + \frac{DL \times dL}{L} + \frac{DF \times dK_f}{Y} + \frac{\theta \times dF}{1+\theta} \]

\[ \text{(7)} \]

Let \( \beta_1 = (DK \times K) / Y, \beta_2 = (DL \times L) / Y, \beta_3 = DF = D/DK_f, \beta_4 = \theta / (1+\theta), \)

where \( \beta_1 \) is the capital elasticity of output, representing the contribution of capital increase on economic increase; \( \beta_2 \) the labor elasticity of output, representing the contribution of the labor force increase on economic increase; \( \beta_3 = \partial D / \partial K_f \) the change of local output caused by addition of FDI, representing the technology spillover effects of FDI on the local section; and \( \beta_4 \) the economic increase contribution of the ratio of FDI output to the local output. Because of the lack of historical data on FDI output, and interrelation between \( dF \) and \( dK_f \), \( dF \) is omitted to avoid multicollinearity.

Thus equation (7) can be rewritten and shown in equation (8):

\[ \frac{dY}{Y} = \beta_0 + \beta_1 \times \frac{dK}{K} + \beta_2 \times \frac{dL}{L} + \beta_3 \times \frac{dK_f}{Y} + u \]

\[ \text{(8)} \]

2.2 Model for co-integration of time series

A production function of the local section is employed to measure effects of technology spillover on the local industry department. The production function was given in (Ramirez, 2000) and is repeated here as:

\[ Y_d = AF(L_d, K_d, E) = A L_d^a K_d^b E^c \]

\[ \text{(9)} \]

where \( Y_d \) is the total output of indigenous firms; \( L_d \) the labor force; \( K_d \) the capital of indigenous firms, \( E \) the knowledge reservation, a function of the local capital and FIE capital, \( E = K_d^a K_f^c \), and \( K_f \) the capital of FIE, then \( Y_d = AL_d^a K_d^b K_f^c \), noted as below:

\[ Y_d = AL_d^a K_d^b K_f^c \]

\[ \text{(10)} \]

By differentiating \( Y_d \), we obtain

\[ \Delta Y_d = \frac{\partial Y_d}{\partial L_d} \Delta L_d + \frac{\partial Y_d}{\partial K_d} \Delta K_d + \frac{\partial Y_d}{\partial K_f} \Delta K_f = \frac{\partial Y_d}{\partial L_d} \frac{\partial L_d}{\partial K_d} \Delta K_d + \frac{\partial Y_d}{\partial K_d} \frac{\partial K_d}{\partial K_f} \Delta K_f + \frac{\partial Y_d}{\partial K_f} \Delta K_f \]

\[ = AK_d^a K_f^c \lambda_1 L_d^a \Delta L_d + AK_d^a K_f^c \lambda_2 K_d^b \Delta K_d + AK_d^a K_f^c \lambda_3 K_f^c \Delta K_f \]

\[ \Delta Y_d = AK_d^a K_f^c \lambda_1 L_d^a \Delta L_d + AK_d^a K_f^c \lambda_2 K_d^b \Delta K_d + AK_d^a K_f^c \lambda_3 K_f^c \Delta K_f \]

\[ \Delta Y_d = AK_d^a K_f^c \lambda_1 L_d^a \Delta L_d + AK_d^a K_f^c \lambda_2 K_d^b \Delta K_d + AK_d^a K_f^c \lambda_3 K_f^c \Delta K_f \]

\[ = \lambda_1 \Delta L_d + \lambda_2 \Delta K_d + \lambda_3 \Delta K_f \]

\[ \text{(11)} \]
where $\lambda_1$ is the boundary product elasticity of labor force, $\lambda_2$ the capital of indigenous firms; and $\lambda_3$ the boundary product elasticity of capital of FIE on indigenous firms, reflecting technology spillover effects of FDI on indigenous firms.

By taking the logarithm of equation (10) and adding constants and errors, the estimation model is given as

$$\ln Y_d = \lambda_0 + \lambda_1 \ln K_d + \lambda_2 \ln L_d + \lambda_3 \ln K_f + \mu,$$

(11)

2.3 Research Data

Data in this research are selected from the Shanghai Statistical Yearbook between 1981 and 2004.

(1) Date for the roll-regression method:

$Y$: Gross industrial output value in Shanghai (in 100 million RMB yuan);

$K$: Gross capital formation in Shanghai (in 100 million RMB yuan);

$L$: Number of industrial staff and workers in Shanghai (in 10,000 people); and

$dK_f$: Total amount of FDI actually used in Shanghai (in 100 million RMB yuan);

Note: FDI has been converted to RMB yuan

(2) Data for the co-integration method:

$Y_d$: Gross industrial output value of indigenous enterprises in Shanghai;

$L_d$: Number of industrial staff and workers of indigenous enterprise in Shanghai (in 10,000 people);

$K_d$: Total amount of capital of indigenous enterprises; and

$K_f$: Total amount of capital of foreign funded enterprises.

3. Results of the Roll-Regression Method

3.1 Regression on total data

First, regression on the total panel data from 1981 to 2004 is given as

$$\frac{dY}{Y} = 0.086 + 0.231 \times \frac{dK}{K} - 0.342 \times \frac{dL}{L} + 0.211 \times \frac{dK_f}{Y},$$

$t$ test : (2.941***, 3.264***, -0.790, 0.267)

$R^2=0.369$, Adjusted $R^2=0.275$, $F = 3.906$, $P = 0.024$, D.W. = 1.339

The coefficient of $dK/K$, $\beta_1$ of about 0.231 passes the significance test but the coefficients of $dL/L$, $dK_f/Y$, $\beta_2$ and $\beta_3$ could not pass the test. This indicates that:

(1) investment has distinct influences on the local industrial improvement, and industrial improvement models in Shanghai have become investment-driven;

(2) the increase of labor force amount do not have distinct effects in promoting industrial models;
(3) there are no distinct technology spillover effects of FDI in Shanghai from 1981 to 2004. \( \beta_3 = \frac{\partial D}{\partial K_f} < 0 \), indicates that FDI might hold back the increase of industrial output value of indigenous firms, but not distinct.

### 3.2 Roll-regression method on data sections

The data are divided into 12 sections to conduct the roll-regression method. The length of each section is 13 years, i.e. the data from 1981-2004 can be divided into 12 sections 1981-1993, 1982-1994, …, 1991-2003 and 1992-2004, to study the change of \( \beta_3 \), and to test the technology spillover effects of FDI (see Figure 2).

![Figure 2. Coefficients of the roll-regression method](image)

The results are listed in Table 1. From Table 1, it is clear that the capital investment always has distinct positive promoting effects on the economical increase. First, this is consistent with the results obtained using the total data, indicating that the industry in Shanghai has become one capital-intensive industry, closely dependent on capital investment. Second, labor force has distinct negative effects on the economical increase during the early sections, and insignificant effects in the later sections. Third, in the early sections, there are only 1983-1995 sections having distinct negative adjustment effects. In the last 6 sections, there are four sections having distinct negative effects on technology spillover, indicating that the restraining effects of FDI on the local economy becomes stronger with the increase of the FDI.

### 3.3 Result of the co-integration method on unsteady time-series data

#### 3.3.1 Unit-root test

There are several methods to conduct that unit root test. For example, Phillips and Perron (1988) developed a nonparametric method (PP method) to control the high order interrelationship of time series data. This method did not strictly demand the errors to be independent and similar simulated, but to solve the high order interrelationship of the errors by correcting the \( t \) statistic of one order self-regression coefficient. It will not change time characteristic to take logarithm on the time series. Logarithmic series can be used to stabilize unsteady time series data of \( LnY_d, LnK_d, LnL_d, \) and \( LnK_f \).
<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>( \beta_0 )</td>
<td>0.131***</td>
<td>0.165***</td>
<td>0.195***</td>
<td>0.148***</td>
<td>0.138***</td>
<td>0.119***</td>
<td>0.131***</td>
<td>0.133***</td>
<td>0.146***</td>
<td>0.142***</td>
<td>0.174**</td>
<td>0.167*</td>
</tr>
<tr>
<td>(4.814)</td>
<td>(6.267)</td>
<td>(6.187)</td>
<td>(4.554)</td>
<td>(3.87)</td>
<td>(3.943)</td>
<td>(4.618)</td>
<td>(4.329)</td>
<td>(0.031)</td>
<td>(4.038)</td>
<td>(2.929)</td>
<td>(1.950)</td>
<td></td>
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<tr>
<td>( \beta_1 )</td>
<td>0.162***</td>
<td>0.200***</td>
<td>0.246***</td>
<td>0.202**</td>
<td>0.233**</td>
<td>0.387***</td>
<td>0.401***</td>
<td>0.399***</td>
<td>0.429***</td>
<td>0.416***</td>
<td>0.413***</td>
<td>0.414***</td>
</tr>
<tr>
<td>( \beta_2 )</td>
<td>-2.070**</td>
<td>-2.366**</td>
<td>-1.595</td>
<td>-0.673</td>
<td>-0.497</td>
<td>-0.479</td>
<td>-0.151</td>
<td>-0.064</td>
<td>0.035</td>
<td>0.004</td>
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<tr>
<td>(-2.662)</td>
<td>(-2.866)</td>
<td>(-1.829)</td>
<td>(-0.992)</td>
<td>(-0.791)</td>
<td>(-0.753)</td>
<td>(-0.423)</td>
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<td>(-0.08)</td>
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<tr>
<td>( \beta_3 )</td>
<td>2.095</td>
<td>-1.080</td>
<td>-3.380**</td>
<td>-0.846</td>
<td>-1.086</td>
<td>-1.401</td>
<td>-1.623*</td>
<td>-1.641*</td>
<td>-1.853**</td>
<td>-1.629**</td>
<td>-1.951</td>
<td>-1.876</td>
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<td>(1.170)</td>
<td>(-2.483)</td>
<td>(-1.196)</td>
<td>(4.618)</td>
<td>(2.158)</td>
<td>(2.487)</td>
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<tr>
<td>( R^2 )</td>
<td>0.910</td>
<td>0.873</td>
<td>0.769</td>
<td>0.607</td>
<td>0.505</td>
<td>0.664</td>
<td>0.745</td>
<td>0.747</td>
<td>0.772</td>
<td>0.650</td>
<td>0.639</td>
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<tr>
<td>Adjusted ( R^2 )</td>
<td>0.880</td>
<td>0.830</td>
<td>0.692</td>
<td>0.476</td>
<td>0.340</td>
<td>0.552</td>
<td>0.661</td>
<td>0.663</td>
<td>0.696</td>
<td>0.693</td>
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<td>0.519</td>
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<tr>
<td>( D.W. )</td>
<td>3.04</td>
<td>2.326</td>
<td>1.328</td>
<td>2.177</td>
<td>1.988</td>
<td>2.186</td>
<td>2.485</td>
<td>2.429</td>
<td>2.448</td>
<td>2.352</td>
<td>1.639</td>
<td>2.204</td>
</tr>
</tbody>
</table>

Note: the numbers in blank are the \( t \) statistic of the coefficients;

*** represent the significance levels of 1%;

** represent the significance levels of 5%;

* represent the significance levels of 10%.
Table 2. Results of PP unit root test

<table>
<thead>
<tr>
<th>Variable Test Form (C,T,K)</th>
<th>PP statistic</th>
<th>5% critical</th>
</tr>
</thead>
<tbody>
<tr>
<td>LnYd (C,N,1)</td>
<td>-2.011</td>
<td>-3.632</td>
</tr>
<tr>
<td>LnKd (N,N,1)</td>
<td>3.33</td>
<td>-1.957</td>
</tr>
<tr>
<td>LnLd (C,T,1)</td>
<td>-1.38</td>
<td>-3.633</td>
</tr>
<tr>
<td>LnKf (C,T,2)</td>
<td>-0.144</td>
<td>-3.633</td>
</tr>
<tr>
<td>ΔLnYd (C,T,3)</td>
<td>-4.353</td>
<td>-3.65</td>
</tr>
<tr>
<td>ΔLnKd (C,T,1)</td>
<td>-3.687</td>
<td>-3.645</td>
</tr>
<tr>
<td>ΔLnLd (C,N,2)</td>
<td>-3.26</td>
<td>-3.012</td>
</tr>
<tr>
<td>ΔLnKf (C,T,11)</td>
<td>-4.717</td>
<td>-3.645</td>
</tr>
</tbody>
</table>

Note: Spectral analysis adopted Bartlett kernel estimate; test form (C,T,K) separately represents constant time trend and bandwidth respectively, N means no constant or time trend, and the bandwidth is determined by Newey-West bandwidth to change error items into white noise.

In this paper, the PP method is employed to carry the unit root test on LnYd, LnKd, LnLd, LnKf. The results are listed in Table 2. The PP statistics of LnYd is about -2.011, larger than the critical value of about -3.622, indicating that the Hypothesis that using the unit root test did not exist for LnYd. This reveals that LnYd is an unsteady series. The first order difference of LnYd and ΔLnYd has the PP statistics value of about -4.353, smaller than the critical value of about -3.65, indicating that ΔLnYd has one unit root, and is steady. That is, LnYd is the first-order integration process I(1) which is suitable for the co-integration analysis.

3.3.2 Co-integration analysis

If all time series have the same integration orders, linear combinations could decrease the integration order of the combined series, and there are distinct co-integration relationships between the time series. Aforementioned results have been shown that all series are of first order integration I(1), which means it is possible to determine whether they have co-integration relationships by using Johanson’s method.

From the results of Johanson test shown in Table 3, it is evident that the trace statistics is about 77.07 for the Hypothesis with no co-integration relationships, larger than the 5% critical value of about 47.856, hence the Hypotheses is rejected.

Table 3. Results of Johanson co-integration test estimation

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Eigen Value</th>
<th>Trace statistic</th>
<th>5% critical value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.911</td>
<td>77.07</td>
<td>47.856</td>
</tr>
<tr>
<td>≤1</td>
<td>0.624</td>
<td>28.67</td>
<td>29.8</td>
</tr>
<tr>
<td>≤2</td>
<td>0.365</td>
<td>9.097</td>
<td>15.495</td>
</tr>
<tr>
<td>≤3</td>
<td>0.001</td>
<td>0.201</td>
<td>3.841</td>
</tr>
</tbody>
</table>

But the Hypotheses indicating that there are more than one co-integration relationship should all accepted. This group of time series has only one co-integration relationship.

Coefficients of the co-integration relationship are listed in Table 4.

Table 4. Coefficients of co-integration

<table>
<thead>
<tr>
<th>Variable</th>
<th>LnYd</th>
<th>LnKd</th>
<th>LnLd</th>
<th>LnKf</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coefficient</td>
<td>1</td>
<td>0.7506</td>
<td>0.7354</td>
<td>-0.2254</td>
<td>-15.007</td>
</tr>
<tr>
<td>Standard error</td>
<td>0.0654</td>
<td>0.0637</td>
<td>0.014</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T statistic</td>
<td>11.481</td>
<td>11.544</td>
<td>15.875</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum likelihood estimation</td>
<td>116.29</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The $t$ statistics of $LnK_d$, $LnL_d$, and $LnK_f$ are about 11.481, 11.544 and 15.875 respectively, which indicates that they are distinctively different. Based on that, the co-integration equation is given as:

$$
LnY_d = 0.7506 LnK_d + 0.7354 LnL_d - 0.2254 LnK_f - 15.007,
$$

(12)

In the co-integration equation (12), coefficients of FIE capital on gross industrial output value are negative, which means that FDI has negative spillover effects on the gross industrial output value of indigenous firms in the industrial area, and the FDI growth restrains the gross industrial output value growth of the indigenous firms.

3.3.3 Error-correction model

According to Granger theory, a group of variables which have co-integration relationships possess an error-correction model (ECM) of time series which is constructed in this section. Using $\varepsilon$, which represents the residuals of equation (12) $u_t$, the ECM is given in equation (13)

$$
\Delta LnY_d = -0.6127*\varepsilon_{t-1} + 0.0537\Delta LnY_{d,t-1} - 0.062\Delta LnY_{d,t-2} + 0.31\Delta LnK_{d,t-1} + 0.3064\Delta LnK_{d,t-2} + 0.0466 \\
\times (-1.777) \quad (0.145) \quad (-1.63) \quad (0.868) \quad (1.07) \\
0.607*\Delta LnL_{d,t-1} + 0.914*\Delta LnL_{d,t-2} - 0.1348*\Delta LnK_{f,t-1} + 0.0212\Delta LnK_{f,t-2} + 0.0466 \\
(2.339) \quad (2.339) \quad (-2.531) \quad (0.342) \quad (1.013) \\
R^2=0.559, \text{ where } F \\text{ maximum likelihood estimate } = 116.29, \text{ and } AIC=-7.22.
$$

Equation (13) shows that co-integration has reverse correction effects on the growth of gross industrial output value of indigenous firms. When gross industrial output value of indigenous firms exceeds long balance restriction, the ECM decreases the current industrial output value of indigenous firms. In addition, it is found in ECM that one lagged period effect of $\Delta LnK_f$ on $\Delta LnY_d$ is about -0.1348. Two-period lagged effect is about 0.0212, which validates equation (12). This reveals that the FDI growth distinctly restrained the growth of the gross industrial output value of the indigenous firms.

4. Discussions

Results of the roll-regression method suggest that technology spillover effects of FDI on indigenous firms are negative. Also the results of the co-integration analysis show that technology spillover effects of FDI on indigenous firms were distinctly negative during the whole period. Granger test shows that the growth of FDI has distinctive reverse correction effects on the growth of gross industrial output value of indigenous enterprises in Shanghai. Our research brings about a converse finding from Liu (2002). Using industry-level data, Liu (2002) investigates the correlation between FDI presence and productivity growth in China. He finds a positive and significant effect of spillovers for the overall sample and for the sub-sample of domestic firms. Furthermore, the productivity of both state-owned and joint-venture firms is more sensitive to the presence of FDI. However, these results may not be robust to using more disaggregated, firm-level panel data (Sinani and Meyer, 2004).

Aitken & Harrison (1999) indicated that the higher of FIEs ratio in one industry, the lower the productivity of the indigenous firms. Although FDI can also spur technology progress of indigenous firms through demonstration and competitive driving (Caves, 1974), this is only a kind of short-dated simulation effect. If the competition is too intense over a long period, indigenous firms may not be able to survive, for their foreign competitors often
have more advanced technologies and management, and more competitive products. Under this circumstance, the induction of FDI can force indigenous firms to transfer to sections of the value chain with lower profit. That undoubtedly brings negative technology spillover effects on indigenous firms.

Conclusion

Theoretically FDI not only creates profit but also introduces advanced technologies which can enhance the technological capability of the host country firms. However, FDI, in practice, brings about double-edged effects on indigenous firms. The entrance of foreign-invested enterprises will drive technology progress of indigenous firms with intense demonstration and competition. On the other hand, intensive foreign-invested enterprises lead to extrusion effects on indigenous firms.

To evaluate the effects of technology spillover in Shanghai, the roll-regression method on the basis of panel data and the co-integration method on time series from 1981 to 2004 have been employed. The finding revealed that the increase of FDI restrained, rather than promoted, the technology increase of indigenous firms. From findings in this paper, it can be concluded that the FDI of Shanghai has negative spillover effects on indigenous firms.

References


FDI Policies in Transition Economies


TIESILOGINĖS UŽSIEINIO INVESTITIJOS IR TECHNOLOGIŲ SKLAIDA: KINIJOS ATVEJIS

S.X. Zeng, T.W. Wan, Vivian W.Y. Tam

SANTRAUKA

Technologijų sklaida suvaidino svarbų vaidmenį, kad skatinę technologijų naujoves ir novatoriskus sprendimus beišvystančių šalių rinkose. Šiame straipsnyje pateikiami technologijų sklaidos Šanchajuje tyrimo rezultatai, nės Šanchajus – tai didžiausias Kinijos miestas, pritraukiantis tiesiogines užsienio investicijas (TUI). Tyrimas parodė, kad tiesioginių užsienio investicijų (TUI) augimas, ne gerina bendrą Kinijos investicijų foną, bet ir daro įtaką vietinių įmonių technologijų sklaidą ir diegimą. Autoriai konstatuoja, jog TUI neigiamai veikia technologijų sklaida Kinijoje, o vietinės įmonės nepatiria jokio teigiamo efekto savo veikloje Šanchajaus regione.

REIKŠMINIAI ŽODžLAI: tiesioginės užsienio investicijos, technologijų sklaida, beišvystančios rinkos, Kinija.