Influence analysis of FDI on China's industrial structure optimization

Zhao Qiong\textsuperscript{ab*}, Niu Minyu\textsuperscript{c}

\textsuperscript{a}Economics and Management School Of Wuhan University, Wuhan Laojia Hill, HuBei 430072,China
\textsuperscript{b}Capital University of Economics and Business, Finance and Taxation Institute, 121 Zhangjialukou, Huaxiang Fengtai District, Beijing 100070, China
\textsuperscript{c}Shenzhen University, Economics College, Nanhai Ave 3688, Shenzhen, Guangdong, 518060, China

Abstract

The paper explores the effects of industrial structure caused by FDI from the aspects of scale and structure by using empirical analysis method. Especially, the paper analyses the impacts of FDI in secondary sector which absorbs the largest portion of FDI. Empirical evidence indicates that we should build up better investment environment to attract more inflow to tertiary industries and bring into the positive foreign capital spillover so as to realize the country’s industrial structure upgrading.

1. The influence of the changes of FDI scale and structure on China's industrial upgrading

Economic growth theory tells us, capital, labor force and total factor productivity are the important factors that influence a country’s economic growth, and total factor productivity makes contribution to economic growth through the changes of industrial structure, technical progress and institutional change. Therefore, industrial structure is an important content when examining the FDI spillover effect on China's economy growth. Theoretically, as a benefit supplement to China's economic development capital, FDI plays an important role in promoting China's economic strength. However, with the enhancement of China’s economic strength and national power, the effect of FDI on making up for the gap of China's economic development capital is gradually weakening. According to the structuralism theory of economic growth, economic growth

* Corresponding author. Zhao Qiong Tel.: +086-135-0130-5671; fax: +8610-8395-2253.
E-mail address: joanzhao626@gmail.com.
not only comes from the increase of total input of production factors such as capital and labor, but also comes
from the resources reconfiguration of production factors in different industry sectors, i.e. structural change,
which is more important to the potential and significance of economic growth for developing countries. So the
contribution of foreign direct investment to the host country’s economic growth is not limited to the capital
effect and the technology transfer spillover effect, and it may promote the host country’s economic growth and
bring industrial structure effect through direct or indirect industrial structure adjustment. Based on the above
thoughts, this paper primarily uses the empirical method to explore the influence of FDI on China’s industrial
structure adjustment from the aspects of FDI scale and FDI industrial distribution structure.

1.1. Model setting

In accordance with the view of the new economic growth theory, technological progress is the source of a
country's economic growth. Under the research framework of the new economic growth theory, FDI has a
variety of mechanisms to affect economic growth. According to the analysis framework of UNCTAD (1992,
1999), FDI has far-reaching impacts on the host country from the aspects of capital, technology, human capital,
trade and natural environment. More importantly, FDI has become an important source of the technological
changes in developing countries. FDI from multinational companies can transfer the advanced technology,
management and marketing experience to developing countries, thereby improving the production efficiency
and factor productivity of local enterprises. At the same time, technological progress also has a pivotal position
among the factors which can impact on a country’s industrial structure adjustment. Industrial structure changes
resulting from technology progress is considered the most lasting, vibrant and effective pathway.

In this section we will investigate the changes of China’s industrial technology progress that the inflows of
FDI brings from the perspective of technology spillover under the framework of new growth theory, and
thereby indirectly illustrate the significance of FDI for a country's industrial structure adjustment. When
analyzing the spillover effects of foreign direct investment, this paper takes the modeling ideas of Levin and
Raut (1997) for reference, that is, while considering the capital effect of foreign direct investment,
all other effects of FDI are regarded as one of the influencing factors of total factor productivity, thus
to establish the endogenous model of technological progress A=B(1+ η share)FDI ©, and add it to the
traditional Cobb-Douglas production function to analyze, now the production function is:

\[ Y_t = A L_t^a K_t^b = B (1+ \eta \text{share}_t) FDI_t^\theta L_t^\alpha K_t^\beta \]  (1)

In formula (1), \( Y_t \), \( K_t \), \( L_t \), and \( A_t \) stand for gross domestic product, capital accumulation, labor input and
total factor productivity (TFP) respectively; \( a \) and \( b \) are the average output share of labor and average output
share of capital respectively; the total factor productivity \( A \) is determined by the flow of FDI and the share
which reflects the technology spillover effect of foreign-funded enterprise (expressed by the proportion that
FDI accounts for in gross domestic investment). \( \theta \) is the coefficient of the relative productivity of foreign-
funded enterprises compared to domestic enterprises, reflecting the direct effect of the relative
factor productivity advantages of foreign-funded enterprises on promoting the host country's technological
progress. When \( \theta > 0 \), it indicates that the technology of foreign-funded enterprise is advanced, and the
production efficiency is higher than domestic enterprise; the higher the value of \( \theta \) is, the bigger the gap of
production efficiency between foreign investment and domestic enterprises. \( B_t \) is the residual value of the
influencing factors of total factor productivity, measuring the other factors that impact technology progress and
institutional change besides FDI; \( \eta \) is coefficient of the proportion that FDI accounts for in total investment,
measuring the technology spillover effect of the foreign-funded enterprise. When \( \eta > 0 \), it indicates that the
spillover effects of foreign-funded enterprise is more obvious, and the influence on the technology progress of
the host country is more effective. From the endogenous model of technology progress we can see that, FDI
can promote technology progress of the host country in two ways: one is the improvement of relative factor productivity of foreign-funded enterprises themselves, which can be regarded as the direct
effect of FDI, the other one is the technology spillover effect of foreign-funded enterprises on the host country enterprise, which can be regarded as the indirect effect of FDI.

1.2. The empirical methods and data sources

Because the FDI data of sub-industry before 1990 is missing, the step-by-step regression method is used to make the specific analysis. Firstly measured is the total factor productivity of our country since 1978, and afterwards estimated is the impact of the inflows of FDI on China’s total factor productivity (TFP) by using the data from 1990 to 2009, and finally estimated is the impact of FDI technology spillover on China’s thrice industries by using the panel data of sub-industry respectively.

When measuring the total factor productivity, this paper uses the Solow’s Residual method, i.e. Cobb-Douglas production function to measure the growth rate of total factor productivity. In other word, the growth rate of total factor productivity is calculated by the residual value which is the growth rate of output minus the growth rate of capital and labor force. Under the assumptions of constant returns to scale ($\alpha + \beta = 1$) and Tom Hicks neutral technological progress, the total factor productivity growth is equal to the rate of technological progress. The Formula is expressed as:

$$ Y_t = A_t L_t^\alpha K_t^\beta $$

Take natural logarithms on both sides of formula (2) and using $y_t$ represents per capita output level, $k_t$ represents per capita capital stock level, we can get formula (3) to estimate the total factor productivity by using the Least Square method.

$$ \ln y_t = \ln A_t + \beta \ln k_t + \varepsilon_t $$

We use Gordon Smith (1951) method when estimating the capital stock and use the data of China's capital stock by Guo Qingwang (2005) for reference and expand the data to 2009, and finally estimate China's total factor productivity by using the data from 1978 to 2009 years. The entire datum used in the regression is derived from China Statistical Yearbook over the years and Wind database.

1.3. The regression results and analysis

1.3.1. The regression results of total factor productivity

$$ \ln y_t = \ln A_t + 0.706448 \ln k_t + \varepsilon_t $$

Regression results show that, during the years of 1978-2009, the return share of capital in China is about 0.706, and returns share of labor force is 0.294. By Formula (4) we can estimate the annual total factor productivity.

1.3.2. The effect of FDI inflows on China’s Total Factor Productivity (TFP)

According to Levin and Raut (1997) model, the effect of FDI on the total factor productivity can be estimated by formula (5):

$$ A_t = B_t (1 + \text{share}_t) FDI_t^\theta $$

Make the logarithmic processing of formula (5), we can get:

$$ \ln A_t = \ln B_t + \theta \ln FDI_t + \ln (1 + \text{share}_t) + \varepsilon_t $$

When the value of $z$ is very small, $\ln (1+z) \approx z$, therefore, the formula (6) eventually becomes :

$$ \ln A_t = \ln B_t + \theta \ln FDI_t + \text{share}_t + \varepsilon_t $$

Considering the large-scale FDI inflow to China after 1990s and the availability of FDI data, this paper uses the time series data from 1990 to 2009 for the actual calculation and the time series data are calculated through the sources from China Statistical Yearbook over the years. In formula (7), FDI is the actual amount of using
foreign capital in China over the years, and is converted into RMB at the average exchange rate of RMB against the dollar over the years, and share is reflected by the proportion of FDI accounts for domestic investment each year while domestic investment is indicated by the total fixed assets investment with the deduction of FDI, A adopts the estimated value obtained from formula (4).

Because the variables of Formula (7) are time series data, there may be non-stationary which leads to pseudo regression. For this reason, we test the ADF for stationary of the relevant variables, and the final regression results are:

$$\ln A_t = -1.171209 + 0.034980 \ln FDI_t + 0.063799 \ln \text{share}_t$$  \hspace{1cm} (8)

Overall, the regression effect of the model is good in the way that the adjusted $R^2$ is 0.694515, indicating that the model has good explanatory power, the value of D-W is 2.1265, indicating there is no self-correlation in the model; the residual value of regression model passes Unit Root Test, proving to be a stationary series.

The regression results confirm that in addition to the active role of FDI as capital in China's economic development, it can also promote improvement of China's total factor productivity indirectly through technology spillover. The regression coefficient of $\theta$ is 0.035, indicating that foreign-funded enterprises, especially the large multinational companies generally have relatively high productivity compared with domestic enterprises; the regression coefficient of $\eta$ is 0.064, reflecting that technology spillover effects of foreign-funded enterprises is more obvious, and FDI can make an impact on the development of China's various industries through demonstration and correlation effects. In general, FDI has a positive effect on the increase of China's total factor productivity, but the effect is not significant.

1.3.3. The influence of FDI flows into different industries on China's total factor productivity (TFP)

According to the economic theory of structuralism, structural changes would play an important role in a country's economic development. The representative figure of "structural dynamic economics" L. L. Pasinetti firstly put forward the idea that "structural changes cause economic growth". Rostow's development stage theory (1988) also holds that economic growth is not a single economic process that separates from industrial structure but rather a result of the changing industrial structure which make its function improve continuously. In addition, Robinson and Feder added structure variables to neo-classical economic growth model in their study, the result of which also confirms the importance of structural factors in relation to the growth. There is no doubt that the tremendous achievements of China's reform and open policy are closely related to the continuous flow of FDI, and the previous empirical analysis also proves this point. However, does FDI have the same spillover effects on all industries? Does the industrial investment structure of FDI have effect on China's industrial structure adjustment? In order to better describe the impact of FDI on all industries so as to understand the impact of FDI industrial structure distribution on the development of each industry, we use the investment data of FDI in each industrial since 1990 and investigate the technology spillover effect of FDI on all industries.

$$\ln A_{it} = \ln B_{it} + \theta \ln FDI_{it} + \eta \ln \text{share}_{it} + \epsilon_{it}$$  \hspace{1cm} (9)

Because the panel data has two-dimensional characteristics and if the model specification is not correct, it will cause a large deviation. According to the model judgment results, we finally choose the variable coefficient model for our study, which also reflects that impacts of FDI on technology progress vary in different industries in China. The regression results of sub-industries are shown in the table 1.

Overall, the regression effect of the model is good and adjusted $R^2$ is 0.663649, the statistic of F is 15.55152, indicating that the model has good explanatory power. The statistics of D-W is 1.947075 and there is no variable autocorrelation in the model.

The coefficients $\theta$ of all industries are positive and very significant, indicating that the distribution of FDI in various industries have positive effect on the improvement of all industries' technological advances. The values of $\theta$ are between 0.02-0.04, which are generally low and show little difference among the industries.
This not only indicates the great improvement of the competitiveness of Chinese enterprises thanks to the reforms and opening up, and a gradually reducing gap of the relative productivity between Chinese enterprises and foreign-funded enterprises, but also suggests that the overall quality of FDI inflow is not high, and the proportion of the large multinational which are influential in the global market and can boost China's integration into the higher end of the global industrial chain is low in the absorption of the total FDI in China.

Table 1: The impact of FDI on the technological progress of different industries

<table>
<thead>
<tr>
<th>Explained variables</th>
<th>Total Factor Productivity (TFP)</th>
<th>Explained variables</th>
<th>Total Factor Productivity (TFP)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>primary industry</td>
<td>secondary industry</td>
<td>The tertiary industrial output value</td>
</tr>
<tr>
<td>LNFDI</td>
<td>0.041402* (6.261883)</td>
<td>0.038351* (6.059491)</td>
<td>0.029461* (5.470785)</td>
</tr>
<tr>
<td>SHARE</td>
<td>0.029225 (0.195212)</td>
<td>0.046752 (0.978607)</td>
<td>0.850209** (2.052445)</td>
</tr>
<tr>
<td>LNB</td>
<td>-1.039950* (-40.49388)</td>
<td>-1.180318* (-24.90620)</td>
<td>-1.098971* (-31.73774)</td>
</tr>
</tbody>
</table>

Adjusted $R^2$=0.663649  Statistic $F$=15.55152  D.W=1.947075

Note: (1) Figures in brackets are the value of t; (2) *, **, *** means statistical value is striking at 1%, 5% and 10% of significance level respectively. * in table 2 means the same.

The coefficient $\eta_i$ of all industries are above zero, indicating that FDI also have more or less positive spillover effect on China’s industry. The coefficient $\eta_i$ of tertiary industry is very significant, up to 0.85, much higher than the primary and secondary industries, indicating FDI’s positive spillover effect on the tertiary industry. At the same time, we note that although the secondary industry is the top industry to attract foreign capital among China’s three industries, the coefficient $\eta_i$ of the secondary is only 0.047, which means that the technology spillover effects of foreign-funded enterprises on domestic enterprises are not satisfactory; the spillover of domestic enterprises are very limited; and the overflow of technology brought by FDI does not translate into the technical capacity of Chinese enterprises. The unobvious technology spillover may be caused by multiple factors. For example, multinational corporations invest in mature technologies; the independence tendency of multinationals forms technological spillover barriers, the FDI absorptive capacity of domestic enterprises is not strong, and so on. But the regression results at least show that the degree of FDI spillover depends more on the quality of FDI, rather than the quantity, and the results also remind us that we must target right FDI in line with China's industrial restructuring objectives when attracting the capital in the secondary industry, further open up the door to the FDI which can boost China's industrial structure upgrading, while raise the threshold of some industries with excessive production capacity.

2. The influence of FDI on upgrading of China's secondary industrial structure

2.1. Model setting

In theory, to fully describe the contribution of FDI to China's various industries and the structural influence, we have to make specific analysis based on specific industry. In this section secondary industry is selected as our research dimension and the study scope is narrowed mainly due to two considerations: Firstly, China's FDI industrial investment tendency is strong, multinational companies have been regarding the secondary industry as the major investment industry in China, and the investment in secondary industry can basically...
reflect the whole picture of the investment effect of FDI. Secondly, it is the availability of data. Historical business datum of foreign-owned enterprises of sub-industries is available in the statistical yearbooks, which provide good material for the empirical analysis. In this section the analysis of the impact of FDI on China's structural upgrading of the secondary industry is based on the ideas of Model Feder (1983), who divides a country's economy into export sector and non-export sector and establishes a theoretical two-sector model when studying the impact of exports on a country's economy. Follow the ideas of Model Feder, we divide the country's economy into domestic sector and foreign sector, and examine the direct and indirect effects of the configuration of FDI in different sectors on China's economic growth.

The formula of the output of the two sectors is as follows:

Domestic sector: \[ N = F(K_d, L_d, X) \]  
Foreign sector: \[ X = G(K_x, L_x) \]

\( N \) and \( X \) respectively represent the output of domestic sector and foreign sector, \( K \) represents capital, \( L \) stands for labor, and the subscript \( d \) and \( x \) respectively represent the domestic sector and foreign sector. Assume that both the capital productivity and labor productivity of foreign sector are higher, that is, \( 1 + \delta \) times higher than the domestic-funded sector.

\[ \frac{G_k}{F_k} = \frac{G_x}{F_x} = 1 + \delta \]  

At the same time, we assume that the impact of foreign sectors on domestic sectors has the constant elasticity coefficient, which is:

\[ N = X^\theta F(L_d, K_d) \]  

Through total differential and deformation, finally we can get:

\[ \frac{\Delta Y}{Y} = \frac{I}{Y} F_L + \frac{\Delta L}{L} . \frac{L}{Y} . \frac{F_L}{F} + \frac{\Delta X}{X} . \frac{X}{Y} + \theta \left( \frac{\Delta X}{X} \right) . \frac{X}{Y} \]  

\( \frac{\Delta X}{X} \) is the product of the output growth rate of foreign investment sector multiplied by the share of GDP produced by the foreign investment sector, which represents the direct contribution of FDI to industrial development. \( \frac{\Delta X}{X} \) represents the indirect contribution of the foreign investment sector to industrial development, which are the spillover effects of foreign investment sector.

We can get the final regression model through the formula (14):

\[ Y = \alpha_1 I_i + \alpha_2 L_i + \alpha_3 W_i + \alpha_4 D_i + \varepsilon_i \]  

2.2. The definition of variables and sources of data

In the above model, the explained variable \( Y \) represents the annual growth rate of industrial output value of different industries, which comes from the data of all state-owned and above-scale non-state industrial enterprises in the “China Statistical Yearbook”; explained variables \( I \) represents the proportion of the annual average balance of fixed assets net value of different industries in industrial output value; \( L \) represents the growth rate of employment of various industries; \( W \), which is in formula 15, uses the annual growth of industrial output value of foreign-funded enterprises divided by industrial output value of various industries and it represents the direct contribution of foreign-funded enterprises to China's economic growth, i.e., the direct effect of FDI, which forms the production capacity of foreign-funded enterprises. The variable \( D \) in the formula 15, uses growth rate of total industrial output value of foreign funded enterprises multiplied by the share of non foreign funded enterprises in total industrial output value of the concerning sector, and it represents the spillover effect of the foreign capital sector, and reflects the indirect effect of FDI as a
"production factors package" on the domestic sector thereby, stimulates economic growth through technology, management and service.

There are big differences among various industries within the secondary sector, and in order to reflect the impact of FDI on the secondary industry more comprehensively, we subdivide the 36 industrial industry selected for our empirical analysis according to the dependence of different industries on resource in the process of production and the differences of multinational corporation investment motives, we adopt the industry classification of resource-intensiveness, and classify the selected 36 industries of secondary sector by 10 resources-intensiveness, 12 labor-intensiveness and 14 capital-intensiveness and adopt the method of sub-industry panel regression to examine the influence of FDI on three different types of industries. The year of regression model is from 2000 to 2008, for a total of nine years. All the data are from the China Statistical Yearbook over the years and wind database.

2.3. Empirical Methods and regression results analysis

This section uses the model of sub-industry panel data for quantitative, we finally decide to use the mixed model to do the regression analysis.

Table 2 the regression results of equation (15)

<table>
<thead>
<tr>
<th>Explained variables</th>
<th>The growth rate of industries output $\Delta Y/Y$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>resource-intensive industries</td>
</tr>
<tr>
<td>I</td>
<td>-0.258654*(-4.577018)</td>
</tr>
<tr>
<td>L</td>
<td>0.552492*(2.922265)</td>
</tr>
<tr>
<td>W</td>
<td>0.094621*(7.858464)</td>
</tr>
<tr>
<td>D</td>
<td>0.100047*(8.684794)</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.293102</td>
</tr>
<tr>
<td>D-W</td>
<td>2.662172</td>
</tr>
</tbody>
</table>

Overall, the regression effect of the model is mostly in line with the expectations, most variables have passed Test t, and there is no autocorrelation in the regression model, $R^2$ of the 3 models after the adjustment are 0.293102, 0.078406 and 0.280805 respectively, indicating that the model has certain explanatory power.

From the regression results we can see:

1. The different economic effects of FDI in three types of industries. From the view of coefficient W representing direct effect, the coefficients of three industries are 0.094621, 0.059142 and 0.423611 respectively, illustrating that the role FDI inflows has played in promoting China's industrial development is obvious and the degree of influence on three types of industry is successively capital-intensive industry, resource-intensive industries and labor-intensive industry, which is in line with China's economic realities. Capital-intensive industry has always been the focus of China’s FDI investment, which, through opening up foreign investment, not only solves the capital shortage problem of China's economic development, but also greatly enhances China’s industrial competitiveness.

From the view of coefficient D representing indirect effects, the coefficients of three types of industry are 0.100047, 0.061564 and 0.349878 respectively, and are all significant at the 1% level, indicating that there are some spillover effect of FDI on industrial development in China, and the capital-intensive industries still get maximum returns through absorbing foreign investment, illustrating that FDI inflows accelerate China's industrialization process, and play a certain role in promoting China's industrial structure adjustment. In the future China should intensify the strength of absorbing capital and the foreign
investment in technology-intensive industry to better promote China's industrial structure adjustment and upgrading through some indirect ways such as FDI technology spillover, backward and forward linkages of industries and demonstration.

2. In the regression results, the improvement of labor growth rate plays a positive role in the growth of three types of industry, indicating that labor is an essential element of industries development. We find that, in three types of industries, the influence of the labor force growth rate on labor-intensive industries is not the largest one, and this result may be related to the saturation of industry's labor demand and the policies of country's industrial structure adjustment. In resource intensive and capital-intensive industries, the ratio of investment to output value and the growth rate of output value present an obvious negative correlation, which does not mean that domestic investment does not promote economic growth, but just shows that the increase of economic growth rate is not necessarily accompanied by the increase of I/Y.

3. Conclusion

The analysis of this paper shows that structure adjustment should be incorporated into the focus of foreign investment utilization at present. We should guide the FDI investment flows through the adjustment of China’s industrial structure, and make the target of foreign investment consistent with that of China's industrial restructuring.

Firstly, the most important thing for China is improving the technological content of FDI in the secondary industry; actively guide FDI to invest in high-tech industries and technology-intensive industries. Secondly, promote an equilibrium distribution of FDI in the tertiary industry. We should guide more foreign capital to invest in finance, insurance, consulting and other modern services industries, and actively undertake the international transfer of services industry to realize China’s industrial rationalization and altitude. Finally, enhance autonomy of industrial restructuring. The government should establish a macro and micro two-level supervision mechanism for foreign capital. We should make appropriate adjustments when making preferential policies and create a fair and efficient market competitive environment.

References