# FOREING DIRECT INVESTMENT AND INDUSTRIAL CLUSTER IN CHINA: A FINANCIAL DEVELOPMENT PERSPECTIVE

*Bing Zhou, Research Center of the Economy on the Upper Reaches of the Yangtze River, Accounting College, Chongqing Technology and Business University, Chongqing, China, 400067*
*649670638@qq.com*

*Hui Xu, Accounting College, Chongqing Technology and Business University, Chongqing, China, 400067*
*1657711434@qq.com*

*Zhong-guo Zhou, Department of Finance, Financial Planning, and Insurance, David Nazarian College of Business and Economics, California State University Northridge, CA 91330-8379, U.S.A.*
*zhong-guo.zhou@csun.edu*

## ABSTRACT

We examine the relationship between foreign direct investment (FDI) and industrial cluster in China with an emphasis on the impact from financial environment. Using panel data from 2000 to 2010, along with inter-provincial financial development, we build a threshold model to examine the FDI effect in different provinces/regions. We find a huge difference in impact from FDI on industrial cluster among different provinces. There exists a threshold effect from financial development, which restricts industrial cluster in regions with less developed financial systems. Our results reveal that the degree of financial development is a key factor to bridge FDI and industrial cluster in China and have policy implications.

## INTRODUCTION

After China adopted the reform and open-to-the-world policy, it has become the largest developing country to attract foreign direct investment (FDI). By the end of 2008, China had utilized more than 1 trillion dollars of FDI. In 2010 alone, China attracted additional 10 billion dollars of FDI. FDI has played an important role to promote China's industrial cluster. Previous research has documented the relationship between FDI and industrial cluster at the national levels and concluded that FDI is one of the most important determinants to cause industrial cluster. However, research about the relationship between FDI and regional industrial cluster is still limited and the results about whether FDI has a notable and positive effect on regional industrial cluster are mixed.

This paper utilizes a unique provincial panel data from 2000 to 2010 to examine the role of financial environment in developing/restricting the industrial agglomeration in China and the threshold effect in the process of reginal industrial agglomeration. It builds a threshold regression model to address the phenomenon of industrial agglomeration in various regions caused by capital inflows of FDI. On both the theoretical and practical levels, the paper shows that it is worthwhile to study factors that will shape FDI's financial environment, which improves the efficiency of using foreign investment.

## HYPOTHESES

In the paper, we focus on the relationship between FDI and industrial agglomeration from the impact of FDI's technology spillovers on industrial agglomeration, the factors that may affect inflows of FDI and industrial agglomeration, and FDI's location choice. We test the following three hypotheses.

Hypothesis 1: Considering financial environment, the effect of FDI on industrial agglomeration should be different across various provinces and regions when infrastructure, regional economic development, human resources and economic structure are different.
Hypothesis 2: Provinces with a high level of financial development will attract more capital inflows, and therefore inter-provincial industrial agglomeration should be more evident.
Hypothesis 3: There exists a threshold effect in promoting industrial agglomeration.

## BASIC MODELS

In Model 1, we directly test whether FDI affects industrial cluster, using the panel data from 30 regions and provinces over the period 2000-2010:

$$Clust_{i,t} = \beta_0 + \beta_{1,i} FDI_{i,t} + \beta_{2,j} Ctrl_{i.t.j} + \varepsilon_{i,t} \quad (1)$$

where $Clust_{i,t}$ stands for the level of industrial cluster in province $i$ in time $t$, $FDI_{i,t}$ is the strength of FDI to province $i$ in time $t$, $Ctrl_{i,t,j}$ is the $j$th control variable for province $i$ in time $t$, and $\varepsilon_{i,t}$ is an error term.

Model 2 tests the threshold effect. In this study, we use the threshold panel model by Hansen. It can be estimated by using the endogenous sample data and does not require any fixed form of nonlinear equations. The basic model is given by:

$$y_i = \theta_1 X + e_i, \ q_i \le y \quad (2)$$

$$y_i = \theta_2^{'} X + e_i, \ q_i > y \quad (3)$$

where $X$ is a set of explanatory variables and $q_i$ is a "threshold variable". The threshold variable can be either a component in $X$ or another independent variable. Based on the corresponding "threshold value" of $y$, the entire sample will be divided into two sub-samples: one contains the observations with "threshold values" greater than $y$ and the other contains the observations with "threshold values" less than or equal to $y$.
Defining a dummy variable $d_i(y) = \{q_i \le y\}$ and an exponential function $\{.\}=d_i(y)$, we denote the aggregation of $X_i(y) = X_i d_i(y)$, then equations (2) and (3) can be rewritten as

$$y_i = \theta^{'} X_i + \xi_n^{'} X_i y + e_i, \text{ where } \theta = \theta_2, \text{ and } \xi_n = \theta_2 - \theta. \quad (4)$$

Using the least square method to estimate the threshold value of $\hat{y}$ that will minimize the sum of squared residuals of $S_n(y)$. Based on the estimated threshold from (4), we further test the following threshold model:

$$Clust_{i,t} = u_i + AX_{i,t} + \beta_1 FDI_{i,t} * I(thre_{i,t} \le \gamma) + \beta_2 FDI_{i.t} * I(thre_{i,t} > \gamma) + \varepsilon_{i,t}, \quad (5)$$

where $u_i$ is the intercept and it reflects the average level of industrial cluster in province $i$ when all the explanatory variables are zero. $X_{i,t}$ is a set of control variables, while A is a set of regression coefficients associated with the explanatory variables. The variable $thre_{i,t}$ is a threshold variable for province $i$ in time $t$ and $\gamma$ is the single-threshold value. I(·) is an indicator function and $\varepsilon_{i,t}$ is a random error term.
In order to estimate the parameters in the model, we first subtract the average of clusters over time from each observation for each province to obtain the unexpected changes in industrial clusters. Defining $\Delta Clust_{i,t} = Clust_{i,t} - \frac{1}{T}\sum_{t=1}^{T} Clust_{i,t}$, we have:

$$\Delta Clust_{i,t} = AX_{i,t} + \beta_1 FDI_{i,t} * I(thre_{i,t} \le \gamma) + \beta_2 FDI_{i.t} * I(thre_{i,t} > \gamma) + \varepsilon_{i,t}. \quad (6)$$

We then accumulate all of the observations and use a matrix form to express (6) as:

$$\Delta Clust = X(\gamma)\beta + \varepsilon^{*}. \quad (7)$$

Through the threshold value of $\gamma$, we use the OLS on (7) to get the sum of squared residuals:

$$S_n(y) = \hat{\varepsilon}^* \hat{\varepsilon}^* = \Delta Clust * (I - X^*(\gamma)'(X^*(\gamma)'(X^*(\gamma)^{-1}(X^*(\gamma)') * \Delta Clust \quad (8)$$

We then try to minimize $S_n(y)$ in (8) to obtain an estimate of $\gamma$. Once we obtain the estimated $\gamma$ we can further get the estimate of $\hat{\beta}$, the residual vector $\hat{\varepsilon}$, and the sum of residual squares.

We further test the two hypotheses: Whether the threshold effect is significant and whether the estimated threshold value is equal to its true value. For the first test, we test the hypothesis $H_0$: $\beta_1 = \beta_2$ in (6). The corresponding alternative is $H_1$: $\beta_1 \neq \beta_2$. The test statistic is a traditional F-test:

$$F = [S_0 - S_1(\hat{y})] / \hat{\sigma}_0^2,$$

where $S_0$ is the sum of squared residuals obtained under the original null hypothesis. Under the original null hypothesis, the threshold value $\gamma$ cannot be identified directly as the corresponding F-value does not follow a standard F-distribution. Hansen proposes a "bootstrap approach" to estimate its asymptotic distribution and the corresponding p-value. We follow his approach to test the hypothesis.

For the second test, we test the hypothesis $H_0$: $\hat{\gamma} = \gamma$. The corresponding likelihood ratio (LR) statistic is: LR ($\gamma$) = $S_1(\gamma)$ - $S_1(\hat{\gamma})$. Again, the distribution is not standard. Hansen [15] provides a formula that can be used to estimate the non-rejection region: when $LR(\gamma_0) \leq c(a)$, we cannot reject the null hypothesis, where $c(\alpha)$ = -2*ln(1-$\sqrt{1-a}$) and $\alpha$ is the significant level.

Similarly, a two-threshold model can be written as follows:

$$Clust_{i,t} = u_i + AX_{i,t} + \beta_1 FDI_{i,t} * I(thre_{i,t} \leq \gamma_1) + \beta_2 FDI_{i.t} * I(thre_{i,t} > \gamma_2) + \varepsilon_{i,t}. \quad (9)$$

To solve and test for threshold values of $\gamma_1$ and $\gamma_2$, we follow the same procedure as we do in the single threshold model described above.

Model 3 is a panel model to test the difference of FDI impact on industrial cluster in three different regions when we add a new factor, the level of financial development, into the model. To test the impact on industrial cluster from using FDI in three different regions with different levels in financial development we estimate the following model for each region:

$$Clust_{i,t} = \beta_0 + \beta_1 FDI_{i,t} + \beta_2 FDI_{i,t} * Find_{i,t} + \beta_3 Find_{i,t} + \beta_j Ctrl_{i.t.j} + \varepsilon_{i,t} \quad (10)$$

where $Find_{i,t}$ is a variable that indicates the level of financial development. The other variables are defined before. We are interested in the estimated coefficients of $\beta_2$ and $\beta_3$, in addition to $\beta_1$.

To explore the impact of financial development on industrial cluster, we use the estimated threshold value in the financial development level from (8) to estimate the last model. This time, we add one control variable a time into the regression to estimate the impact of each variable on industrial cluster and to avoid possible collinearity and heteroskedasticity. Specifically, with the entire panel data, we repeat the following regression six times, using the FGLS approach:

$$Clust_{i,t} = C_0 + \beta_i X_{i,t} + \beta_2 FDI_{i,t} + \beta_3 D * FDI_{i,t} + \varepsilon_{i,t}, \quad (11)$$

where $D$ is a dummy variable and it is 1 when the financial development level is greater than the estimated threshold determined in (8); it is 0, otherwise. Other variables are the same as before. This time, we are also interested in the signs and significance of $\beta_i$, in addition to $\beta_2$ and $\beta_3$.

## DATASET AND CONTROL VARIABLES

The entire sample consists of various provinces in mainland China over the period 2000-2010, except for Tibet where we lack the data. The entire sample includes 30 provinces in three regions: eastern,

central and western. The eastern region includes Beijing, Tianjin, Shanghai, Guangdong, Hebei, Jiangsu, Zhejiang, Fujian, Shandong, and Liaoning. The central region includes Shanxi, Anhui, Hainan, Jiangxi, Henan, Hubei, Hunan, Jilin, Heilongjiang, and Inner Mongolia. The western region includes Guangxi, Sichuan, Chongqing, Guizhou, Yunnan, Qinghai, Shaanxi, Ningxia, Xinjiang, and Gansu. It is obtained from annual statistical yearbooks of various provinces and autonomous regions.

In selecting the control variables, we follow the related literature that documents the factors useful to explain the impact of FDI on industrial cluster. They include:

Cluster index ($Clust_i$). Audretsch et al. use Gini coefficients of regional production to measure American industrial cluster levels while Luo et al. use Herfindahl index to analyze Chinese industrial cluster. We use the following to measure regional industrial cluster in China:

$$Clust_i = \frac{1}{24}\sum_{j=1}^{24} G_{i,j},$$

where $G_{i,j}$ = ($i$ regional industrial output value of industry $j$ / $i$ area GDP) / (national industrial output value of industry $j$ / national GDP). As a result, $G_{i,j}$ actually reflects the comparative advantage in region $i$ and industry $j$. If the value is greater than 1 region $i$ has a comparative advantage in industry $j$. It also reflects that the $j$th industry has a higher degree of industrial cluster in region $i$. On the other hand, if that value is less than 1 then the industry $j$ has a lower degree of industrial cluster in region $i$. If we sum across 24 industries then $Clust_i$ reflects the level of cluster for region $i$ across all the industries.

Foreign direct investment ($FDI_i$). We use the proportion of sales from products produced by foreign invested enterprises in region $i$ to the sales from all industrial enterprises in the region to measure the strength of FDI in the region. We expect that FDI should have a positive effect on industrial cluster.

Financial market development ($Find_i$). We include MSI and FIR. MSI is the ratio of broad money in circulation and GDP, which is M2/GDP. FIR is also known as financial interrelation ratio, which is equal to the value of all financial assets divided by the total value of GDP.

Product of financial market development and foreign direct investment ($FDI_i \times Find_i$). We use this variable to measure the FDI spillover effect caused by financial market development, which measures whether the FDI spillover effect is constrained by the local financial market development.

The other control variables used in this study include the level of economic development (Pgpd), capital investment (Inve), human capital (Educ), infrastructure (Infr), economic structure (Stru), and private sector economic development (EOP).

## EMPIRICAL RESULTS

Examining the results from Model 1, we find that the adjusted $R^2$ is 0.92, which indicates that the model fits the data well. The D-W value is 1.82, which is close to 2, indicating the regression residuals are well behaved. From regression coefficients ($\beta_s$) and the corresponding t-values for the control variables, we find that all the regression coefficients are positive but significant only for the material capital investment, economic structure, and private economic development. The level of economic development is only significant at the 10% level. The results seem to indicate that among the factors that restrict FDI from promoting industry cluster formation in 2000-2010, human capital and infrastructure do not play a significant role. On the other hand, physical capital investment, economic structure, and private economic development are more important in affecting industrial cluster. Within the three important factors, the coefficient from physical capital investment is the largest, suggesting a significant role in promoting industrial cluster during the period 2000-2010. Also from Model 1, we find that the effect of FDI on industrial cluster varies in different regions and provinces. The promotion of FDI on industrial cluster seems stronger in the eastern region, while the promotion in the central region seems less strong, and the impact in the western region is even weaker.

From Model 2, we find that FDI indeed affects industrial cluster, and the financial development level has a single threshold value of 1.253. However, the hypothesis that there are two threshold values is rejected. In testing for one threshold value, we find that the F-value associated with the test is 9.446 >7.731 (the critical value) and the p- value is 0.062<10%. The results indicate that at the 10% significant level, single threshold hypothesis cannot be rejected. When we assume two threshold values, the F-value drops to 3.328, which is not significant.
In addition to the level of financial development, we also perform threshold tests for other explanatory variables and find that all the explanatory variables, Pgdp, Inve, Educ, Infr, Stru, and EOP, do not have threshold effects. Thus, we conclude that in China the main factor that restricts the formation of industrial cluster is financial development.

Model 3 estimates the eastern, central, and western regional industry cluster, using the variables that include the regional financial development. We find that the level of financial market development affects industrial cluster formation through FDI and that effect is different in different regions. Specifically, the coefficients of FDI in the eastern and central regions are positive and significant, indicating that FDI has a positive impact on industrial cluster in those regions. The financial development level and the product term (FDI*Find) are positive and significant for the eastern and central regions, suggesting that the level of financial market development plays a significant role in promoting formation of industrial cluster and FDI spillover. However, the coefficients of FDI and FDI*Find in the western region vary in sings and sometimes not even significant. The results seem to indicate that financial development in the western provinces is still weak and it plays only a limited role in industrial clustering.

Examining other control variables, we find that the coefficients associated with physical capital investment are significantly positive across all the regions, indicating that investment in physical capital plays a big role in promoting industrial cluster. The economic development level, human capital, infrastructure, economic structure, and private economic development are significant only in the eastern or central regions. In the western region, those variables are not significant in promoting industrial clustering.

From regression (10), we find that the coefficients associated with *FDI* are all positive and significant. The results show that *FDI* inflow can significantly boost local industrial cluster. The coefficients associated with *D*FDI* are also significantly positive. Those results re-enforce the previous findings that there exists a threshold for financial development. When the financial development level is greater than the threshold value, *FDI* can effectively promote industrial cluster. If the financial development level is less than the threshold value, *FDI* cannot effectively promote industrial cluster. It may even bring negative effects. Therefore, in a province, when the financial development level is low, the local government should improve its local financial development level first rather than blindly try to attract *FDI* to promote industrial cluster. The financial development level index is 1.040 from regression (2) and it is significant at the 1% level. An increase and improvement in the financial development level can promote the formation of industrial cluster. It shows the importance of local financial development for industrial cluster again. It provides an effective solution to the provinces and regions where the development of industry and economy is low. The coefficients associated with physical capital investment are all positive and significant, which means that physical capital investment also can effectively promote industrial cluster, in addition to the financial development level. Regression (3) adds per capita gross domestic product in the regression and the coefficients associated with that are positive and significant. However, the coefficient of FDI index changes from 0.004 into 0.033, which suggests that the level of economic development has an important impact on *FDI* inflows. Regression (4) adds human capital index and the coefficients are

significant. The coefficient of industrial concentration degree changes from 0.033 into 0.036, suggesting that human capital is also one of the important factors that affect industrial cluster. From regression (5), we find that the infrastructure's coefficients are not significant, implying that infrastructure investment does not seem to affect industrial cluster during the sample period. From regression (6), we find that the coefficients of economic structure index and private economic development level index are significant, which shows that the economic structure and private economic development are the essential factors that affect industrial cluster. As a result, we conclude that financial development, the level of economic development, economic structure, private economic development, and human capital are the main factors to attract FDI and to promote industrial cluster.

## CONCLUSIONS

This paper examines the impact of FDI on provincial and regional industry cluster and threshold effect in China. We develop a threshold model and estimate the threshold value. We further examine what variables are important to promote industrial cluster. Here are the main findings.

The effect from FDI on industrial cluster in China is different in different provinces/regions. The effect is more apparent in the eastern provinces than in the central and western provinces in attracting FDI and promoting industrial cluster using FDI. Several provinces have more FDI inflows, such as Beijing, Shandong, Shanghai, Jiangsu, etc., where the industrial concentration degree index is higher. In the central provinces, the effect seems less strong and the effect in the western provinces seems the least in attracting FDI and promoting industrial cluster. Those results suggest that the inflow of FDI will not promote industrial cluster automatically. There are other factors needed before FDI can play a positive role in industrial cluster.

The factors that affect FDI and industrial cluster include the level of economic development, human capital, infrastructure, economic structure, and the private economy development. The financial development level is the most important factor. It directly restricts the industrial cluster formation and FDI spillover effect. An important reason why FDI in the eastern provinces can significantly promote industrial clustering is that the local region has a higher financial development level. Therefore, we suggest that the local government should pay more attention to the development of related conditions and development of the corresponding measures at the time of attracting FDI. As China is a developing country FDI is a main way to speed up its economic development. However, if we only rely on the increase in FDI inflows but don't pay attention to the related economic and financial conditions, FDI cannot play its role in promoting industrial cluster and in stimulating fast economic growth.

There is an obvious threshold effect in the development of financial markets in China. Whether FDI can promote industrial cluster depends on the level of financial development in the provinces or in the regions. Since there is a big difference in the level of financial development in the eastern, central, and western provinces, only in the provinces where they pass the threshold in financial development, they can better digest and use the capital and technology from FDI. In those provinces, the inflows of FDI can produce a positive effect on the local industrial cluster. On the other hand, in some provinces where the level of financial development is low and they cannot pass the threshold and FDI may produce a negative effect. As a result, we recommend our government to design a comprehensive and detailed plan that will balance financial development in different regions and provinces, especially for those under-developed regions to help them pass the financial threshold in order to accelerate economic development in those areas.