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Foreign Direct Investment and Industrial Cluster in China: A Financial Development Perspective

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

Key words: foreign direct investment; industrial cluster; threshold effect; financial environment

JEL codes: F21, F43, L16, O16, O53

1. Introduction

As foreign direct investment (FDI) keeps flowing into the country, China has become the largest developing country in terms of attracting FDI. By the end of 2008, China has utilized more than 1 trillion US dollars of FDI. In 2010 alone, China attracted additional 10 billion US dollars of FDI. During the period when large scaled FDI flows into China, it plays an important role on China's industrial cluster. Previous research, such as Barrell and Pain (1999) and Head, Ries and Swenson (1995) have documented the relationship between FDI and industrial cluster at national levels and have concluded that FDI is one of the main determinants to cause industrial cluster. However, research about the relationship between FDI and regional industrial cluster is limited and the results about whether FDI has a notable and positive effect on regional industrial cluster are mixed.

In this paper, we use provincial and regional data to test that relationship. The effect of FDI on industrial cluster, usually through technology spillover, depends on the absorptivity of the hosting country. The hosting country needs to meet certain conditions to promote fast industrial cluster. Those conditions include political

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environment, availability of productive assets and technology, human capital, infrastructure, and institutional factors (e.g., Alfaro et al., 2004). However, the level of financial development in the hosting country is often ignored in the past analysis. Recently, researchers begin to notice that a healthy level of financial environment in the hosting country can speed up capital accumulation process, increase the efficiency in resource allocation, and encourage entrepreneurship, all lead to a faster and stronger FDI spillover effect. Using a regional panel data from 2000 to 2010, we examine the impact of FDI on industrial cluster in China, with a focus on the role that financial development plays. We find that, in addition to the factors documented in the previous research, there exists a threshold effect from financial development, which is a key factor that affects the formation of industrial cluster in China.

The rest of the paper is organized as follows. Section 2 provides literature review and the hypotheses to be studied in this paper. Section 3 describes the empirical models, explanatory and control variables, and the dataset. Section 4 provides empirical results on the impact from FDI on industrial cluster from a financial development perspective while Section 5 concludes the paper.

2. Literature Review and Hypotheses

Industrial cluster refers to a process in which certain industries and supporting enterprises on a relevant value chain and material flows gather in a specific geographic region. Previous research shows that FDI has a significant and positive impact on industrial cluster. In their study of FDI flowing into Venezuela's manufacturing sector, Aitken and Harrison (1999) find that FDI has a significant spillover effect through the forward linkage on industrial cluster. On the other hand, the backward linkage is not so obvious. Sjoholm (1973) reaches a similar conclusion for Indonesia's geographically adjacent companies. Using the US industry data, Serapio and Dalton (1999) find that FDI does not bring technology spillover in Silicon Valley where industrial cluster is present. However, they find that FDI causes the emergence of proprietary technology reverse diffusion. Cantwell (1989), through studying investment within Europe between1955 and 1975, concludes that large U.S. multinationals do not tend to have technology spillover and the technology spillover mainly appears in industries where there are smaller companies that have technology gaps.

Researchers also find that financial development in the hosting country has become one of the key factors to cause FDI spillover and it restricts the formation of industrial cluster in the regions where it is lacking of a healthy financial system. Earlier studies, such as Schumpeter (1934), Goldsmith (1969), McKinnon (1973), and Shaw (1973) all point out that a healthy financial environment reduces transaction costs and results in more funds directly allocated to projects, which leads to industrial cluster and promotes economic growth. In a recent study that covers 11 Arab countries, Omran and Bolbol (2003) find that FDI inflows to the Arab region are very low, mainly due to the lack of a healthy financial environment in those countries. As a result, they suggest that, before attracting FDI, the hosting country should first reform its domestic financial system. Bailliu (2000) argues that a developed financial system can lower cost of borrowing and lead to a positive and faster transformation from foreign capital inflows into a good investment, which effectively attracts new capital flows to cause industrial cluster.

Alfaro et al. (2006) use financial environment as a channel for transformation between FDI and industrial cluster. They divide the entire sample into two sub-groups: One is composed of 71 countries with only credit markets and the other is composed of 49 countries with both security markets and credit markets. Through a

comparative study of the two sub-samples, they find that FDI spillover is not significantly different for both sub-samples if the difference in financial environment is not included in the analysis. After taking into account the difference in financial environment, they find that the spillover effect from FDI for the second sub-sample becomes more significant. They conclude that financial markets can prevent development lags when a country uses FDI to enhance its technology spillover. Alfaro et al. (2006) also examine the effect of economic growth on financial environment. Using 71 countries as a sample, they find that economic growth for a hosing country with large FDI inflows can stimulate financial and technological innovation even though the financial environment in the hosting country lacks efficiency.

Rajanand Zingales (1998) examine large and listed firms and find that a well-developed financial environment reduces the cost of external financing for those firms in the US. Therefore, they conclude that financial environment is a decisive factor in promoting industrial cluster when firms rely on external financing. Villegas-Sanches (2008), using micro-level data from Mexico, finds that firms will benefit from FDI only when they are large and located in a well-developed financial area. Choong, Yusop, and Soo (2004) also show that the higher the level of a hosting country's financial development, the stronger the FDI-related technology spillover. Hermes and Lemink (2003), through studying 67 less-developed countries, find that financial development in the hosting country plays an important role in promoting industrial cluster. Levine (1997), as well, finds that the level of financial development affects the speed of capital accumulation and the level of technology spillover, which in turn, affects industrial cluster.

This paper focuses on the threshold effect from financial environment on industrial cluster, using Chinese FDI data. Even though it is found that FDI and economic growth start from threshold effect, especially from threshold in infrastructure, economic development, human capital, financial development, economic structure, and other factors, but only limited research has focused on the impact of financial environment, as a main threshold factor, in the process of industrial cluster. If the industrial cluster caused by FDI indeed comes from financial threshold effect, we should find a "threshold value" for financial environment that will trigger industrial cluster. In order to examine FDI inflows and industrial cluster in different provinces and regions in China with different financial, culture, and economic conditions, we propose and test the following three hypotheses.

Hypothesis 1: FDI should affect industrial cluster in China, even though the impact may be different in different provinces and regions. In particular, FDI should have a positive and significant effect on industrial cluster in the provinces and regions where the conditions to digest FDI are better.

Hypothesis 2: Many factors, such as infrastructure, regional economic development, human capital, institutional and technological conditions, and economic structure, in addition to FDI inflows should affect industrial cluster. Thus, in the provinces and regions where those conditions are better, FDI should have a stronger impact on industrial cluster.

Hypothesis 3: Financial development should have a threshold effect on industrial cluster. As a result, in the provinces and regions where the level of financial development exceeds the threshold value, FDI inflows should be higher and industrial cluster should be stronger, provided that the other conditions, such as infrastructure, regional economic development, human capital, institutional and technological development, and economic structure are also better.

3. Econometric Models and Data

3.1 Basic Models Setup

To test for the role of FDI in the process of industrial cluster in China, we examine the impact of FDI on industrial cluster indifferent provinces and regions, the effect of financial market development on industrial cluster, and the existence of a threshold effect. We propose the following models.

Model 1 directly tests whether FDI affects industrial cluster. We use the panel data from 30 provinces over the period 2000-2010 to analyze the impact of FDI on industrial cluster in each province:

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

Where $Clust_{i,t}$ stands for the level of industrial cluster in province i in time t, $FDI_{i,t}$ is the inflow 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. We are interested in the regression coefficients of $\beta_{l,i}$, after controlling for other factors. If $\beta_{l,i}$ is positive and significant FDI promotes industrial cluster in province i.

Model 2 tests the threshold effect. A traditional threshold model usually is determined by an external mechanism. As a result, the traditional model cannot provide the confidence interval of the threshold and the effectiveness of the parameters is usually poor. In this study, we use a threshold panel model by Hansen (1999). The model can be estimated by the endogenous sample data and it does not require any fixed form of nonlinear equations. The basic model of Hansen (1999) is given below:

$$y_i = \theta_1 X + e_i, \; q_i \le y \tag{2}$$

$$y_i = \theta_2^{'} X + e_i, \; q_i > y \tag{3}$$

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. According to 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.

Define 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

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

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

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

Where $Clust_{i,t}$ and $FDI_{i,t}$ are defined before, u_i is the intercept of the regression 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, which include economic development, physical and human capital, infrastructure, economic structure, private economic development, and other factors in province i and time t, 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 γ

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 in order to obtain the unexpected change in industrial cluster. If we define $\Delta Clust_{i,t} = Clust_{i,t} - 1/T \sum_{t=1}^{T} Clust_{i,t}$ we obtain the following equation:

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

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 γ, we use the OLS on (7) to get the corresponding 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 the corresponding $S_n(y)$ in equation (8) to obtain an estimate of γ. Once we obtain the estimated γ we can further get the estimate of β, the residual vector ε, and the sum of residual squares.

We further test 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 equation (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 γ cannot be identified directly as the corresponding F-value does not follow a standard F-distribution. Hansen (1999) 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: $\gamma = \gamma$. The corresponding likelihood ratio (LR) statistic is: $LR(\gamma) = S_1(\gamma) - S_1(\hat{\gamma})$. Again, the distribution is not standard. Hansen (1999) provides a formula that can be used to estimate the non-rejection region: when $LR(\gamma_0) \le c(a)$, we cannot reject the null hypothesis, where $c(\alpha) = -2*\ln(1-\sqrt{1-a})$ and α is the significant level.

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

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

To solve and test for threshold values of γ_1 and γ_2, we follow the same procedure as we do in the single threshold model described above. Refer to Hansen (1999) for more detailed model and test discussions.

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 β_2 and β_3, in addition to β_1.

To explore the impact of financial development on industrial cluster, we use the estimated threshold value in the financial development level from equation (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 value determined in equation (8); it is 0, otherwise. Other variables are defined the same as before. This time, we are also interested in the signs and significance of β_i, in addition to β_2 and β_3.

3.2 Sample Data, Control Variables, and Indicators

To test industrial cluster caused by FDI in different provinces and regions in China, we use a sample that consists of various provinces in mainland China during the period 2000-2010, except for Tibet where we lack 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, Gansu, Ningxia, and Xinjiang. The data is obtained from annual statistical yearbooks of various provinces and autonomous regions. In selecting the control variables, we just follow the related literature that documents the significant variables to affect industrial cluster. They are defined below.

Cluster index ($Clust_i$). Audretsch et al. (1996) use Gini coefficients of regional production to measure American industrial cluster levels. Luo et al. (2008) use HHI (Herfindahl Index) to analyze China's industrial cluster. Since our study focuses on FDI and its impact on regional industrial cluster, we use the following to measure regional industrial cluster in China:

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

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 in 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). Previous research uses different measures on the FDI variable. Blomstrom (1986) uses the ratio of foreign employment in region i to the total employment. Some Chinese scholars use either the ratio of foreign direct investment in region i to the total GDP to express the strength of FDI or the proportion of actual use of foreign capital in region i relative to the total GDP published in the "China City Statistical Yearbook" as the measure for FDI strength. In this study, 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 ($Find_i$). The representative indicators to measure financial development

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. In practice, due to data constraints, it is difficult to collect information on M2 in different provinces or regions and therefore most studies use FIR to measure the regional financial level of development. King and Levine (1993) use the local loan balance from financial institutions relative to GDP to express the level of financial development. In this study, we replace the bank loan balance by the value of local financial assets and use the ratio of that asset value to GDP to reflect the level of local financial market development. We believe that a well-developed financial system should speed up the FDI spillover effect. As a result, we expect a positive relationship between industry cluster and the level of financial development.

The product of financial market development and foreign direct investment ($FDI_i \times Find_i$). This is a slope variable that is used to measure the FDI spillover effect caused by domestic financial market development, which measures whether the FDI spillover effect is limited or constrained by the local financial market development. The larger the coefficient of the product the greater the impact the level of financial development has on FDI spillover effects. Since we believe that, a healthy financial system stimulates industrial cluster, we expect a positive and significant coefficient from the product.

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). They are defined below along with the expected impacts on industrial cluster.

The level of economic development ($Pgdp_i$). Many researchers suggest that the level of economic development affects FDI spillover and industrial cluster. Therefore, in our regression analysis, we choose the level of per capita GDP in region *i* as the measure of regional economic development.

Capital investment ($Inve_i$). Before the formation of industrial cluster, there should be a process of physical capital accumulation. Investment in fixed assets reflects the original value of fixed assets minus depreciation. Since investment in current assets usually accounts for a small portion of capital investment and it is hard to obtain, we use the ratio of total investment in fixed assets to the regional GDP to measure capital investment. We expect that a higher capital investment should cause a higher FDI spillover effect, and thereafter a faster industrial cluster process.

Human capital ($Educ_i$). In the past, the proportion of local college enrollment to the local population was often used to represent human capital. Since the free flow of college graduates in China, using that index to reflect regional human capital has lost its significance. At the same time, many scholars show that human capital is an important factor to attract FDI inflows. For example, Borensztein et al. (1998) find that a key factor of whether FDI can cause industrial cluster is whether the area of FDI inflows has plenty of human capital. In this study, we use the number of college students per million as the human capital index. We believe that in a region with more human capital, it is easier to attract FDI. As a result, the industrial cluster should be stronger after FDI inflows.

Infrastructure indicator ($Infr_i$). Infrastructure not only is one of the most important factors to attract FDI inflows, but also affects FDI spillover and industrial concentration directly. In this study, we use transportation infrastructure to represent infrastructure indicator and select the set of integrated density of transportation lines in different regions in China. The actual indicator is (railway mileages + highway mileages + inland waterway mileages)/(total area of China). We expect that an area with a higher infrastructure index should attract more FDI inflows, resulting in a faster industrial cluster in that area.

Economic structure indicator ($Stru_i$). The economic structure in a region may affect FDI spillover as well. At

present, most FDI is concentrated in the manufacturing sector. However, the level of development in the secondary industry in a region may also affect FDI innovation and spillover. In addition, high-tech industries usually are located in a densely populated area that attracts more FDI in China. Since high-tech industries usually adopt lots of advanced technology from aboard, an area with more high-tech industries may cause faster FDI technology spillover. In this paper, we use the proportion of high-tech industry output relative to the total industry output to measure the regional economic structure. We expect that in a region with more high-tech companies, FDI technology spillover should be stronger.

Private sector economic development (EOP_i). We choose the proportion of the number of urban private and individual staff relative to the total population in the region to represent the private sector economy development level. That variable, to some extent, also reflects the level of region's private sector economic system. We expect that in a region with higher private sector economic development, it is more likely to attract FDI inflows, which should lead to a faster industrial cluster.

4. Empirical Results and Discussions

From the results in Table 1, we find that the effect of FDI on industrial cluster varies significantly across different regions and provinces in China. The promotion of FDI on industrial cluster is strong in the eastern region, while the promotion in the central region is less strong, and the impact in the western region is weak. For the eastern region, except for Fujian and Shandong, the effect of FDI is significant, especially in Beijing, Tianjin, Shanghai, Guangdong, Jiangsu and Zhejiang. The β_1 coefficients for those provinces are larger and significantly positive, suggesting that the promotion of FDI in those provinces to industrial cluster is stronger. In the central region, only Shanxi, Hainan, Jiangxi and Hubei have significant β_1 coefficients. Out of those provinces, only Jiangxi and Hubei have positive coefficients, indicating that FDI in these two provinces contributes to the formation of industrial cluster in a positive way. In the western region, FDI plays a much less role in industrial cluster. Only in Guangxi, Ningxia and Chongqing, the regression coefficients β_1 are significant. Only in Chongqing, FDI contributes to industrial cluster positively. Those results are consistent with the studies by Grabber (1993) and Birkinshaw (2000) that FDI spillover depends on regional development. Indifferent provinces in China, FDI plays a different role to promote industrial cluster, due to different local conditions. The adjusted R^2 from the regression is 0.92, which indicates the goodness-of-fit of the model. The D-W value is 1.82, indicating that the regression residuals are well behaved.

Since we adopt a threshold model, we test whether there is a threshold effect and what is the corresponding threshold value. We report the test results in Table 2. We find that the financial development level has a single threshold value of 1.253. The hypothesis that there are two threshold values is rejected. In testing for one threshold value, we find that the corresponding F-value is 9.446, which is higher than the critical value of 7.731 at the 10% significance level. The p-value is 0.062. The result indicates that at the 10% significant level, the single threshold hypothesis cannot be rejected. When we assume two threshold values, the F-value becomes 3.328, which is not significant. The p-value is 0.759. Overall, the results support the conclusion that there exists only one threshold value. Therefore, we focus on the single threshold model.

In addition to the level of financial development, we also perform threshold tests on other explanatory variables and report the results in Table 3. Overall, we find no other variables that have significant threshold effects since their F-values are all less than their critical levels (their p-values are not significant at the 10% level).

Thus, we conclude that the only significant factor that restricts the formation of industrial cluster in China is the level of financial development.

Table 1 Test of FDI on Industry Cluster

To test whether FDI affects industry cluster in China, we use the panel data from 30 provinces during the period of 2000-2010 to analyze the impact of FDI on industrial cluster. We report the results in this table.

$$Clust_{i,t} = \beta_0 + \beta_1 FDI_{i,t} + \beta_j Ctrl_{i.t.j} + \varepsilon_{i,t} \quad (1)$$

where $Clust_{i,t}$ stands for industrial cluster in province i in time t, $FDI_{i,t}$ is the inflow 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 a random error term. We only report the regression coefficients associated with FDI, along with their t-values. *, **, and *** denote the 1%, 5%, and 10% significant levels respectively.

Eastern Region			Central Region			Western Region		
Province	β_1	t-value	Province	β_1	t-value	Province	β_1	t-value
Beijing	0.769	5.02*	Shanxi	-0.561	-3.36*	Guangxi	-0.348	-2.86*
Tianjin	0.093	1.92***	Anhui	0.068	1.29	Sichuan	-0.042	1.09
Shanghai	1.023	12.17*	Hainan	-0.747	-2.15**	Chongqing	0.463	1.94***
Guangdong	0.359	2.55**	Jiangxi	0.262	2.21**	Guizhou	0.163	1.45
Hebei	-0.462	-1.98**	Henan	-0.337	-1.33	Yunnan	-0.209	1.13
Jiangsu	0.927	3.78*	Hubei	0.677	2.53**	Qinghai	-0.420	-1.15
Zhejiang	0.269	2.60**	Hunan	-0.196	-1.74	Shaanxi	0.122	1.48
Fujian	1.337	1.21	Jilin	0.976	0.81	Gansu	0.606	0.69
Shandong	0.303	0.89	Heilongjiang	0.221	0.60	Ningxia	-0.137	-2.51**
Liaoning	-0.743	-2.11**	Inner Mongolia	-0.542	-1.41	Xinjiang	-0.337	-1.20
Adjusted R^2 0.92								
D-W value	1.82							
F-statistics	19.27							
Sample size	300							

Table 2 Threshold Test for Financial Development

We perform the threshold test for the level of financial development under two different hypotheses, using the panel data from 2000 to 2010 and report the results in this table.

H_0: There is only one threshold value		H_0: There are two threshold values			
Threshold γ_1	1.253	Threshold γ_1	0.892	Threshold γ_2	1.253
F-value	9.446	F-value		3.328	
p-value	0.062	p-value		0.759	
1% significant level	15.279	1% significant level		14.226	
5% significant level	10.621	5% significant level		9.071	
10% significant level	7.731	10% significant level		5.328	

Table 3 Threshold Test for Other Explanatory Variables

We perform the threshold test for other explanatory variables, using the panel data from 2000 to 2010 and report the results in this table.

Explanatory Variable	Pgdp	Inve	Educ	Infr	Stru	EOP
Threshold γ	9267.726	40.325	15.796	37.978	39.175	11.823
F-value	56.72	20.43	28.92	9.82	14.74	6.23
p-value	0.623	0.335	0.726	0.523	0.275	0.216
1% significant level	65.229	23.499	33.259	11.302	16.961	7.173
5% significant level	63.528	22.886	32.392	11.007	16.519	6.985
10% significant level	58.252	20.986	29.702	10.093	15.147	6.405

Since financial development is the main factor to promote industrial cluster through FDI, we further estimate the relationship between regional industrial cluster and the variables that include the level of regional financial development. We report the results in Table 4. We find that the level of financial market development affects industrial cluster via FDI and that the 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 coefficients of financial development and its cross product with FDI, FDI*Find, are all positive and significant for the eastern and central regions, suggesting that financial market development plays a significant role in promoting industrial cluster and FDI spillover. However, the same coefficients in the western region are usually not significant or even negative at times, suggesting that FDI inflows do not play a significant role in promoting industrial cluster and FDI spillover. Even though the coefficient of financial development in the western region is positive but it is not significant. The results indicate that financial development in the western region is still weak and it plays only a limited role in industrial cluster.

Table 4 Threshold Test of Financial Development on Industry Cluster in Three Regions

To test the difference of FDI impact on industrial cluster in different regions in China after we introduce a key factor, the level of financial development we estimate the following model:

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

where, $Find_{i,t}$ is a variable that indicates the level of financial development. We report the results in this table. FE and RE indicate using the panel data with the fixed effect and random effect respectively. IV-FE and IV-RE refer to using the instrumental variable approach with the fixed effect and random effect respectively. *, **, and *** denote the 1%, 5%, and 10% significant levels.

Dependent Variable (*Clust*)						
Independent Variable	Eastern Region		Central Region		Western Region	
FDI	0.172	0.169	0.269	0.260	-0.369	-0.350
t-value	2.11**	2.07**	3.30*	3.18**	-1.537	-1.297
FDI*Find	0.093	0.091	0.145	0.140	-0.199	-0.189
t-value	1.97**	1.93***	3.08**	2.97**	-2.23**	-2.00**
Find	0.0273	0.027	0.043	0.041	0.059	0.056
t-value	2.33**	2.28**	3.64*	3.51*	1.003	1.737
Pgdp	0.006	0.006	0.009	0.009	0.012	0.012
t-value	1.75***	1.72***	2.74**	2.64**	1.76***	1.570
Inve	1.271	1.246	1.987	1.917	2.729	2.584
t-value	3.66*	3.59*	5.73*	5.53*	4.87*	4.45*
Educ	0.007	0.006	0.012	0.011	0.010	0.009
t-value	2.01**	1.97**	3.14**	3.03**	1.324	1.095
Infr	1.127	1.104	2.762	2.90	2.420	2.291
t-value	3.32**	3.26**	5.20*	5.02*	1.143	1.76***
Stru	0.013	0.013	0.020	0.019	0.014	0.020
t-value	1.99**	1.95***	3.11**	3.01**	1.280	1.053
EOP	0.002	0.002	0.023	0.020	0.014	0.009
t-value	4.87*	4.77*	1.616	1.349	1.458	0.904
Adjusted R^2	0.78	0.82	0.75	0.78	0.76	0.72
F-value	24.76	21.26	18.70	18.04	25.67	24.31
Hausman-test	21.582	17.39	14.97	10.45	16.56	7.47
p-value	0.026	0.056	0.041	0.060	0.066	0.353
Test method	FE	IV-FE	FE	IV-RE	FE	IV-RE
Sample size	100	90	100	90	100	90

Examining other control variables in Table 4, we find that the coefficients associated with capital investment (Inve) are significantly positive across all regions, indicating that investment in physical capital plays a big role in promoting industrial cluster. The economic development level (Pgdp), human capital (Educ), infrastructure (Infr), economic structure (Stru), and private sector economic development (EOP) are only significant in the eastern and central regions. In the western region, the economic development level (Pgdp), human capital (Educ), infrastructure (Infr), economic structure (Stru), and private sector economic development (EOP) are found not significant. Those results support the previous findings from Table 1 that the effect from FDI on industrial cluster is more evident in the regions where the economic conditions are better.

Table 5 provides the results from regression (11). We find that the coefficients associated with FDI are all positive and significant. The results show that FDI inflows can significantly boost local industrial cluster. The coefficients associated with D*FDI are significantly positive as well. Those results reinforce the previous findings that there exists a threshold effect from 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, we suggest that in a province where the financial development level is low, the local government should focus on improving its financial system first rather than blindly try to attract more FDI to promote industrial cluster. The coefficient associated with the financial development level is 1.040 from regression model (2) in Table 5 and it is significant, suggesting that an increase and improvement in the financial development level can promote the formation of industrial cluster. It also shows the importance of local financial development for industrial cluster and provides an effective solution to the provinces and regions where the industry and economic development are low.

The coefficients associated with capital investment (Inve) are all positive and significant, which means that capital investment also can effectively promote industrial cluster, in addition to financial development. Regression model (3) in Table 5 adds per capita gross domestic product (Pgdp) in the regression and the coefficients associated with that variable are positive and significant. The coefficient of FDI index changes from 0.004 to 0.033, which suggests that the level of economic development has an important impact on FDI inflows. Regression model (4) in Table 5 adds human capital (Educ) and the coefficients associated with it are significant. The coefficient of industrial cluster changes from 0.033 to 0.036, suggesting that human capital is also one of the important factors in the process of industrial cluster. From regression model (5) in Table 5, we find that the infrastructure's (Infr) coefficients are not significant, implying that infrastructure does not seem to affect industrial cluster significantly during the sample period. From regression model (6) in Table 5,we find that the coefficients of economic structure (Stru) and private sector economic development (EOP) are significant, which shows that the economic structure and private sector economic development are the essential factors that affect industrial cluster. As a result, we conclude that financial development, the level of economic development, human capital, economic structure, and private sector economic development are the main factors to attract FDI and to promote industrial cluster.

Table 5 Threshold Test with a Dummy Variable

To explore the degree of financial development on industrial cluster, we use the estimated threshold value of the financial development level from (7) to run regression (11). We respectively include Pgdp, Educ, Infr, Stru, and EOP, one at a time, in the regression model to estimate the impact from each variable on industry cluster. We repeat the regression six times, using the FGLS approach:

$$Clust_{i,t} = c_i + \beta_1 X_{i,t} + \beta_2 FDI_{i,t} + \beta_3 D * FDI_{i,t} + \varepsilon_{i,t} \quad (11)$$

where, D is a dummy and it is 1 when the financial development level is greater than the estimated threshold value determined in (7); otherwise, it is 0. X_{it} is a set of other control variables defined before. *, **, and *** denote the 1%, 5%, and 10% significant levels.

Independent Variable	Regression Model 1 *Clust*	*Regression* Model 2*Clust*	Regression Model 3 *Clust*	Regression Model 4 *Clust*	Regression Model 5 *Clust*	Regression Model 6 *Clust*
FDI	0.004	0.029	0.033	0.036	0.052	0.046
Z-value	0.020*	0.044**	0.032**	0.047***	0.051***	0.065***
D*FDI	0.022	0.021	0.034	0.032	0.047	0.042
Z-value	0.019**	0.040**	0.030***	0.043***	0.048***	0.043***
Inve	1.037	1.016	2.541	2.668	2.226	1.974
Z-value	1.157**	1.134**	1.808***	1.744***	2.483***	2.202***
Find		1.040				
Z-value		0.416*				
Pgdp			0.015	0.011	0.041	0.036
Z-value			0.132**	0.137*	1.051**	0.025*
Educ				1.020	1.055	0.128
Z-value				1.037**	1.072**	0.014**
Infr					0.055	0.028
Z-value					0.072	0.044***
Stru						0.036
Z-value						0.022***
EOP						0.228
Z-value						0.004***
C	1.907	1.869	2.981	2.876	4.094	3.876
Z-value	0.091*	0.103*	0.130*	0.133*	0317*	0.319*
Log	51.476	50.463	45.474	42.639	40.525	39.652
Sample size	300	300	300	300	300	300

5. 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 examine the variables that are important to promote industrial cluster, in addition to FDI. Here are the main findings.

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

The other possible factors that affect FDI inflows and industrial cluster include the level of economic

development, human capital, infrastructure, economic structure, and private sector economy development. In China, the financial development level is the most important factor. It directly restricts industrial cluster and FDI spillover. An important reason why FDI in the eastern region can significantly promote industrial cluster is that there is a higher financial development level in that region. Therefore, we suggest that the local government should pay more attention to improve the necessary conditions and corresponding measures before attracting FDI. China is a developing country and using foreign direct investment is a main way to speed up its economic development. However, if we only rely on the increase in FDI inflows and do not pay enough attention to the local economic and financial conditions, FDI cannot play its role in promoting industrial cluster and stimulating a fast economic growth.

There is a 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 region or province. There are big differences in the level of financial development in different provinces and 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 local industrial cluster. On the other hand, in other provinces where the level of financial development is low and they cannot pass the threshold FDI may produce a negative effect. Therefore, we suggest that our central and local governments should design a financial development plan that will balance financial development in different regions and provinces, especially in the under-developed regions to help those areas to pass the financial threshold in order to accelerate economic development in those areas such that those under-developed areas can use FDI more efficiently.

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