

## Environmental Regulations and the Location Choice of FDI in Pollution Intensive Industries: Evidence from China

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**ABSTRACT:** As more foreign direct investment (FDI) inflows to pollution intensive industries in China, policy makers become concerned with the environmental problems causing by FDI. Because of environmental regulation in different regions can be formulated with different strength, whether or not environmental regulations in different regions can affect the location choice of FDI in China. Using the data of pollution intensive industries in 28 provinces, we examine the environmental regulation effects on the location choice of FDI (*LOCFDI*). Besides the regional total product volume and the area economic development level, the results also show that environmental regulation is one of the important determinants of *LOCFDI*. In some developed provinces, stricter environmental regulations have no effective influence on *LOCFDI*. While in other developing provinces, the environmental regulations have particularly significant effects on *LOCFDI*.

### INTRODUCTION

Foreign direct investment (FDI) has been among the fastest growing economic activities around the world, especially in China. While this growth has increased the large scaled capital, advanced technologies, and export trades, it has been accompanied by serious environmental problems as the foreign funds transfer to be invested in pollution intensive industries in China. Especially many polluting industries are located in the densely populated metropolitan areas where emissions exposure causes serious damage to human health and economic activity.

Beginning in the mid 1960's, the thought of using environmental regulation policies to control pollution levels started to emerge in China, such as improving the access threshold to pollution intensive industries, closing the small enterprises with high energy dissipation and heavy pollution, and decreasing the pollutant sources connected to the eco-environment system. Furthermore, according to the environment protection law of the People's Republic of China (one of environmental regulation policies in China), the regional authority has right to formulate the index of local contamination and collect the emission fees on the basis of the local situations, and the regional standards cannot lower than national standards. Therefore, we analyze the relationship between the different regional environmental regulation and location choice of FDI in pollution intensive industries using industrial level data over 8 years in 28 provinces in China. The results will help the regional authorities to balance attracting foreign investment and protecting the environment.

### Literature Review

There are different viewpoints on the issue of how environmental regulations affect FDI. Several theoretical papers have examined the linkages between environmental regulation and competitions, and concluded that strict environmental regulation may attract FDI. Cole and Elliott (2005) found that domestic sectoral capital intensity and pollution abatement costs have had a positive and significant effect on US FDI to Brazil and Mexico. Lu Xin-de, Liu Xiao-ming and Liu Chang-mei (2010) present a statistical test of the impact of environmental regulations on the capital movement of foreign investment, and indicated strict environmental regulation can act as an incentive for FDI. Bouwe R. Dijkstra, Anuj J. Mathew and Arijit Mukherjee (2011) show that a foreign firm may invest in the home country although total costs (taking the costs of production, environmental taxation and transportation into account) are higher there.

An alternative view is that environmental regulations have no effect on plant location. The basic argument is either that cost effects are so small as to be negligible or that increased environmental quality is reflected in reduced employee compensation. Eskeland and Harrison (2003) examined the pattern of foreign investment across industries within Mexico, Venezuela, Morocco, and Cote d'Ivoire. They found that abatement costs are not significant determinants of the distribution of foreign investment among manufacturing industries within a country.

The above previous studies assume that there is some or no relationship between FDI and environment regulation. However, FDI-environment regulation relationship is controversial, especially when FDI flows to pollution intensive industries in different regional area. Another shortcoming of previous empirical studies lies in measuring the strictness of environmental regulations on FDI from the whole area. Therefore, on the basis of the previous studies, the paper uses a theoretical modeling to explore the problem: the regional differences of the environmental regulation's effects on FDI in pollution intensive industries in China.

## Empirical Model and Data

### The Theoretical Model

We hypothesize that the environmental regulation will affect the inflow of FDI to China. Usually FDI in the pollution intensive industries will choose a low environmental restriction as the investment location. On the basis of this hypothesis, we examine the effect of the environmental regulation on the location of FDI in pollution intensive industries using a panel model. Then we estimate the following reduced form equation:

$$LOC_{FDI_{it}} = b_0 + b_1 REGU_{it} + b_2 DQZ_{it} + b_3 AGDP_{it} + e_{it} \quad (1)$$

Where  $i$  indexes provinces,  $t$  indexes time,  $\beta_0$  is the intercept term and  $\beta_1$ ,  $\beta_2$ ,  $\beta_3$  respectively denotes regression coefficient of environmental regulation, regional total product volume and area economic development level,  $\varepsilon$  is the stochastic deviation.

### The meaning of each variable

The explained variable – *LOC<sub>FDI</sub>*. As indicated by Guo Jian and Wang Tao-feng (2009), the number of FDI in pollution intensive industries not only shows the area that the foreign investors prefer to move but also shows the situation that how much the foreign investors will invest. Thus, the *LOC<sub>FDI</sub>* is measured by the ratio of pollution intensive's foreign investments in different regions to the whole national FDI.

The explanatory variable – *REGU*. On the basis of Li Wan-hong and other scholars' method of testing the environmental regulation, the *REGU* is using the ratio of the contamination emission of the pollution intensive industries in different regions to the total product volume in the whole industries. Because the value presents the relationships between the total product volume and the contamination emission, the ratio can eliminate the effect of industry scale on environmental regulation intensity. When the value is lower, the intensity of the environmental regulation will be higher. What's more the amount of the contamination emission can reflect the basic situations of the environmental regulation [8].

The controlled variable *DQZ* and *AGDP*. The variable, regional industrial total product (*DQZ*) shows the industrial development degree of the specific area. The high product volume in the area means the high industrial development degree.

The area economic development level (*AGDP*) reflects the competitive ability in a specific area, which is an important factor for the foreigners to make a decision on invest. Considering the distraction of the populations and the size in different areas, we use the per capita GDP to interpret the economic development degree in different regions.

### Industry Selection and Data source

On the basis of the Xia You-fu and Jiang Ke's researches, the pollution intensive industries in our paper refer to 19 industries in China, including coal mining and washing industry, petroleum and natural gas industry, mining and processing of ferrous metals ores, mining and processing of non-ferrous metal ores, mining and processing of nonmetal ores, nonmetallic minerals industry, papermaking and paper products, manufacturing of raw chemical materials and chemical products, electricity-heat production and supply industry, agricultural and sideline products processing industry, medical and

pharmaceutical products, chemical fiber, smelting and pressing of ferrous metals, smelting and pressing of nonferrous metals, metal products, petroleum-coking and nuclear fuel processing, rubber and plastic products industry, fur industries, and textile industry.

As some data is missing in Hainan, Yunnan, Tibet Macao, Hongkong, Taiwan, the paper uses 28 provinces panel data in 2005-2012 and 261 observations to research the relationship between the different regional environmental regulation and location choice of FDI in pollution intensive industries. The data were got from *China Economy Network's database*, *Chinese environment statistical yearbook* and *Chinese statistical yearbook*.

## Estimations and Results

### Root of unity test

In order to avoid spurious regression and grantee the data's stability, the first step is to test the unit root. We show the test results using LLC, ADF Fisher and PP Fisher in Table 1. As each Prob. is lower than 5%, we reject the null hypothesis of unit root.

Table 1 Results of the root of unity test

Variables	Methods	Statistic	Prob.
<i>LOCFDI</i>	LLC *	-2.15075	0.0157
	ADF-Fisher	65.9273	0.0171
	PP – Fisher	111.152	0.0000
	L LLC*	-25.9752	0.0000
<i>REGU</i>	ADF-Fisher	254.030	0.0000
	PP – Fisher	255.671	0.0000
	LLC *	-12.4608	0.0000
<i>DQZ</i>	ADF-Fisher	183.311	0.0000
	PP – Fisher	186.713	0.0000
	LLC*	-12.6770	0.0000
<i>AGDP</i>	ADF-Fisher	186.150	0.0000
	PP – Fisher	190.738	0.0000

### Co-integration test

We also performed co-integration test in order to guarantee the stability of the data after unit root test. The meaning of the co-integration test is to judge whether the two variables will keep a long-lasting equilibrium relationship. When two group variables both are same the order in one-stage, the co-integration test can be continued. The results of co-integration test are shown in Table 2.

Table 2 Results of co-integration test

Variables	T statistic	Prob.
<i>LOCFDI</i> <i>REGU</i> <i>DQZ</i> <i>AGDP</i>	-3.006341	0.0013

As is showed in Tab. 2, the P is 0.0013, lower than 1% tested by ADF, which means the variables keep a long- lasted relation and variables also keep co-integration relation.

### Hausman Test

Hausman test is the method to judge whether the model is a fixed effect model or a random effect model. As the results showed in Table 3, the value of the statistic is 73.1700, and the value of Prob. is 0.0000. Then we can choose the fixed effect models to research.

Table 3 Results of Hausman test

Variables	Statistic	Prob.	Model assumptions
<i>LOCFDI</i> <i>REGU</i> <i>DQZ</i> <i>AGDP</i>	73.1700	0.0000	Fixed effects model

## F Test

After we choose the fixed effect models to research, we also should use the F test to decide whether the models are varying coefficient models, variable intercept models or the mixing coefficient models. The results of  $F$  test are shown in Table 4.

Table 4 F test of panel data

Variables	Values
$S_1$	5.540974
$S_2$	14.88161
$S_3$	20.94738

According to the equations as follows,

$$F_1 = \frac{(S_2 - S_1) / [(N-1)K]}{S_1 / [NT - N(K+1)]} F[(N-1)K, N(T-K-1)] \quad (2)$$

$$F_2 = \frac{(S_3 - S_1) / [(N-1)(K+1)]}{S_1 / [NT - N(K+1)]} F[(N-1)(K+1), N(T-K-1)] \quad (3)$$

We can get  $F_1=2.33$ ,  $F_2=2.88$ . Because  $F_1$ ,  $F_2$  are both bigger than the critical value under the significance level, so we choose the varying coefficient models in our research.

## Regression analysis

With software Eviews6.0, we use the weighted least square to estimate the fixed effect model. The results are showed in Table 5.

Tab. 5 Regression results of panel data

Variables	Coefficient	T statistic	Prob.
<i>DQZ</i>	1.4205	4.792269	0.000
<i>AGDP</i>	0.0589	4.172218	0.000
Beijing	151.70	1.886316	0.060
Tianjin	271.76	3.038612	0.002
Hebei	212.35	5.890355	0.000
Shaanxi	494.46	10.24178	0.000
Neimenggu	352.00	8.379014	0.000
Liaoning	295.63	8.640195	0.000
Jilin	430.81	18.08807	0.000
Heilongjiang	283.99	9.436627	0.000
Shanghai	126.08	1.957298	0.051
Jiangsu	37.400	0.808729	0.419
Zhejiang	113.71	3.518749	0.000
Anhui	206.04	9.683915	0.000
Fujian	114.92	9.841742	0.000
Jiangxi	195.90	10.29997	0.000
Shandong	128.28	1.292343	0.197
Henan	220.71	5.983867	0.000
Hubei	152.31	8.460770	0.000
Hunan	129.73	8.527619	0.000
Guangdong	42.138	0.946311	0.345
Guangxi	59.366	10.71235	0.000
Chongqing	68.703	10.23574	0.000
Sichuan	144.20	8.210143	0.000
Guizhou	439.75	12.28623	0.000
Shanxi	275.76	10.99370	0.000
Gansu	416.86	11.71305	0.000
Qinghai	355.30	11.09422	0.000
Ningxia	114.32	7.538714	0.000
Xinjiang	423.60	10.51614	0.000
Adjusted $R^2$		0.756723	
$F$		24.12174	
D.W.		1.560344	

Firstly, the coefficients of the environmental regulation in Jiangsu, Shandong, Guangdong, Beijing, Shanghai are not significant test at 5% level. So the environmental regulation in these provinces shows non-significant influence on the FDI in pollution intensive industries. The reasons maybe the environmental regulation is not the only element of pollution intensive industries FDI location choosing. The regional total production and the regional economic development degree also have the impact on the location choosing. What's more, the regional total production is more important than the economic development degree for location choice of FDI in pollution intensive industries.

Secondly, except these five provinces mentioned above, each coefficient of the environmental regulation is positive and passes the significance test, and the total regression result is fit enough. That is, when environmental regulation becomes harsher, the effect on FDI in pollution intensive industries to choose a proper location is greater as well. It is worth mentioning that the coefficients in Shanxi, Jilin, Guizhou, Gansu and Xinjiang are relatively larger more than 400, which means the increase of one intensity unity of the environmental regulation, the FDI to these provinces will much bigger than other provinces.

## Conclusions

According to the results, the environmental regulation is one of the important determinants of the *LOC FDI*. In some developed provinces, stricter environmental regulations have no effective influence on the *LOC FDI*. While in other developing provinces, the environmental regulations have particularly significant effects on *LOC FDI*. The results also show that the regional total product volume and the area economic development level also have the significant influence on the choosing a proper location for the pollution intensive industries FDI.

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