

Different Sources of FDI, Environmental Regulation and Advancement of Industrial Structure

Rui-Bo Liu^{1,a,*}, Hai-Yong Lu^{1,b}

Keywords: Advancement of Industrial Structure, Different Sources of FDI, Environmental Regulation.

Abstract: Using provincial panel data of China, this paper examines the effects of the overall FDI and different sources of FDI on the industrial structure from the perspective of heterogeneity, and introduces the interaction between FDI and environmental regulation to explore the indirect impact of environmental regulation through FDI on industrial structure. The paper finds: FDI has an inhibitory effect on the advancement of industrial structure in China at present, but the interaction between environmental regulation and FDI contributes to the advancement of industrial structure; Different sources of FDI have varying degrees of negative effects on the industrial structure in China, the negative effect of FDI from Japan, South Korea and Singapore is the biggest, FDI from the United States, Britain, France and Germany second, FDI from Hong Kong, Macao and Taiwan is the smallest; Environmental regulation has been able to positively regulate the impact of FDI on Industrial Structure. Therefore, the local government should pay attention to the quality of FDI from different sources when attracting investment, and selectively and specifically introduce foreign investment. At the same time, the local government should give full play to the role of environmental regulation policy tools, and effectively regulate and guide FDI, which is helpful for the region to upgrade industrial structure.

1. Introduction

In the past 40 years since the reform and opening-up policy was adopted, foreign direct investment (FDI) as a combination of capital, technology, market and management (Leonard and Kwan, 2000) has played a major role in making up for the capital and technology gaps in the early stages of industrial development of China. It has promoted the process of industrialization and the improvement of the service industry in China. The actual use of foreign capital was 885.61 billion yuan, and the actual use of foreign capital reached a record high. The rapid growth of foreign investment has also brought a series of problems. FDI is attracted by abundant resources and relatively loose environmental regulations of China, concentrated in pollution-intensive and labor-intensive industries. Resources and environment of China has been seriously damaged and has become a "pollution sanctuary" of developed countries to some extent. The unreasonable distribution of FDI in industry has also led to the middle and low links in China in global value chains

specialization. There is a serious asymmetry between trade volume and trade income. The formation of “pollution shelters” is due to China's relatively loose environmental regulations. Improving the intensity of environmental regulation maybe become a effective way to guide the flow of FDI and improve the quality of FDI. In addition, there are differences in FDI investment objectives, technical level, management experience,(Xi-Bao Guo and Xi Luo, 2009), the quality of which must be different, so different sources of FDI may have different effects on the advancement of industrial structure. Therefore, this paper attempts to study the relationship between the different sources of FDI, environmental regulation and industrial structure, and then explore appropriate environmental policies and investment policies to provide concrete and feasible measures to upgrade the industrial structure.

2. literature review

The relationship between FDI and industrial structure has been studied for a long time, but FDI is usually regarded as homogenized capital. Academic views fall into three broad categories. One view is that FDI can promote the advancement of industrial structure. FDI can effectively complement the capital gap in the early stage of host industry development (Apergis et al., 2006; Wang-Yuan Chen, 2012), and FDI can also achieve effective technology spillovers thereby promoting the advancement of industrial structure through demonstration and imitation effects,(Sinani and KEMeyer, 2004; Jun-Hui Shan and Yu-Kai Zhang, 2016), competitive effects (Kokko, 1994; Li Lianbo, 2017), industry-related effects (M. Bwalya, 2006; Luo Wei, 2018), personnel mobility (Fosfuri and Saggi, 2002; Lin-He Chen, 2009). Another view is that FDI is not conducive to the advancement of industrial structure. The research on such viewpoints mainly analyzes the weak effect of FDI technology spillovers and the lock-in effect of division of labor caused by FDI. Alert (2010) through research on 45 developing found that when the gap is too large, there is no technology spillover effect. Domestic research confirmed that FDI could not achieve effective technology spillovers from the perspectives of the protection of core technologies from the investment country (Ping Zhang, 2016), the host country's technical dependence on FDI (Yong-Hua Yang, 2010), and the industrial structure imbalance caused by FDI (Jing Tao, 2017). The last view is that FDI has different impacts on the advancement of industrial structure under different research perspectives, sample periods and research samples. Janissa(2018) found that the role of FDI in the industrial structure showed a dynamic trend, which was expressed as an inverted U-shaped. Zu-Yi Yang(2018) found that the effect of FDI on manufacturing upgrading showed obvious regional heterogeneity by dividing the country into the eastern, central and western regions.

The above research mainly focuses on the perspective of FDI homogenization, but there are obvious differences in different sources of FDI between technology level, market bias, investment purpose, investment industry, and the impact on the economic development of the host country is also inevitable (Alfaro and Charlton, 2013). At present, the literature on the study of industrial structure from the perspective of different sources of FDI relatively scarce. The existing literature on different sources of FDI research focuses on the impact of economic growth and technology spillover effects. Fortanier(2007) conducted a study of direct investment in 71 countries by six major foreign-sourced countries, and found that the impact of FDI from different sources on the Meconomic growth of host countries is different. Domestic Xi-Bao Guo and Zhi Luo(2009) also

reached similar conclusions. Domestic Ri-Sheng Mao and Hao Wei(2007) divided the source of foreign capital into Hong Kong, Macao and Taiwan regions and non-Hong Kong, Macao and Taiwan regions, and found that non-Hong Kong, Macao and Taiwan regions have greater technological spillover effects. But Juan-Jie Long and ZhiYa Chen(2009) studied 35 industrial sector panels, the data leads to the opposite conclusion. In recent years, as the Chinese government has increased its emphasis on the environment, the intensity of environmental regulation has also increased. Studies have found that environmental regulation is not only an important consideration for FDI site selection (Keller and Levinson, 2002;Gang Chen, 2009), but also significantly affects the size of FDI spillover effects (Kwon and Chun, 2009;Zhong-Yuan Zhang, 2012), so environmental regulation can through influencing indirectly affecting the industrial structure。

3. Measurement model construction

To test the relationship among FDI, environmental regulation and advancement of industrial structure, set the measurement model as follows:

$$ts = \beta_0 + \beta_1 fdi_{it} + \beta_2 ers_{it} + \beta_3 fdi_{it} * ers_{it} + \phi X_{it} + V_i + \varepsilon_{it} \quad (1)$$

To further explore the heterogeneity of FDI from different sources, this paper uses different sources of FDI to replace total FDI in model 1 to obtain:

$$ts = \beta_0 + \beta_1 fdi_{oit} + \beta_2 ers_{it} + \beta_3 fdi_{oit} * ers_{it} + \phi X_{it} + V_i + \varepsilon_{it} \quad (2)$$

Among them, the subscripts i the province, the subscripts t represent year, the subscript o represents the FDI source, V_i represents the individual fixed effect, and ε_{it} represents the random disturbance term. Ts is the level of the advancement of industrial structure, FDI means foreign direct investment, ers means strictness of environmental regulation, and $fdi*ers$ is the interaction between foreign direct investment and environmental regulation. X is the vector of control variables, including regional economic development level and its squared term, human capital level, R&D investment, trade dependence, financial development level and infrastructure level.

3.1 Construction of variable indicators

3.1.1 Interpreted variable

As a measure of industrial structure upgrading, the advancement of industrial structure indicates the trend of economic structure. In the whole industrial structure system, it is reflected as the evolution from the primary industry to the secondary industry and tertiary industries. Affected by the information revolution, the degree of economic service is further deepened. The deepening is embodied in the fact that the growth rate of the tertiary industry is faster than that of the secondary industry (Jing-Lian Wu, 2008). Therefore, this paper selects the ratio of the output value of the

tertiary industry to the output value of the secondary industry as a measure of the level of industrial structure.

3.1.2 Core explanatory variables

For foreign direct investment, this paper measures the level of foreign investment by the ratio of the actual foreign direct investment after conversion of exchange rate of each region to the regional GDP. Different sources of FDI chose FDI from 11 countries and regions such as Hong Kong, Macau, Taiwan, USA, UK, France, Germany, Japan, Korea and Singapore. They fall into three categories according to investment motivation, investment industry and technology level. The first is FDI from Hong Kong, Macao and Taiwan. The second is FDI from Japan and South Korea and Singapore. The last is US, UK, France and Germany.

For environmental regulation, this paper refers to the practice of DongBo Zhu(2017), using the ratio of completed investment in industrial environmental management to industrial added value to measure the intensity of environmental regulation.

3.1.3 Control variables

Regional economic development level (grf) is expressed by per capita GDP; the level of human capital (hr) is measured by the average number of years of education for each region's employed personnel; technological innovation level (r&d) is measured by the ratio of total expenditure of regional science and technology activities to regional GDP; trade openness (open) is expressed by the ratio of total imports and exports of each region to regional GDP; financial development level (fd) is measured by the ratio of total loans to total deposits of regional financial institutions; infrastructure level (inf) is expressed as the ratio of urban road area to urban floor area.

3.2 Data sources

The statistical yearbook of some provinces does not publish FDI from different source countries, Therefore, based on the data availability, this paper selects panel data of 24 provinces, municipalities and autonomous regions from 2005 to 2016 as samples, and 24 provinces are: Beijing, Tianjin, Hebei, Shanxi, Liaoning, Heilongjiang, Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Shandong, Henan, Hunan, Guangdong, Guangxi, Chongqing, Yunnan, Shanxi, Gansu and Xinjiang. All price-related variables are converted into comparable prices using the gdp index, per capita gdp index, or fixed asset investment price index. The base period is 2000.

4. Empirical analysis

4.1 Analysis of the impact of foreign direct investment, environmental regulation and their interaction items on the advancement of industrial structure

Table 1: Regression results of the influence of total FDI on advancement of industrial structure

variable	OLS	RE	FE
fdi	-11.137***	-4.009***	-3.652***

	(-6.48)	(-3.13)	(-3.02)
ers	0.001 (0.13)	-0.009* (-1.77)	-0.011** (-2.37)
fdiers	0.493* (1.74)	0.759*** (4.24)	0.790*** (4.66)
lngrf	-4.309*** (-4.92)	-2.954*** (-5.30)	-2.902*** (-5.65)
lngrf2	0.210*** (4.87)	0.141*** (5.00)	0.144*** (5.56)
hr	0.092** (2.29)	0.148*** (3.19)	0.080* (1.74)
rd	33.421*** (10.36)	22.026*** (4.93)	-2.570 (-0.45)
open	0.164** (2.18)	-0.253*** (-3.02)	-0.570*** (-5.64)
fd	-0.047 (-0.28)	0.826*** (3.88)	0.958*** (4.51)
inf	-0.006 (-1.42)	0.020* (1.90)	0.077*** (3.31)
cons	21.843*** (4.92)	14.326*** (5.06)	14.222*** (5.45)
N	288	288	288
R2	0.751	0.473	0.531
F	83.643		28.729
Hausman Test			Chi-sq.=53.15 P=0.0000

Note: ***, ** and * are significant at 1%, 5% and 10% levels respectively; The Numbers in brackets are t statistics.

As shown in Table 1, this paper uses the least squares method, random effect model and fixed effect model to obtain the regression results of the influence of total FDI on advancement of industrial structure. According to the Husman test, the fixed effect model should be selected.

According to the regression results, the regression coefficient of FDI is negative and significant at the level of 1%, indicating that foreign direct investment at this stage has an inhibitory effect on the industrial structure of China, which is basically consistent with the research conclusion of Ping Zhang (2016). For a long time, with cheap labor, abundant resources and preferential investment policies, China has attracted FDI to integrate into the global division of labor system. There are obvious industry deviations in the investment direction of FDI, mostly concentrated in the labor-intensive low-end processing manufacturing industry. Technology-intensive enterprises with foreign investment will protect core technologies, and it is difficult to achieve effective technology spillovers, which is not conducive to the advancement of industrial structure. On the other hand,

environmental regulation is an important factor affecting the location of FDI, thus local governments may race to the bottom in order to attract foreign investment. The types of industries that are more sensitive to environmental regulations are mostly pollution-intensive enterprises. The foreign capital attracted by local governments is mostly of this type, which constrains the industrial structure to further develop.

The regression coefficient of environmental regulation is negative, and significant at the level of 5%. This indicates that the improvement of environmental regulation intensity at this stage is not conducive to the development of industrial structure. Xing-Zhi Xiao(2013) and Dong-Bo Zhu (2017) also reached similar conclusions. The relationship between environmental regulation and industrial structure upgrading is u-shaped. The anti-driving mechanism of environmental regulation on industrial structure upgrading is based on the fact that environmental regulation has reached a certain intensity. At present, the environmental regulation intensity is not conducive to the development of the advancement of industrial structure, which may be related to the fact that the environmental regulation intensity is still not beyond the left inflection point.

Foreign direct investment and environmental regulation are significantly positive at the 1% statistical level, which shows that the interaction between FDI and environmental regulation is conducive to the advanced industrial structure. Shuang-Yan Wang(2016) also reached similar conclusions. Although the introduction of foreign capital is not conducive to the advancement of industrial structure, environmental regulations have become an important threshold for FDI entry, and to a certain extent, it has hindered the inflow of polluting FDI represented by low-end processing and manufacturing, and guided FDI to the clean industry represented by the service industry. In addition, with the deepening of environmental regulations, foreign-invested enterprises will improve the technological level of products and change production methods due to the consideration of environmental governance costs, thus contributing to advancement of industrial structure.

From the results of the control variables, the regional economic development level and its squared term are negative and positive respectively at the 1% statistical level, indicating that there is a u-type relationship between the regional economic development level and the advancement of industrial structure. The improvement of trade openness, human capital, financial development and infrastructure contribute to the upgrading of the industrial structure.

4.2 Empirical analysis after distinguishing different sources of FDI

	Hong Kong, Macao and Taiwan (1)	Japan, South Korea and Singapore (2)	US, UK, France and Germany (3)
fdi_hmt	-8.632*** (-4.50)		
fdi_hmters	2.281*** (5.07)		
fdi_jks		-29.164*** (5.077)	
fdi_jksers		2.538*** (3.58)	

fdi_ubfg			-13.586** (-2.21)
fdi_ubfgers			5.182 (2.74)
ers	-0.013*** (-2.75)	-0.003 (-0.71)	-0.005 (-1.06)
lngrf	-3.080*** (-6.07)	-2.829*** (-5.56)	-2.941*** (-5.48)
lngrf2	0.153*** (5.97)	0.140*** (5.46)	0.146*** (5.38)
hr	0.082* (-0.01)	0.086* (-1.00)	0.088* (-0.49)
rd	-0.084 (1.81)	-5.612 (1.91)	-2.897 (1.86)
open	-0.544*** (-5.61)	-0.464*** (-4.68)	-0.576*** (-5.54)
fd	0.871*** (4.26)	0.900*** (4.43)	0.802*** (3.75)
inf	0.065*** (2.76)	0.084*** (3.63)	0.080*** (3.29)
cons	15.149*** (5.90)	13.872*** (5.39)	14.434*** (-5.48)
N	288	288	288
R2	0.544	0.548	0.504
F	30.259	30.856	25.849
Hausman Test	Chi-sq.=43.80 P=0.0000	Chi-sq.=61.96 P=0.0000	Chi-sq.=49.19 P=0.0000

Note: ***, ** and * are significant at 1%, 5% and 10% levels respectively; The Numbers in brackets are t statistics.

According to Hausman's test results, fixed effect panel model should be used for FDI from Hong Kong, Macao and Taiwan, FDI from Japan, South Korea and Singapore, and FDI from US, UK, France and Germany.

The regression coefficient of FDI from Hong Kong, Macao and Taiwan is -8.632, the regression coefficient of FDI from Japan and South Korea and Singapore is -29.164, and the regression coefficient of US, UK, France and Germany is -13.586. There are obvious differences in the impact of different sources of FDI on the industrial structure. Among them, FDI from Hong Kong, Macao and Taiwan has the weakest inhibitory effect on the advancement of industrial structure. FDI from Japan, South Korea and Singapore is the most unfavorable to the advancement of industrial structure.

The coefficients of interaction between FDI from Hong Kong, Macao and Taiwan and environmental regulation are positive and pass the 1% significance test, So are the other two.

Hypothesis 3 is verified, which shows that environmental regulation plays a guiding role in FDI from these three regions, the stricter the environmental regulations are, the greater the promotion effect of FDI on the advancement of industrial structure. From the perspective of coefficient size, the interaction effect of FDI from America, Britain, France and Germany and environmental regulation has the largest effect on the promotion of industrial structure. The other two have roughly the same promotion effect on the advancement of industrial structure.

5. Conclusions and policy implications

This paper empirically tests the relationship between different sources of FDI, environmental regulation and advanced industrial structure. The results show that:(1)current FDI is not conducive to the advanced industrial structure of China, but environmental regulation can through guiding the flow of FDI and improving technology spillover effect of FDI indirectly affect the industrial structure and promotes the level of advancement of industrial structure.(2)Different sources of FDI have different influences on the advancement of industrial structure.FDI from Hong Kong, Macao and Taiwan has the least inhibiting effect on the upgrading of industrial structure. FDI from America, Britain, France and Germany followed, While FDI from Japan, South Korea and Singapore have the strongest inhibition effect on FDI.(3)Environmental regulation plays a guiding role in FDI from different sources, among which, FDI from America, Britain, France and Germany is the most affected by environmental regulation.Based on the above conclusions, this paper proposes policy recommendations from the following two aspects.

First, the government should give full consideration to the purpose investment, the investment industry and its technical level of FDI and introduce foreign capital in a targeted and selective way when inviting investment. Second, the local government assessment system should be adjusted to avoid the GDP-oriented assessment system. The assessment should pay more attention to the quality of investment and environmental performance, Reasonable environmental regulation requirements should be established. It is conducive to the realization of anti-driving mechanism mechanism of environmental regulation, stimulating the compensation effect of innovation, Which directly promote the advancement of industrial structure; On the other hand, it is conducive to giving full play to the guiding role of environmental regulations on FDI, guiding FDI to flow into clean industries represented by the service industry, and achieving a win-win situation between economy and environment.

References

- [1]LEONARDKC,KWAN Y K.What are the determinants of the location of foreign direct investment? *The Chinese experience*[J].*Journal of International Economics* , 2000,1(99) :379-400.
- [2]XING Y Q, KOLSTAD C D.Do lax environmental regulations attract foreign investment? [J].*Environmental and Resource Economics*,2002,21(1) :1-22.
- [3]Apergis N,Katrakilidis CP,Tabakis NM.Dynamic Linkages between FDI Inflows and Domestic Investment:A Panel Cointegration Approach[J].*Atlantic ECONOMIC journal*,2006,34(4):385-394.
- [4]E.Sinani,K.E.Meyer.Spillovers of Technology Transfer from FDI:the Case of Estonia[J].*Journal of Comparative Economics*,2004,3(32):445-466.

- [5] KOKKO A. *TECHNOLOGY, Market Characteristics, and Spillovers*[J]. *Journal of Development Economics*, 1994, 43(2): 279-293.
- [6] S.M. Bwalya. *Foreign Direct Investment and Technology Spillovers: Evidence from Panel Data Analysis of Manufacturing Firms in Zambia*[J]. *Journal of Development Economics*, 2006, 81(2): 514-526.
- [7] Fosfuri A, Saggi K. *Foreign direct investment and spillovers through workers' mobility*[J]. *International Economics*, 2002, 53(1) : 205-222.
- [8] Wijeweera Albert, Villano Renato. & Dollery Brian. *Economic growth and FDI inflows: A stochastic frontier Analysis*[J]. *Journal of Developing Areas*, 2010, 43(2): 143-158.