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THE IMPACT OF FOREIGN CAPITAL INFLOWS AND TRADE EXPANSION ON INTEGRATED POLLUTANT DISCHARGE FROM CHINA: REGIONAL DIFFERENCES

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This article is based on the years from 1991 to 2012 of the nine categories of the provincial pollutant discharge indexes of China, uses the „vertical and horizontal method" to calculate the comprehensive indexes that can fully measure the provincial pollutant discharge situation of China, establishes a dynamic inter-provincial panel data regression model and makes an empirical test on the relationship among foreign direct investments, foreign trade and pollutant discharge these three factors. The results show that foreign direct investment and foreign trade in different regions have a different impact on pollutant discharge. Therefore, local governments should at all levels be based on local conditions to attract foreign investment and develop foreign trade for the targeted optimization of the structure of introducing foreign investment and improving the quality of foreign trade growth, thus improving the overall situation of China's pollutant discharge.

Keywords: foreign direct investment, foreign trade, integrated pollutant discharge, regional differences

JEL Classification: R11

INTRODUCTION

Since 1992, when Deng Xiaoping's southern tour speech affirmed that the market was an allocation of the resources means of the socialist economy, China has been speeding up the pace of opening up, and foreign direct investment (FDI) and foreign trade have entered the fast lane. The total actual use of foreign investment in China in 1992 was $ 19.202 billion, of which the FDI accounted for 57.3%, for the first time exceeding foreign borrowing and becoming the primary source of China's actual use of foreign capital. By 2012, China's total foreign investment reached $ 111.72 billion, which was nearly six times as much as that the one of 1992; China's total exports accounted for the world exports of goods rising from less than 1 percent in 1978 to 11.2% in 2012, ranking the first in the world for four consecutive years; China's total imports of the world's total imports of goods accounted for 9.8%, ranking the second in the world for four consecutive years (The General Affairs Department of the Ministry of Commerce, 2012).

Foreign direct investment and foreign trade have been considered as the fundamental driving factor backing up China's rapid economic growth. However, the continuous introduction of foreign investment and trade were simultaneously being expanded, with

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China's deteriorating environmental situation being an indisputable fact.

The deterioration of the environmental conditions mainly reflected in a sharp increase in various types of pollutant discharge in 2010, when, for example, China's total wastewater discharge was 61.73 billion tons, the total industrial emissions were 51.9168 trillion cubic meters, industrial solid waste generation was 2.41 billion tons, which was 1.5 times, 3.8 times and 2.7 times that the ne of 2000, respectively. The pollution situation continued to deteriorate, so people began to ponder the over-introduction of foreign investment and the low-quality growth of foreign trade were responsible for the impact on China's pollutant discharge problems.

Because of China's vast territory, regionally in different stages of economic development, there are differences in the introduction of foreign investment and foreign trade expansion, which has led to the introduction of foreign investment and foreign trade in different regional areas with an also different impact of pollutant discharge. Therefore, the study of these problems, for the targeted optimization of the structure of introducing foreign investment and improving the quality of foreign trade growth for improving the overall situation of China's pollutant discharge, has practical significance.

REVIEW OF THE LITERATURE

Related to the FDI, the effect of the environmental impact of foreign trade has been a hot issue which domestic and foreign scholars have concerned, producing controversial conclusions. The FDI and the impact of foreign trade on the host country's pollutant discharge are the focus of this research. Foreign scholars' research into this area is divided into two views: the „good" and the „not good" theories. According to the first, „good theory" view, trade and the FDI provide a motivation and opportunities for developing countries to adopt new technologies and promote them to achieve clean or green production, thereby improving the quality of the global environment and the regional sustainable development capacity (Frankel & Rose, 2003). According to the second, „not a good theory" view, the FDI will stimulate economic growth, leading to more industrial pollution and environmental degradation (Jensen, 1996; World Bank, 2000).

The empirical study carried out by Chinese scholars also holds the same two views: according to the first view, the FDI and foreign trade are beneficial for reducing pollutant discharge; Fang Ming, Ying Ruiyao and *et al* (2010) selected industrial wastewater emissions, industrial emissions and industrial solid waste emissions as three types of indicators, used the panel co-integration theory based on the panel data of the 27 provinces in mainland China in 2000-2006, and concluded that China's experience was all but supportive of the „pollution haven" hypothesis, the technical effect of the FDI having a positive impact on the environment (Jensen, 1996); Deng Yuping and Xu Helian (2013) selected industrial sulfur dioxide emissions, industrial wastewater emissions and industrial soot emissions as three kinds of pollutant discharge as the measure of the pollution-status indicators, using the 2003-2010 national statistics of the 278 prefecture-level cities, thinking the FDI themselves in the production activities would reduce the total amount of pollutant discharge.

However, another view is that the FDI and foreign trade are unhelpful to reduce pollutant discharge. Su Zhendong and Zhou Weiqing (2010) selected industrial wastewater emissions as a measure of the degree of the environmental pollution indicator, used the dynamic panel data model and made an empirical analysis of the impact of foreign direct investment and regional differences on the environment of China, thought that the „pollution haven" hypothesis in our country was founded and that the FDI inflows to China had a significant negative effect on its environment. Zhang Peng, Chen Weimin and *et al* (2013) selected wastewater emissions *per capita*, the *per capita* emissions of sulfur dioxide, the *per capita* emissions of industrial dust and industrial soot emissions *per capita* as the four indicators to measure the pollutant discharge status, used the provincial panel data to do an empirical research and found out that foreign direct investment had made China's environmental conditions deteriorate, but such impact existed market dependence. Lu Jinyong, Yang Jie and *et al* (2014), respectively, selected industrial wastewater and industrial sulfur dioxide emissions of the overall pollutant discharge situation of China, analyzed the impact of the FDI on the pollutant discharge situation, thought that foreign direct investment would lead to increased emissions from industrial wastewater, corresponding to the advanced stage of the introduction of foreign capital, with foreign direct investment having a relationship of conditionality with industrial sulfur dioxide emissions.

There are manu studies dealing with the related subject research for other developing countries (Copeland & Taylor, 1994; Wheeler, 2000; Smarzynska & Wei, 2001; Aldaba & Cororaton, 2001; Busse, 2004).

Analyzing the prior literature, the following problems mainly exist:

- For the most part the literature applies a single or multiple single pollutant discharge index to substitute the overall pollutant discharge situation, which cannot fully reflect the overall pollutant discharge situation, leading to a deviation of conclusions and policy recommendations, although there was some literature attempting to build the pollutant discharge indexes that could reflect the overall environmental situation (Yang Wanping & Yuan Xiaoling, 2008; Wang Shanshan & Qu Xiao'e, 2012). However, the construction of indexes lacks a comprehensive, its representative for the overall state of the environmental situation needs to be improved;
- The majority of the literature mainly studied in the country's foreign trade and FDI for the impact of pollutant discharge did not consider the environmental effects of the regional heterogeneity of China's foreign trade and FDI;
- They made an empirical analysis mainly from a static perspective, using the panel model, but did not consider the dynamic cumulative effects of pollutant discharge leading to doubts about the estimation results.

In view of this, this paper attempts to expand the research into the following aspects:

- According to the human production and living activities for the influence of the atmosphere, the water and the soil as three environmental factors taking full account of the comprehensiveness and complexity of pollutant discharge, we have constructed the pollutant discharge indexes system that includes nine categories of pollutants, and used the „improved vertical and horizontal method" to assess the overall pollutant discharge condition of 30 provinces and cities in China from 1991 to 2012 (except Tibet and Hong Kong, Macao and Taiwan);
- Considering that the imbalance of the regional economic development has led to the heterogeneity of the environmental effects of foreign trade and the FDI, we respectively, from the national and sub-regional perspectives, study the different effects of foreign trade and the FDI on pollutant discharge;
- We have fully dedicated our consideration to the dynamic cumulative effects of pollutant discharge, building a dynamic panel data model, using the GMM system estimation methods to examine the relationship between foreign trade, the FDI and pollutant discharge, and enhancing the credibility of the findings.

THE MODEL APPROACH AND DATA

The model approach

This paper is in the framework of the environmental Kuznets curve theory and studies of foreign direct investment and foreign trade situation for the impact on pollutant discharge situation. The static panel model was constructed as follows:

$$P_{it} = \alpha + \beta_1 FDI_{it} + \beta_2 EX_{it} + \beta_3 \mathrm{IM}_{it} + \\ + \beta_4 PGDP_{it} + \beta_5 (PGDP)^2 + \eta_i + \varepsilon_{it} \quad (1)$$

In the formula (1), i represents the provinces, t stands for the year, η_i represents the individual effects, capturing the characteristics of each region, ε_{it} is the random error term. P is the pollutant discharge index value, FDI is foreign direct investment, EX is export trade, IM is import trade, $PGPD$ is the *per-capita* gross domestic product, β_1 - β_5 are the estimated parameters. In this paper, in order to eliminate the impact of the different estimates of the variance, all the variables are made log processing.

Taking into account the dynamic cumulative effects of pollutant discharge, namely pollution in an area not only affected by the current value, but also related to the value of the previous period, this paper adds the pollution index of the lag one term index value in the model (1), expanded into the dynamic panel model as follows:

$$P_{it} = \alpha + \beta_0 P_{i\,t\text{-}1} + \beta_1 FDI_{i\,t} + \beta_2 EX_{i\,t} + \beta_3 \mathrm{IM}_{i\,t} + \\ + \beta_4 PGDP_{i\,t} + \beta_5 (PGDP)^2 + \eta_i + \varepsilon_{it} \quad (2)$$

While the model (2) captures the continuing characteristic of pollutant discharge, the lag of the explanatory variables P_{it-1} and random disturbance are often correlated, leading to the explanatory variables associated with random disturbance, resulting in endogenous problems. In order to solve the endogenous problem, D. Holtz-Eakin, H. S. Rosen and W. Newey (1988), M. Arellano and S. Bond (1991) presented the first difference GMM estimation method (GMM-difference). Although the GMM can effectively solve the problem of endogeneity and the measurement error and the omitted variables problem, in most cases, however, due to the lag of the variable value, it is not an ideal tool for the difference equations of the first order, and the first-order differential generalized matrix estimation method does not apply to any situation. R. Blundell and S. Bond (1998) pointed out that, when variables of the estimating model are cumulative variables, the first-order differential generalized matrix estimation will show biased estimates. At this time, the instrumental variables used will be weakened, leading to the no-longer-perfect effectiveness of such estimates. M. Arellano and S. Bover (1995), and R. Blundell and S. Bond (1998) proposed the system GMM estimation method, which can well overcome the problem of variable cumulative. Therefore, we have used the system GMM estimation method to estimate the dynamic panel data.

Data Description and Sources

Explanatory Variables: the Pollutant Discharge Index

The construction of the index: According to the influence of human production and living activities on the atmosphere, the water and the soil as three environmental factors, and fully considering the comprehensiveness and complexity of pollutant discharge, this paper selects the pollutant discharge indicators as shown in Table 1:

Because the sample interval of each index is inconsistent, it is impossible to calculate the effective index. In this paper, we referred to the approach of Chen Shiyi's (2012) (Holtz-Eakin *et al*, 1988), constructed

Table 1 The Chinese pollutant discharge evaluation system

Target layer	Criterion layer	Index layer	Unit	Sample interval
Pollution Comprehensive Index (PEI)	Air pollution	Carbon dioxide emissions (CO_2)	Billion tons	1995-2012
		Total sulfur dioxide emissions (SO_2)	Ten thousand tons	1991-2012
		Total Smoke (dust) Emissions (SE)	Ten thousand tons	1991-2012
		Industrial Emissions (IE)	Billion standard cubic meters	1991-2012
	Water pollution	Total Wastewater Emissions (WE)	Billion tons	1991-2012
	Soil pollution	Transported Garbage (TG)	Ten thousand tons	1996-2012
		Chemical Fertilizers (CF)	Ten thousand tons	1991-2012
		Industrial Solid Waste Generation (ISWG)	Ten thousand tons	1991-2012
		The Usage of Pesticides (UP)	Ton	1991-2012

Source: Authors, based on: *China Statistical Yearbooks; The Provincial Statistical Yearbooks* the three sub-indexes of different sample intervals and made an average treatment of the duplicate sample intervals, which enabled us then to obtain the pollutant discharge indexes sequence of the provinces in 1991-2012. This method can effectively reduce a bias which is brought by single-model evaluation indexes. The concrete construction form is presented in Table 2:

Table 2 The three sub-indexes of different sample intervals

Total index	Sub-index	Sample interval	Index included
Pollutant discharge index	1	1991-2012	SO_2 SE IE WE ISWG UP
	2	1995-2012	SO_2 SE IE WE ISWG UP CO_2
	3	1996-2012	SO_2 SE IE WE ISWG UP CO_2 TG

Source: Authors, according to: Chen Shiyi, 2012

The source of the pollutant discharge index data: Industrial emissions, the total sulfur dioxide emissions, the total smoke (dust) emissions, the total amount of wastewater emissions, industrial solid waste generation, transported garbage and chemical fertilizers data originate from The China Statistical Yearbooks and The Statistical Yearbooks of the Provinces and Autonomous regions. The total amount of sulfur dioxide emissions data as well as the total amount of wastewater emissions data are formed by applying the sum of industrial and domestic sulfur dioxide emissions. The total smoke (dust) emissions are based on the latest statistical definition and it is the sum formed by industrial and domestic emissions; the complete data of the pesticide usage are derived from The Chinese Rural Statistical Yearbook. At present, there is no official statistics for carbon dioxide emissions data, The Statistical Yearbook of China for Energy provides us with more complete provincial data of various types of the consumption of energy and electricity. In this article, the types of the final energy consumption are divided into coal, coke, crude oil, gasoline, kerosene, diesel, fuel oil, natural gas and electricity as nine categories, according to their respective standard coal conversion coefficients and carbon emission coefficients to calculate the carbon dioxide emissions of the provinces. The specific factor is noticeable in the IPCC The National Greenhouse Gas Emission Inventory Guidebook (2006). A particular note is made as to improve the relevance of this study by our referring to the Yuan Xiaoling's and Li Zhengda's method (2013) and by decomposing the indicators in Sichuan and Chongqing before 1997.

The Measurement Methods

In this paper, the method proposed by Guo Yajun (2007) is used. It is based on the overall difference-driving principle, namely the „vertical and horizontal method", in order to measure the pollution status of the 30 provinces and cities in China. The method is based on the characteristics of the index data themselves. Not only is the empowerment principle completely objective and avoids the subjective factors' influence on the results, but it also maximally reflects differences between objects in order to meet the measure requirements of the objectivity, diversity and complexity of pollutant discharge. For more details about the calculation steps, please be referred to the Yuan Xiaoling's and Li Zhengda's article (2013). Taking into account the results of intuition, using the geographical information system (GIS), this method

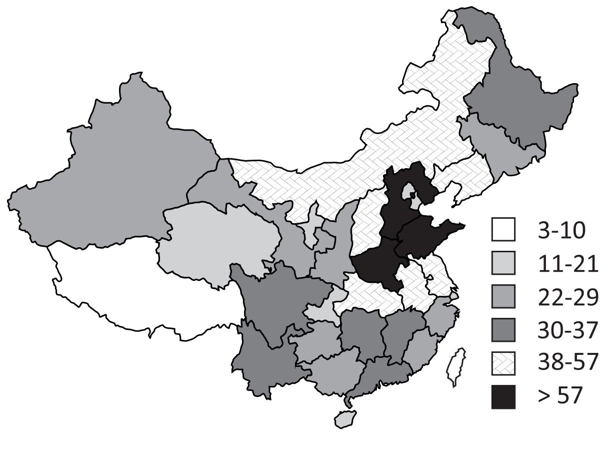

Figure 1 The geographical distribution of China's 2012 pollutant discharge

Source: Authors

illustrates the 2012 pollutant discharge results of the provinces and the cities, as it is shown in Figure 1.

The Explanatory Variables

The main explanatory variables are:

- Foreign Direct Investment (FDI): It is represented by the actual use of foreign direct investment in the RMB to the GDP ratio. The data have been generated from the statistics of the Department of Commerce;
- Imports (IM): They are represented by the total imports in the RMB to the GDP ratio. The data have been taken from the The New China - the Sixty Years of Statistics Compilation and The Foreign Economic Trade Statistics Yearbook of China;
- Exports (EX): These are represented by the total exports in the RMB to the GDP ratio. The data originate from The New China - the Sixty Years of Statistics Compilation and The Foreign Economic Trade Statistics Yearbook of China;
- GDP *per capita* (PGDP): In 1990, the constant prices are to be adjusted. The data are taken from The Statistical Yearbook of China.

The study sample of this paper has selected the panel data of China's 30 provinces, municipalities and autonomous regions, in the period from 1991 to 2012, for the purpose of estimating the econometric model (1) and model (2) - Table 3.

THE ANALYSIS OF THE RESULTS OF THE MEASUREMENT

In this paper, based on the static model (1) and the dynamic models (2), the STATA metering software has been used, making the separate static and dynamic analyses of the nationwide and the three regional FDI, foreign trade and pollutant discharge of the panel data. Since the static panel data analysis does not consider the cumulative effects of pollutant discharge, the regression results are only for reference, and our focus is on the regression results of the dynamic model. In Table 4, the models (1) - (8) are all of the estimation result, wherein the models (1), (3), (5) and (7) represent the static model estimation result; the models (2), (4), (6), (8) represent the dynamic model estimation results.

Table 3 The descriptive statistics of variables

Variables	Observed values	Mean	Standard deviation	Min	Max
P	660	24.92	15.77	1.57	121.37
FDI	660	0.03	0.03	0.0001	0.24
EX	660	0.16	0.18	0.0017	0.94
IM	660	0.15	0.25	0.0046	1.75
PGDP	660	0.65	0.57	0.078	3.45

Source: Authors

The static model estimation results reveal that: the *F* test results of the three regions and the country show that the individual effects model should be used. In addition to the Hausman test, the results for the central region support the fixed effects while the rest are supportive of the random effects. The dynamic model estimation results show that: the second-order correlation test of the three regions and the country have failed to pass the significance test. This paper establishes a dynamic model in which there is no serial correlation problem with the interference, so the model established is considered as reasonable; the over-identification Sargan statistics test has also failed to pass the significance test, indicating that the applied instrumental variables are all effective, feasible, and the estimated coefficients of the LP variables are significantly positive, indicating the necessity of applying a dynamic panel data estimation model.

China's territory is vast; the levels of the eastern, central and western regions' economic development are quite different. For the FDI and foreign trade to promote China's sustained rapid economic growth on the basis of driving factors there must be regional heterogeneity. From the perspective of the regional structure of China's actual use of foreign investment, the actual FDI for the year 1991 of China's eastern, middle and western regions accounted for 92.48%, 4.48% and 3.05%, respectively, whereas in the year 2012, the proportion of the actual FDI in China's eastern, central and western regions, as the three regions which structural changes were made in, were 47.01%, 31.33% and 21.66%, respectively. As can be seen from the data obtained in the sample interval of this article, in the 21st century, the middle and west regions have increased their strength for capital attraction, which has resulted in the actual FDI continuing to radiate from east to west; however, there are still the problems of the regional imbalances of the actual utilization of foreign investment. According to the regional structure of China's foreign trade, in 2012, China's eastern, central and western regions' exports accounted for 89%, 6% and 5%, respectively, the proportion of import trade being similar to that of export trade, which shows us that there are greater regional differences in foreign trade in this country of ours. According to the 2012 data of the regional pollutant discharge displayed in Figure 1, China's pollutant discharge presents us with the pattern from more to less form middle, eastern and western regions. Therefore, it is necessary that the regional differences present in the relationship amongst foreign trade, the FDI and pollutant discharge should be studied.

Table 4 The national and three-regional regression results

Variables and test statistics	nationwide		Eastern region		Central region		Western region	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
L.P		0.774*** (29.56)		0.852*** (25.01)		0.588*** (12.3)		0.879*** (28.36)
FDI	-0.026*** (-2.33)	-0.013*** (-8.05)	-0.134*** (-4.91)	-0.053*** (-1.07)	-0.042*** (-2.51)	0.021*** (0.9)	-0.007 (-0.42)	-0.021 (-1.26)
EX	0.061*** (2.73)	0.067*** (2.62)	0.023 (0.47)	0.295*** (3.992)	0.098*** (3.6)	0.113 (0.34)	0.021 (0.6)	0.034 (0.27)
IM	-0.086*** (-4.15)	-0.044* (-1.74)	0.049 (1.07)	0.123** (-2.01)	0.032 (1.09)	0.005 (0.14)	-0.131*** (-3.92)	-0.100*** (-3.0)
PGDP	-0.111*** (-5.24)	0.235*** (0.68)	-0.232*** (-8.02)	0.158*** (0.36)	-0.136*** (-3.54)	0.083** (0.12)	0.146** (2.26)	0.679 (0.87)
PGDP2	-0.136*** (-11.66)	-0.012*** (-0.07)	-0.221*** (-9.92)	-0.674*** (-2.45)	-0.13** (-6.15)	-0.278 (-0.97)	-0.026 (-0.87)	0.074 (0.25)
Constant term	2.842*** (20.02)	0.786*** (7.81)	2.703*** (11.03)	0.457*** (3.76)	3.618*** (34.91)	1.574*** (7.47)	2.487*** (10.14)	0.386** (2.25)
R-squared	0.223		0.348		0.363		0.254	
Hausman	6.24		6.72		31.57***		2.96	
Affect form	Random effects		Random effects		Fixed effects		Random effects	
Abond (1)		0.00		0.007		0.016		0.005
Abond (2)		0.1426		0.36		0.971		0.355
Sargan		153.8		169.9		154.2		149.2

Note: *, ** and *** denote by passing 10%, 5% and 1% significance level test, repectively.

Source: Authors

The regression results accounted for in Table 4 show that the pollutant discharge factors lagging one term are all positive, depending on whether they are nationwide or three-regional, which is indicative of the fact that there really is a dynamic cumulative effect of pollutant discharge. In the nationwide context, the FDI coefficient is significantly negative, reflecting the existence of a negative correlation between the introduction of the FDI and pollutant discharge, and illustrating that the FDI brings cleaner production techniques and technology spillovers effect have a positive impact on environment. FDI inflows may be out the original backward production technology used in domestic production, and they may accelerate the improvement of the production processes and encourage managers to gradually establish modern environmental management concepts so as to reduce environmental pollution. Therefore, from a national perspective, foreign direct investment may not be the major factor leading to the deterioration of environmental conditions although FDI inflows alleviate pressure on the environment to some extent. Accordingly, the pollutant discharge effects of the FDI of the eastern, central and western regions are similar nationwide, although the negative effect in the western region is not significant, which results in the „pollution haven" that does not hold. This is different from the conclusions of the Fang Ming's *et al* article (2010), but is similar to the conclusions of the Yang Wanping's and Yuan Xiaoling's article (2008). One possible reason is that Fang Ming *et al* (2010), used three single indexes to measure pollutant discharge. From the perspective of improving the overall environmental situation, the conclusion we have come to in this paper is more reliable.

From the estimated coefficients of the observed export trade, the estimated coefficients of the three regions and nationwide are all positive, reflecting the positive relationship between exports and pollutant discharge, but only the positive impact of the coefficients nationwide and of the eastern region are significant, the eastern region being the largest positive impact areas. This shows that the expansion of China's export trade is based on an increase in the cost of pollutant discharge, especially in the eastern part of China, whose export trade accounts for about 90%, with processing trade prioritizing the export structure, and a large number of domestic production activities leading to pollutant discharge in the production process also remains in domestic. This is consistent with the conclusion of Yang Wanping's and Yuan Xiaoling's (2008) and Wang Shanshan's and Qu Xiao'e's (2012).

From the estimated coefficients of the observed import trade, various regions greatly differ from one another. The country's and the western regions' estimated coefficients are significantly negative, thus reflecting the negative correlation between imports and emissions, the negative influence of the western region being the biggest one, which suggests the limited level of the economic development of the western region. Imports play a role by producing alternative pollution. The estimated coefficients of the eastern and central regions are positive, reflecting the positive correlation between imports and pollutant discharge, where only the eastern region passes the significance test combined with the eastern region of the proportion of import trade, indicating the eastern region remains with the import problems of contaminated waste.

From the observed estimated coefficient of the level of the economic development, the estimated coefficients of the three regions and nationwide are positive, indicating that rapid economic growth has been achieved at the expense of serious pollutant discharge, with the extensive mode of development not being the fundamental shift in our country. The Kuznets hypothesis, rendering the inverted U-shaped curve, has only been confirmed in the eastern region and nationwide

CONCLUSION

We have used different samples and methods of the relations among the FDI, foreign trade and pollutant discharge. This paper is based on the years 1991-2012 of the nine categories of the provincial pollutant discharge indexes of China and applies the „vertical and horizontal method" in order to calculate the pollutant discharge indexes that are fully capable of measuring the overall provincial pollutant discharge situation of China. The dynamic inter-provincial panel data regression model has been established and the empirical test of the relationship among foreign direct investment, foreign trade and pollutant discharge as the three factors has been performed. The results have shown the following:

- The overall pollutant discharge situation of China is characterized by significant regional differences. There is no matching of the actual FDI and export trade of the three regions representing the country. This conclusion differs from those made in the past, using the multiple single index to measure the overall pollutant discharge situation.
- Depending on its either nationwide- or the three-regional nature, pollutant discharge has a significant dynamic cumulative effect, which is the evidence of the reasonableness of the dynamic panel data model constructed in this paper.
- From the perspective of regional differences, depending on its either nationwide- or the three-regional nature, there is a negative correlation between the FDI and pollutant discharge. The „pollution have" hypothesis does not hold, nor are the test results in the western region significant, either; there is a significant positive correlation between exports and pollutant discharge of the overall nationwide and eastern regions, in which the positive impact of the eastern region is the largest. Although the central and western regions have a positive impact, the result is not significant; there is a significant negative correlation between the import trade and the pollutant discharge of the western regions and nationwide, in which the negative impact of the western region is the largest. There is a positive correlation between the import trade and the pollutant discharge of the eastern and central regions, but only the eastern region passes the significance test.

Because of the regional heterogeneity of the FDI, foreign trade and the overall state of pollutant discharge in our country, according to the local conditions, it is essential that differentiated investment and trade policies should be developed. In the eastern region, e.g. eastern China export trade accounts for about 90%, processing trade prioritizes the export structure, and a large number of production activities are of a domestic nature, resulting in the production process pollutant discharge remaining in the country. Trade expansion in the eastern part in the future should be environmental costs into the cost of production of export enterprises, through economic means should be applied to adjust and optimize the structure of export products; to gradually solve import problems of contaminated waste which still exists in eastern, improve the structure of imported products, and encourage imports products of low added value, resource consumption and the connotation in high pollutant discharge. The FDI brings cleaner production technologies and technology spillover effect to reduce the pollutant discharge caused by the nation and the three major regions, but the introduction of the FDI is closely related to the environmental access to various regions; therefore, we should avoid local governments at all levels in order to develop the economy, competing reduce environmental access standards, ignoring the negative environmental effects of the introduction of foreign capital, which should be the main pollutant emission targets as pre-conditions for the introduction of foreign capital, to raise the level of introducing foreign investment. Due to limitations in data collection, the comprehensive evaluation system of this article needs to be further expanded. In the future, we should reflect the overall pollutant discharge status of the regional economic development and build new, relatively uniform elements of a comprehensive evaluation system of pollutant discharge.

ENDNOTES

1 The total wastewater discharge contains part of life and refers to domestic sewage emissions

2 Due to space limitations, this article does not provide the calculation process in full detail or the calculation results. The authors can provide them to interested readers.

3 Due to space limitations, this article does not provide the results obtained in other years. The authors can provide them to interested readers.

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