ISSN : 0974 - 7435 Volume 10 Issue 9

2014

BioTechnology

An Indian Journal

FULL PAPER

BTAIJ, 10(9), 2014 [4263-4271]

# Where is haze from? - Studies on equilibrium relationship between China's foreign trade and environment deterioration

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## ABSTRACT

Fast economic growth leads to a fact that China faces serious environmental degradation. Haze becomes the hot topic on which the domestic and foreign media focus. So, where is the haze from? In this paper, the theory of general equilibrium model was used. To study the balance relationship between foreign trade and environmental degradation in China, Data of 28 provinces from 1990-2012 is used. With the help of a panel cointegration technique, we analyzed the structure effect, technological effect and targeted to set up three kinds of environmental pollution indexes. The results show that the scale effect of foreign trade and the influence of industrial waste water are positively correlated, and the effects of industrial solid waste, industrial waste gas showed a negative correlation relationship. Trade dependency is negatively related to the industrial wastewater emission; the consumption structure and environmental pollution are related, namely the income increase pollution did not have a positive impact on the environment.

## KEYWORDS

Environmental pollution; Scale effect; Structure effect; Technique effect.

## INTRODUCTION

Haze weather makes the most area of cities in poor visibility. In the morning and night the fog is formed because the humidity is very big, while during the ascension of temperature leads to reduction of humidity resulting in that the fog slowly turned into a haze. The situation is not only influenced by meteorological factors, also affected by the pollution emissions. On January 9, 2013, the central and eastern regions in China are under the fog haze weather and pollution. The national meteorological center makes blue fog warning changes in the weather forecast for the yellow warning, and 10 am, 13, Beijing issued a haze orange alert for the first time in history. In mid-January, Beijing's air pollution index is close to 1000. China's northeast, northwest, north China and Jiangnan, Huanghuai region, suffered massive pollution and the influence of the fog.

China as the world's largest developing country, in the past few decades, has experienced rapid economic growth, but also met the challenge of the severe environmental degradation. China's total import and export volume increased from 69.6 billion dollars in 1985 to 25.83 trillion yuan in 2013 Trade dependence increased from 24.7% in 1985 to 47% in 2012, but the China environmental bulletin 2008 data showed that apart from industrial wastewater emissions, relative stability, industrial emissions and industrial solid waste emissions are on the rise, while some environmental quality indicators have improved, but still faces grim environmental situation.

## THEORETICAL HYPOTHESIS AND RESEARCH REVIEW

At first, the research of the relationship between trade and environment initiative began at[3][11], and they together studied the environmental impacts of North American Free Trade Area (NAFTA) and will affect the collation for the scale, structure and technical effects. Then scholars do research in the same area using such method. International scholars are carefully discussed the relationship between trade and environment quality, forming a number of hypotheses:

(1) the Environment Kuznets Curve (EKC) hypothesis. Analyzed from economic Angle, the hypothesis suggests that once income reaches a critical value, economic growth will cause adverse effects on development environment, and when the reach a critical value, economic growth will be beneficial to the improvement of environmental quality. Because all sorts of EKC curve related research on selecting the different object and the sample, the research method also each are not identical, therefore many experts and scholars on the skeptical;

(2) the pollution haven hypothesis. The hypothesis is the basis of factor endowment wheel, in this hypothesis; national production and export of products have the characteristics of the intensive use of rich elements. Due to the good environment and resources in developing countries, huge resources intensive products exports, the nature of these products is tainted products. At the same time, the environmental resources in the developed countries, and has the very high environmental standards, so will a lot of polluting enterprises migration to developing countries[4].

National experts study the relationship between trade and environment, mainly through the following perspective. (1) Trade can improve the environment quality, (2) Trade is an important factor of environmental degradation, (3) Trade has no impact on the environment quality and (4) Trade impact on environmental quality is depends on the specific situation[11]. When they study relationship between NAFTA and environment, getting the inverted-u environmental Kuznets curve, they trade as measured by strength of trade openness and found that trade intensity effects on environmental quality is not great by analysis[2][10]. Found that northern countries improved environmental quality because of free trade but environment in the South is subjected to more pollution. World's total pollution levels improved because of free trade. They consider underdeveloped regions in order to occupy the competitive advantages of free trade, had to make to its own environmental standards reduced transfer high polluting industries from developed to developing countries[1]. Provided an analysis of 44 countries on environmental targets for 1971-1996 to explore the trade effects of environmental. Their results suggest that environment of the capital-rich countries in the structure of the trade effect of has been severely affected by pollution, structural effects around the world is positive and negative is not knowing for sure, but if larger technical effects than scale, the environment tends to be more of a high quality. This model in this paper is selected during the research process[1, 2]to create a model of general equilibrium theory, on this base we also discuss the trade effects of environmental, include pollution as a factor in the trade model, and analyze the systematically the impact of trade on the environment. The dynamic relationship between growth and environmental change is thereby tested.

## THEORETICAL MODELLING AND ANALYSIS OF CHARACTERISTIC PARAMETERS

For example, a large country with n actors, and the country adopted an open economic policy, this policy production products x and y, and the products of the factors of production are k and l. In the case, scale does not change, CX (w, r) and CY (w, r), two units of cost function can be used to represent the x and y of production technology. When y is valuation standards, the relative price of x is indicated by p. And domestic and foreign prices are generally not the same, because it can be affected by the State's geographic location and distance from the suppliers and various trade barriers. If the trade friction is $\beta$, the relative price for X can be written by the following equation with Pw

$$P=\beta Pw \quad \textbf{(1)}$$

If X represents a country's imports $\beta$ >1; export X, $\beta$ <1.

### Manufacturer

When manufacturer manufactures x, amount of pollution emissions is expressed by z. Both the subjective and the objective aspect, manufacturers have reduced pollution emissions, in addition to selecting element density, x-elements of productive activities and to ensure that the density is the same. For example in the reduction of polluting emissions, are part of X, then when the manufacturer's total output is net output for a unit of Da, $D_n = D - D_a$ into reducing emissions is the net Da output. Set $\theta = D_a / D$, In order to reduce the intensity of pollution emissions, then $D_n = D(1-\theta)$, When the relationship between the pollution and output is proportional relationship, then the reward of reducing the scale of the pollution emissions remuneration is certain. Pollutant discharge can be written by

$$Z = e(\theta)D \quad \textbf{(2)}$$

Following expressions can represent producers of equilibrium

$$P^N = C^X(w,r) \quad 1 = C^Y(w,r) \quad K = C_r^X D + C_r^Y y \quad L = C_w^X D + C_w^Y y \quad \textbf{(3)}$$

### Consumer preference

From the point of consumer preference of pollution, we can make consumers are divided into two kinds. One is the green consumer $N^g$, concerning environment, another Brown consumer $N^b$. When the pollution level is constant, we can use the following function to indicate maximum indirect effects of one of the consumer in category i groups consumers,

$$V^i(P, G/N, Z) = u\left(\frac{G/N}{\rho(P)}\right) - \delta^i Z \quad \textbf{(4)}$$

Where $i=\{g,b\}$, $\delta^g > \delta^b \geq 0$, $G/N$ is the per capita income. $\rho(P)$ is a price index, monotone increasing function is u. By contrast, in terms of utility cost, green consumers bear is bigger.

### Act of government

Tax is the main source of finance in China. Therefore, when the government's tax levels to T, the T here is assuming, of course, this can make the two kinds of consumer groups to maximize the weighted effect.

$$\max_T N\left[\lambda V^g + (1-\lambda)V^b\right] \tag{5}$$

$\lambda$ is different for different government in different countries. Standard production functio n $R\left(P^N, K, L\right)$ can be used to maximize the after-tax profit of the private sector. Income can be the sum of the above profit and pollution emission taxes.

$$G = R\left(P^N, K, L\right) + TZ \tag{6}$$

$$\frac{dI}{dT} = \frac{1}{N\rho(P)}\left[R_{P^N}\frac{dP^N}{dT} + z + T\frac{dZ}{dT}\right] = \frac{T}{N\rho(P)}\frac{dZ}{dT} \tag{7}$$

$$= N\left[\lambda MD^g(P,I) + (1-\lambda)MD^b(P,I)\right] \tag{8}$$

### Pollution of the supply and demand

$Z = e(\theta)D$ represents the private sector's demand for pollution in the output, $\varphi$ defined as the proportion of D, reflecting the structural effect. S used to represent the gross domestic product, reflects the scale effect. And for pollution, e ($\theta$) indicates the size of the degree of pollution emissions, reflecting the technical effect. The following is the differential equation after logarithmic,

$$\hat{Z} = \hat{\varphi} + \hat{e}(\theta) + \hat{S} \tag{9}$$

Where ^ refers to the percentage change. In the case of world prices unchanged, its differential is divided by $\varphi$ to get

$$\hat{\varphi} = \varepsilon_{\varphi k}\hat{k} + \varepsilon_{\varphi p}\hat{p}^N \quad (\varepsilon_{\varphi k} > 0, \quad \varepsilon_{\varphi p} > 0) \tag{10}$$

The pollution from the private sector demand is decomposed into

$$\hat{Z} = \hat{S} + \varepsilon_{\varphi k}\hat{k} + \left[(1+a)\varepsilon_{\varphi p} + \varepsilon_{e,P/T}\right]\hat{\beta} + \left[(1+a)\varepsilon_{\varphi p} + \varepsilon_{e,P/T}\right]\hat{P}^w - \left[a\varepsilon_{\varphi p} + \varepsilon_{e,P/T}\right]\hat{T} \tag{11}$$

And make the pollution of the price, according to the government to supply the pollution. Combining equation (1) with equation (11), contaminated supplies can be decomposed into

$$\hat{T} = \hat{Q} + \varepsilon_{MD,P}\hat{\beta} + \varepsilon_{MD,P}\hat{P}^{w} + \varepsilon_{MD,I}\hat{I} \quad (12)$$

## EMPIRICAL ANALYSIS

### Empirical model

Based on the above model, it is easy to get the following empirical equation to represent relationships between pollution and economic factors.

$$\hat{Z} = \pi_1\hat{S} + \pi_2\hat{k} - \pi_3\hat{I} + \pi_4\hat{\beta} + \pi_5\hat{P}^{w} + \pi_6\hat{Q} \quad (13)$$

$\hat{Z}$ the change of said pollution emissions. The change ratio of GDP is $\hat{S}$, the change of the capital labor ratio is $\hat{k}$, The change of national income per head is $\hat{I}$, it is also the technical effect. $\hat{\beta}$ is the change of the degree of openness to trade. $\hat{P}^{w}$ is pollution changes in world prices. $\hat{Q}$ is changes in national type, reflects the intensity of an international environmental governance. Environmental pollution $\pi_i$ is used to indicate the share of each economic component. Generally speaking, we have no way to accurately judge the world price of polluting products, so we provided it is invariant throughout the year, namely, $\hat{P}^{w}$ =0, So that we can come up with in terms of pollution, economic factors influence. Here is a combination of empirical equations. The exponential is in order to eliminate the heteroscedasticity of the time series.

$$\ln Z = \pi_1 \ln S + \pi_2 \ln k + \pi_3 \ln \beta + \pi_4 \ln I + \pi_5 \ln Q \quad (14)$$

### Instructions of source of data instructions

Data is the selected data from 1990 to 2012 the country 28 provinces autonomous region. Here does not include Chongqing, Xi 'an, and Hainan because of lacking comprehensive statistics. Industrial emissions (FQ, the unit is million standard cubic meters), industrial wastewater emissions (FS, with ten thousand tons) for the unit and the discharge of industrial solid waste (FW, with ten thousand tons) are viewed as indicators of environmental pollution. The capital labor ratio (KL, The unit is yuan/person). KL= Total investment in fixed capital/labour force. Gross domestic product (GDP) GDP deflators (1985=100) have been adjusted. Trade dependence (YCD, The unit is %), YCD = (exports plus imports)/gross domestic product (GDP), with the yuan's central parity rate with the dollar in each of the count value converts the provincial import and export to local currency. I is provincial per capita real disposable income of urban households (Yuan), to reflect the technical effects [5]. General, the number T of students at the school (per) is used to reflect provincial differences in consumer preferences for environmental quality. All the data is from the Statistical Yearbook of China of 2012, the Chinese economic statistics database and the compilation of statistics on new China's 55.

### Panel unit roots test

Unit root tests mainly includes the following test, Breitung inspection[5], LLC examination[6], Hadri inspection, and when they are not accompanied[7], unit root tests have the following three ways[8], namely Fisher-ADF test[9], the Fisher-PP test and PS test. Hadri main test is employed here, and in addition, scarcely began to provide a unit root, TABLE 1 shows the data and variables Panel unit root test results.

**TABLE 1: Economic variables Panel unit root test results**

| **Test method** | | **InFQ** | **InFS** | **InFW** | **InGDP** |
|---|---|---|---|---|---|
| | LLC | 2.324(0.98) | 0.231(0.59) | 5.739(1.00) | -0.59(0.27) |
| | Breitung | 3.922(1.00) | -1.268(0.10) | 7.701(1.00) | -2.81(0.10)* |
| Horizontal values | IPS | 2.891(0.99) | 1.334(0.91) | 6.147(1.00) | 5.94(1.00) |
| | Fisher-ADF | 54.28(0.54) | 46.05(0.83) | 27.77(0.99) | 12.55(1.00) |
| | Fisher-PP | 60.75(0.31) | 36.75(0.98) | 47.26(0.79) | 17.39(1.00) |
| | LLC | -17.91(0.20)* | -20.52(020)* | -21.64(0.10)* | -5.188(0.10)* |
| | Breitung | -4.637(0.30)* | -14.40(0.10)* | -7.738(0.20)* | -9.599(0.20)* |
| First order difference | IPS | -15.70(0.10)* | -16.61(010)* | -22.65(0.10)* | -5.647(0.10)* |
| | Fisher-ADF | 313 (0.10)* | -307.3(010)* | 561.4(0.20)* | 119.0(0.20)* |
| | Fisher-PP | 680.2(0.10)* | 332.3(0.10)* | 1711(0.10)* | 94.99(0.20)* |

| **Test method** | | **InKL** | **InYCD** | **InI** | **InT** |
|---|---|---|---|---|---|
| | LLC | -1.143(0.12) | 4.09(1.00) | -0.87(0.19) | -5.973(0.10) |
| | Breitung | -2.304(0.01)* | -2.379(0.00)* | 5.39(1.00) | 3.117(0.99) |
| Horizontal values | IPS | 9.18(1.00) | -5.249(0.00)* | 1.14(0.87) | -0.845(0.20) |
| | Fisher-ADF | 13.54(1.00) | 12.94(1.00) | 58.02(0.40) | 59.22(0.36) |
| | Fisher-PP | 29.30(0.99) | 11.62(1.00) | 72.92(0.06) | 12.98(1.00) |
| | LLC | -9.268(0.10)* | -18.88(0.20)* | -8.723(020)* | -0.009(0.20)* |
| | Breitung | -9.739(0.10)* | -12.40(0.20)* | -8.575(0.20)* | -4.411(0.10)* |
| First order difference | IPS | -9.918(0.10)* | -17.06(0.20)* | -10.63(0.20)* | -2.480(0.01)* |
| | Fisher-ADF | 193.5(0.10)* | 319.7(0.20)* | 205.0(0.20)* | 81.37(0.02)** |
| | Fisher-PP | 218.7(0.10)* | 1411(0.20)* | 447.1(0.20)* | 305.1(0.20)* |

**Note: *, * *, represent the Significant level rejected the original hypothesis of 1%, 5%, respectively, the probability of the statistics are shown in brackets.**

In the above test that can be seen clearly, lnKL, lnYCD and lnGDP level value is different from the other, for Breiting test. For the IPS inspection, lnYCD the level of value is different from the other. Except for those, as opposed to a test conclusion, others four or more test methods and inspection results are consistent. In other words, these variable terms I

(1) represents a variable used in this paper belong to the non-equilibrium variables.

## Panel cointegration test

When we make bread cointegration, using regression residuals constructed 7 statistical quantities, where component description and United Group are include in. The following TABLE 2 is the outcome of cointegration test.

## Result analysis

In the Panel data model is divided into three models. First, the fixed effect model, second, the mixed model, third, the random effects model. Therefore, when the model is determined correctly, both F-test and Hauseman test are used. TABLE 3 and 4 listed the results of sample in an F-test, as well as Hauseman test when explanatory variables are industrial emissions, from which you can determine the model in the form of individual fixed effect model.

**TABLE 2: Cointegration test of economic variables**

| Variable | | Panel cointegration test results | | | | |
|---|---|---|---|---|---|---|
| Explanatory variables lnGDP lnKL Lnycd lnI lnT | Explained variables lnFQ | Statistics in the group | Panel v-stat -2.43* | Panel $\rho$ -stat 2.40* | Panel PP-stat -5.22* | Panel ADF-stat -5.88* |
| | | Statistics in the group | | Group $\rho$ -stat 4.02* | GroupPP-stat -6.99* | GroupADF-stat -4.99* |
| | Explained variables lnFS | Statistics in the group | Panel v-stat -2.82* | Panel $\rho$ -stat 3.03* | Panel PP-stat -3.39* | Panel ADF-stat -4.22* |
| | | Statistics in the group | | Group $\rho$ -stat 5.09* | GroupPP-stat -2.69* | GroupADF-stat -2.32* |
| | Explained variables lnFW | Statistics in the group | Panel v-stat -3.45* | Panel $\rho$ -stat 2.45** | Panel PP-stat -7.40* | Panel ADF-stat -8.36* |
| | | Statistics in the group | | Group $\rho$ -stat 4.54* | GroupPP-stat -8.21* | GroupADF-stat -7.62* |

**Note: *, * *, represent the Significant level rejected the original hypothesis of 1%, 5%, respectively.**

**TABLE 3: Hausman test results**

| Test Summary | Chi-Sq.Statistic | Chi-Sq.d.f. | Prob. |
|---|---|---|---|
| Cross-section random | 16.594925 | 5 | 0.0053 |

**TABLE 4: F test results**

| Effects Test | Statistic | d.f. | Prob. |
|---|---|---|---|
| Cross-section F | 65.976561 | (27,611) | 0.0000 |

In order to overcome errors result from the possibility, the AR (1) was added. The results of individual fixed effects model estimates are as follows:

$$1nFQ = 3.34 + 0.151nGDP + 0.101nKL + 0.221nT + 0.74AR(1)$$

(0.00) (0.00) (0.01) (0.00) (0.00)

R2=0.98 DW=1.89 N*T=28*23=644

$$1nFS = 12.32 - 0.321nGDP + 0.101nKL - 0.341nYCD + 0.90AR(1)$$

(0.00) (0.00) (0.02) (0.00) (0.00)

R2=0.98 DW=2.1 N*T=28*23=644

$$1nFW = 4.27 + 0.171nGDP + 0.081nKL + 0.131nT + 0.78AR(1)$$

(0.00) (0.00) (0.03) (0.00) (0.00)

R2=0.98 DW=1.85 N*T=28*23=644

**(Note: the above in parentheses is the p-value of t statistic, and the variable which does not pass the t test has been removed)**

### In conclusion

1. Trade economies of scale were exacerbated by industrial solid wastes and emissions, but to a certain extent deter industrial wastewater discharge. Industrial solid wastes and emissions from industrial economies of scale expand respectively 1% and 0.15%. Industrial wastewater reduces 0.32% because economies scale expands 1%, which is a significant result on behalf of my country on waste water management issues.
2. Scale effect arising from the capital accumulation is more obvious than a technical effect. Trade openness increase 1%, industrial wastewater emissions would be reduced by 0.34%, optimization of customer's consumption structure change on the environment had a negative impact on the quality[12].

**TABLE 5: lnFQ, lnFS, lnFW independent emissions in different districts of China**

| District | lnFQ | lnFS | lnFW | District | lnFQ | lnFS | lnFW |
|---|---|---|---|---|---|---|---|
| Beijing | -0.71 | -1.49 | -0.92 | Shandong | 0.63 | 1.36 | 0.58 |
| Tianjing | -0.63 | -1.04 | -1.35 | Henan | 0.31 | 1.03 | 0.31 |
| Hebei | 0.83 | 0.96 | 1.14 | Hubei | 0.03 | 0.77 | -0.03 |
| Shanxi | 0.69 | -0.33 | 1.10 | Hunan | -0.19 | 0.80 | -0.01 |
| Inner Mongolia | 0.58 | -0.81 | 0.61 | Guangdong | 0.13 | 1.84 | -0.51 |
| Liaoning | 0.63 | 0.77 | 1.02 | Guangxi | 0.17 | 0.93 | 0.15 |
| Jilin | -0.14 | -0.50 | -0.21 | Sichuan | 0.33 | 0.86 | 0.57 |
| Heilongjiang | -0.03 | -0.46 | 0.08 | Guizhou | 0.20 | -1.47 | 0.37 |
| Shanghai | -0.12 | 0.19 | -0.74 | Yunnan | -0.33 | -0.42 | 0.37 |
| Nanjing | 0.36 | 2.02 | 0.02 | Shanxi | -0.42 | -0.42 | 0.13 |
| Zhejiang | 0.18 | 1.49 | -0.56 | Gansu | -0.08 | -1.26 | -0.03 |
| Anhui | 0.07 | 0.34 | 0.36 | Qinghai | -0.86 | -2.96 | -1.14 |
| Fujian | -0.43 | 0.80 | -0.32 | Ningxia | -0.28 | -1.88 | -0.85 |
| Jiangxi | -0.48 | 0.07 | 0.79 | xinjiang | -0.42 | -1.20 | -0.83 |

Industrial waste gas emissions independently sorted from largest to smallest are: Hebei, Shanxi, Liaoning, and Shandong. Industrial wastewater emissions independently sorted from largest to smallest are: Jiangsu, Guangdong and Zhejiang. Industrial solid waste emissions independently sorted from largest to smallest are: Hebei, Shanxi, and Liaoning. We can see from the results sorted, the industrial "three wastes" most larger emissions independently of the province is the provinces with faster economic development, while autonomous emit less, as most are economically underdeveloped provinces. Beijing is an exception. Despite it has rapid economic growth, but very little pollution emissions. Therefore, for economic development, taking into account the quality of the environment at the same time, we can learn from the “Beijing model”.

## CONCLUSION AND SUGGESTION

In this paper, we analysis the effects of China's foreign trade on the environment using the Panel co-integration technology, under the premise of a model of general equilibrium theory created by the[1,2], and from science and technology, structure and on the scale.

### Research Conclusions

The increase of foreign trade expands the scale of economic activities, promotes the need for resources resulting in a negative impact to the environment. Continuous expansion of our country foreign trade scale promotes the economic development as well as damages to the natural environment.

Aggravated by environmental pollution increases as the capital-labour ratio raises, our export product structure from primary products to manufactured goods. Core positions in industrial exports of manufactured goods, it also means that our capital to participate in the global division of labour and labour-intensive products has changed.

Environmental pollution and consumption structure has a lot relationships, namely pollution worsened because of increase pf the high quality talent, which does not comply with the general theory. Income has no positive impact on environmental pollution, which means that there are still many people without creating environmental awareness in China.

## Policy proposal

Government restraints on the manufacture and export of pollution-intensive goods, supports enterprises 'technological innovation, improves the investment in research and development of clean technology, lowers levels of pollution and increases competition in the global market and enhance competitive advantage product when it faces very stringent environmental standards.

Establish cooperation relations with other countries introduce foreign advanced pollution control technology to a number of environmental governance, reference their good experience and methods of environmental protection. Combining our real national conditions Find environmental protection methods that are consistent with our national conditions, ensuring the rapid development of trade and improve the level of environmental pollution.

Internalization of environmental cost. Many Chinese exports is excluding environmental costs, competitive advantage in the global market it is clear. But low-cost anti-dumping allegations are often exposed to the global community. In addition to this, our deteriorating environmental quality also can have an impact on the quality of agricultural and industrial products. Environmental costs exclude the gain global competitive advantages thus lose because product quality due to the deterioration of the environment is not guaranteed.

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