An Empirical Research on Trade Liberalization and CO_2 Emissions In China

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Abstract. This paper studies this relationship between free trade and carbon dioxide emissions by utilizing the time series data collected from the year 1981 to 2010. The study shows: there's a long-term equilibrium relationship between trade liberalization and carbon dioxide emissions in China; a unidirectional causality exists from Foreign Trade Dependency to carbon dioxide emissions, while the causality between FDI Dependency and carbon dioxide emissions is bidirectional.

Background Introduction

With the development of trade openness, China's energy consumption has increased constantly, and the problem of environmental pollution is becoming more and more serious, especially the total emission of carbon dioxide (CO_2) which has shown a rapid growth tendency. According to the international energy agency statistics, China's emission of carbon dioxide from fossil fuel consumption is 7.25 billion tons in 2010[1], which has become the world's largest emitter of greenhouse gases, facing huge double emission reduction pressure from the international and domestic. Therefore, the problem with which we are concerned is whether trade liberalization has an effect on emissions of carbon dioxide in China. Answers to the questions above will help our country take various factors into consideration when making effective CO_2 emission reduction policy.

Variable Selection and Data Sources

The majority of previous research both at home and abroad on the relationship between trade liberalization and CO_2 emissions have utilized foreign trade dependence indicator to reflect trade liberalization, while paying no attention to studying other trade openness indicator. In fact, the Foreign Trade Dependency can only reflect the changes of import and export scale. Considering the problem that the proportion of import and export of enterprises with foreign capital in China's foreign trade volume is more than 50%, the paper will do this work that trade openness consists of Foreign Trade Dependency and FDI Dependency. Foreign Trade Dependency is the ratio of total import and export volume and gross domestic product (GDP). FDI Dependency is the ratio of foreign direct investment and GDP in those days. All of these basic data are collected from China Statistical Yearbook in each corresponding year.

Studies on relationship between trade openness and CO_2 emissions in existing domestic literature mostly use total CO_2 emissions as the index measuring carbon dioxide emissions[2], while in this paper, we will select CO2 emissions intensity index, that is, the ratio of carbon dioxide emissions and GDP (CO_2 / GDP). The data of CO_2 / GDP is collected from CO_2 Emissions from Fuel Combustion (2012 Edition), IEA.

Length of time series for the variables of trade liberalization and CO_2 emissions intensity is all from the year 1981 to 2010. In the course of actual analysis, this article will utilize the logarithm of each variable for the reason that we can get stationary sequence by obtaining the logarithm of time

series data, not changing the characteristics of time series data. The code and unit of each variable are shown in the Tab. I.

TABLEI THE CODE AND UNIT OF EACH VARIABLE

Names of Index	Unit	Code
Foreign Trade Dependency	%	LnTR
FDI Dependency	%	LnFDI
CO_2 Emissions Intensity	Ten thousand tons/ Billions of Dollars	LnE

Long-term Equilibrium Analyses

A. Unit Root Test

We should firstly do the unit root test for all of variables to examine the stability of the variable itself before analyzing whether there is a long-term stable relationship between the two trade liberalization indicators and CO_2 emissions intensity indicator. Only when the variable is stable in first order, that is I (1), can we make co-integration analysis. In this article, the ADF test is used to implement stationary test for variables of LnE, LnTR and LnFDI and their sequence of differences. And the test results can be seen from Tab. II. In the significant level of 5%, teach variable is I (1) course of first-order single entire, and there may be a stable relationship among them.

TABLEII UNIT ROOT TEST

Variable	Test Form (C,T,K)	ADF Statistic	5% Critical Value	P Value	Conclusion
LnE	(C,T,0)	-2.2431	-3.5806	0.4491	Nonstationarity
LnTR	(C,0,0)	-1.748082	-2.971853	0.3972	Nonstationarity
LnFDI	(C,0,1)	-1.864011	-2.976263	0.3433	Nonstationarity
DLnE	(C,T,0)	-5.009648	-3.587527	0.0021	Stationarity
DLnTR	(C,0,0)	-3.346565	-2.976263	0.0225	Stationarity
DLnFDI	(C,0,0)	-3.334128	-2.976263	0.0231	Stationarity

Note: Test form(C, T, K) stands respectively for unit root test equation including intercept, temporal trend and lagging order number; D represent first-order difference of variables.

B. Long-Term Equilibrium Analysis: Cointegration Analysis

There's a need for co-integration test in order to examine whether there is a long-term equilibrium among LnE, LnTR and LnFDI. Here are two kinds of methods for Co-integration Test. One is EG two-step-methods co-integration test presented by Engle and Granger in 1987 on the basis of regression residuals, and the EG two-step-methods test can only examine whether co-integration relationship exists between the two variables; the other is called Johansen Co-integration Test, also known as the JJ (Johansen-Juselius) Test, which is a kind of method used to examine regression coefficients based on the VAR model put forward together by Johansen and Juselius in 1990, and to undertake multivariable co-integration test. So in this paper, we choose to use Johansen Co-integration Test for co-integration test, explaining the long-term correlation among these variables according to co-integration equation. According to the analysis above, we can use co-integration analysis method because each variable is I (1) sequence, and results of inspection we can see from Tab. III.

TABLEIII TEST RESULTS OF COINTEGRATION

Hypothesized No. of CE(s)	Trace Statistic	0.05 Critical Value	Max- Eigen Statistic	0.05 Critical Value
None	62.35524	35.19275	51.77188	22.29962
At most 1	10.58337	20.26184	6.398046	15.89210

Tab. III suggest that regardless of Characteristic Roots Tracing Test of Co-integration or the

Maximum Eigen-value Test, test statistics of corresponding original hypothesis None are all more than the critical value of significant level of 5%, which means refusing no co-integration relationship assumption in the confidence level of 95%, explaining that the co-integration relationship exists among the three variables including LnE, LnTR and LnFDI; the value of test statistic of corresponding original hypothesis At most 1 are all less than the critical value of significant level of 5%, which means not refusing the original hypothesis of one cointegration vector at most. Therefore, there is only one kind of co-integration vector relationship among the three variables including LnE, LnTR and LnFDI, that is, there is a long-term equilibrium relationship among CO_2 Emissions, Foreign Trade Dependency and FDI Dependency in the confidence level of 95%. The co-integration equation is:

$$LnE = -5.3639 + 1.0894LnTR + 0.7914LnFDI \quad (1)$$

The co-integration equation suggests CO_2 emissions in China will grow greatly in the long run with the rapid development of foreign trade and the use of foreign investment, that is, it is foreign trade and the use of foreign investment that cause CO_2 emissions to increase rapidly in the long term. This shows the phenomenon of "Carbon Emissions Transfer" [3] really exists in our country. China has transferred huge amounts of CO_2 emissions for some other developed countries through the introduction of foreign capital and forms of foreign trade.

Granger Causality Test

Granger Causality Test is a kind of test that examines the causal relationship between variables in terms of statistical significance, and its basic principle is: given two variable X and Y and they influence each other. If X lag value has significant effects on Y, we say X is the Granger reasons of Y; similarly, if Y lag value has significant effects on X, then Y is the Granger reasons of X. From the analysis above, we can find that there's a co-integration relationship among CO_2 emissions, Foreign Trade Dependency and FDI Dependency. Thus they can be respectively Granger causality test.

Cointegration Test has demonstrated that a long-term co-integrating relationship exists in the three variables, but the specific direction of causal relationship is still not clear. In order to study the specific causal relationship of the three variables talked above, we decide to analyze their causal relationship through Granger Causality Test. The results are shown in the Tab. IV below.

TABLEIV RESULTS OF VARIABLE CAUSAL RELATIONSHIP TEST

Null Hypothesis	Number of Samples	F-Statistic	Probability	Conclusion
LnTR does not Granger Cause LnE	28	10.0505	0.0040	Reject
LnE does not Granger Cause LnTR	28	0.00825	0.9283	Accept
LnFDI does not Granger Cause LnE	28	4.45069	0.0451	Reject
LnE does not Granger Cause LnFDI	28	4.86265	0.0369	Reject

From Tab. IV, we can see that:

Firstly, a unidirectional causality exists from Foreign Trade Dependency to carbon dioxide emissions, that is, the rapid development of foreign trade is the Granger reasons for the growth of CO_2 emissions, but CO_2 emissions is not the reasons for the growth of foreign trade. While making important contributions to economic growth, foreign trade has also brought a lot of emissions of carbon dioxide, which shows the "pollution haven hypothesis"[4]. We can draw a conclusion that the growth of foreign trade in our country at present is extensive, and belongs to resource consumption of high energy consumption and high pollution pattern, going against the improvement of environment quality in China; it also reflects from the side that various trade policies and industrial policies made by government only have limited effects on optimizing the mix of imports and exports or their effects are still not shown at present. How to make the structure of China's imports and exports improved as early as possible in the direction of sustainability and environmental protection is still one of the main factors taken into consideration when formulating

and implementing trade policy [5].

Secondly, the causality between FDI Dependency and carbon dioxide emissions is bidirectional. The economic meaning of this result is that the relationship between the use of foreign capital and CO_2 emissions not only reflects that the former is the reason for changes of the latter, but also indicates that CO_2 emissions can influence FDI. However, the current research literature mostly tends to focus on unilateral roles FDI has played in CO_2 emissions, neglecting the influences CO_2 emissions has on foreign investment policy and the degree. On one hand, the international industrial transfer carried by FDI has not played an important role in optimizing the structure of China's manufacturing industry, and foreign capital entering high carbon-correlation industry will buy high carbon products back to the domestic through processing trade. When foreign capital transferred industry to China, it also transferred parts of CO_2 emissions at the same time. On the other hand, the increase of CO_2 emissions will influence policy adjustments of the use of foreign capital, and then influence the introducing standard and structure of foreign capital.

Conclusion

This paper studies this relationship between free trade and carbon dioxide emissions by utilizing the time series data collected from the year 1981 to 2010. This research arrives at conclusions as follows: There's a long-term equilibrium relationship between trade liberalization and carbon dioxide emissions in China. It is foreign trade and the use of foreign investment that cause CO_2 emissions to increase rapidly in the long term. And a unidirectional causality exists from Foreign Trade Dependency to carbon dioxide emissions, while the causality between FDI Dependency and carbon dioxide emissions is bidirectional.

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