

The Impact of Import and Export Trade on Carbon Emissions: Based on The Perspective of Belt and Road Countries

Shiyong He^{1,*}

¹ Straits Chenggong Institute, Wuyi University, Nanping, Fujian, 354300, China

*Corresponding author's e-mail: ShiyongHe0103@outlook.com

Abstract: In the context of economic globalization, environmental issues have gradually attracted people's attention, and the "Belt and Road" Cooperation Initiative (hereinafter referred to as B&R) proposed by China aims to promote economic development at the same time, the environmental role has become particularly important. This study uses linear regression model, two-stage least square (2SLS) method and event study method to analyze the relationship between international trade and carbon emissions from the perspective of B&R countries. The results are as follows: the influence of import and export trade on carbon emissions is generally positive.; The correlation between industrial structure and carbon emission in the B&R countries is low. Joining the B&R has increased the volume of international trade to certain extent, thus increasing the carbon emissions of B&R countries.

Keywords: Import and export trade; Carbon emission; Belt and Road.

1. Introduction

1.1. Background

Since the invention of the steam engine and electricity, the increasing consumption of coal and other mineral resources by all countries in the world has made the emission of carbon dioxide into the atmosphere by all countries in the world achieve a substantial increase. At present, global warming has become an objective fact and become more serious, and many climate problems brought by global warming continue to threaten the survival and development of human beings. In this grim situation, managing the global warming crisis, reducing carbon dioxide emissions, and improving global governance capacity have gradually become the general consensus of the most countries and regions in the world, which has become very important for improving the global climate and improving the ability to cope with global warming. After the Second World War, economic globalization accelerated rapidly, and various factors of production, including commodities, flowed more frequently across borders and regions, and import and export trade gradually occupied a significant position in the development of countries. At the same time, China and other countries have jointly built the B&R Initiative, which aims to provide countries in different regions, stages of development and civilizations with an opportunity for win-win cooperation and shared development.

1.2. Objective and significance

Based on the the background mentioned above the research on carbon emissions and import and export trade has quickly become a hot topic in the academic community. When the B&R achieves the original mission of common development and sharing results, whether it will affect the CO₂ emissions of the B&R countries is a problem we urgently need to solve.

This paper referred to other scholars' studies on the relationship between international trade and carbon emissions to explore and enrich the existing studies. In this paper, carbon

emission is discussed from the perspective of B&R countries to fill the gap in relevant research perspectives. It provides a theoretical basis for the further promotion of green trade and the development of both "quantity" and "quality" of national economy. In addition, based on the CO₂ emissions and foreign trade data of B&R countries, this paper uses the empirical method of regression analysis to conduct a specific exploration on the international trade and carbon emissions, providing a basis for the study of the relationship between the two, and also providing reference for the environmental problems to be dealt with during the construction of the B&R.

2. Literature Review

2.1. Influencing factors of carbon emission

The existing researches mainly focus on economic development, population size, industrial structure, technology, energy structure and other aspects. In the first four aspects, existing studies agree that economic development will exacerbate carbon emissions, and studies have been conducted based on carbon emission data of multiple countries or cities, such as: Using comparative analysis and regional difference analysis and other methods, Chen et al. analyzed the spatial differences of China's carbon emissions and their influencing factors, and concluded that the change trend of per capita carbon emission (CCE) is consistent with that of per capita GDP[1]; Dong et al. took 128 countries as samples and found that a country with a larger population consumes more energy and therefore produces more carbon emissions[2]; Another study suggested that technological progress would reduce carbon emissions to a certain extent. Wang et al. analyzed the main influencing factors of CO₂ emission based on data from Guangdong Province and concluded that technological progress is negatively correlated with CO₂ emission [3]; What's more, Ping et al., using data from several countries and spatial econometric models, found that industrial structure is correlated with CEE (global carbon emission efficiency), and the correlation is negative .[4]

In terms of energy structure, some scholars believe that energy structure factors may exacerbate carbon emissions, because Wang et al. also predicted the emission trend during 2015-2030 and estimated the emission reduction potential. Empirical results show that the CO₂ emissions will decrease with the reduction of energy consumption structure. On the contrary, some scholars believe that the influence of energy structure on carbon emission fluctuates. [5]

2.2. The effect of the development of import and export trade

As for the effects brought about by the development of international trade, some studies use China's recent data to analyze the CO₂ emissions implied by China's foreign trade during 2002-2007. It indicates that the export behavior of CO₂ emissions implied by China's international trade is becoming more and more significant.[6] Other studies believe that import and export trade has positive and negative effects. On the positive side, the positive impact of international trade on economic growth is reflected in investment, technological progress, etc. On the negative side, open trade may cause certain countries to specialize in highly polluting industries and export its products to other countries with high environmental protection requirements and do not allow the mass production of highly polluting products, resulting in increased environmental pollution. [7]

2.3. Impact of import and export trade on carbon emissions

Studies have fully demonstrated international trade and carbon emissions are inextricably linked. Some studies believe that the import and export trade increases the resources required for production by expanding the scale of production, and ultimately leads to the deterioration of the environment.[8]In addition, Boamah, K et al. found that there is an N-type relationship between carbon emission and economic growth related to import and export trade by using methods such as cubic environmental Kuznet curve framework.[9]Some scholars have conducted further studies, the research results confirm that there is a stable relationship between CO₂ emissions and trade and other factors. Imports increase consumption-type carbon emissions, while exports help reduce them.[10]

2.4. Review

Although existing studies have conducted a large number of studies on import and export trade and CO₂ emissions respectively, and there are relevant discussions on how to make import and export trade and environmental protection complement each other. However, there are few literatures

that directly discuss the impact of import and export trade on CO₂ emissions from the perspective of countries along the B&R. To a certain extent, this paper complements the gap in relevant research perspectives.

3. Method and Data

3.1. Data

Based on the perspective of B&R countries, this study explores the impact of import and export trade on CO₂ emissions. The selected variables can be divided into three categories: explained variable, core explanatory variable and other control variables. Among them, other control variables include total population, employment rate and industrial structure. The economic implications of the variables selected in this model are as follows:

3.1.1. Explained variables

In this paper, the logarithm (\ln_{CO_2}) of total carbon emissions of 203 countries and regions is used as an indicator to measure carbon emission levels. Data from the World Bank.

3.1.2. Core explanatory variables

In this paper, the total import and export volume (\ln_{IE}) of 203 countries and regions was selected as the core explanatory variable and used as an indicator to measure import and export trade. In order to make the regression results more relevant, the logarithm of IE was taken, the original data came from the International Monetary Found (IMF).

3.1.3. Other control variables

(1) Total population (\ln_{P}) : Since the explained variable is the total carbon emission, the explained variable will be affected by population factors. Other factors being equal, a country with a larger population will, to some extent, increase its carbon emissions compared to other countries. Data from the World Bank.

(2) Employment rate (\ln_{E}) : With the development of economy, enterprises will increase recruitment and expand production scale, thus driving the growth of employment. Therefore, the employment rate has a certain relationship with the development of economic level. However, the development of economic level will affect carbon emissions, so the employment rate is selected as the control variable in this paper. Data from the World Bank.

(3) Industrial structure (\ln_{ST}) : The proportion of secondary industry in all industries will affect CO₂ emissions, so this paper chooses the ratio of industrial added value to GDP to represent industrial structure. Data from the World Bank.

The specific description of variables and data is shown in Table 1:

Table 1. Variable selection and data description

Type of Variable	Variable Name	Variable Meaning	Variable Unit	Data Sources
Explained Variable	\ln_{CO_2}	Logarithmic form of total CO ₂ emissions	kiloton	World Bank
Explaining Variable	\ln_{IE}	Logarithmic form of total import and export volume	million dollar	IMF
Control Variable	\ln_{P}	Logarithmic form of population gross	people	World Bank
	\ln_{E}	Logarithmic form of employment rate	%	World Bank
	\ln_{ST}	Logarithmic form of industrial structure as measured by the ratio of industrial additions to GDP	%	World Bank

Since there are gaps in total carbon emission, total import and export volume, employment rate and tariff rate, Stata/MP

17.0 software uses the interpolation method to fill individual gaps in total import and export volume, employment rate and

industrial structure, and then deletes the unfilled gaps. However, the data of total carbon emission was deleted because of large gaps in the data of Aruba Island, American Samoa, Bermuda and other countries or regions. Since the deleted panel data was not balanced, the xtbalance command

in Stata was used to balance the panel data from 1995 to 2020. So far, 26 years of balanced panel data of 145 countries were obtained. The descriptive statistics of each variable are shown in Table 2 below:

Table 2. Descriptive statistics of variables

VARIABLES	N	mean	sd	min	max
ln_IE	3,770	9.804	2.175	3.613	15.32
ln_CO ₂	3,770	9.669	2.215	4.357	16.21
ln_E	3,770	4.016	0.192	3.398	4.448
ln_P	3,770	16.02	1.739	11.51	21.07
ln_ST	3,770	3.248	0.370	1.488	4.440

3.2. Method

3.2.1. Empirical research

This paper adopts a linear regression model to conduct linear regression between the explanatory variable (import and export trade) and the explained variable (carbon emission) to study the relationship between them. In a model that depends on its unknown parameters, linearity is easier to fit than nonlinear, and the statistical characteristics of the generated estimates are easier to determine. Therefore, it is widely used in practical applications, and is more suitable for

this study to explore the impact of international trade on CO₂ emissions. The form of the simplified equation is:

$$\ln_CO_{2i} = a + b_1 \cdot \ln_IE_i + b_2 \cdot \ln_P_i + b_3 \cdot \ln_E_i + b_4 \cdot \ln_ST_i + \varepsilon_i, i = 1, 2, 3, \dots, n$$

a is the equation constant, b_1 is the coefficient of total import and export trade, which is the explanatory variable; b_2 , b_3 and b_4 are the coefficients of population, employment rate and industrial structure, which are the three control variables respectively, and ε is the random disturbance term. The regression results are shown in Table 3:

Table 3. The regression result

Variable Name	ln_CO ₂
ln_IE	0.299*** (0.065)
ln_E	-0.364 (0.228)
ln_P	1.161*** (0.183)
ln_ST	0.149 (0.105)
_cons	-10.752*** (3.172)
N	3770.000
r ²	0.618

Standard errors in parentheses
* p<0.1, ** p<0.05, *** p<0.01

From the regression results of 145 countries, it can be seen that international trade is significantly correlated with carbon emissions, and the correlation is positive. Because this paper discusses the relationship between import and export trade on CO₂ emissions from the perspective of B&R countries, they are selected from 203 countries in the original panel data, and

valid data of 55 B&R countries are obtained by using the same data processing method as above. Linear regression model is used for linear regression, and the results are shown in Table 4:

Table 4. The results of the return of the "Belt and Road" countries

Variable Name	ln_CO ₂
ln_IE	0.389*** (0.102)
ln_E	-0.464 (0.329)
ln_P	1.650*** (0.176)
ln_ST	0.322* (0.178)
_cons	-19.884*** (3.076)
N	1430.000
r ²	0.733

Standard errors in parentheses
* p<0.1, ** p<0.05, *** p<0.01

The regression results also show that in the B&R countries, import and export trade has a strong correlation with carbon emissions.

3.2.2. Robustness test

However, trade is an endogenous variable, so the coefficient of explanatory variable cannot represent whether there is a causal relationship between international trade and

CO₂ emissions. Therefore, a new variable, BRI, can be introduced as an instrumental variable, that is, whether to participate in the B&R (1 if participating in the Initiative, 0 if not), to explain the import and export trade. In this part, this study uses a 2SLS model of the instrumental variable method. The regression results of the two stages are shown in Table 5 below:

Table 5. Results of 2SLS

VARIABLES	ln IE	ln CO ₂
ln_E	-0.512*** (-3.64)	-1.364*** (-16.83)
ln_P	0.711*** (44.86)	0.539*** (9.88)
ln_ST	1.245*** (16.82)	0.999*** (9.88)
BRI	0.572*** (6.57)	
ln_IE		0.468*** (6.22)
Constant	-3.637*** (-5.80)	-1.328*** (-3.25)
Observations	3,770	3,770
R-squared	0.425	0.864

t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

However, the instrumental variable BRI here needs to be tested whether it is a weak instrumental variable. If it is a weak instrumental variable, it is inappropriate to choose BRI as an instrumental variable. In the F test, if the P value corresponding to F is less than 0.05 and the F value is 23.4006, and the F value is obviously greater than 10 according to the rule of thumb, BRI is a strong instrumental variable, and the deviation of weak instrumental variable is less than 10%. This is enough to show that there is a causal relationship between international trade and CO₂ emissions

Finally, for further explain the causal relationship between the core explanatory variables and the explained variables, the event study method is also used. Event study is a commonly used research method to analyze the impact of a specific event on a social group or individual. It explores the degree and mechanism of the impact of an event on social phenomena by studying the differences before and after the event and the correlation between the event and other factors. The purpose here is to show whether joining the B&R has any impact on carbon dioxide emissions and import and export trade.

The event was defined as joining the B&R Cooperation Initiative, the sample selection range was 145 countries and regions in the panel data from 1995 to 2020, the event occurred in the year when all countries joined the B&R Cooperation Initiative, and (-3, +3) was the research period. In addition, the variable names of the first three years of joining the B&R Cooperation Initiative are set as bri_1, bri_2 and bri_3, the year of joining is bri0, and the three years after joining are bri1, bri2 and bri3. A total of seven variables are 1-0 variables, with 1 representing yes and 0 representing no. The results of event analysis are shown in Table 6 below:

Table 6. Results of event study

VARIABLES	ln CO ₂
ln_IE	0.293*** (0.063)
ln_E	-0.369 (0.230)
ln_P	1.165*** (0.183)
ln_ST	0.149 (0.104)
bri_3	0.038 (0.024)
bri_2	0.036 (0.028)
bri_1	0.052* (0.031)
bri0	0.075** (0.036)
bri1	0.084** (0.038)
bri2	0.080** (0.039)
bri3	0.115** (0.058)
_cons	-10.730*** (3.183)
N	3770.000
r2	0.620

Standard errors in parentheses
* p<0.1, ** p<0.05, *** p<0.01

4. Conclusion

This paper uses linear regression model, two-stage least square method and event study method to analyze the impact

of international trade on CO₂ emissions from the perspective of B&R countries, and uses panel data of 145 countries and regions and 55 of them to draw the following conclusions:

First, the impact of international trade on carbon emissions is generally positive. This probably has to do with two factors. On the one hand, import and export trade expands the production scale of some products, which leads to a corresponding increase in carbon emissions. According to factor endowment theory, a country should export what is produced by its relatively abundant factors of production. Compared with the absence of international trade, the production scale of abundant factor products will expand, and carbon emissions will also increase. On the other hand, there is a technological gap between different countries and relatively few technologically developed countries in the world. However, due to technical problems, most countries currently have imperfect environmental protection technologies and cannot effectively reduce carbon emissions during production, which ultimately increases the carbon emissions.

Second, the industrial structure of the B&R countries is not highly correlated with carbon emissions. This may have something to do with its level of skill. The correlation between industrial structure and CO₂ emissions, expressed by the ratio of industrial added value to GDP, is not high, indicating that for B&R countries, industry and other industries have similar impacts on carbon emissions. According to statistics, there are only 18 high-income countries in the B&R countries, and the economic development level and technological level of most countries are not very high, so no matter which industry will cause a large increase in carbon emissions.

Third, joining the B&R has increased the carbon emissions of B&R countries. The results of event study are as follows: in the first three years of joining the B&R, the coefficient is not significant; However, from the year of joining the B&R, the coefficient began to become more significant. This may be related to the Belt and Road Initiative increasing import and export trade, which affects carbon emissions.

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