

Research on the Relationship between Foreign Trade and Carbon Emissions based on Econometric Model

Jian-Na ZHAO^{1,a}, Xiao-Chen SHAN^{1,b,*}, Lei FENG^{1,c}

¹North China Electric power University, Hebei Baoding 071003, China

^azhjnzfhf@163.com, ^bjjsxc1022@163.com, ^cfenglei0011@126.com

*Corresponding author

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Abstract: Based on the data of foreign trade import and export volume and carbon emissions in China from 1990 to 2012, statistical analysis through econometric models, the results showed that both showed a significant linear correlation. By stationary test and co-integration explain the existence of long-term stable equilibrium relationship between carbon emissions and foreign trade, through error correction shows the short-term dynamic relationship between them, the results show that the development of foreign trade will continue affect our environment. Finally, we put forward a proposal of industrial development.

As economic of China strength, our influence in the world also greater and greater. According to customs statistics, 2012 foreign trade volume of China reached \$3 866.76 billion, more than the United States ranks first in the world. On the surface, China has obtained the aura of world trade, but follow the harvest is big business environmental issues, in particular pollution problems. According to the British Tyndall Centre for Climate Change Research "Global Carbon Project" research in 2012 shows that, in 2011, the first three countries in global carbon emissions were China (28%), the U.S. (16%), EU (11%)[1], as can be seen from the data, our carbon emissions have exceeded the sum of the U.S. and the EU. So the analysis of the relationship between carbon emissions and our foreign trade, have particularly important practical significance for the sustainable development of trade and ecological terms.

Analysis of the data and relationships¹

Calculation of carbon emissions

Since in the China Statistical Yearbook, did not give the corresponding carbon emissions statistics, so we need to find a formula of carbon emissions over the years. The main source of carbon emissions is the fossil fuel, fossil fuel energy including coal, oil and natural gas three categories. So for the calculation of carbon emissions, Academia use the consumption of various types of energy multiplied by the carbon emission factor of various types energy, and then add the sum total[2]. This article uses a formula for estimating carbon emissions from Xu Guoquan[3] and other scholars. The formula is:

$$C = \sum_i m_i \alpha_i \quad (1)$$

¹ Philosophy and Social Science Research Base of Hebei Province

In the formula, C representative of carbon emissions, m_i is the consumption standard amount of energy i , that is in accordance with the standard coal reference coefficient converted to unified thermal units of energy—standard coal, α_i is the carbon emission factor of energy i . Due to the current statistics on carbon emission factor have no consistent conclusion, to avoid large errors, carbon emission factor used in this article is the average calculated according to each Energy Agency of Table 1, then according to the formula and energy consumption from Energy Statistics Yearbook of China and composition data, finishing derived by calculating the carbon emissions data of 1990-2012 years. Table 2 shows the annual carbon emissions by 1990-2012 and a summary of import and export value of China.

Tab. 1 The carbon emission factors of each kinds of energy

Data Sources	carbon emission factors		
	Coal	Petroleum	Natural gas
U.S. Department of Energy DOE/EIA	0.702	0.478	0.389
IPCC	0.755	0.585	0.448
National CST of climate change project	0.726	0.583	0.409
NDRC Energy Research Institute	0.748	0.583	0.444
Average	0.733	0.557	0.423

Tab. 2 Chinese carbon emissions and import and export of foreign trade in 1990-2012

Years	Carbon emissions C/One hundred million Tons	Import and export volume X/ One trillion dollars	Years	Carbon emissions C/One hundred million Tons	Import and export volume X/ One trillion dollars
1990	6.5133	0.11544	2002	10.0888	0.62077
1991	6.8655	0.13570	2003	11.7680	0.85099
1992	7.2095	0.16553	2004	13.6324	1.15455
1993	7.6203	0.19570	2005	15.1097	1.42191
1994	8.0357	0.23662	2006	16.5793	1.76044
1995	8.5515	0.28086	2007	17.9480	2.17657
1996	8.7946	0.28988	2008	18.4452	2.56326
1997	8.7607	0.32516	2009	19.3872	2.20754
1998	8.7589	0.32395	2010	20.2399	2.97400
1999	9.0767	0.36063	2011	21.7892	3.64186
2000	9.3168	0.47429	2012	22.5269	3.86676
2001	9.5089	0.50965			

Data Analysis

According to table 2, make carbon emissions and import and export volume plotted by years, that got both trends (Figure 1). In 23 years time, our foreign trade import and export volume grew by 33.5 times, Especially since the beginning of 2000, its growth rate significantly increased, In addition to 2009 due to the financial crisis, other years, there is an increasing trend basically, also,

from Figure 1, carbon emissions and the import and export trend ,we can see that, growth trend of our carbon emissions compared with the growth trend of import and export trade, maintaining a substantially similar growth trend. So, there is a certain degree of linear relationship between carbon emissions and our country's foreign trade.

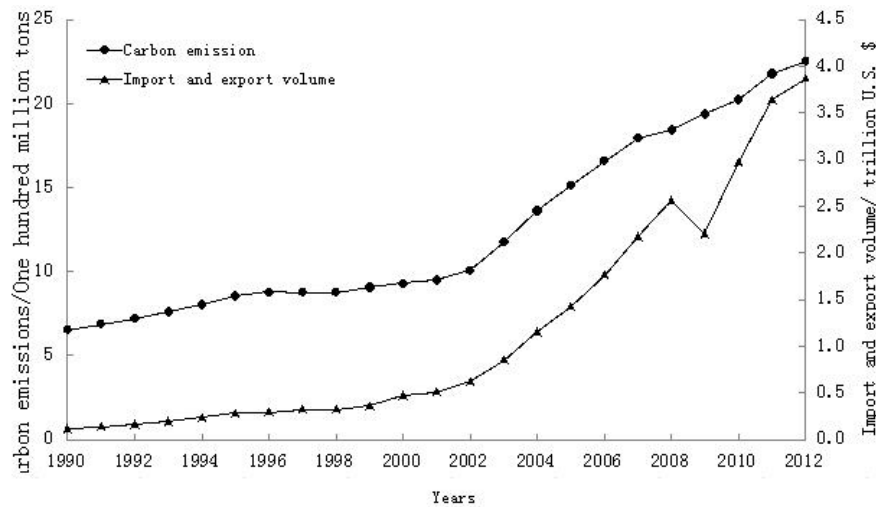


Fig 1 The trend of carbon emission and foreign trade

Correlation Analysis

After calculated by Eviews6.0 on carbon emissions and time series data of import and export trade volume, obtained the linear equations between the two: $LNC = 0.3603 \times LNX + 8.4717$, correlation coefficient $R = 0.9942$, statistics $F = 1360$, the probability value corresponding with statistics F $p \approx 0$, less than significant level $\alpha = 0.05$, therefore reject the irrelevant hypothesis H_0 , illustrate a highly positive correlation between foreign trade of China and carbon emissions.

Even after calculated by Eviews6.0, carbon emissions and import and export trade show highly significant relationship, But the upward trend of growing together on the table between the two may also appear spurious regression phenomenon. To avoid the spurious regression phenomenon arise between carbon emissions and foreign trade turnover, correlation test analysis needs to be.

Analysis

Unit Root Tests

For stationary of time series in addition to graphics and intuitive judgment, but also can be tested using statistics. Compared to graphics judge, the statistical test would be more accurate, but also more important. Unit root test is a test method commonly applied in statistical tests. There are a variety of unit root test methods, we use ADF[4] in this article.

As the number of samples used in this paper is only 23, in order to avoid a reduction in the degree of freedom, number of lags in the test equation is not suitable for too much, therefore, this paper selects fewer lags. Using software Eviews6.0, we carry on the relevant time series data between carbon emissions C and import and export volume X with unit root test, test results are shown in Table 3.

Tab. 3 The ADF unit root tests on carbon emission and foreign trade

Sequence	Level						Conclusion
	Inspection forms (c,t,n)	ADF	1% thresholds	5% threshold s	10% thresholds	Accompanied probability	
LNC	(c,t,1)	-2.590761	-4.467895	-3.644963	-3.261452	0.2872	Not smooth
LNx	(c,t,1)	-1.780595	-4.467895	-3.644963	-3.261452	0.6776	Not smooth
Δ LNC	(c,t,1)	-2.176263	-4.498307	-3.658446	-3.268973	0.4761	Not smooth
Δ LNx	(c,t,1)	-3.071752	-4.498307	-3.658446	-3.268973	0.1391	Not smooth
Δ^2 LNC	(c,t,1)	-3.301268	-4.532598	-3.673616	-3.277364	0.0961	Smooth
Δ^2 LNx	(c,t,1)	-5.621345	-4.532598	-3.673616	-3.277364	0.0012	Smooth

After the unit root test results on carbon emissions and import and export trade volume, as can be seen. When their time series have been the second-order differential can become stationary sequence, thus, their original sequences are both the single whole sequence of order 2. we can prove that, there may exist long-term stable relationship between the two, Then need to analyze with co-integration test.

Co - integration test

Since carbon emissions and import and export volume are both second-order single whole, we can use co-integration test. This article use Engle-Granger two-step method to make co-integration test .The first step is to estimate the long-run equilibrium equation of carbon emissions and the import and export volume by OLS method: $LNC_t = 0.3603 \times LNx_t + 8.4717$. Then calculated corresponding residuals according to the equation. $et = LNC_t - 0.3603 \times LNx_t - 8.4717$; The second step is to test the stationary of residuals et. if the residual series items et is stationary , so the relationship between the variables Y_t and X_t is co-integration. Otherwise, there is no co-integration. Residuals stationary test results are shown in Table 4.

Tab. 4 The ADF unit root tests on residual sequence

Sequenece	Level						Conclusion
	Inspection forms (c,t,n)	ADF	1% thresholds	5% threshold s	10% threshold s	Accompanied probability	
Residuals	(0,0,3)	-1.981424	-2.692358	-1.960171	-1.607051	0.0479	Smooth

From Table 4: Through the stationary test of residuals et, the ADF test statistic values of residuals are less than the critical value of under 10% significance level .Reject the null hypothesis of existence of unit root, that is considered the residual sequence is stationary sequence, this indicates that there is a correlation co-integration between the LNC and LNx. That is within the sample interval, there is a long-term stable equilibrium relationship between the total import and export volume and carbon emissions, the specific relationship is equation $LNC = 0.3603 \times LNx + 8.4717$, that foreign trade volume of China increased by 1% , carbon emissions of China increased by 3% 0.360, shows that foreign trade have a certain effect on our carbon emissions.

Error Correction

Establish error correction model to analyze the dynamic relationship between carbon emissions and our foreign trade[5],calculated by eviews6.0 introduce a first-order differential after error correction

model: $\Delta LNC_t = 0.1293 \times \Delta LNX_t + 0.4525 \times \Delta LNC_{t-1} + 0.0318 \times \Delta LNX_{t-1} - 0.2905e_{t-1} + 0.0033$,while the correlation coefficient $R=0.8304$,statistics $F=8.9$ corresponding to F statistics the probability value is $p=0.006$ less than significant level $\alpha=0.05$. $DW=1.97$.In the absence of the autocorrelation range, indicating that there are some changes in the relationship between short-term dynamics of foreign trade and carbon emissions.

The regression results indicate short-term changes in foreign trade of China growth in the presence of a positive impact on carbon emissions, current every 1% increase in foreign trade, current carbon emissions will increase by 0.129 3%,previous each 1% increase in foreign trade, current carbon emissions will increase by 0.031 8%,previous carbon emissions also exists a positive influence on current carbon emissions, previous carbon emissions on every 1% increase, current carbon emissions will increase by 0.452 5%.

Conclusions and Suggestions

Conclusions

To illustrate the relationship between the foreign trade import and export volume of China and carbon emissions of China, this paper analyzes the data of them from 1990 to 2012,drawn that between 1990-2012 our carbon emissions and foreign trade export volume to maintain a similar growth trend. Before 2002, carbon emissions and import and export volume of Chinese foreign trade are in a state of slow growth, then in a fast growth. Explains that for a long time, the foreign trade contributed to the rapid increase of unreasonable carbon emissions. There is a high correlation between long-term positive and significant relationship between import and export volume of the foreign trade carbon emissions. After co-integration explain the existence of a stable long-term equilibrium relationship between them, the trade has a positive role in promoting on carbon emissions. Its long-term elasticity coefficient is 0.3603.By error correction can be seen there is also a short-term dynamic equilibrium relationship between the them. In the short term, the current foreign trade volume for each 1% increase in current carbon emissions will increase 0.1293%, non-equilibrium error to lag a current ratio of 29.05% carbon emissions to make amendments, promotes foreign trade and carbon emissions to long-term equilibrium relationship. Thus, in the long term, the development of our foreign trade will continue to affect our country's environmental problems.

Suggestions

Accelerate economic growth mode

At present, China is still the extensive economic growth mode, such economic development is bound to create enormous pressure on our environment. So in the process of our economic development, we should fully recognize the importance of the economic development approach in dealing with our country's resources and environment and foreign trade. Therefore, to accelerate the pace of adjustment of the economic development mode, implement resource-saving and environment-friendly industrialization and urbanization strategy, optimize the industrial structure and energy consumption structure, so that our economy comes into the fast low-carbon

development road, thus achieving a virtuous ecological cycle of the foreign trade[6].

Reasonable planning industrial trade layout

Foreign trade of China growth mainly depends on the product or resource-intensive manufacturing, its production and consumption process is relatively high carbon emissions, causes of structural environmental pollution. Therefore, the foreign trade layout should be rational planned, accelerate the elimination of backward production capacity and polluting enterprises. China is very urgent need to conduct low-carbon energy technology innovation[7], focus on improving the production technology of high energy-consuming enterprises, increase the carbon products industry in the proportion of our foreign trade.

Establish an early warning mechanism of carbon emissions in foreign trade

Since our country does not have established an early warning mechanism of foreign trade environment, meanwhile, the development of international environmental law, our economic development and the production methods are also put forward higher requirements. In this context, establish of an early warning mechanism of foreign trade carbon emissions need to put on the agenda, establish of foreign trade and environmental pollution monitoring system information, select the appropriate warning evaluation, depending on the industry's carbon emissions, a modest portion of carbon tariffs charged. Force our foreign trade in good a atmosphere.

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