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Research on Equilibrium between Logistics Industry Added Value and Carbon Emissions

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Abstract: It studies the implementation mechanism and Countermeasures of low carbon logistics, carbon emissions estimation method of logistics enterprise, the carbon emissions and the logistics industry added value for data gathering and measuring. Two series stationary test shows that there is co-integration relationship. Observe impulse response between the two series and get the result that carbon emissions and the logistics added value impact and influence each other.

Key words: Logistics industry, low carbon, co-integration, pulse response

INTRODUCTION

Low carbon logistics is a modern logistics theme, also should be the direction of future development of the logistics. It rose in green environmental protection official advocacy by the “low carbon economy and Copenhagen Conference on environment”. Logistics as a high-energy consumption industry, the original business model of development harms to the environment. It must take the road of carbide, realize the purification of the logistics environment and make full use of the logistics resources. In recent years, research on low carbon logistics academia gradually increasing and summarize the domestic and foreign research results, statistical research on low carbon logistics is still blank. Statistical study of low carbon logistics can be roughly divided into three aspects. One is the definition of low carbon Logistics, the second is to implement the mechanism and Countermeasures of low carbon logistics, the third is the quantitative statistical analysis and model of low-carbon logistics.

IMPLEMENTATION MECHANISM AND COUNTERMEASURE OF LOW CARBON LOGISTICS

Domestic and foreign scholars researched from macro level and micro-level mechanism research on how to apply low carbon concept into all aspects of logistics operation. Low carbon economy(Dai, 2008) issue in logistics has three levels: the technical level, planning level and policy level. Technical aspect mainly refers to technology innovation and application to encourage energy-saving emission reduction. The planning level, include macro and micro. Macro refers to the industrial layout; the micro level mainly refers to the specific logistics solutions. The policy level refers to a class of problems need new measures in the system construction of the country will be able to solve, because the benefits and social not corporate benefits can always maintain a consistent.

The nature of low carbon logistics (Wang and Li, 2010) is the logistics rationalization, implemented in the process to provide low cost, high quality logistics services, achieve energy conservation, reduce pollution, promote the sustainable development of economy; the so-called "low carbon logistics", is in the whole logistics system, by adopting advanced technology to enhance the level of logistics management, logistics to economic benign promotion and development cycle. Most of the scholars put forward three characteristics of low-carbon logistics. Low carbon logistics operate in the middle of the whole logistics system.

Dong *et al*. (2010) used logistics integration thought to analyze low carbon logistics theory and model points and pointed out that the scheme planning and operation monitoring management is an important guarantee of realizing low carbon logistics operation, demonstrated the freight logistics is an important way to realize the low carbon logistics operation. Zhou (2010) compared the domestic and foreign development status of low carbon logistics, pointed out the restriction of our current low carbonization development of five main factors.

CARBON EMISSIONS ESTIMATION METHOD OF LOGISTICS ENTERPRISES

At present, China has not yet established a carbon emission monitoring system perfect, so there is no direct monitoring data of industry and enterprise carbon

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emissions in a certain region. The domestic scholars, according to the IPCC fourth assessment report of the research conclusion: major source of greenhouse gases increase is the burning of fossil fuels, the present estimate are based on energy consumption amount. Estimate equation is:

$$C = \sum C_i = \sum \frac{E_i}{E} \times \frac{C_i}{E_i} \times E = \sum S_i \times F_i \times E \quad (1)$$

where, C is carbon emissions, Ci is carbon emissions of the ith kind of energy, E is total consumption of primary energy consumption, Ei is the corresponding energy consumption, Si represents the ith energy proportion in the total energy, Fi is the carbon emissions intensity of the ith energy. About the value of Fi, at present, there is no uniform standard. Domestic scholars mainly adopted data used by Energy Research Institute National Development and Reform Commission to solve China's energy problems. This study also uses the published data, specific data such as shown in Table 1.

Table 1: Carbon emission coefficient of kinds of energy

Coefficient	Coal	Oil	Gas	Power
F_i	0.75	0.58	0.44	0

National Development and Reform Commission Energy Research Institute

The data of this study are from "Energy Statistics Yearbook", "China Statistical Yearbook" and "China logistics yearbook", a collection of logistics enterprises from 1980 to 2008, a total of 29 years of energy consumption data, specific data such as shown in Table 2.

CORRELATION ANALYSIS OF CARBON EMISSIONS AND LOGISTICS INDUSTRY ADDED VALUE

Data Descriptive Statistics. Logistics industry added value of 1991-2008 are from "China logistics statistical yearbook", a part of carbon emission time series data from the above calculation.

Carbon emissions is larger than logistics industry added value in 1993 years ago, illustrate the logistics efficiency is low. Since, 1993 the logistics industry added

Table 2: Logistics enterprises energy consumption in 1980-2008

		Coal		Oil		Gas		
Year	Total energy consumption	Consumption proportion (%)	Carbon emissions	Consumption proportion	Carbon emissions	Consumption proportion	Carbon emissions	Total carbon emissions (million tons)
1980	2902	66.66	1446.16	31.41	530.95	0.02	0.31	1977.42
1981	2942	70.90	1559.42	29.15	499.49	0.02	0.31	2059.22
1982	3108	69.92	1624.68	29.86	540.50	0.02	0.27	2165.45
1983	3261	67.21	1638.59	30.75	584.07	0.02	0.35	2223.02
1984	3436	66.34	1704.23	30.96	619.61	0.02	0.35	2324.19
1985	3713	62.14	1724.79	31.68	685.25	0.02	0.35	2410.40
1986	3996	57.43	1715.74	34.43	801.35	0.03	0.44	2517.53
1987	4126	54.33	1675.75	35.79	860.06	0.01	0.22	2536.03
1988	4327	52.22	1689.13	35.99	907.07	0.03	0.49	2596.68
1989	4499	50.77	1707.59	36.33	952.15	0.02	0.31	2660.06
1990	4541	47.59	1615.49	37.07	980.46	0.04	0.84	2596.80
1991	4756	42.57	1513.74	39.34	1089.97	0.03	0.53	2604.25
1992	5058	37.09	1402.42	41.22	1214.40	0.02	0.49	2617.31
1993	5587	31.33	1308.67	44.68	1453.92	0.01	0.35	2762.95
1994	5625	33.30	1400.55	41.78	1369.05	0.02	0.58	2770.18
1995	5863	22.43	983.17	48.84	1668.05	0.03	0.70	2651.91
1996	5994	19.62	879.10	49.01	1711.21	0.07	1.78	2592.09
1997	7543	18.97	1069.82	49.49	2174.47	0.05	1.64	3245.93
1998	8245	16.87	1039.61	51.49	2472.89	0.04	1.63	3514.13
1999	9243	14.00	967.62	54.14	2915.00	0.05	2.13	3884.75
2000	10067	11.32	852.19	54.73	3209.23	0.06	2.60	4064.02
2001	10257	10.25	785.65	55.50	3316.11	0.06	2.64	4104.41
2002	11171	9.44	788.72	55.11	3586.22	0.06	2.83	4377.76
2003	12819	8.33	797.91	55.33	4131.79	0.05	3.02	4932.73
2004	15404	5.40	622.08	55.96	5021.50	0.07	4.95	5648.53
2005	16629	4.90	609.52	58.38	5655.20	0.10	7.29	6272.01
2006	18583	3.90	541.86	59.03	6389.56	0.09	7.65	6939.07
2007	20643	3.32	512.48	59.57	7162.77	0.08	7.49	7682.74
2008	22917	2.90	497.45	57.95	7735.25	0.31	31.70	8264.44

"Energy Statistics Yearbook", "China Statistical Yearbook", "China logistics yearbook" and Duan (2011) value increased rapidly, increasing faster than the increases in emissions value fast,which demonstrate the efficiency of our logistics industry upgrade faster.

Stability test of series: Make unit root test, respectively for the total carbon emissions and logistics industry added value by using DFGLS method which is the sequence difference of tests for high order autoregressive variable. In the empirical study, although the ADF test is the most widely used unit root test, but its power is low, especially in the situation of small sample. When the data generation process is highly correlated, the test effect is not ideal. In addition the ADF inspection is failure to test descending stationary sequence containing a time trend. Therefore, in order to improve the efficiency of ADF test, Elliott, Rothenberg and Stock (1996) put forward GLS method based on the back DF test that is DFGLS test. Null hypothesis and alternative hypothesis consistent with ADF test. Elliott, Rothenberg and Stock gives different confidence threshold level, DFGLS test and ADF test is the same as the general left the one-sided test.

As carbon emissions C for example, namely ΔC do regression to $C_{t-1}, \Delta C_{t-1}, \cdots, \Delta C_{t-p}$ and make t-test for coefficients C_{t-1}. The DFGLS test can be done to three models, model with constant and time trend as below:

$$\Delta C_t = \mu + \beta t + \delta \Delta C_{t-1} + \sum_{j=1}^{p} \lambda_j \Delta C_{t-j} + u_t \tag{2}$$

where, μ is the intercept term, βt is the time trend. The minimum of SIC choose lag order standard. To do DFGLS test to carbon emissions C and logistic industry added value L contain a constant and time trend.

Co-integration analysis and error correction model: Co-integration test use the EG two step method, make first-order regression of the logistics industry added value to carbon emissions, then do ADF test on the residuals. If the residual is I (0), then the total carbon emissions and logistics industry added value are co-integrated. If the residual sequence is not stationary, then carbon emissions and logistics industry added value are not co-integration.

Find the co-integration relationship between variables, namely the long-run equilibrium relationship and this relationship constitutes the error correction term. Then set the short-term model, the error correction term as an explanatory variable, with short-term fluctuations in other explanatory variables, the establishment of short-term model, namely, error correction model.

Table 3: Regression of two sequences

Variable	Coefficient	Std. error	t-statistic	Prob.
C	-4.54	1.17	-3.89	0.00
LnC	1.60	0.14	11.42	0.00

Table 4: Regression of two differenced sequences

Variable	Coefficient	Std. error	t-statistic	Prob.
DLnC	1.03	0.002	436.08	0.00
E(-1)	0.09	0.022	3.94	0.00

Compute the two variables C and L logarithm is denoted as lnC and lnL, the first lnL to do regression analysis of lnC, consider long-term impact to logistics industry by carbon emissions, the results shown in the (Table 3).

Model equation is:

$$LnL = -4.54+1.60\times LnC \tag{3}$$

Secondly, make a regression of two stationary differenced sequences as dluC and dlnL, study logistics industry added value by short-term impact coefficient of carbon emissions. The results are shown in the (Table 4).

Model equation is:

$$DLnL = 1.028\times DLnC+0.088E(-1) \tag{4}$$

The stability residual sequence e_t as error correction term, error correction model can be established:

$$\Delta \ln L_t = a_1 \Delta \ln C_t + a_2 e_{t-1} \tag{5}$$

The long-term and the short-term model have goodness-of-fit. Logistics industry added value deviates from equilibrium by the short-term effects of total carbon emissions, because of the existence of error correction term., logistics industry added value deviates from equilibrium in long term more by the effects of carbon dioxide emissions. Long-term effect coefficient is 1.6, means per unit of carbon emissions that increase the logistics added value of 1.6 the unit. The short term influence coefficient is 0.088, indicates that per unit of carbon emissions increase 0.088 units of logistics industry added value.

Make the pulse response on two differential sequences (Fig. 1).

Figure 1 shows that the logistics industry added value impact from carbon emissions in more than 10 years are divergence, not convergence, means the long-term impact of pulse response. Also Fig. 1 shows that the effects of carbon emissions by the logistics industry

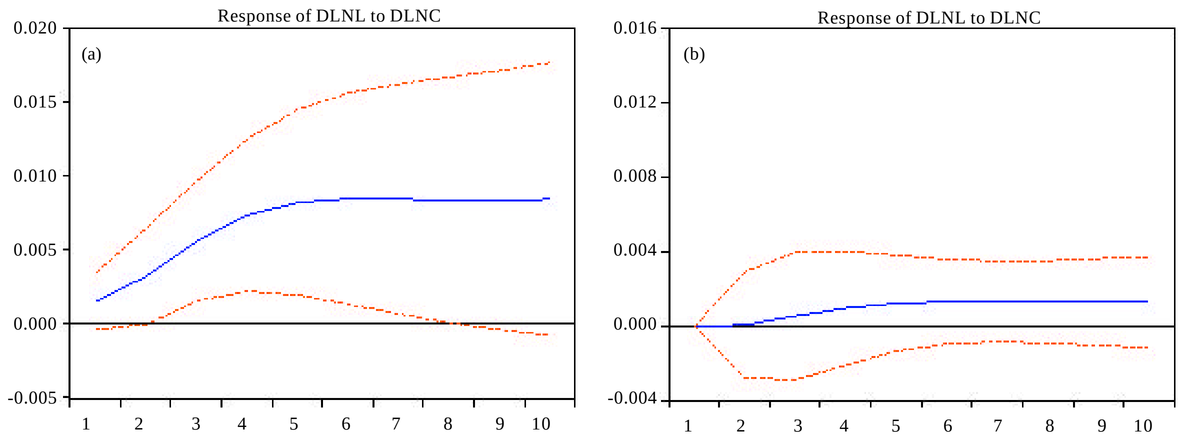

Fig. 1(a-b): Pulse response between logistics industry added value and carbon emissions

added value in the short term is not very volatile, in the zero axis fluctuation. The long-term impact of logistics industry exists, but is not violent.

CONCLUSION

Through the empirical research, there is co-integration relationship between China's carbon emissions and logistics industry added value. The rapid development of logistics industry, logistics activities, particularly in the transport industry as the most, carbon emissions impact to logistics growth is not only in the short-term, but also in the long-term obviously. That shows a significant positive correlation between carbon emissions and logistics demand of logistics enterprises. The faster logistics demand growth, the more carbon emissions. How to meet the needs of economic development of the logistics demand growth condition and keep a low carbon development of logistics enterprises is a difficult problem. Logistics process optimization and improve the level of information management are the inevitable choice.

At present, development of environment and logistics industry is not coordinate. Development cannot take into account the economic benefits and environmental benefits at the same time. It means the development of logistics enterprises and the growth of carbon emissions control both have not yet reached the collaborative development stage. Carbon emissions have not reached the threshold point. Sometime in the future carbon emissions will increase; logistics enterprises are facing tremendous pressure to reduce emissions.

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