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Research on sustainable development of international trade in Shandong Province under the background of the fourth industrial revolution

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Abstract

Purpose: After entering the 21st century, a new industrial revolution, i.e. industrial revolution 4.0, which is characterized by intelligence, automation and networking, has opened the curtain of the "industry 4.0" era. In recent years, "low-carbon economy" has been a development goal that has been paid close attention to and adhered to at home and abroad. As a major economic province, Shandong Province has not only brought about rapid economic growth, but also caused rapid environmental deterioration due to its high energy consumption, high dependence and high environmental pollution. In this environment, low-carbon economy has become an inevitable trend in the development of foreign trade in Shandong Province. Based on the current situation of foreign trade in Shandong Province and various existing problems, this paper explores the relationship between low-carbon economy and foreign trade in Shandong Province under this strategic background. **Research design, data and methodology:** By selecting the data from 2008 to 2017, using the carbon emission coefficient method to measure the CO₂ emissions in the past decade, analyzing the impact of ecological factors on trade, selecting the most representative GDP and total imports for regression analysis, it is proved that they have a real impact on CO₂ emissions. The total GDP is positively correlated with carbon emissions, while the total import is negatively correlated with carbon emissions. **Results:** This paper discusses the impact of low-carbon economy on foreign trade of Shandong Province from the perspective of foreign trade. Especially in today's "low-carbon economy" background. **Conclusions:** it is helpful for relevant departments to formulate relevant policies and promote the sustainable development of foreign trade in Shandong Province.

Keywords : Low Carbon Economy, Foreign Trade of Shandong Province, Sustainable Develop, Carbon Emission.

Major classifications: Artificial Intelligence Convergence, Case study

1. Introduction

After entering the 21st century, a new industrial revolution, i.e. industrial revolution 4.0, which is characterized by intelligence, automation and networking, has opened the

curtain of the "industry 4.0" era. The coming of "industrial revolution 4.0" has changed the mode of production, life and thinking of human beings, which needs our deep thinking and serious treatment. For a long time, the industrial

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development of Shandong Province has been used to the extensive trade growth mode, that is, a large amount of energy consumption, high income but low technology content and added value industrial mode, which leads to many problems in the rapid development of foreign trade in Shandong Province, such as unreasonable industrial structure and extremely low utilization rate of resources. With the advent of industry 4.0 era, the pressure of emission reduction in Shandong Province is increasing day by day. The topic of low-carbon economy will inevitably become the major trend of foreign trade development in Shandong Province. Through the analysis of the data in recent years, this paper concludes the problems faced by the sustainable development of foreign trade in Shandong Province, so as to provide more comprehensive and effective ideas for solving the problems in the future, which is conducive to the improvement of the research on the related issues of the sustainable development of foreign trade. At the same time, it draws the complementary relationship between the low-carbon economy and the sustainable development of foreign trade, and puts forward suggestions for the relevant conclusions. We can adjust the structure of energy consumption, reduce the use of high-carbon energy; adjust the economic and industrial structure to reduce the proportion of the secondary industry; increase scientific and technological support, focus on the development of low-carbon green industries; and strengthen the protection of ecological environment to change the current situation of foreign trade in Shandong Province, so as to ensure the sustainable development of foreign trade in Shandong Province. In addition, dealing with the foreign trade problems of Shandong Province under the low-carbon economy is conducive to provide reference for other provinces on related issues, and has practical significance for promoting the sustainable development of foreign trade under the background of low-carbon economy in China.

2. Literature Review

Aiming at the hot spot of "low carbon economy", Wang Mengting (2013), Chen Junda (2016) and Liu Xiaoli (2017) respectively take Jilin Province, Guangdong Province and Qingdao city of Shandong Province as examples to analyze the current economic development situation and problems of a certain province (city), study the impact of low-carbon economy background on the sustainable development of foreign trade of specific provinces (cities), and aim at the situation of the provinces (cities) According to the local conditions, the paper draws a conclusion and countermeasures. Wang Mengting (2013) analyzed the problems existing in the foreign trade development of Jilin Province through the case analysis method (Taking Jilin

Province as the specific research case), literature review method and comparative analysis method (the proportion of import and export in different years), and by comparing the GDP growth of Jilin Province from 2006 to 2012, Wang Mengting (2013) emphatically described the "three high and one low" phenomenon. Chen Junda (2016) analyzed the CO2 emission of Guangdong Province by carbon emission coefficient method Eviews carries out regression analysis on panel data, and concludes that the main factors affecting carbon dioxide emissions in foreign trade, among which GDP is the largest factor affecting carbon dioxide emissions, followed by the secondary industrial structure, and finally the total amount of imports and the actual use of foreign investment. Liu Xiaoli (2017) started from relevant literature and theory, took Qingdao as the research object, combined with the economic development and data availability, studied and compared the development level of Qingdao's low-carbon economy in the past ten years, and compared the comprehensive scores of Dalian and Xiamen horizontally, and concluded that Qingdao should formulate a low-carbon planning that can grasp the overall path, and strengthen the students' health with the goal of improving the environmental carrying capacity State protection is to improve energy utilization efficiency by adjusting the structure, and to develop low-carbon technology by increasing scientific and technological investment.

Roberta quadrelli and Sierra Peterson (2007) found that fossil fuel combustion is the greatest impact of human on climate, accounting for 80% of human greenhouse gas emissions, by investigating the constraints and choices of energy use in two major developing economies, China and Brazil. Yan Xin, Ge Jianping, Lei Yalin, duo Hongyu (2019) believe that from 2002 to 2012, some non-metallic mining, non-metallic manufacturing, chemical industry and other industries have gradually become low-cost economic industries with the development of the times. These industries promote the development of low-carbon economic provinces, and make LCE provinces gradually transfer from coastal areas to inland areas.

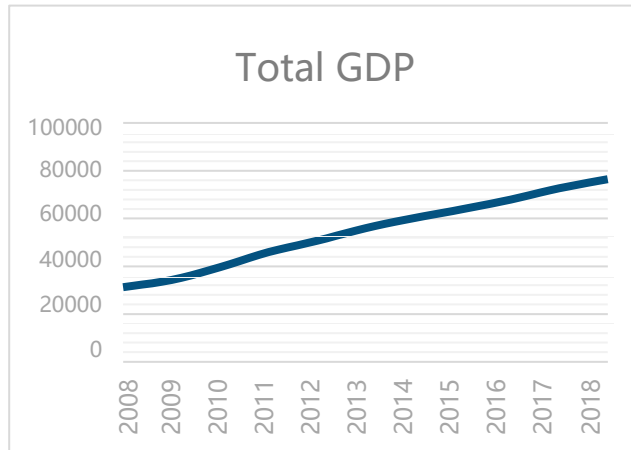
3. Current situation and problems of foreign trade development in Shandong Province

Shandong Province is one of the major coastal economic provinces in China. The annual GDP growth shows that the economy of Shandong Province has been growing rapidly in recent years, and the development prospect of all walks of life is good. According to the relevant data in 2018, Shandong Province ranks the third in the country in terms of GDP, with steady progress in economic operation and stable development of foreign trade. The total import and export of goods reached 193.25 billion yuan, an increase of 7.7% over the previous year. Among them, export was 1056.96 billion

yuan, an increase of 6.1%; import was 873.29 billion yuan, an increase of 9.7%. The growth rate of import was 3.6% faster than that of export, and the trade surplus narrowed by 12.8%. Import and export gradually tended to balance.

3.1. The current situation of Shandong Province GDP development

It can be seen from Figure 1 that the GDP of Shandong Province showed a stable growth trend from 2008 to 2017, and showed the characteristics of slow and steady increase. In 2008, the total GDP of Shandong Province was 312.234 billion yuan, which increased by 2 trillion yuan in 2012. By the end of 2017, the total GDP of Shandong Province had increased by about 4 trillion yuan, and the overall trend was stable. We can infer the development trend of Shandong Province's GDP in the future.



Data source: Shandong Provincial Bureau of statistics

Figure 1: Trend of Shandong Province's GDP from 2008 to 2017

3.2. Current situation of import and export development in Shandong Province

As can be seen from table 1, the overall trend of Shandong Province's import and export volume has shown an upward trend since 2007-2017. Excluding the special situation that imports and exports in 2009 decreased at the same time (due to a long period of time, data errors or omissions are not excluded). From 2010 to 2017, the overall export trend showed a slow rise, with the export volume of 705.72 billion yuan in 2010 and increased to 889.17 billion yuan in 2014, a year-on-year increase. By 2017, the export volume has increased to 994.12 billion yuan, with a year-on-year increase of 10.56%. The total increase was 347.05 billion yuan, up 34.91% year on year. Compared with the steady growth of export volume, the overall trend of import from

2007 to 2018 fluctuated greatly, showing an upward trend from 2009 to 2013. Compared with the 403.3 billion yuan in 2009, the import volume in 2013 increased to 821.53 billion yuan, an increase of 418.23 billion yuan, a year-on-year increase of 50.91%; however, from 2014 to 2015, the import volume decreased significantly to 608.45 billion yuan, a year-on-year decrease of 25.94%; and then 201.3 billion yuan. In 2017, although the import volume gradually rebounded, by 2017, the import volume still decreased by 42.26 billion yuan compared with that in 2013. It is predicted that the import volume will continue to rise by 2020.

Table 1: Summary of foreign trade related data of Shandong Province from 2008 to 2017

Year	Total GDP (100 million yuan)	Total imports (100 million yuan)	Total export volume (100 million yuan)
2008	31212.34	4512.2	6470.7
2009	34219.28	4033.0	5345.4
2010	39571.20	5733.8	7057.2
2011	45874.95	7117.6	8124.5
2012	50626.96	7373.6	8126.1
2013	55911.86	8215.3	8330.5
2014	60164.80	8131.2	8891.7
2015	63858.62	6084.5	8972.6
2016	67925.62	6446.4	9110.6
2017	72634.15	7828.7	9941.2
2018	76469.67	8751.5	10597.1

Data source: Shandong Provincial Bureau of statistics

3.3. Development status of CO2 emission in Shandong Province

As a big economic province, Shandong's high consumption of energy, high dependence on energy and high environmental pollution have always been a major feature of traditional industries in Shandong Province. In recent years, the economic growth of Shandong Province makes Shandong Province better promote the development of foreign trade, but also leads to the increase of carbon energy consumption and CO2 emissions. Since there is no direct method to measure CO2 emissions in China at this stage, and the three main sources of carbon dioxide are coal, oil and natural gas, this paper calculates CO2 emissions with the help of carbon emission coefficient (source: China carbon emission trading network) and the consumption of raw coal, crude oil and natural gas converted into standard coal (source: China Statistical Bureau), and the calculation results are carried out Summary and analysis. Calculation formula:

$$Y = \sum_1^3 Y = \sum_1^3 TE \times \frac{Y_i}{TE_i} = \sum_1^3 TE \times A \tag{1}$$

Among them, y is the total carbon emission, T_{ei} is the primary energy consumption converted into standard carbon by the type I fossil energy, Y_i is the CO₂ emission of the I type fossil energy, and AI is the carbon emission coefficient corresponding to the class I fossil energy. After calculating the carbon emissions, the formula should be introduced again.

$$Z = Y \times \frac{44}{12} \tag{2}$$

Where Z is the actual CO₂ emission.

The following energy related data are from Shandong statistical yearbook over the years, and the data of nearly ten years from 2008 to 2017 are selected to calculate CO₂ emissions. The carbon emission coefficient comes from Energy Research Institute of China Development and Reform Commission and China carbon emission trading network.

Table 2: Summary of energy related data of Shandong Province from 2008 to 2017

Year	Energy consumption (ten thousand tons of standard coal)	Raw coal (ten thousand tons of standard coal)	Crude oil (ten thousand tons of standard coal)	Natural gas (10000 tons of standard coal)	CO ₂ emission (10000 tons of standard coal)
2008	32116.2	25044.2	6609.5	124.0	79156.8
2009	34535.7	26637.4	7345.7	126.7	84968.9
2010	30235.7	23970.9	4644.2	34.0	71494.9
2011	31211.8	24844.6	5343.5	72.6	75458.8
2012	32686.7	26221.3	5210.3	60.8	78557.3
2013	34234.9	27298.9	5576.9	42.0	82138.5
2014	35362.6	28555.3	5265.5	41.0	84507.3
2015	37945.4	28652.6	5832.2	48.9	86164.6
2016	38722.8	29766.2	6300.2	49.8	90110.4
2017	38683.7	27260.4	6591.7	53.3	84570.9

Data sources: The data of energy consumption, raw coal, crude oil and natural gas are from Shandong Statistical Bureau; the data of CO₂ emission are calculated by formula

Table 3: Carbon emission coefficient of three types of fossil energy

	Coal	Oil	Gas
Coefficient	0.682	0.676	0.323

Data sources: Energy Research Institute of China Development and Reform Commission, China carbon emission trading network

4. Empirical research

4.1 Model establishment and data explanation

In order to study the impact of foreign trade on CO₂ emissions, this paper selects several important factors of foreign trade for research, and uses Eviews software to carry out regression analysis on each panel data to study the correlation between CO₂ emissions and foreign trade, so as to provide empirical support for the sustainable development of foreign trade in Shandong Province. Through combing and analyzing the relevant literature, in the paper written by Chen Junda in 2016, he took CO₂ emission as the explanatory variable, and took the GDP and import amount of Guangdong Province as explanatory variables to establish an empirical model for empirical research. Combined with the actual

situation of Shandong Province in recent years, with the rapid economic development, the total GDP increases year by year, which means the increase of CO2 emissions; customs import Most of the products are mechanical and electronic equipment, so the increase of import will lead to the decrease of CO2 emission. The model is established as follows:

$$LNY_t = a_0 + a_1 LNGDP_t + a_2 LNIM_t + \varepsilon \quad (3)$$

In the formula, ε is the random disturbance term obeying the normal distribution with expectation 0 and variance δ^2 . The random perturbation term converges, and logarithm is taken for each variable, and T represents the time dimension. Y_T is the CO2 emission of Shandong Province in the T year; gdpt is the total GDP of Shandong Province in the T year; IMT is the total import of Shandong Province in the T year. Where A₀ is the constant term in the model, and A₁-A₃ is the parameter term with estimation in the model.

Due to the lack of energy data in 2018 and 2019, this paper will use the data from 2008 to 2017 for regression analysis of panel data. The data are from Shandong statistical yearbook and China carbon emissions trading network.

Table 4: Summary of foreign trade related data of Shandong Province from 2008 to 2017

Year	Total GDP (100 million yuan)	Total imports (100 million yuan)	CO2 emission (10000 tons of standard coal)
2008	31212.34	4512.2	79156.8
2009	34219.28	4033.0	84968.9
2010	39571.20	5733.8	71494.9
2011	45874.95	7117.6	75458.8
2012	50626.96	7373.6	78557.3
2013	55911.86	8215.3	82138.5
2014	60164.80	8131.2	84507.3
2015	63858.62	6084.5	86164.6
2016	67925.62	6446.4	90110.4
2017	72634.15	7828.7	84570.9

Data source: Shandong Provincial Bureau of statistics, CO2 emission data calculated by formula

4.2. Analysis results

Table 5: Eviews regression coefficient, standard deviation, t value, P value results

	Regression coefficient	Standard deviation	T value	P Pvalue
C	10.34660	0.601566	17.19945	0.0000
LNGDP	0.296725	0.083066	3.572172	0.0091
LNIM	-0.256822	0.098888	-2.597089	0.0356

Therefore, this paper also selects CO2 emission as the explanatory variable, i.e. y variable in the model, while the explanatory variable in the model selects the most representative GDP and import volume of Shandong Province.

Table 6: R2, adjusted R2, Durbin Waston value, F statistic

R ²	Adjusted R2	Durbin-Waston value	F statistic
0.646720	0.545782	2.018013	6.407144

According to the analysis results, the following regression equations were obtained:

$$LNY_t = 10.34660 + 0.296725 LNGDP_t - 0.256822 LNIM_t \quad (4)$$

According to the equation, lnGDP coefficient is 0.296725, which means that every 10% increase in GDP, CO2 emissions increase by 2%, which is a very large amount for Shandong Province, which ranks the third in the country in terms of GDP. The lnim coefficient is -0.256822, which means that every 10% increase in imports will reduce CO2 emissions by two percentage points.

5. Conclusion

This paper selects the data of Shandong Province from 2008 to 2017 for empirical research, and concludes that the CO2 emissions of Shandong Province are affected by many factors. In the previous related papers, the total GDP, the structure of the secondary industry, the total amount of import and export, the actual use of foreign investment and so on are the factors affecting CO2 emissions. Combined with previous studies, this paper selects the most representative GDP and total imports for regression analysis, and proves that the two have a real impact on CO2 emissions. The total GDP is positively correlated with carbon emissions, while the total imports is negatively correlated with carbon emissions. Shandong Province is used to the extensive trade growth mode, and relies too much on the "two high and two low" mode, that is, high income, high energy consumption, low technology content and low added value industrial model, which leads to the industry and manufacturing industry in Shandong Province, which leads to the secondary industry production as high as 44.0% of the total GDP. The CO2 emission has been on the high side. Therefore, Shandong Province should speed up the transformation of the industrial structure dominated by the secondary industry, and vigorously develop the tertiary industry, agriculture, forestry, animal husbandry and fishery or high-tech industries with low energy consumption. On the one hand, it can reduce the proportion of industry in the industry, on the other hand, it will also help to reduce carbon emissions. The government should increase the general financial expenditure on science and technology, focus on supporting low-carbon green industry, carry out technological innovation for some high-energy consumption industries, reduce energy consumption, accelerate the research and development of green energy, devote itself to creating renewable clean energy, accelerate the invention speed of low-carbon green technology, make full use of talents, learn more advanced foreign technologies, strengthen and low-carbon economy We will experience rich

exchanges between countries in order to improve our deficiencies.

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