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An Empirical Study of the Carbon Emission Kuznets Curve in Tianjin

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Abstract. With the reform and opening up, China's economy had developed with high speed, but the problem of carbon emissions has become increasingly prominent. Based on the traditional environmental Kuznets model, this paper studies the relationship between carbon emissions and economic growth in Tianjin from 2009 to 2018, and considers three control variables of industrial structure, energy intensity and urbanization level. The impact of carbon emissions, the establishment of an extended Kuznets model for comprehensive analysis. The results show that: First, there is no inverted "U" relationship between industrial carbon emissions and economic growth in Tianjin, it is a kind of inverted "N" type curve relationship, and it is currently at the second turning point. Second, Tianjin's carbon emissions are also affected by industrial structure, energy intensity and urbanization rate. The share of secondary industry and energy intensity have a positive impact on carbon dioxide emissions, and the impact of urbanization on carbon emissions is also very low.

1. Introduction

Since the Industrial Revolution, people with carbon dioxide and sexual heat have been living in the atmosphere, increasing greenhouse gases in the atmosphere every year, and as a result of the strengthening caused by warming. climate change and a number of very serious problems, there have been significant changes in the global climate since the 19th century, with the average global temperature high at 0.3 0.6 degrees Celsius, thus causing the level of pests and diseases, and increasing the forest area of a range of issues, including cuts, increased pests and diseases, and reduced rainforest area. Carbon dioxide emissions from human activities and direct combustion of fossil fuels are the main causes of global climate change. After years of economic development and extensive economic growth in China, carbon emissions have suddenly increased. In this context, China has proposed the concept of a low-carbon economy, not maintaining economic development at the expense of the environment, and maintaining economic growth while saving energy and reducing emissions. Therefore, studying the relationship between carbon emissions and economic growth, how to scientifically choose low-carbon economic policies has attracted wide attention of researchers.

Based on the current severe environmental situation in the Beijing-Tianjin-Hebei region, the state has formulated a policy of coordinated development of Beijing-Tianjin-Hebei, promoting the complementary advantages of the three places, getting rid of the imbalance of the development of the three places, and realizing the economic development and environmental quality of the Beijing-Tianjin-Hebei region at an early date (carbon). The decoupling of emissions). As an important port city in the

north, Tianjin is also an important industrial city in the north. During the "Twelfth Five-Year Plan" period, Tianjin's economy continued to develop rapidly and its economic status in the country continued to increase. However, there is a certain degree of imbalance in the industrial structure and it faces a bottleneck in development. In 2014, the proportion of the three industries in Tianjin was 1.3:49.4:49.3.Tianjin's industrial added value accounted for 49.4% of GDP, far higher than Beijing and Shanghai's 17% and 31%, while in the service industry, Beijing and Shanghai accounted for more than 60%, while Tianjin only 50%.Tianjin's industry is dominated by heavy chemicals, which have a greater impact on the environment, and environmental pollution has become more prominent. At the same time, Tianjin faces the problem of industrial structure transformation and upgrading. Therefore, studying the relationship between industrial energy consumption and economic growth in Tianjin has a strong practical significance, and can provide empirical data reference for promoting industrial restructuring and sustainable development in Tianjin.

2. Literature review

The Environmental Kuznets Curve (EKC) is named after Kuznets (1955). He first proposed that income inequality will increase at the initial stage and then decrease as the economy develops. The concept of the blacksmith's environmental curve emerged in the early 1990s with innovative research by Grossman and Kruger (1991) on the potential impact of the North American Free Trade Agreement (NAFTA) and adopted worldwide in 1992. The Bank's Development Report (BIRD, 1992) has gained popularity. The blacksmith's ecological curve is a hypothesis about the relationship between different factors or substances and per capita income that leads to environmental degradation. At the beginning of economic development, economic growth declined and pollution increased. However, when per capita income exceeds a certain level, the reverse trend has reversed. Therefore, economic growth in which per capita income is at a higher level cause environmental improvement. It can also be understood that in the initial stage of development, environmental pressures are growing faster than per capita income, and slower than GDP growth at a higher level of per capita income. The "inverted U" curve is formed between the factors causing environmental pollution and per capita income (see Figure 1).
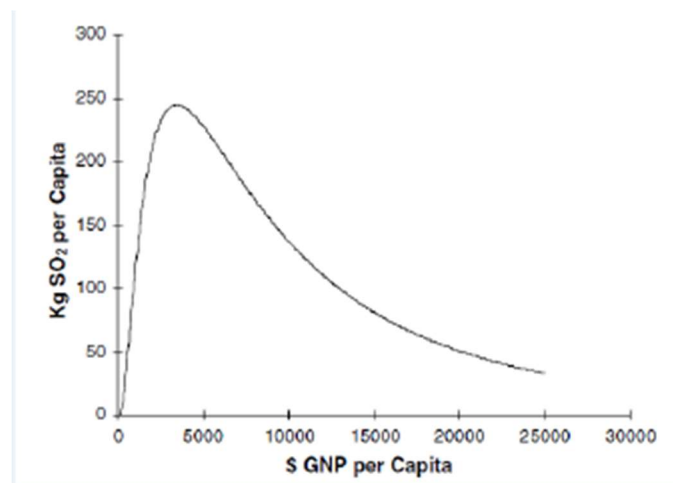

Figure 1. Environmental Kuznets curve of sulfur dioxide emissions
Source: Panayotou (1993) and Stern, Common, and Barbier (1996).

3. Statistical Analysis of Carbon Emissions in Tianjin

3.1. The selection and analysis of data variables

A summary of the literature on environmental Kuznets curve research at home and abroad reveals that the literature on EKC focuses on the study of the relationship between emissions of SO_2, NO_x and per capita income, with Nicholas Apergis. The representative research focuses on the study of emissions. This paper attempts to use the 2009-2018 industrial energy consumption data provided by the National Bureau of Statistics of China's Industrial Statistical Yearbook to establish a correlation between carbon emissions and economic growth. An empirical study of the EKC hypothesis. The indicators of economic growth in this paper are measured by per capita GDP. The data is compiled and calculated by the China Statistical Yearbook over the years. The actual per capita GDP① is obtained by eliminating the impact of inflation on economic development.

3.2. Page Numbers

Choose a model and build carbon emissions and a ratio of GDP per capita, taking into account the relationship between carbon emissions and economic growth, if it corresponds to the relationship with the environmental needs of the blacksmith turned to statistical results curve. According to Chang Yajun's research, this paper analyzes and compares the models of the domestic and international research environment by establishing the following models.

Linear: $E_t = \alpha_0 + \beta_1 Y_t + \mu_t$

Quadratic: $E_t = \alpha_0 + \beta_1 Y_t + \beta_2 (Yt)2 + \mu t$

$$\text{Three times: } Et = \alpha 0 + \beta 1 Yt + \beta_2 (Yt)^2 + \beta_3 (Y_t)^3 + \mu_t \tag{1}$$

Semi-logarithm quadratic: $LnE_t = \alpha_0 + \beta_1 Y_t + \beta_2 (Y_t)^2 + \mu_t$

Logarithmic linearity: $LnE_t = \alpha 0 + \beta 1\ LnYt$

Logarithmically quadratic: $LnEt = \alpha_0 + \beta_1\ LnY_t + \beta_2 (LnYt)2 + \mu t$

$$\text{Logarithmically three times: } LnEt = \alpha 0 + \beta 1\ LnYt + \beta_2 (LnY_t)^2 + \beta_3 (LnY_t)^3 + \mu_t \tag{2}$$

In formula (2): Et is the carbon emissions in year t; Yt is the per capita gross domestic product (GDP) in year t; α_0, β_1, β_2 and β_3 are the parameters to be estimated; μ_t is the random error term.

4. Empirical analysis of the relationship between carbon emissions and economic growth.

This section firstly compares the per capita carbon emission, economic growth and economic growth rate of Tianjin from 2009 to 2018.Then the empirical results of the above model are used to verify the relationship between carbon emissions and economic growth. References are cited in the text just by square brackets [1]. Two or more references at a time may be put in one set of brackets [3, 4]. The references are to be numbered in the order in which they are cited in the text and are to be listed at the end of the contribution under heading references, see our example below.

4.1. Comparative analysis of per capita GDP and carbon emissions in Tianjin

Table 1 shows per capita carbon emissions and GDP per capita consumed by industrial energy in the city of Tianjin. The economic growth rate is calculated from the actual regional GDP. From the table, it is found that Tianjin's actual per capita GDP is steadily starting from 2009. The upward trend, the peak of nearly 10,000 yuan in 2013, the economic growth rate has basically maintained double-digit growth since 2009, although in 2013 China's economy is no longer moving in double-digit growth momentum, However, Tianjin still maintains steady growth, and the root of its growth lies in fixed asset investment and Tianjin's strong industrial base. However, while the economy is developing at a high speed, the pollution to the environment is also increasing year by year.

Per capita carbon emissions before 2009, per capita carbon emissions tend to be upward, indicating that industrial carbon emissions increased with economic growth after 1999, with the severe environmental situation in recent years, Tianjin has increased With the elimination of backward production capacity and the rectification of zombie enterprises, vigorously developing clean energy and

alleviating the degree of environmental pollution, It is clear that since 2012, Tianjin's per capita carbon emissions have decreased.

4.2. Empirical analysis of the relationship between carbon emissions and economic growth
Through regression analysis, the regression results of model (2) are as follows:

The linear objective analysis of the empirical results of the relationship between industrial emissions and GDP per capita shows that the seizure of logarithmic cubic type reaches 0.980608, which reflects the good fit of the logarithmic cubic type, and each variable passes. The t significance test. By regressing the models listed in equation (2), comparing and analysing the significance of the results obtained and the autocorrelation, and considering the inadequacy of the zero or negative values in the actual research considering the index level, this paper The logarithmic cubic empirical model is used as the regression equation for carbon emissions and GDP per capita. The specific results are as follows:

$$LnE_t=283.664-82.46753LnY+7.943357(LnY)^2-0.253002(LnY)^3 \quad (3)$$

t =(7.069977) (-7.029917)(6.964634)(-6.861605)

R^2=0.976729

DW=1.624750

F=252.8350

Observe the coefficient of the explanatory variable in model (3), $\beta1$=-82.46753<0, $\beta2$=7.943357>0, $\beta3$=-0.253002<0, so there is no inverted "U" type between the explanatory variable and the interpreted variable. Curve relationship, but an uncommon relationship of "N" type, that is, at the beginning of the period, carbon emissions begin to decrease with economic growth. After a certain inflection point, carbon emissions increase with the economy. It will increase. After another inflection point, carbon emissions will decline with the growth of the economy. This curve relationship is consistent with the analysis in Table 1, that is, There is a gap between industrial carbon emissions and economic growth. N" type relationship.

Table 1. Three Scheme comparing.

years	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Actual per capita gdp (yuan)	62574	72994	85213	93173	100105	105231	107960	115053	118944	120711
Economic growth rate (%)	16.5	17.4	16.4	13.8	12.5	10	9.3	9	3.6	3.6
Per capita carbon emissions (tonnes)	2.36	2.45	2.73	2.81	2.79	2.76	2.77	2.65	2.57	2.44

5. Conclusions and recommendations

5.1. Main conclusions
Based on data on carbon emissions and economic growth of industrial energy consumption in Tianjin, this paper explores the direction of Tianjin's economic development through continuous industrial energy consumption. carbon based emissions data .At the same time, in order to analyse the relationship between carbon emissions and economic growth, the following conclusion can be drawn by using the theory of theme .

In Tianjin, there is no feedback of u between industrial carbon emissions and economic growth, but there is a reverse curve n. Carbon emissions at the second point are quite a level. The negative growth of the economy is that the carbon footprint after Tianjin's second turning point is shrinking. This is because carbon emissions depend on other factors, such as urbanization, trade liberalization and

termination. The second turning point of the effects of population control and carbon emissions on economic growth can be postponed.

5.2. Policy recommendations
Enhancing energy efficiency, recycling economy and low-carbon economy, strengthening technological innovation, improving energy efficiency and promoting transformation in the E stage of economic development Further development of low-carbon economy has long been conducive to the healthy and sustainable development of Tianjin's economy.

According to the relationship between Tianjin's carbon emissions and the early industrial structure of the economy, we should rationally adjust the growth of carbon emissions and gross domestic product. The dual-track system of agriculture, the all-round development of modern services, the increase of the share of tertiary industry and the rationalization of industrial structure.

Deepening supply-side structural reform, abandoning underdeveloped productive capacity and promoting rational distribution and use will help deepen supply-side reform and abandon backward products on the basis of "E" gap. Focus on carbon emissions and economic growth. Operational efficiency, rational optimization of resources, improving the quality and speed of Tianjin's economic development, maintaining the rate of carbon emissions and promoting development Tianjin Resources

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