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Comparative Analysis of Factors Affecting Carbon Prices in China and Europe

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Abstract: Global warming has become a hot issue of common concern to the international community in recent years. With the frequent occurrence of extreme weather events, reducing carbon dioxide emissions has become a priority for governments. The Paris Agreement makes it possible to connect carbon trading platforms of various countries and set up a global carbon emission rights exchange. The carbon price is affected by many factors, among which energy price, economic indicators and temperature are important factors. This paper compares how carbon prices fluctuate in response to different influencing factors in China and Europe. The reason for these differences is that China and Europe have different emission reduction policies, economic systems and energy structures. Research shows that the same influencing factor has a different impact on the carbon price in China and Europe. Participants in carbon trading may find this study useful in helping them comprehend the variations between the carbon trading markets in China and Europe.

Keywords: carbon price, influence factor, China and Europe, comparative analysis

1. Introduction

1.1. Research Background

Nowadays, the ever-warming earth is one of the biggest challenges facing mankind. Since the industrial revolution, Global industrialization has led to a dramatic increase in energy consumption. The exponential increase in greenhouse gas emissions derives from the burning of fossil fuels, such as natural gas and crude oil. Greenhouse gases such as carbon dioxide in the air cause global warming, and the global atmospheric temperature near the ground continues to rise. In addition, Extreme weather events are becoming more frequent and more serious. How to balance economic development and ecological protection is a major issue for human society to consider. For the reason of preventing global warming from getting worse and promoting sustainable economic growth, the Paris Agreement became the first legal document in the field of global climate governance in 2015. The Paris Agreement makes it possible to set up a global carbon market. In the current carbon trading market, quota-based carbon emissions trading occupies a dominant position, such as the European Union Emission Trading Scheme (EU ETS) and China's pilot carbon exchanges. However, regardless of where the carbon trading market is located, the carbon emission price has a direct impact on participants' strategy of dealing with carbon price's fluctuation, as well as the efficiency of the carbon

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trading market. The same factor has a different impact on the carbon price in different countries, so it is significant to compare and analyze these factors in various regions.

1.2. Literature Review

Current research generally believes there is a link between fossil fuel price and carbon price, but different types of fossil energy affect carbon prices in different ways [1]. Wang Zhonghua, Hu Yao found that among many other factors, the crude oil price has the highest impact on the carbon price. Regional quarterly GDP, temperature and precipitation all have different degrees of impact on the carbon price [2]. Jiang Yu, Wu Zheyu found that the financial market has a strong impact on the price of carbon emission rights, and the coal price has an obvious negative correlation with the carbon price by using a multiple regression model [3]. Zhao et al found that although the carbon prices of China's pilot markets varied greatly, the carbon prices of each market were affected by the coal price [4]. The CO2 emitted by burning natural gas is half of the CO2 generated by burning coal. Therefore, it is highly likely that natural gas to become the dominant fuel in power plants in the future. Hammoudeh et al revealed that the higher the natural gas price was, the lower the price of European Union Allowance (EUA) became [5]. Han et al found that in Shenzhen Carbon Exchange, temperature affects the carbon emission price obviously [6]. Jimenez-Rodriguez studied the causal relationship between the European stock index and the EUA price and found there was a positive correlation between the two. One of the important reasons for the sharp decline of the EUA spot price was the adverse development of the European stock market in the second stage of the EU ETS [7]. Energy prices, economic environment, and temperature factors are important factors affecting the carbon price, which has been accepted by most scholars. In terms of research methods, researchers often use statistical methods, especially multivariate correlation analysis, which has become one of the mainstream methods to study the factors affecting carbon price.

1.3. Research Significance

The EU ETS began in 2005 and its trading volume is far more than that of other carbon trading markets in the world, and its maturity is second to none in the world as well. Compared with other countries, China consumes the most energy, and its carbon emissions are on top in the world and much more than the United States, which ranks second. The carbon emissions exchange market of China has broad prospects. With the development of the regional carbon markets, international carbon trading is bound to flourish. It can be expected that the carbon trading activities between Europe and China will grow rapidly. Therefore, how the influencing factors affect carbon prices in Europe and China has drawn attention among carbon trading participants. They can better predict carbon prices in different markets, avoid risks caused by carbon price fluctuations, and make optimal decisions. This study is conducive to international coordination, so as to better play the role of the international carbon exchange in reducing carbon emissions.

2. Core Conception

Carbon emission right refers to the right of enterprises to emit CO2 into the environment. Carbon emission rights are granted by the government to specific CO2 emission enterprises. Under the premise of total carbon emission limitation control, Carbon emission right has become a scarce resource, thus possessing the commodity attribute. The government allows enterprises to possess, trade, transfer and allocate their own carbon emission rights.

Kyoto Protocol hopes to use the market-based mechanism to promote the reduction of CO2 emissions, which endows carbon emission rights with commodity attributes. It makes transactions of carbon emission rights possible. Government agencies determine the maximum CO2 emissions in a

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specific area, and then allocate the emission quota to each CO2 emission enterprise. Enterprises vary in emission reduction technologies and the cost of reducing carbon emissions, which leads to different demands for CO2 emission rights [8]. When the allocated carbon quota of an enterprise is insufficient, the enterprise must buy the carbon emission quota from other enterprises in the carbon exchange to fulfill its shortage. Enterprises with sufficient carbon quotas can sell their carbon quotas for profits.

The participants of the carbon exchange include governments, financial institutions, performing enterprises, non-performing enterprises, social organizations and individuals. The carbon exchange generally adopts the membership system. The carbon trading market includes quota-based market and project-based market. The trading objects of the quota-based market are the Assigned Amount Units (AAU) specified by Kyoto Protocol and EUA of EU ETS. The trading objects are carbon credits in the project-based market, including the Emission Reduction Units (ERU) belonging to the Joint Implementation Mechanism and the Certification Emission Reduction (CER) belonging to the Clean Development Mechanism.

3. Carbon Price's Influence Factors in EU and China

According to the existing research, most scholars believe that fossil fuel price, economic indicators and temperature are carbon price's influence factors. Multivariate correlation analysis is a general method to quantitatively study the relationship between variables. Sun Yue analyzed the influence factors of EUA [9]. Zhao Xuanmin et al analyzed the influence mechanism of carbon price influencing factors in China's pilot carbon exchanges [10].

3.1. Carbon Price's Influence Factors in EU

3.1.1. Variables and Data Sources

The EU Emission Trading Scheme is currently the most mature carbon market on the earth. The purpose of the European Union Emission Trading Scheme is to promote enterprises to reduce carbon dioxide emissions, thus helping the EU to achieve the phased emission reduction target. European Union Allowance is the main trading object in the EU ETS, so EUA is the indicator of carbon price variation. Take fossil energy prices as energy price variables. The stock market can reflect the macroeconomic situation, and FTSE 100 index is selected as the macroeconomic indicator. Refer to Table 1.

Table 1: Variables and their data sources (Europe).

Variables	Indicators	Data Sources
Carbon price	Price of EUA	Bloomberg database
Coal price	Coal Futures prices of ARA	Wind database
Oil price	Brent oil futures prices	Wind database
Natural gas price	NYMEX natural gas futures prices	Bloomberg database
Stock market	FTSE 100 index	Wind database
Temperature	Average temperature(Paris、Berlin、London、Barcelona、Amsterdam、Istanbul)	Wind database

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3.1.2. Analytic Method

Sun Yue used the ordinary least squares method to find out the correlation between fossil fuel price, macroeconomic situation, temperature situation and carbon price and the Cochrane-Orcutt iteration method to estimate the parameters [9].

3.1.3. Results of Statistical Analysis

According to the statistical analysis results, coal price was negatively correlated with carbon price. The carbon price decreases with the rise of coal price. The same phenomenon occurs in the correlation between temperature and carbon price, which indicated that temperature affected the carbon emission rights price to a considerable extent. No obvious link existed between the European stock index and the carbon price, which reflected that the stock-index and the carbon exchange market were not closely linked. The same thing happened between the natural gas and carbon price. The most surprising is the positive correlation between oil price and carbon price.

3.2. Carbon Price'S Influence Factors in China

Since 2013, Chinese government has carried out carbon exchange pilot projects in seven cities. China has integrated seven pilot carbon exchanges and established a national carbon market on June 25, 2021 One month later, the online trading system of carbon exchange market was launched. Since the thermal power industry contributes more than one-third of carbon dioxide emissions, it is not surprising that it has become the first industry to be included in the carbon trading market and more than two thousands of power plants were included.

3.2.1. Variables and Data Sources

Zhao Xuanmin et al selected the carbon prices of seven carbon exchanges in China as the research object [9]. The selection of indicators for fossil energy is consistent with that of Sun's research above. Since the market value of the sample enterprises of the Shanghai-Shenzhen 300 Index accounts for about 60% of the market value of China's securities market, the Shanghai and Shenzhen 300 Index has become a variable to measure China's stock market. The daily average temperature of cities where pilot carbon trading exchanges were located was used as the temperature variable. Refer to Table 2.

Table 2: Variables and their data sources (China).

Variables	Indicators	Data Sources
Carbon price	Carbon prices of the China's pilot carbon trading exchanges	Official websites of the seven carbon trading pilot exchanges
Coal price	Coal Futures prices of ARA	Wind database
Oil price	Brent oil futures prices	Wind database
Natural gas price	NYMEX natural gas futures prices	Wind database
Stock market	Shanghai-Shenzhen 300 Index	NetEase website
Temperature	Average temperature (Beijing, Tianjin, Shanghai, Chongqing, Hubei, Guangdong, Shenzhen)	Official website of National Oceanic and Atmospheric Administration

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3.2.2. Analytic Method

Zhao et al established a regression analysis model, used generalized least squares (GLS) to estimate the parameters, and obtained the correlation between various influencing factors and carbon prices [9].

3.2.3. Results of Statistical Analysis

Carbon emission trading prices in China was negatively correlated with oil prices, coal prices and natural gas prices. China's stock index had a negative correlation with the carbon prices, while the average temperatures of the seven cities had a weak interaction with the carbon prices.

4. Comparative Analysis of Factors Affecting Carbon Prices in China and Europe

The researchers of Sun [9] and Zhao et al [10] selected the same influencing factors, which could represent the situation of the region, and used similar analysis methods, so the analysis results can be compared. Refer to Table 3. This paper explains the reasons for the correlations and focuses on the reasons for the differences between China and Europe.

Table 3: The relationship between carbon price and its influencing factors in China and Europe.

	Coal price	Oil price	Natural gas price	Stock market index	Temperature
Europe	Negative	Positive	Not relative	Not relative	Negative
China	Negative	Negative	Negative	Negative	Not relative

4.1. Comparative Analysis of the Factor of the Coal Price in EU and China

When the price of coal rises, the demand of enterprises for coal is restrained. The amount of carbon emissions decrease with the decrease in coal use and the carbon price decreases due to the weakening of carbon emission rights demand. In EU and China, the similarity of the impact of coal price on carbon price indicates the important impact of coal combustion on greenhouse gas emissions.

4.2. Comparative Analysis of the Factor of the Oil Price in EU and China

There was an obvious negative correlation between crude oil prices and carbon prices in China. The rise of crude oil prices made a downward trend in demand for oil. The reduction of oil use has played a role in restraining the carbon price.

In EU carbon market, higher oil price made enterprises turn to other cheaper but high carbon-emission energy sources, such as coal. This has stimulated the demand for carbon emission rights and pushed up the carbon price.

4.3. Comparative Analysis of the Factor of the Natural Gas Price in EU and China

Under the condition of generating the same calorific value, the cost of burning natural gas is higher than that of burning coal, so in China, the high price of natural gas will inevitably lead some enterprises to seek other cheap alternative energy. The decline in carbon emissions led to a decline in carbon prices.

In Europe, natural gas prices did not affect carbon prices. This may be due to the fact that compared with oil and coal, the combustion of natural gas emits less carbon dioxide, so the carbon price will not fluctuate sharply.

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4.4. Comparative Analysis of the Factor of Stock Index in EU and China

No significant correlation existed between EUA prices and FTSE 100 index. The traditional view is that in a period of economic rise, the demand for energy is strong, more quantity of fossil fuels is consumed, and more CO2 emissions are. However, due to the great efforts made by countries to reduce carbon emissions, the positive correlation between economic activities and global total carbon emissions has weakened. This may cause the FTSE 100 index to reduce its impact on carbon prices. China's carbon price was negatively correlated with the stock index. In theory, the stock price index of the mature market will indicate the direction of economic development, and the booming of the economy means a rapid increase in the stock market. However, the Chinese stock market is not mature, so the stock index is not closely related to the macroeconomic situation. Sometimes the stock index falls during the economic rise. This may be the reason why the stock index of China showed a negative interrelation with carbon prices.

4.5. Comparative Analysis of the Factor of Temperature in EU and China

The negative interrelationship between temperature and carbon price is not hard to understand. All kinds of climate problems caused by climate change urge the EU to trim the carbon quotas of its member states, which results in a higher carbon price. In addition, changes in temperature will affect household energy demand. When the temperature rises, the frequency of residents using air conditioners increases. When the temperature drops, residents will use central heating facilities to maintain a higher room temperature. This will boost energy demand and increase carbon emissions. With the carbon quota unchanged, the carbon price will inevitably rise.

In China, the short operation time of carbon exchanges and the relatively concentrated distribution of pilot cities were two limitations that made the temperature change during the study period (2013-2017) cannot reflect the long-term temperature change trend in China. As a result, the interrelationship between the carbon price and temperature was not conspicuous.

5. Conclusion

Among the factors of energy prices, coal prices show a negative correlation with carbon prices in China and the EU, indicating that the decline in coal use has driven the decline in carbon prices. The carbon price in China and Europe has an opposite corresponding relationship with the oil price. This reflects the differences in energy structure between China and Europe. As China is a developing country, the sensitivity of nature gas prices is quite high. The high price of natural gas has an obvious inhibitory effect on natural gas demand. Weak demand for natural gas led to a decline in the carbon price. China's stock market cannot accurately reflect the economic situation. The immaturity of China's stock market explains why the carbon price and stock index have the opposite trend. In terms of temperature influencing factors, because temperature change is a long-term process, the limited research period is not conducive to empirical research, which is particularly obvious when studying the relationship between temperature and carbon price in China.

In addition to energy price, temperature, and stock index, other factors will also have an impact on carbon price, such as interest rate, exchange rate, national and global policies to reduce greenhouse gas emissions, etc. How the impact mechanism works are all directions worth studying in the next stage.

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