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Analysis of Influencing Factors on the Value of Carbon Assets in China Under the Background of Double Carbon — Take the Pilot Carbon Emission Trading Program in Guangdong Province as an Example

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Abstract

In recent years, with the rapid development of the global industrial economy, carbon dioxide emissions, the greenhouse effect, and other environmental problems have become increasingly obvious, the development of a low-carbon economy has become the goal pursued by all countries in the world, carbon market trading has also emerged and developed. With the continuous development of the carbon market, carbon assets are playing an increasingly important role for enterprises, and the assessment of carbon assets has greater potential for development prospects. However, at this stage, there are few studies on the value of carbon assets in the field of assessment, and the studies on the influencing factors of the value of carbon assets are more focused on the analysis of the price of carbon emission rights. This paper takes carbon asset trading as the background and carbon emission trading pilot in Guangdong Province as an example and selects five indicators from different fields to establish a linear regression model to analyze the influencing factors of carbon emission rights price.

Keywords: carbon asset value, carbon emissions, influencing factor

1. Introduction

1.1 Research Background

With the intensification of climate change and the increasingly serious global environmental problems, carbon emission has become an important problem that needs to be solved urgently on a global scale. To reduce greenhouse gas emissions and promote sustainable development, many countries and regions have implemented the carbon emission cap-and-trade system, also known as the carbon emission trading market. In 1997, when more than 100 countries signed the Kyoto Protocol, carbon emission rights became a commodity. At present, carbon trading has become one of the core policy tools of carbon emission reduction, and

the carbon emission trading system has a wide coverage. To promote the achievement of the "double carbon" goal, China's carbon emission trading market pilot work was officially launched in 2011, the National Development and Reform Commission officially approved Beijing, Tianjin, Shanghai, Chongqing, Hubei, Guangdong, and Shenzhen to carry out carbon emission trading pilot, and in 2013, the carbon emission trading market in the above seven provinces and cities was officially opened. On July 16, 2021, the national carbon emission trading market will also be fully opened to promote the development of a low-carbon economy.

Data from the Ministry of Ecology and Environment show that by the end of June 2021, the cumulative quota trading volume of carbon markets in pilot provinces and cities has reached 480 million tons of carbon dioxide equivalent, with a turnover of about 11.4 billion yuan. As of August 13, 2021, the cumulative volume of carbon emission allowances in the national carbon market has exceeded 6,518,800 tons, with a cumulative turnover exceeding 329 million yuan. After China announced the goal of "carbon peak" and "carbon neutrality" to the world for the first time in 2020, the government work report and the Central Economic Work Conference in 2021 once again clarified that "carbon peak" and "carbon neutrality" are one of the eight key tasks. It can be seen that China's carbon emission space is becoming smaller and smaller, and the carbon emission space is tight. With the continuous maturity and development of the carbon asset trading market, enterprises must attach importance to the assessment of carbon assets, and more and more carbon asset trading behaviors require the assessment of carbon asset value to be more accurate. The importance of carbon asset value has become increasingly prominent, and the requirements and demands for carbon asset value assessment have also been upgraded.

1.2 Research Significance

In recent years, China has vigorously promoted the development of a low-carbon economy, achieved rapid development in the carbon trading rights emission market, and will be promoted nationwide in 2021. In this context, the demand for the management, allocation, and investment of carbon assets related to the valuation level has risen rapidly, which is of great significance for the research on the factors affecting the value of carbon assets. Through the study of the influencing factors of the value of carbon assets, it is helpful for enterprises to evaluate the value of carbon assets, which is not only conducive to reducing the trading risk of the carbon assets trading market, activating carbon assets trading market, improving carbon assets trading system, but also conducive to improving China's pricing discourse power in the world. At the same time, it guides the development of carbon asset assessment.

2. Literature Review

The academic circles at home and abroad generally believe that carbon emission rights are similar to general commodities, which are determined by market supply and demand and affected by macroeconomic policies. Based on the data of the Shanghai carbon trading market, Zhang Xin (2023) conducted an empirical study on the influencing factors of carbon trading prices by establishing a vector error correction (VEC) model and using impulse response function and variance decomposition, and the results showed that carbon emission right prices were greatly affected by their previous prices. The change in the price of fossil fuel will hurt the price of carbon emission rights in the short term, but it will turn positive in the long run. The domestic macroeconomic situation has a significant impact on the carbon market, while the impact of international exchange rate fluctuations is relatively small. Song Yueyuan and He Lingyan (2023) studied the carbon price of Beijing's carbon emission rights trading market through the vector error correction (VEC) model and explored the influencing factors of carbon price in Beijing. The results show that the carbon emission permit (BEA) price in Beijing is positively correlated with industrial output value, crude oil price, and temperature, and negatively correlated with thermal coal price index and CSI 300 index.

Hu Changqing (2023) took five pilot carbon trading markets in Beijing, Shanghai, Hubei, Guangdong, and Shenzhen as research samples, and used the VAR model, impulse response function, and variance decomposition measurement methods to conduct an empirical study on the influencing factors of carbon emission trading prices. The results show that the carbon price is greatly affected by the historical price, which indicates that China's carbon trading market is not yet perfect. The manufacturing PMI has little impact on carbon

trading prices in the five pilot provinces and cities, while coal prices are more closely linked to carbon trading markets. Based on the carbon trading data of eight carbon trading markets in China, Wu Qin (2023) used the GA-PSO-BP neural network model to study the goodness of fit between carbon trading price and these influencing factors and predicted carbon price respectively through traditional neural network model and multiple regression model, and found that there was a correlation between these influencing factors and China's carbon emission rights trading price with a very strong nonlinear relationship, the model can fit the price trend more accurately.

Leng Zhongbin (2023) identified the influencing factors of carbon emission trading price in Guangdong theoretically and then used the vector autoregressive model to empirically test the identified factors, and used impulse response and variance decomposition to verify the validity of the model. After variance decomposition, the historical data of carbon emission trading price in Guangdong has the highest contribution, and other factors have the strongest to weakest influence on carbon emission trading price from the coal price index to the CSI 300 index and Guangdong Air Quality Index, respectively. The carbon emission trading price in Shanghai has the least contribution.

3. Variable Selection and Model Construction

3.1 Variable Selection

The research object of this paper is the pilot carbon emission trading in Guangdong Province, one of the pilot carbon emission trading markets in China. As the first exchange in China with a total spot turnover of more than 100 million tons and a total turnover of more than 2 billion yuan, Guangzhou Carbon Emission Exchange has a complete range of carbon trading products, active market trading, and complete trading data, so the conclusions drawn from this research object are reliable and representative. In this paper, the carbon emission right price on the first day of each month of the Guangzhou Carbon Emission Exchange from January 2016 to February 2023 is selected as the explained variable, and the coal price index, crude oil price, closing price of CSI 300 index, closing price of Shanghai Industrial Index and AOI index are selected as explanatory variables to study the influencing factors of carbon asset price. The following table provides a detailed description of each explanatory variable:

Table 1. Explain the variables

Variable		Index	Variable symbol	Instructions
Explanatory variable	Energy price index	Coal price	COA	Coal price index
		Crude oil price	OIL	Brent crude oil spot price index
	Industrial development index	Degree of industrial development	SII	Shanghai Industrial Index (Closing price)
	Macroeconomic indicators	Degree of financial prosperity	CSI	The closing price of the CSI 300 index
	Environmental quality index	Air quality	AQI	Pilot provinces and cities air quality index

3.2 Model Construction

This chapter mainly studies the factors affecting the price of carbon emission rights, that is, analyzes the factors affecting the value of carbon assets. In this chapter, Stata software is used to perform regression analysis on the selected data. The optimal matching equation for the data is determined by the least square method which minimizes the sum of squares of errors. The specific model of this chapter is set as follows:

$$\ln CEA = \beta_0 + \beta_1 \ln COA + \beta_2 \ln OIL + \beta_3 \ln SII + \beta_4 \ln CSI + \beta_5 \ln AQI + \varepsilon$$

4. Empirical Results and Analysis

4.1 Descriptive Statistics of Variables

Table 2. Descriptive statistics of variables

Variable	Obs	Mean	Std. dev.	Min	Max
Coal price index	108	108.1556	23.97006	74.7	195.3
Shanghai Shenzhen 300	108	3820.817	745.7784	2146.3	5351.96
AQI index	108	72.44444	34.95721	24	197
Closing price of carbon assets	108	31.41139	21.8472	8.19	80.16
Crude oil price	108	66.63472	21.31517	22.74	122.84
Closing price of industrial index	108	2607.372	449.9117	1670.36	3883.78
ln Coal price index	108	4.661308	.2079321	4.31348	5.274537
ln Shanghai and Shenzhen 300	108	8.228051	.2063207	7.671501	8.585218
The lnAQI Index	108	4.180764	.449857	3.178054	5.283204
ln Closing price of carbon assets	108	3.241437	.6249885	2.102914	4.384025
ln crude oil price	108	4.148232	.3251965	3.124125	4.810883
ln Industrial Index closing price	108	7.851208	.1743763	7.420794	8.264565

4.2 Stationarity Test of Variables

Through the ADF unit root test, we can know whether the explanatory variable is a stationary time series, if there is a unit root, the time series is a non-stationary time series, and it will cause the pseudo-regression phenomenon in regression analysis. The test results are shown in the table:

Table 3. Stationarity test of variables

Variable	ADF test value	Critical values for each significant level		P-value	Test result
		1%	5%		
ln Coal price index	-3.495	-3.508	-2.890	0.0081	Smooth and steady
ln crude oil price	-3.074	-3.508	-2.890	0.0285	Smooth and steady
ln Shanghai and Shenzhen 300	-3.179	-3.508	-2.890	0.0212	Smooth and steady
The lnAQI Index	-10.283	-3.508	-2.890	0.0000	Smooth and steady
ln Shanghai Composite Index	-3.690	-3.508	-2.890	0.0043	Smooth and steady
Ln Industrial Index closing price	-2.720	-3.508	-2.890	0.0706	Smooth and steady

According to the data in the above table, all explanatory variables pass the ADF test at the significance level of 5% and 1%, that is, the original time series has no unit root and is a stable time series.

4.3 Empirical Analysis

After the stationariness test of the original variables, the model is established based on the selected carbon emission right price of Guangdong Province, the selected coal price index, crude oil price, CSI 300 index, AQI index, and Shanghai Industrial Index. The multiple regression is carried out by Stata software, and the regression results are obtained. To understand the effect of various macro factors on the change of carbon emission right price. The concrete empirical results are as follows:

Table 4. Regression result

ln Closing price of carbon assets	Coefficient	Std. err.	t	P>|t|	Sig
ln Coal price index	-1.162896	.234871	-4.95	0.000	***
ln crude oil price	.9061773	.1461944	6.20	0.000	***
ln Shanghai and Shenzhen 300	1.201012	.387441	3.10	0.003	***
The lnAQI Index	-.0886622	.0926647	-0.96	0.342	
ln Industrial Index closing price	1.799928	.4321445	4.17	0.000	***
_cons	-18.76803	2.5805	-7.27	0.000	***
Number of obs		86	R-squared		0.6707
F(5,80)		32.58	Adj R-squared		0.6501
Prob > F		0.0000	Root MSE		.38221

Note: *** p<.01, ** p<.05, * p<.1

Since the AQI index is not significant, the regression of the remaining variables after removing the AQI index is carried out, and the specific empirical results are as follows:

Table 5. Regression result

ln Closing price of carbon assets	Coefficient	Std. err.	t	P>|t|	Sig
ln Coal price index	-1.210244	.2294788	-5.27	0.000	***
ln crude oil price	.9294579	.1440801	6.45	0.000	***
ln Shanghai and Shenzhen 300	1.257183	.3827675	3.28	0.002	***
ln Industrial Index closing price	1.806471	.4318649	4.18	0.000	***
_cons	-19.5273	2.454174	-7.96	0.000	***
Number of obs		86	R-squared		0.6669
F(4,81)		40.54	Adj R-squared		0.6504
Prob > F		0.0000	Root MSE		.38201

Note: *** p<.01, ** p<.05, * p<.1

Through least square regression, the model can be finally determined as:

$$\ln CEA = -19.53 - 1.21 \ln COA + 0.93 \ln OIL + 1.81 \ln SII + 1.25 \ln CSI$$

According to the results of empirical analysis, the following conclusions can be drawn:

Changes in energy prices will affect the energy choices of enterprises, which in turn will affect the price of carbon emission trading rights. Through the empirical results, it can be seen that coal price has a significant negative effect on carbon emission price, which means that the rise of coal price may lead to the decline of carbon emission price. With the rise of coal prices, enterprises will reduce the demand for coal to a certain extent, for China, coal occupies an important proportion in the energy structure, the reduction of coal demand will reduce greenhouse gas emissions to a certain extent, and then lead to a decline in the demand for carbon emissions trading rights, according to the law of supply and demand, the price of carbon emissions trading rights will decline.

The amount of carbon emitted by burning coal per unit of heat is 20% higher than that of crude oil. Therefore, when the price of crude oil rises, enterprises will choose coal at a lower price, which leads to a substantial increase in greenhouse gas emissions and a substantial increase in the demand for carbon emission trading rights, which ultimately leads to a rise in the price of carbon emission trading rights, that

is, the price of crude oil is positively correlated with the price of carbon emission trading rights.

Macroeconomic changes will affect the price of carbon emission trading rights. According to the regression results, the macroeconomic changes are positively correlated with the price of carbon emission trading rights. When the macro economy runs well, market trading will become more active, and enterprises will increase the production of corresponding products, which will lead to an increase in the demand for carbon emissions, and an increase in the demand for carbon emission trading rights, which will lead to an increase in the price of carbon emission trading rights.

The prosperity of the industry will also affect the change in the price of carbon emission trading rights. According to the empirical results, industrial prosperity is positively correlated with the price fluctuation of carbon emission trading rights. The possible reason is that at present, China's industrial technology level is not high, most enterprises still use traditional coal energy, so with the continuous increase of industrial prosperity, the increase of production activities of enterprises, promotes the demand for carbon emission trading rights, and then lead to the increase of carbon emission trading rights price.

4.4 Robustness Test

In China's energy structure, the main components are still traditional energy: coal, oil, and natural gas. Coal and crude oil have been used as explained variables for regression. To test the robustness of the model, the natural gas price index is used instead of crude oil price for regression, and the specific regression results are as follows:

Table 6. Robustness test results

ln Closing price of carbon assets	Coefficient	Std. err.	t	P>|t|	Sig
ln Coal price index	-1.240848	.2041341	-6.08	0.000	***
ln Natural Gas Price Index	.545775	.0641443	8.51	0.000	***
ln Shanghai and Shenzhen 300	1.724585	.3471408	4.97	0.000	***
ln Industrial Index closing price	.9526765	.413524	2.30	0.024	***
_cons	-15.40666	2.297067	-6.71	0.000	***
Number of obs		86	R-squared		0.7337
F(4,81)		55.80	Adj R-squared		0.7206
Prob > F		0.0000	Root MSE		.34154

Note: *** p<.01, ** p<.05, * p<.1

According to the above table, it can be found that the empirical results of the original model are still significant, that is, the robustness of the original model is good.

5. Research Conclusions and Suggestions

5.1 Research Conclusions

This paper conducted an empirical study on the trading data of Guang carbon Institute and selected four levels of energy price index, industrial development index, macroeconomic index, and environmental quality index as explanatory variables for regression. The results show that the coal price has a significant negative effect on carbon emission price, while crude oil price is positively correlated with carbon emission trading right price. Macroeconomic changes and industrial prosperity are positively correlated with the price of carbon emission trading rights.

5.2 Policy Suggestions

5.2.1 Adjust the Energy Structure

China's energy revolution is in the ascends, the energy structure continues to optimize, the formation of a multi-wheel drive supply system, nuclear power, and renewable energy development at the forefront of the world, with the foundation and advantages to accelerate the development of energy transformation. However, the problem of unbalanced and inadequate development is still prominent, the level of supply chain security and industrial chain modernization needs to be improved, and

the construction of a modern energy system faces new opportunities and challenges.

Relevant departments should strengthen the planning and construction of new energy supply and consumption systems, and gradually promote the replacement of traditional energy based on ensuring the safety and reliability of new energy. Accelerate the construction of a clean energy power generation system and promote the steady development of non-fossil energy; At the same time, we will accelerate the construction of a new power system and continue to promote the adjustment of the energy structure.

5.2.2 Promote Industrial Technological Progress

By improving the efficiency of fuel combustion, and thus reducing the waste of resources, it can also reduce greenhouse gas emissions to a certain extent. The government should strengthen scientific research and innovation, encourage enterprises to increase investment in research and development and strengthen scientific and technological innovation capabilities. At the same time, we will strengthen industry-university-research cooperation and promote the transformation of scientific research results into actual production.

While improving the level of industrial technology, enterprises should accelerate the promotion of digital transformation, actively promote the digital transformation of industrial enterprises, and use new technologies such as artificial intelligence, big data, and cloud computing to improve production efficiency and quality levels.

5.2.3 Accelerate the Construction of China's Carbon Emission Trading Market

Accelerating the construction of a unified national carbon emission market means that it is necessary to open up the gap between the national carbon market and local pilot carbon markets in the future, unify carbon prices, improve the liquidity of carbon quota trading, improve the efficiency of carbon trading, and better play the role of carbon pricing. A unified national carbon emission trading market should focus on the following aspects: strengthening carbon market legislation, gradually promoting the compensated auction mechanism for carbon emission trading quotas, encouraging enterprises to disclose carbon emission information, improving the carbon emission monitoring report verification (MRV) system, expanding the coverage of the carbon market, accelerating the integration of market data with green electricity and green certificates, and vigorously developing integrated markets.

By speeding up the construction of a unified national carbon emission trading market, it will help create a better carbon trading order and ensure the smooth and orderly progress of carbon trading.

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