Analysis of Determinants of Carbon Finance Market Price in China Based on VAR Model

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ABSTRACT

'Peak Carbon Dioxide Emission' and 'Carbon Neutrality' are the carbon emission reduction targets set by China to deal with major climate problems caused by the rise of global greenhouse gases. This paper takes carbon finance markets as the research object and selects the daily data of carbon trading prices in Guangdong, Hubei, Shanghai and Shenzhen, four pilot provinces and cities from January 1, 2018 to February 28, 2022, which represent the carbon financial trading market price in China after elimination and weighted average processing. VAR model is used to study the direction and degree of influence of thermal coal, Daqing crude oil, liquefied natural gas, air quality, SSE Industrial index, CSI 300 index and EU carbon quota on China's carbon financial trading market price.

According to the impulse response result, the price of the carbon financial exchange market has the smallest impact on the price of Daqing crude oil spot market, the largest fluctuation effect on its own impact, and the longest response time to the disturbance of air quality index. According to the result of variance decomposition, the contribution degree of each determinant under impact is in the following order from low to high: Eu carbon quota < thermal coal Shenwan industry index < Daqing crude oil spot price < national liquefied natural gas price < CSI 300 index < air quality index < SSE industrial index < carbon financial transaction market price.

Keywords: *Carbon Finance, Transaction Price, Determinants, VAR Model*

1. INTRODUCTION

"Carbon Peak" and "Carbon Neutral" are the carbon emission reduction targets set by China to deal with major climate problems caused by the rise of global greenhouse gases As China's carbon emissions rank first in the world, therefore, whether China's "double carbon" target can realize, will directly affect whether the global greenhouse gas emissions can control at a reasonable level, it will also directly determine whether the global climate problem can be fundamentally improved. Therefore, realizing the "dual carbon" goal is an urgent political task for China to complete.

Carbon price fluctuation in the financial market in China is big. Price is influenced by many factors in the process of the actual transaction, and how to reasonably control these factors, avoid market volatility, and allows it to be stable is a major subject that needs to be studied. This paper takes carbon financial markets as the research object and analyzes the various factors influencing the market price fluctuations of the influence degree and direction. VAR model of this paper is used to analyze the empirical results, draw the corresponding conclusions and put forward the corresponding feasible suggestions for the challenges faced by China. According to the national policy goals, the primary goal is to establish a perfect market operation mechanism, stabilize the financial market and the price of the carbon trading system, and improve the field of risk control. The significance of this paper is to make the carbon financial market develop rapidly in China and catch up with the global level as soon as possible by analyzing relevant data.

2. LITERATURE REVIEW

So far, there is no agreement on what constitutes a "carbon financial market". Its definition is usually divided into two levels: the first is the narrow sense of carbon financial market, which refers to the financial trading activities caused by carbon dioxide emissions based on exchanges, which is limited to the scope stipulated in the Kyoto Protocol; The second layer is the carbon financial market in a broad sense, which refers to the trading of carbon dioxide emission rights and the general term of various financial activities and

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transactions related thereto [2]. Carbon finance is defined in this paper as a financial financing activity aimed at reducing carbon emissions by trading carbon emission rights in the financial market.

In the actual trading activities of the carbon financial trading market, the market price is often affected by various factors, such as traditional energy prices, climate, weather, production level and macroeconomic factors [3, 4]. In addition, After analysis, Wang Ying believed that the change in coal price and carbon price showed a reverse restraining relationship, while oil price, air quality index and market fundamentals would positively promote the change in carbon price [5]. Combining the basic development of China's carbon finance field, Wang Yung-He discussed the influence on the price of carbon financial products and pricing mechanism from four aspects: changes in foreign carbon price conditions, impacts on the economic environment, energy price fluctuations and interference brought by exchange rate fluctuations [6]. This paper, considering the above factors, selects the thermal coal index, the Daqing crude oil spot price, the price of liquefied natural gas (LNG), air quality index, the Shanghai industrial index, the Shanghai and Shenzhen 300 index and the EU carbon quotas as factors which affect the carbon financial market price fluctuations, uses VAR model to investigate the extent of the impact of various factors on the carbon price.

3. METHODOLOGY

3.1 Model Introduction

The core of the dynamic vector autoregression model (VAR Model) lies in that not only does the current variable regress to its own lag variables but also the explained variable regress to the current and lag periods of each explanatory variable. In this paper, the VAR model is used to analyze the influencing factors of China's carbon finance market price. The basic mathematical form of the VAR model is as follows:

$$Y_t=C+A_1Y_{t-1}+A_2Y_{t-2}+...+A_nY_{t-n}+\Sigma_{i=1}B_{i,1}X_{i,t}+B_{i,2}X_{i,t-1}+...+B_{i,n}X_{i,t-n}+\varepsilon_t \quad (1)$$

Where Yt is the endogenous variable of the current period, Yt-p (p= 1,2... M) is the endogenous variable of hysteresis p order, Xi, t is the exogenous variable of the current period, Xi, t-q (q= 1,2... N) is the hysteretic variable with lagging order q, Az (z=1,2... N) is the coefficient matrix-vector of the endogenous variable, Bi, z (z= 1,2... N) is the coefficient matrix-vector of exogenous variables, εt is the random disturbance term, and C is the constant term[7].

3.2 Data Sources and Data Processing

The explained variable selected in this paper is the average transaction price of carbon emission rights in the carbon financial trading market. Since 2013, China has entered the second phase of the carbon trading process, with pilot trading in eight provinces and cities including Beijing, Fujian, Guangdong, Hubei, Shanghai, Shenzhen, Tianjin and Chongqing. The third phase -- the national carbon trading market -- will begin pilot operation in September 2021. Due to the short operation time of the national carbon emission trading market, there is no sufficient data to support empirical research, and this paper mainly studies the carbon emission trading in China from the end of the second stage to the beginning of the third stage, so the average transaction price of carbon emission rights in Guangdong, Hubei, Shanghai and Shenzhen among the eight pilot provinces and cities mentioned above is selected. The weighted average calculation is used as the average transaction price (AEA) of carbon emission rights in the national carbon financial trading market.

This paper studies and analyzes the impact of the carbon finance market price from three aspects: energy price, climate and macroeconomy. In terms of energy price, shenwan Industry Index (COAL), Daqing crude OIL spot price (OIL) and National liquefied natural gas market price (LNG) are selected as explanatory variables. In terms of climate and weather, the weighted average of AIR quality Index (AQI) of the above four provinces and cities is selected as explanatory variables. The daily closing price of Shanghai Industrial Index (SSE), Shanghai and Shenzhen 300 Index (CSI300) and the continuous futures settlement price of European Union carbon Emission Quota (EUA) are selected as explanatory variables in macroeconomic aspects.

The range of sample data selected above is from January 1, 2018 to February 28, 2022. After the data is removed, there are 305 daily data in total. The data used are all from the Wind database. This paper uses Eviews10 as the econometric analysis software.

3.3 Experimental Process

3.3.1 Unit Root Test

Considering the instability of time series, avoiding the appearance of pseudo regression and ensuring the stability of data is the basis for establishing the VAR model. Therefore, unit root test is carried out after logarithmic processing of the above data.

Table 1. Unit root test of first-order integral sequence

	ADF Test Value	Critical Value(1%)	Critical Value(5%)	Critical Value(10%)	P Value	Conclusion
ΔlnCOAL	-18.7426	-3.4517	-2.8708	-2.5718	0.0000	Stable
ΔlnOIL	-6.1232	-3.4517	-2.8708	-2.5718	0.0000	Stable
ΔlnLNG	-17.0336	-3.4517	-2.8708	-2.5718	0.0000	Stable
ΔlnAQI	-19.5931	-3.4517	-2.8708	-2.5718	0.0000	Stable
ΔlnSSE	-15.6820	-3.4517	-2.8708	-2.5718	0.0000	Stable
ΔlnCSI300	-16.4022	-3.4517	-2.8708	-2.5718	0.0000	Stable
ΔlnEUA	-16.7571	-3.4517	-2.8708	-2.5718	0.0000	Stable
ΔlnAEA	-14.4310	-3.4517	-2.8708	-2.5718	0.0000	Stable

As can be seen from Table1, unit root test was performed for all data after first-order difference processing, and all P values were less than 0.05, rejecting the null hypothesis of "the existence of unit root", indicating that there is no unit root in logarithmic first-order integration sequence, which is a stationary sequence and has the conditions for subsequent tests.

3.3.2 Co-integration and Stability Test

This paper adopts the feature root trace test method in the Johansen co-integration test, which starts from the null hypothesis of "no co-integration relationship" and continues until the acceptance of the null hypothesis.

Table 2. Johansen cointegration test result

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.4589	929.3335	175.1715	0.0000
At most 1 *	0.4376	744.4579	139.2753	0.0001
At most 2 *	0.3707	571.2088	107.3466	0.0001
At most 3 *	0.3179	431.8072	79.3415	0.0001
At most 4 *	0.2624	316.6419	55.2458	0.0001
At most 5 *	0.2506	225.0176	35.0109	0.0001
At most 6 *	0.2324	138.1991	18.3977	0.0001
At most 7 *	0.1769	58.59344	3.8415	0.0000

The Table2 shows that one of the biggest cointegration vectors for each number, the tracking characteristic values were greater than 5% significance level, the critical value, and the corresponding probability

values are less than 5%, therefore, declined to "does not exist co-integration relationship" of the original assumption, that one be explained variable AEA and seven explain there are at least 8 collaborators between variable vector, That is, there is a long-term equilibrium relationship between them.

This paper uses Eviews software to apply the graph method and AR root estimation method to test the stability of the VAR model.

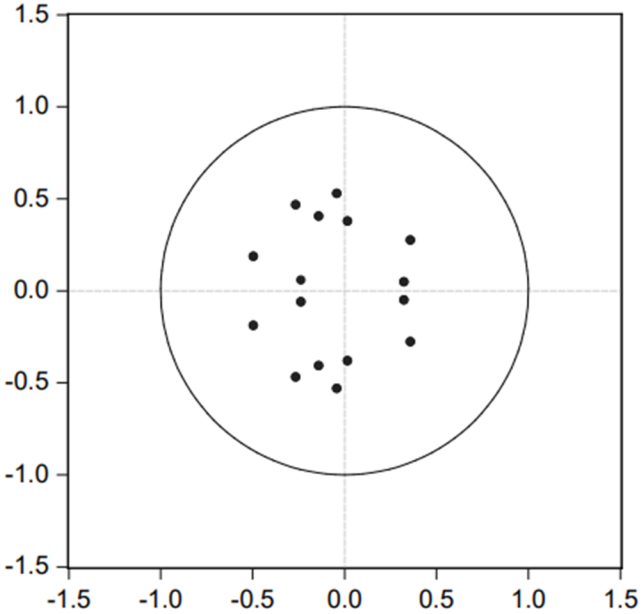

Figure1. AR unit root diagram of VAR model

It can be seen from Figure1 that 16 unit-roots are all within the unit circle, indicating that the model is stable and has passed the stability test.

3.3.3 Determination of Lag Period

This paper comprehensively considers Akaike Information Criterion(AIC), Schwarz Criterion(SC) and Hannan-Quinn Information Criterion(HQIC) to determine the lag order, the optimal lag order determined is 2 after comprehensively considering the three indicators mentioned above.

3.4 Results

3.4.1 Impulse Response

The Impulse response function (IRF) reflects the dynamic influence of other variables in the VAR model when one variable is subjected to an exogenous shock. The impulse response graph is drawn based on the dynamic changes of these variables over a period of time after the impact. On the basis of the above empirical analysis, the 10-stage impulse response function is established, and the results are shown in Figure2-9.

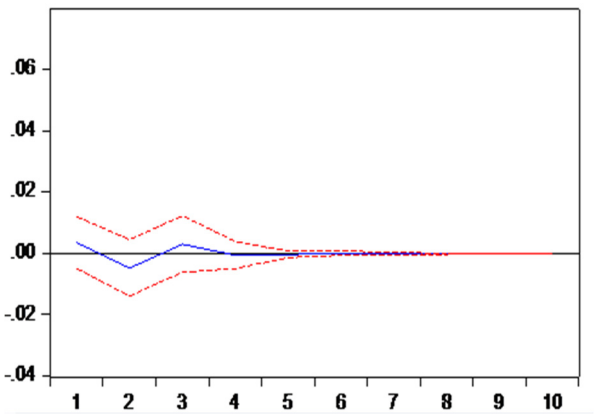

Figure 2 Response of DLNY to DLNX1

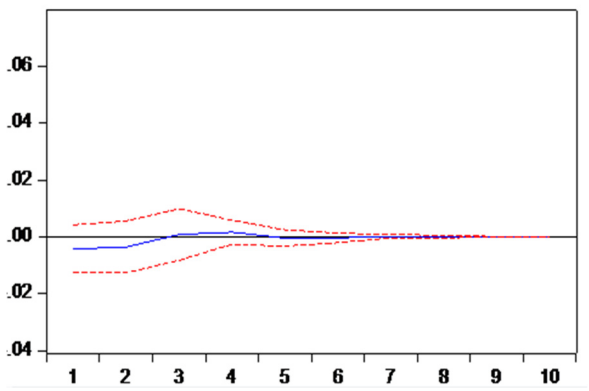

Figure 3 Response of DLNY to DLNX2

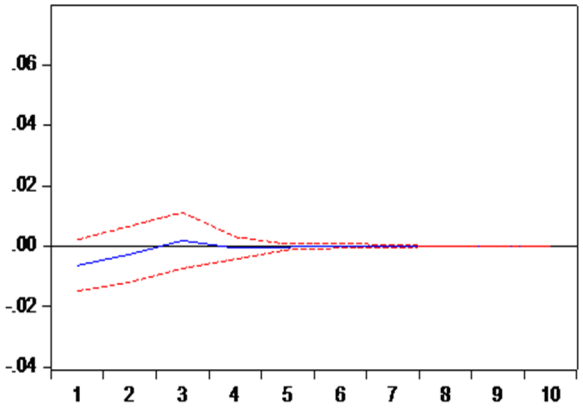

Figure 4 Response of DLNY to DLNX3

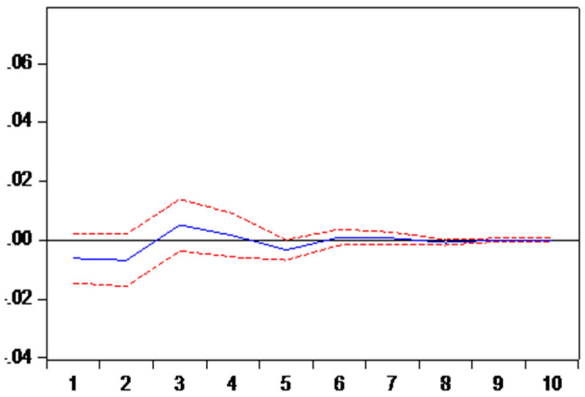

Figure 5 Response of DLNY to DLNX4

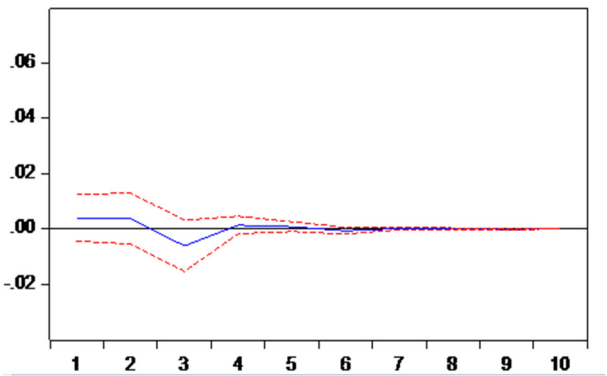

Figure 6 Response of DLNY to DLNX5

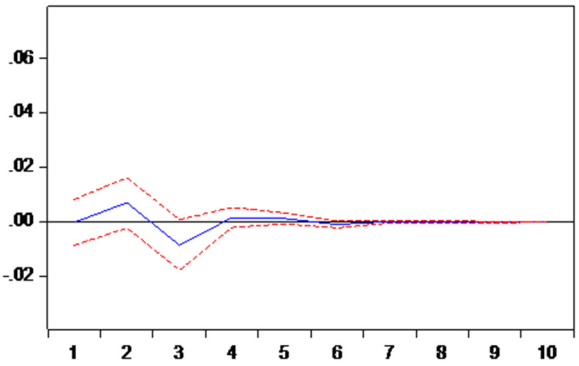

Figure 7 Response of DLNY to DLNX6

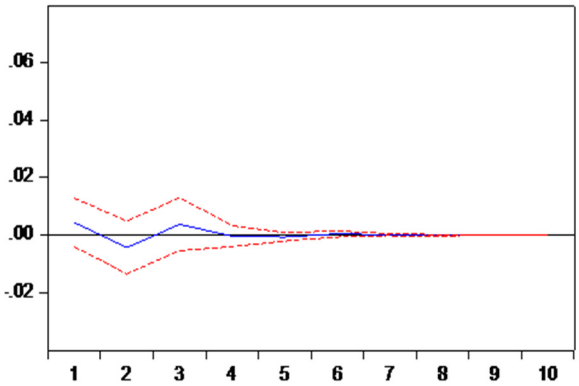

Figure 8 Response of DLNY to DLNX7

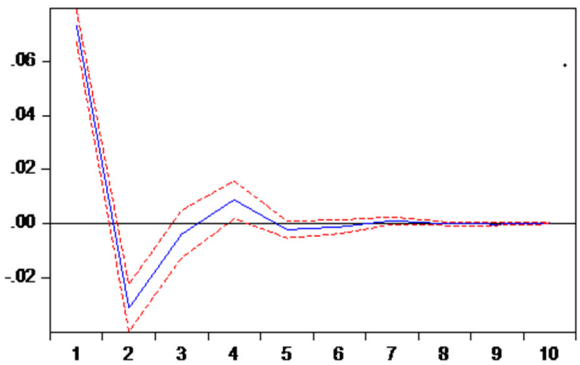

Figure 9 Response of DLNY to DLNY

As can be seen from Figure2-9, the price of the carbon financial trading market has the smallest impact on the price of Daqing crude oil spot market, the largest fluctuation effect on its own impact, and the longest response time to the disturbance of the AIR quality index. Due to the cost of drilling for oil requires a lot, at the same time, the coastal ecosystems such as the environment will produce irreversible damage, oil-burning large amounts of carbon dioxide and other greenhouse gases emitted into the atmosphere when they lead to global warming. If people want to achieve the purpose of the "carbon neutral" in 2060, it must be widely spread with low carbon technology. Therefore, in recent years, domestic and foreign people are struggling to find energy sources that can replace oil. Since 2013, methanol has been used as vehicle fuel instead of petroleum in China. The safety, environmental protection, reliability, economy and applicability of methanol vehicles have been verified, making up for various deficiencies of petroleum as fuel. At present, the domestic energy structure is still dominated by coal, supplemented by crude oil and natural gas. Meanwhile, more than 40% of the domestic coal resources are inferior high-sulfur coal, which is not suitable for direct use as energy fuel, but inferior high-

sulfur coal can be used to produce methanol. At present, methanol fuel production technology is relatively mature, and methanol can be extracted from inferior coal and other materials in China to achieve the maximum clean utilization of coal resources. The partial substitution of methanol for crude oil reduces the impact response of the price of carbon financial trading market to the change of crude oil price. Disturbance effect, in the long run, the air quality of the carbon market prices stable long-term effects of air quality will be affected by a variety of energy production, in the process of combustion emissions of pollutants, the influence of which usually takes time to spread to the whole environment, and the negative effects take a long time to get its slow release. Under the background of carbon neutrality, China continues to implement clean air policies to fundamentally solve the problem of air pollution. When the air quality is stable at a high level, China's demand for carbon emissions will be reduced and stable. The carbon market price will also be stable, which is more conducive to the rapid development of the carbon market.

3.4.2 Variance Decomposition

Table 3. Result of variance decomposition

Period	S.E.	DLNX1	DLNX2	DLNX3	DLNX4	DLNX5	DLNX6	DLNX7	DLNY
1	0.0730	0.0212	0.7244	1.1309	0.3478	0.4829	1.0095	0.1992	96.0841
2	0.0805	0.0675	0.6318	1.0084	1.1560	1.2460	1.2718	0.1937	94.4248
3	0.0815	0.0784	0.6208	1.0510	1.5565	2.7137	1.5291	0.2009	92.2497
4	0.0823	0.1542	0.7383	1.0417	1.5622	3.0251	1.5561	0.1971	91.7253
5	0.0825	0.1952	0.7357	1.1206	1.6811	3.0321	1.5593	0.1964	91.4796
6	0.0825	0.1972	0.7832	1.1552	1.6838	3.0289	1.5576	0.1966	91.3975
7	0.0825	0.1998	0.7898	1.1622	1.6930	3.0291	1.5570	0.1994	91.3699
8	0.0825	0.2012	0.7925	1.1628	1.6964	3.0291	1.5572	0.2001	91.3605
9	0.0825	0.2013	0.7940	1.1628	1.6965	3.0291	1.5573	0.2001	91.3589
10	0.0825	0.2013	0.7941	1.1628	1.6970	3.0291	1.5573	0.2002	91.3582

It can be seen from Table3 that the contribution degree of each influencing factor is in ascending order: Eu carbon quota < thermal coal Shenwan Industry index < Daqing crude oil spot price < national LIQUEFIED natural gas price < CSI 300 index < Air quality index < SSE Industrial Index < carbon financial transaction market price.

4. CONCLUSION

In this paper, the VAR model is used to empirically study the influence relationship among thermal coal index, Daqing crude oil spot price, LIQUEFIED natural gas price, air quality Index, Sse Industrial Index, CSI 300 index, EU carbon quota and the price of China's carbon financial trading market. The main conclusions are as follows:

First, EU carbon quotas have the least impact on China's carbon finance market. The EU carbon market is the most successful and largest carbon finance market in the world. China is now in the early stage of building a national carbon market. Learning and drawing lessons from the strategic measures of the EU carbon market has a positive incentive effect on the development of China's carbon market[8], so the EU carbon market has a certain impact on China's carbon market.

Second, energy prices have a high degree of influence on China's carbon finance market. Carbon emissions depend on the production of enterprises, and the output of enterprises depends on the income and profit of enterprises, and the income and profit of enterprises depend on the production cost of enterprises, and the production cost of enterprises depends on the change of various energy prices. Therefore, the fluctuation of energy prices has an impact on the price of the carbon financial market to some extent.

Third, China's macroeconomy has the highest impact on China's carbon finance market[9]. The development of various industries drives the overall development of China's macro economy. The industrial industry, as the industry with the largest impact on carbon emissions, plays an important role in driving macroeconomic growth.

This paper only considers the influencing factors of the carbon financial market price and does not study the market risk fluctuation. The price of China's carbon financial trading market fluctuates greatly, and the price is affected by many factors in the actual trading process[10]. In order to avoid large fluctuations in the market and ensure stable trading, the GARCH family model should be used to analyze and study the volatility of the market return rate in the future.

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