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Study on the Influencing Factors of Price Fluctuation of Shanghai Carbon Emission Right Trading

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Abstract: *This paper takes the Shanghai carbon emissions trading market as an example, and based on the gray correlation analysis method to calculate the cumulative contribution of each influencing factor to the Shanghai carbon emissions trading price, the VAR model is used to study how the energy price, the climate environment, the level of macroeconomic development, and the foreign market influence the price of the Shanghai carbon emissions rights. The results of the study show that the price of carbon emission rights in Shanghai is mainly influenced by energy prices. Among them, the influence of regional economy on the Shanghai carbon emission rights trading market is stronger. Regional temperature and air quality have a continuous impact on the Shanghai carbon market. The daily closing data of the European carbon emissions trading price and the exchange rate of the euro against the Chinese yuan have a more significant impact on the Shanghai carbon market, and the exchange rate factor has the largest contribution in the gray correlation analysis. Therefore, it is necessary to take into account the differences of regional economies, which will help to construct the steady development of the national carbon market.*

Keywords: *Carbon emissions trading price; GRA; VAR model; energy intensity*

1. Introduction

Extreme weather and ecological disasters caused by global warming have taken a huge toll on our lives, and climate risk has become a major risk that people are facing together. Carbon dioxide (CO2) emissions from human society since the industrial revolution are the main cause of climate change in the world today. The carbon trading market has proven to be a market-based approach that can effectively control or reduce greenhouse gas emissions. The report of the Twentieth Party Congress points out that the Party will actively and steadily promote carbon peaking and carbon neutrality, and actively participate in global governance to address climate change. At present, China is focusing on the development of a low-carbon economy, and carbon finance will be an important means of energy conservation and emission reduction. In order to implement the concept of green development and effectively respond to global climate change, the Chinese Government has taken a number of measures to control greenhouse gas emissions. Due to the immature development and short history of China's carbon finance market, there is a serious lack of relevant quantitative data, and the market lacks risk management tools for participants in carbon finance transactions. In order to accomplish this goal as soon as possible, the Chinese government established seven pilot carbon emissions exchanges in Beijing, Shanghai, Shenzhen, Guangdong, Hubei, Tianjin and Chongqing provinces and cities in 2011, and started trading in 2013. However, the late start of China's carbon financial trading market, the existence of unsound trading mechanism, the influence of trading price factors are many and complex, which reflects the risk characteristics of the carbon financial trading market, and these risks will cause fluctuations in the trading price, increase the risk and the difficulty of management and control. It is also difficult to achieve the goal of reducing greenhouse gas emissions through carbon emissions trading in the carbon trading market. Therefore, studying the influencing factors and volatility characteristics of carbon emission prices is conducive to reducing carbon market risks and controlling unexpected fluctuations in carbon emission prices. In the above context, quantifying the price fluctuation of carbon emission right trading and its influencing factors in China is of great theoretical and practical significance for realizing the green and sustainable development of China's economy as well as carrying out the national unified carbon emission reduction work.

Since the Shanghai Carbon Market went live in 2013, the market has operated smoothly and orderly, with standardized and transparent transactions, and is the only pilot market in China that has achieved 100% compliance in all eight compliance years. At the same time, the market covers a wide range of market players and is relatively rich in types, the Shanghai carbon market also fully leverages the advantages of international financial centers, cooperates with a wide range of financial institutions, and actively explores and develops carbon finance, to better serve the development of the real economy to the green transition. As a commodity, the price volatility of carbon credits is also affected by a number of other external factors. Changes in the supply and demand situation in the carbon market can affect the price at which carbon credits are traded. This paper chooses the Shanghai carbon emissions trading market as the research object, and is divided into three periods according to the time point of the "National Carbon Emissions Trading Market Construction Program" and the introduction of the "Dual Carbon" policy. The contribution of each macro factor to the trading price of carbon emission rights in Shanghai was analyzed using gray correlation analysis. Again based on the use of VAR modeling to study the impact of energy prices, macroeconomic development level, air quality index, climate environment, and foreign markets on carbon emissions and carbon emissions trading prices. As the world's largest developing country, China can play a more important role in the development of the global carbon market. Therefore, this study also provides some insights for other developing countries to establish a unified carbon emissions trading market[1-3].

The rest of the paper is organized as follows: a summary of related research work is presented in Section II. Data description and preliminary analysis are presented in Section III. Section IV is an introduction to the modeling methodology. Section V is an empirical analysis of the influencing factors and volatility characteristics of the carbon emissions trading price in Shanghai, China. Section VI is the conclusion and some policy implications.

2. Literature review

Current research on the factors affecting the price of carbon emissions trading is mainly focused on energy prices, the level of domestic macroeconomic development, and the climate environment(Aatola P,2013; Tan X P,2017; ZHAO Pingfei,2020). The main research results of energy prices affecting the price of carbon emissions trading are that there is a positive and significant between the two (Li Yuanyuan,2018). There is a negative and significant(ZHAO Xuan-Xue,2019). Scholars constructed multivariate autoregressive lag models from fossil energy prices, macroeconomic and electricity variables, and concluded that weather changes are an important driver of changes in the spot market for carbon emission rights(Jan Horst Keppler，MMansanet-Bataller，2010). Empirical analysis of the first stage of the EUETS market to carry out carbon emissions rights trading price factors, the analysis results of the temperature situation on the carbon emissions rights trading price there is a significant impact(Rickels，2017). Other scholars have empirically demonstrated the two-way effect of carbon trading price and air quality through the Granger causality test(Li Yi,2020). A VAR model was constructed to analyze the dynamic relationship between the coal stock index and the trading price of carbon emission rights, and the results showed that the trading price of carbon emission rights was significantly affected by the coal index in the short term(LI Qianglin,2019). Some scholars have also analyzed the risk premium by analyzing the correlation between carbon emissions trading prices and stock indices of carbon trading-related industries(Zhang Yifan,2021). Lasso regression variable analysis of macroeconomics, energy prices, and the climate environment to study the factors influencing the carbon emissions trading market(Guo W.J,2015). A system of price indicators and price risk prediction using a gray BP neural network were also developed(JIN Lin,2020). In addition, the pilot carbon emissions trading policy has a guiding effect on low-carbon technological innovation(WANG Weidong,2020).

In addition to the above, many scholars compare the several carbon emissions trading markets that are currently piloted and analyze the characteristics of each carbon emissions trading market. By comparing the price volatility of China's eight carbon emissions trading markets, it is found that all eight carbon emissions trading markets are in the primary stage and need further support in various aspects(Chen Liuhui,2019). Using wavelet resolution to compare and analyze the three carbon emissions trading pilot markets with the European market, it is found that the current stability of China's carbon emissions trading market is relatively insufficient(Lv Jingye,2021; Yang X，2018).

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3. Data description and preliminary analysis

In order to study the relationship between the price of carbon emissions trading and the influencing factors, this paper analyzes the price fluctuation of carbon emissions and the influencing factors based on the study of scholars, starting from the climate environment, macroeconomic development, energy price, foreign carbon price and exchange rate factors. When studying the factors affecting the level of macroeconomic development, national macroeconomic data are often used as the factors, but this paper focuses on the Shanghai carbon emissions trading market, so the Shanghai sector index is chosen as a proxy for the macroeconomic development, and the CSI 300 index, which represents the macroeconomy, is used as a proxy for the level of influence on the price of Shanghai carbon emissions rights. According to China's energy consumption, among the many sources of energy, China's coal resources have the highest carbon emissions, and therefore the coal futures price index was chosen as the influential energy factor. For the environmental factors, the local Air Quality Index (AQI) and the local daily average temperature were selected, where the treatment of temperature was to select the average of the maximum and minimum temperatures of the day. In addition the exchange rate of the Euro to the Chinese Yuan and the daily closing data of the European Carbon Emission Trading Price (ECTP) were used as exchange rate factors and foreign carbon price factors. In this paper, the data excluding holidays corresponds to the trading days of Shanghai carbon emission rights one by one. The data from December 19, 2013 to September 30, 2022 were selected as the start time of the Shanghai Open Day. Mainly from Wind database. In order to ensure the reliability of the data, the data were refined and validated again with reference to the public content of China Statistical Yearbook, Weather.com, and so on. In order to eliminate the heteroskedasticity without acting on the cointegration and smoothness between the series, the 8 sets of data are logarithmized and denoted by lnSHEA, lnSHINDEX, lnAQI, lnTEMPT, lnHS300, lnCOAL, lnEUA, and lnUR, respectively.

Table 1: Indicator selection and data sources

variable name	Variable Code	Data sources
Shanghai carbon price	SHEA	Wind
Shanghai Sector Index	SHINDEX	Wind
Shanghai Air Quality Index	AQI	PM2.5 Weather Network
Average temperature in Shanghai	TEMPT	Wind
CSI 300 index (stock market index)	HS300	Wind
Coal Futures Price Index	COAL	Wind
European carbon emissions trading price day close data	EUA	Wind
Euro to Chinese Yuan Exchange Rate	UR	Wind

As can be seen from Figure 1, in the first few years of the trading market, the price of carbon emission rights showed a downward trend, the lowest to 4.2 yuan / ton. As the market attaches importance to energy conservation and emission reduction and the demand for carbon emission credits from enterprises is increasing, the operation of the carbon emission trading market, which is constructed on the basis of carbon finance and environmental externalities, is gradually showing its effect. The price of carbon credits has risen gradually since 2017, reaching $63 per ton as of the date the data was taken. That's nearly three times as much as in the early days. As can be seen from Figure 1, the fluctuation of Shanghai carbon emission right price yield is roughly between -0.4 and -0.8, and the fluctuation of daily yield shows obvious time-varying and sudden characteristics, so it is initially judged that there is heteroskedasticity in the time series of yield, and this paper will follow up to test the heteroskedasticity by using the ARCH model, and to evaluate the fluctuation of the price yield of carbon emission rights by using the CARCH model as a whole. Characteristics of Carbon Emission Right Price Yield[4-6].

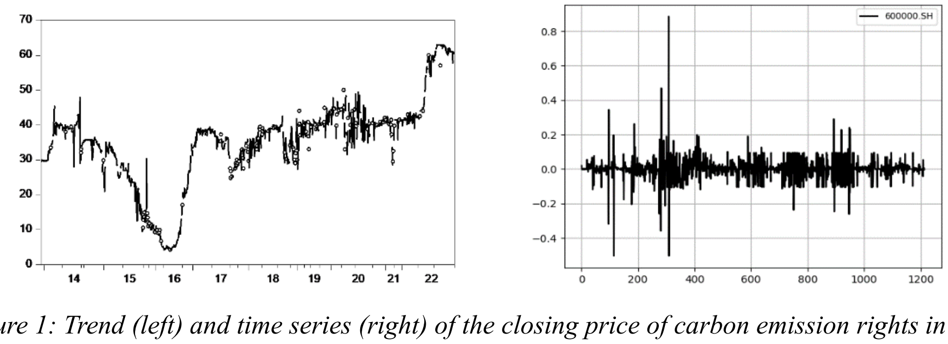

Figure 1: Trend (left) and time series (right) of the closing price of carbon emission rights in Shanghai Province (in yuan per ton)

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Table 2: Descriptive statistics of the variables.

	Valid data	Minimum	Maximum	Mean	Std.Dev	Skewness	Kurtosis
SHEA	1213	4.2	63	0.000597	0.068431	1.288834	34.17216
SHINDEX	1210	1991.25	5166.35	3094.463	531.387	0.305103	4.95175
AQI	1213	21	1332	79.91838	50.85676	12.81047	304.8616
TEMPT	1214	-3	35.4	17.32002	8.619626	0.04079	1.956907
HS300	1210	2086.97	5768.38	3720.953	792.1042	-0.20039	2.779868
COAL	1210	288.40	1040	591.7470	141.3347	0.4292	3.154935
EUA	1199	4.3	96.04	23.21631	25.74120	1.60384	4.1992
UR	1210	6.5553	8.6847	7.56908	0.47270	0.133465	2.47824

A small standard deviation indicates that there is a small gap in the selected data, the data shows a tendency to cluster and there is a clustering characteristic. Skewness is less than 0, indicating that the data are right-skewed; kurtosis is 34.17216 greater than 3, indicating that the normal distribution data are steep, JB test results at a significant level of 1% are rejected the assumption of normal distribution, are not normal. According to the skewness, kurtosis, JB statistic analysis, it can be seen that the yield has the characteristics of right trailing spiked distribution and does not obey the normal distribution, presented in Table 2.

4. The model

4.1. Grey Correlation Analysis

Firstly, the gray correlation analysis method was used to analyze the degree of contribution of each macro-factor to the price change of the carbon emissions trading market, and to identify the main influencing factors, based on the National Carbon Emissions Trading Market Construction Program and the proposal of the "Double Carbon" policy as the time stage, divided into three stages[7-8].

On this basis, a VAR model is used to explore the impact shocks of each macro-factor on the trading price of carbon emission rights.

Gray correlation analysis is one of the main methods used in the study of influencing factors, and has the advantage of being helpful in case of insufficient data and poor information.

According to the grey correlation calculation method, a data series that reflects the characteristics of the system's behavior, similar to the dependent variable Y , and a data series that consists of factors affecting the system's behavior, similar to the independent variable X . It is written in the following form:

$$Y = \left[y_1, y_2, ..., y_k \right]^T \tag{1}$$

$$X_{nm} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1m} \\ x_{21} & x_{22} & \cdots & x_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{nm} \end{bmatrix} \tag{2}$$

Where: Y represents the status of Shanghai's carbon emissions trading price in different periods; X_{nm} represents the value of each macro factor in different periods; k represents the time of the sample study; m represents the number of factors; n represents the number of years.

The data were dimensionlessized as follows:

$$\tilde{y}_k = \frac{y_k}{\overline{y}_i}, \overline{y}_i = \frac{1}{n} \sum\nolimits_{k=1}^{n} y_k \tag{3}$$

$$\tilde{x}_{ki} = \frac{x_{ki}}{\overline{x}_{-i}}, \quad \overline{x}_{-i} = \frac{1}{n} \sum\nolimits_{k=1}^{n} x_{ki}, \quad (i = 1, 2, .., m) \tag{4}$$

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Calculate the correlation coefficients of the 2 sequences at different time points k, as in Eq:

$$M = \max_i \max_x \Delta_i(k), \quad m = \min_i \min_x \Delta_i(k) \tag{5}$$

$$r_{0i}(k) = \frac{m + \lambda M}{\Delta_i(k) + \lambda M} \tag{6}$$

Where: M is the maximum value of the correlation coefficient; m is the minimum value of the correlation coefficient; $r_{0i}(k)$ is the correlation coefficient; λ is the resolution coefficient, , $\lambda \in (0,1)$ this paper takes 0.5.

The gray correlation of the sequence to the reference sequence can be found after finding the average of the correlation coefficients r_{0i} of the comparison sequence:

$$r_{0i} = \frac{1}{n}\sum_{k=1}^{n} r_{0i}(k) \tag{7}$$

4.2. VAR Model construction

A vector autoregressive model is used to analyze the degree of influence of each macro factor on the price of carbon emission rights in Shanghai. In the VAR model, each of the explanatory variables is regressed on a number of period lagged values of itself as well as the other explanatory variables. A total of 8 variables are selected in this paper. According to the optimal lag order of 5, the expression of the fifth order VAR model is obtained as:

$$Z_t = A_1 Z_{t-1} + A_2 Z_{t-2} + ..A_5 Z_{t-5} + U_t \tag{8}$$

where, denotes an 8-dimensional vector of Z_t consisting of observations from period t; A_i denotes a 6 × 6 matrix of coefficients; and U_t denotes a vector of perturbations.

5. Empirical results

5.1. Analysis of the contribution of macro-factors

In order to study in depth the intrinsic causes of the fluctuating characteristics of China's production safety situation, the gray correlation degree analysis method was used to derive the degree of contribution of seven factors, such as energy prices, climate environment, macroeconomic development level, foreign markets, etc., to the price of the Shanghai carbon emission right market in the three periods during the period of 2013-2022, and the cumulative degree of contribution of the different macro-factors to the situation of production safety accidents in the three periods was shown in Table 3

Table 3: Cumulative Contribution of Different Factors to Shanghai's Carbon Emission Trading Price in Three Periods between 2013-2022

Time	SHINDEX	AQI	TEMPT	HS300	COAL	EUA	UR
2013-2017	0.746	0.724	0.709	0.746	0.841	0.773	0.816
2017-2020	0.921	0.787	0.775	0.925	0.894	0.844	0.934
2020-2022	0.991	0.962	0.965	0.971	0.981	0.969	0.975
2013-2022	2.658	2.473	2.449	2.642	2.716	2.586	2.725

From the table, it can be seen that from 2013 to 2022, the price of Shanghai carbon emissions trading is mainly due to the exchange rate of the euro against the renminbi and the coal futures price index, of which the cumulative contribution of the exchange rate of the euro against the renminbi is the strongest, with 2.725, and the contribution of the exchange rate of the euro against the renminbi is also more significant from the viewpoint of each stage.

The year 2017 is the time period in which the Program was introduced, and this period can be seen as having a more pronounced impact on the SHINDEX and HS300, from 0.746 to 0.921 and from 0.746 to 0.925, respectively. Therefore, the extent of the Shanghai plate index and CSI 300 index after the

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introduction of the Program brought a significant positive impact on the price of carbon emissions trading.

The introduction of the Dual Carbon policy shows that all the factors are increasing accordingly, suggesting that the introduction of Dual Carbon can have a positive impact.

5.2. Unit Roots and Model Stability Tests

In order to ensure that the relationship of the original data does not change, the original data are first log-transformed to eliminate heteroskedasticity in the test results to avoid adverse effects on the experimental results. After the logarithmic transformation, in order to avoid pseudo-regression, the transformed data are checked for smoothness before modeling, and the ADF test results show that (see Table 4) the seven variables obtained before the logarithmic treatment are unstable, but after the first-order difference treatment, all the variables become a stable series, so in this paper we use the first-order single-integer time series. After several fits to the study data, it was found that the lag order was more appropriately set at 5.

Table 4: Unit root test

series	ADF	1%	5%	10%	P-value	Yes/No
SHINDEX	-2.387409	-3.965712	-3.413561	-3.12883	0.3859	no
DSHINDEX	-15.36901	-3.435585	-2.863740	-2.567991	0.0000	yes
AQI	-29.05301	-3.965642	-3.413527	-3.128812	0.0000	yes
TEMPT	-3.446862	-3.965655	-4.413533	-3.128815	0.0458	no
DTEMPT	-24.02190	-3.965655	-3.413553	-3.128815	0.0000	yes
HS300	-1.856516	-3.965661	-3.413536	-3.128817	0.6763	no
DHS300	-32.47950	-3.965674	-3.413542	-3.1288	0.0000	yes
COAL	-3.628359	-3.965661	-3.413536	-3.128817	0.0278	yes
DCOAL	-33.32658	-3.965674	-3.413542	-3.128821	0.0000	yes
EUA	-2.052206	-3.965803	-3.413605	-3.128858	0.5714	no
DEUA	-21.93500	-3.965977	-3.413691	-3.128909	0.0000	yes
UR	-1.934164	-3.965661	-3.413536	-3.128817	0.6358	no
DUR	-34.09812	-3.965674	-3.413542	-3.128821	0.0000	yes

5.3. VAR Model building

By performing a unit root test on the 7 series, the results show that although they are all non-stationary, their first order differences are again all stationary, so there is some kind of equilibrium relationship between these variables. It is common to analyze non-stationary data by building a VAR model with the smoothed data after differencing, but first-order differencing loses important non-equilibrium information and makes the results difficult to interpret. The Johansen cointegration test shows that (see Table 5), the cointegration between the variables in this study does not pass the significance test, so the VAR model can be built. The Johansen cointegration test shows (Table 1) that the cointegration relationship between the variables in this study does not pass the significance test, so the VAR model can be built.

Table 5: Johansen cointegration test results

	Eigenvalue	statistic		5% threshold		P-value	
		Trace Statistic	Max-Eigen Statistic	Trace Statistic	Max-Eigen Statistic	Trace Statistic	Max-Eigen Statistic
0*	0.1632	318.993	198.482	159.529	52.36261	0.000	0.0001
At most 1	0.0314	120.510	35.5761	125.615	46.2314	0.0982	0.4237
At most 2	0.0249	84.9347	28.1721	95.7536	40.0775	0.2195	0.5496
At most 3	0.0225	56.7626	25.3888	69.8188	33.8768	0.3479	0.3592

The results of the unit root test for the lagged 5th order VAR model are shown in Figure 2, which shows that the VAR(5) model satisfies the smoothness condition.

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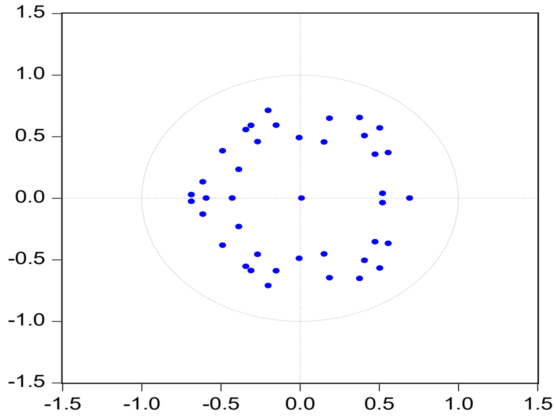

Figure 2: Smoothness test results of VAR model.

5.4. Impulse Response Analysis

After modeling and estimating the VAR model, the impulse response is used to further analyze the impacts of each influential factor on the price of carbon emissions trading in Shanghai. The solid line shows the direction and magnitude of the change in the shock factor, the dashed line shows the deviation from the positive and negative criteria, the horizontal axis shows the lag period, and the vertical axis shows the magnitude of the shock. From Figure 3 to Figure 6, it can be seen7 that each variable has different degrees of influence on the price of carbon emission rights in Shanghai.

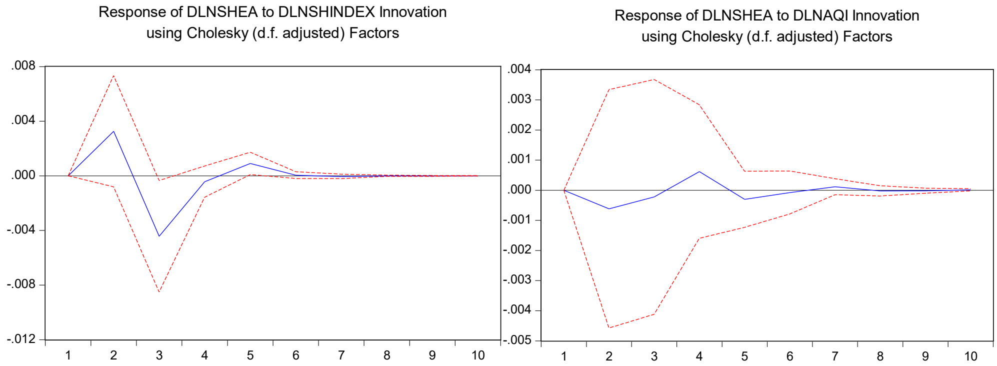

Figure 3: Impulse Response Combination Plot (Shanghai plate index on the left, air quality on the right)

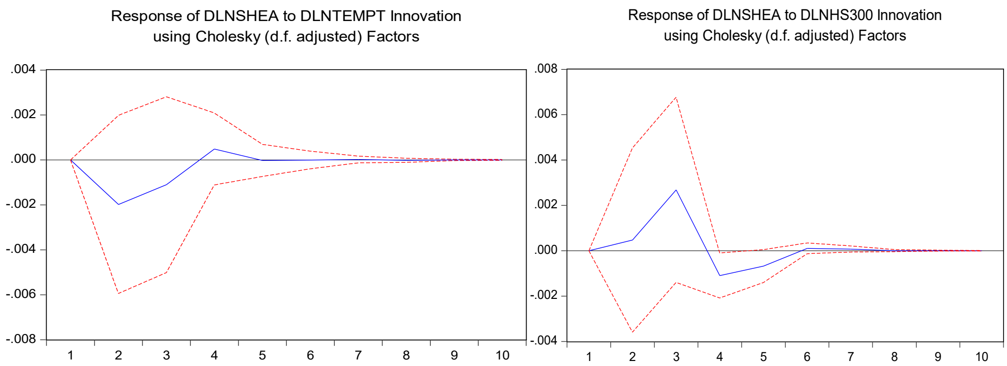

Figure 4: Impulse Response Combination Plot (Tempt on the left, CSI 300 on the right)

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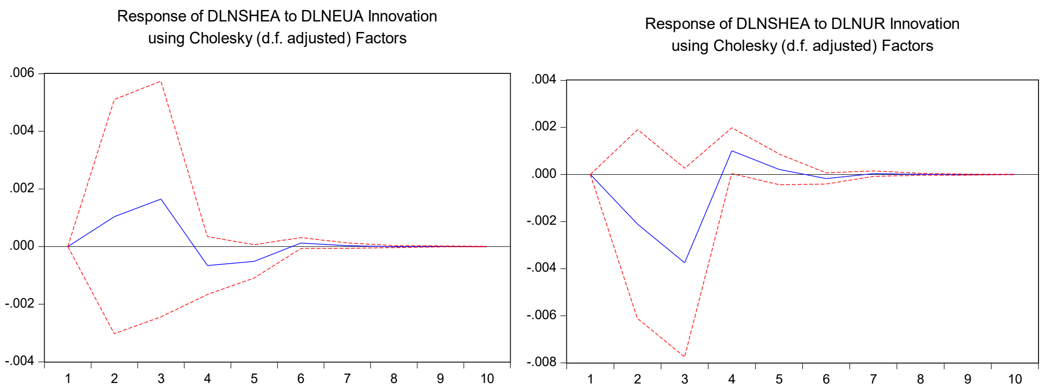

Figure 5: Impulse Response Combination Plot (EUA on the left, UR on the right)

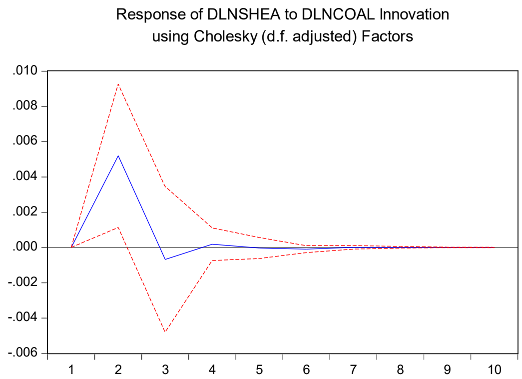

Figure 6: Impulse Response Plot of COAL on the Price of Carbon Emission Rights in Shanghai

As can be seen from Figure 3, the Shanghai sector index is the second most influential factor on the price of Shanghai carbon emission rights among several variables. All the influencing factors have almost no significant fluctuation in the first period, a positive shock of 0.0033 in the second period and a negative shock of -0.0044 in the third period. The variability of the economic environment has an important impact on production and operation. When the regional economic environment is good, enterprises will expand their business enthusiastically, which means that the demand for carbon emission rights increases, but then rational thinking reduces the decision-making of over-production, which reduces the demand for carbon emission rights, and because of the impact of the Program, the demand for carbon emission rights will be rationally formalized, which is moderate with the negative impact in the third period.

The AQI has a negative shock of 0.006 in the second period, which increases slightly until it disappears in the seventh period. Overall, the impact of AQI on the price of carbon emission rights in Shanghai is smooth. The AQI can indirectly reflect whether the carbon dioxide emissions are excessive or not.

As can be seen from Figure 4, the impact of temperature on the Shanghai carbon market is relatively small, with a positive impact of only 0.0004. The impact of temperature on the price of the Shanghai carbon market is relatively small. Enterprises are the main body of greenhouse gas emissions and are the key targets of monitoring, and the price of carbon allowances fluctuates under the influence of demand.

The positive impact of CSI 300 index, which represents the macroeconomic situation, on the price of Shanghai carbon emission rights is only 0.0005 in the second period, and reduced from 0.0027 to negative impact in the third period. The CSI 300 index represents the economic situation of the whole country, but its impact is not as large as that of the Shanghai sector index. The reason is that the regional economic development is different, which leads to Shanghai's economic development is not consistent with the whole country's economy, thus showing its own characteristics in the carbon emissions trading market.

As can be seen from Figure 5, the impact of the two indicators of foreign markets, the daily closing data of the European carbon trading price and the exchange rate of the euro against the renminbi on the Shanghai carbon trading price, the impact of the European carbon trading price on the Shanghai carbon market is only 0.0010. The impact of the exchange rate of the euro against the renminbi on the Shanghai carbon trading price is negative 0.0021.

As can be seen from Figure 6, the coal futures price index has the largest impact on the Shanghai carbon credit price. The second period produces 0.0052 to completely disappear after the fifth period. Compared with the spot market coal futures market is more sensitive to information. The coal futures index has a big impact on the price, which shows that the energy price is an important factor for enterprises to consider whether to buy carbon emission rights. In the case of a certain amount of carbon allowances, the price of coal affects the price of carbon emission rights in Shanghai through the demand break.

5.5. Analysis of Variance Decomposition

The significance of the variance decomposition is that it can quantitatively analyze the degree and strength of the explanation of the influencing factors on the price changes of Shanghai carbon emission rights at different time points. The specific variance decomposition is shown in Table 6.

From the longitudinal view of Table 6, the AQI increases sharply from the 4th period and then stabilizes. The impact of temperature on the price of Shanghai carbon emissions trading shows an increasing trend. The impact of coal futures price increases from the second period to the sixth period and then stabilizes. The Shanghai sector index stabilizes from the sixth period. The contribution of the Shanghai carbon price itself is consistently high, always above 96%.

From a cross-sectional perspective, in the second period, the largest contributor to the price change of Shanghai carbon emission rights is the coal futures price index, followed by the Shanghai plate index, and according to the original table without exact decimal point, the CSI 300 index has the smallest contribution. From the third period onwards, the coal futures price index is always the main factor causing the price fluctuation of Shanghai carbon emission rights, and the Shanghai plate index becomes the second factor causing the price fluctuation of Shanghai carbon emission rights.

Table 6: Variance decomposition table for each influencing factor

Period	SHINDEX	AQI	TEMPT	HS300	COAL	EUA	UR	SHEA
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	100.00
2	0.451	0.010	0.157	0.003	0.828	0.004	0.086	98.458
3	0.622	0.010	0.158	0.046	0.820	0.143	0.331	97.867
4	0.739	0.014	0.164	0.139	0.911	0.166	0.383	97.479
5	0.799	0.152	0.178	0.362	0.897	0.333	0.375	96.901
6	0.853	0.153	0.230	0.391	0.905	0.363	0.396	96.706
7	0.848	0.164	0.234	0.389	0.914	0.361	0.453	96.630
8	0.854	0.165	0.236	0.396	0.916	0.361	0.457	96.611
9	0.855	0.171	0.238	0.400	0.916	0.372	0.465	96.579
10	0.859	0.172	0.238	0.402	0.916	0.379	0.465	96.579

6. Conclusion

This paper analyzed the price fluctuation of Shanghai carbon emission rights and the factors affecting the price with the help of grey correlation analysis and VAR model, and got the following conclusions:

1) Shanghai's carbon credit price is more sensitive to regional economic conditions.

Traditionally, macroeconomics is the most important factor affecting the production and operation of enterprises. However, the empirical results of this paper show that the Shanghai carbon emission rights market is significantly more affected by the regional economic situation than the macro-economy. The macroeconomic impact of the CSI 300 index on the price fluctuations of Shanghai carbon emission rights is minimal. That is to say, the regional environment and air quality have a greater impact on the emission control of enterprises, thus causing the fluctuation of the price of carbon emission rights in Shanghai.

2) Energy price is an important factor causing fluctuations in the price of carbon emission rights in Shanghai.

The results in Table 6 show that since the second period, coal futures price has always been an important factor in the volatility of Shanghai's carbon emission rights price, and enterprises in Hubei region are very concerned about the energy price. The energy price fluctuation can reflect the high energy dependence of Shanghai.

3) The results of grey correlation analysis show that.

It is useful to divide the time into three phases based on the introduction of the Program and the Dual

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Carbon policy and analyze the changes in each period separately. It can be seen that the contribution of the Shanghai sector index and the CSI 300 index is increasing before and after the Program. The coal futures price index has been among the top contributors during the period. The introduction of the Bi-Carbon policy has had a significant positive impact on each of the influencing factors in general.

References

[1] Aatola P, Ollikainen M, Toppinen A. Price Determination in the EU ETS Market: Theory and Econometric Analysis With Market Funda-mentals [J].Energy Economics, 2013, (36).
[2] Tan X P, Wang X Y. Dependence Changes Between the Carbon Price and Its Fundamentals: A Quantile Regression Approach [J].Applied Energy, 2017,(190).
[3] Yang X, Liao H F. A Study on the Law of Cyclical Fluctuation of Car-bon Price—Empirical Evidence From EU ETS [J].Low Carbon Economy, 2018,9(4).
[4] Li Yuanyuan, Impact of energy price on carbon price in China's carbon emissions trading pilot market[D]. Guangzhou. State: Dissertation of Jinan University,2018.
[5] ZHAO Xuanxue, WEI Xue. Study on the Relationship between Traditional Energy Prices and China's Carbon Emission Right Trading Prices --Based on the panel data of seven pilot provinces and cities of carbon emissions trading in China[J]. Ecological Economy Economy,2019,35(2).
[6] Zhang Yifan. Research on Risk Spillover Effect of Carbon Trading Market and Stock Market [D]. Northwest Agriculture and Forestry University of Northwest Agriculture and Forestry Science and Technology,2 021.
[7] Rickels W, Duscha V, Keller A , et al. The determinants of allowance prices in the European Emissions Trading Scheme - Can we expect an efficient allowance market 2008?[J]. Kiel Working Papers, 2007.
[8] Li Yi. An empirical study on the factors influencing the pricing of carbon emissions trading[J]. Price Theory and Practice. 2020(6):4.