Driver Analysis of Trading Price Volatility in Carbon Emissions Market

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Abstract—With the development of global low carbon economy, the academic circle focus more and more on the carbon emissions permit trading, and on the influence on price volatility of carbon emissions permit products.To know more about the price volatility of carbon emissions permit products and to know better about the practical significance of the low carbon economy, this paper will pay attention to the drivers of price volatility of CERs and EUAs from theoretical and empirical analysis. In the theoretical analysis, we carry out our research from three points of view: macro-perspective, genetic analysis and demand and supply. In the empirical analysis, we will make the pulse response analysis on the VAR model we built between future prices of carbon emissions permit products and that of energy products to learn the change scope and change direction of price of carbon emissions permit products.On the basis of the analysis, we could learn more about the pricing rule of the carbon emissions permit products in order to build China's carbon emissions trading market price mechanism.

Keywords-component; carbon emissions permit; price volatility; theoretical analysis; empirical analysis; price mechanism

I. INTRODUCTION

The outbreak of the industrial revolution brought unprecedented changes to the world, the revolution promoting the development of the world, but at the same time, it brought unimaginable damage to the global environment. Nowadays, global environmental problems have raised the world's attention and thinking. How to control greenhouse gas emissions, to developing low carbon economy has become one of the important objectives of the development of the global economy.

In 1992, the United Nations Framework Convention of Climate Change (the UNFCCC) is the first international Convention for the response to the global environment problems, and then, in 1997, the Kyoto Protocol as its supplementary conditions, make some more specific requirements to the developing countries and developed countries on gas emission reducing.

As the first international agreement with practical significance, the Kyoto protocol help states parties to fulfill emission reduction plan more flexible by setting up Joint Implementation Mechanism (JI), Clean Development Mechanism (CDM) and Emissions Trading mechanisms (ET). With these three trading mechanisms, the global carbon trading market has gradually formed.

At present, there are a lot of mature global carbon trading markets, such as the European energy exchange (EEX), the European climate exchange (ECX), the Chicago climate exchange (CCX), etc., and a lot of carbon trading in emerging markets, such as Asia carbon emissions exchange, Shanghai environmental energy exchange, India Commodity Exchange, etc.

The overall carbon trading market can be divided into two categories, based on the quota and based on the project, and since the global carbon market formation, both market got great development over the years according to World Bank. According to data from 2005 to 2011, the two market trading volume average annual growth rate as high as 62.8% and 62.8% respectively.

According to 2012 World Bank's development report, in 2011, the world's carbon trading market clinch a deal amount up to $176 billion, total carbon trading as high as 10.3 billion tons, among them, the EU carbon quotas EUA trading is the predominant one, its volume of transaction and trading volume is $148 billion and 7.9 billion tons respectively. The CER trading under the clean development mechanism is next, and its volume of transaction and trading volume is $22 billion and 1.7 billion tons respectively.

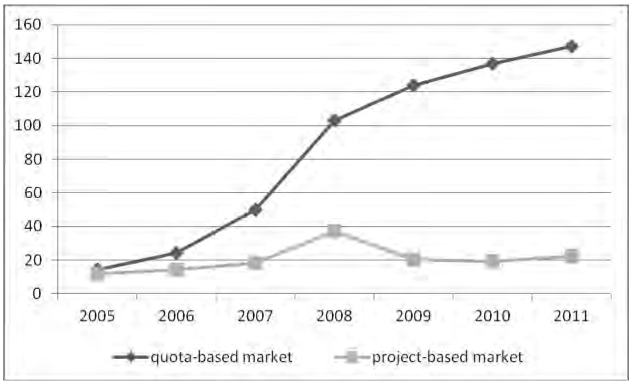

Figure 1. Volume of global carbon emissions market, 2005-2008[1]

[1] Fig .1, 2005-2008 State and Trends of the Carbon Market, World Bank

II. DRIVER ANALYSIS

A. Theoretical Analysis

First of all, from a macroeconomic perspective, due to the carbon emissions trading market, especially the largest mandatory cap-and-trade market, is established on the basis of Kyoto Protocol, is established under the subjective intention of every country, so that the price fluctuations will surely influenced by their own government and other influential governments (such as the United States).

Not only these governments' attitude on the reduction action will influence the price, population, industrial development and even macroeconomic factors such as the degree of financial scale will also indirectly cause fluctuations in the price of carbon emissions trading. Population intensive degree and level of industrial development will affect the carbon emissions price by changing the emission of the carbon dioxide. And the financial scale will affect the stability of carbon trading market, thus influence the establishment of the market pricing mechanism and regulation means.

Secondly, from the angle of genetic analysis, industrial use of coal, gas or oil to generate power, society use of heating power, etc., will result in huge amounts of carbon emissions.

These will directly promote the change of carbon emissions, so we assume energy prices maybe is the main factor to cause price volatility of carbon emissions products. This has been confirmed by many scholars, Anna Creti (2011), carry out her research with the carbon emissions future price of European carbon market, she think that there is a long-term equilibrium relationship between carbon trading price and the price of oil futures, prices of natural gas and coal conversion price etc[2].; Jun-li Wang (2012) found that there exists a long-term equilibrium relationship and spillover effect between the international crude oil prices and the spot price of carbon, she think the international crude oil price is one of the factors that affect the carbon stock price change.[3]

Third, from the supply and demand, the supply and demand of carbon emissions trading depends on the emission target the real economy assigned and its ability to reduce emissions.

At present, the Europe's carbon emissions trading system (EU ETS) is the most active one on the market. EU ETS make its system allocation of carbon emissions from all over the world through a cap-and-trade plan, and the national scheme (NAP) each country declared must include the country's total carbon emissions and the allocation of each discharge entity, when the expected allocations of usage does not match the real emission, the carbon market supply and demand is produced, and it is due to this mismatch, will ultimately affect the market price of carbon emissions.

[2] Anna Creti, Pierre-André Jouvet, Valérie Mignon, Carbon price drivers: Phase I versus Phase II equilibrium? [J]. Energy Economics, 2012(34): 327–334

[3] Jun-li Wang, The spillover effects of international oil price volatility on the carbon market research [J]. Economic Research Guide, 2012(5):70-72

B. Empirical Analysis

Based on theoretical analysis and data availability, the empirical research will focus on the tests for the cause analysis, which is, through the VAR model established between the price of the CER, EUA and the energy prices, through the Granger causality test, analyze their long-term correlation. Furthermore, we will analyze the change on the price of carbon emissions products corresponding to energy fluctuations in the price through the impulse response analysis.

1) Sample selection and data sources

Due to the influence of the global financial crisis in 2008, the global carbon market prices and other financial markets experienced dramatic fluctuations, although after a period of recovery and adjustment, the situation has improved, but the current available data is still very limited.

According to the actual situation, this paper selects the CER and EUA futures price under ECX European carbon emissions trading system (EU ETS), Rotterdam coal futures price under IPE, British gas futures daily trading price under ICE, Brent crude oil futures price under NYMEX and the MSCI Ming sheng EU power utilities futures price as the research samples, time range from November 29, 2010 to October 31, 2013, each has 718 observations, all data from the Wind and Bloomberg.

2) Sample description

By making preliminary statistics of all the samples through Eviews, all sample observation value are shown in the table below

Table I THE BASIC STATISTIC SAMPLE SEQUENCE

Sample	EUA	CER	Gas	Oil	Coal	Elec
Mean	9.46	5.18	6.57	89.27	100.38	83.05
Median	8.09	4.08	6.55	88.02	93.92	79.68
Maximum	19.53	14.43	8.48	114.02	133.2	111.88
Minimum	2.75	0.24	5.01	62.59	73.7	58.14
Std. Dev.	4.79	4.72	0.93	11.70	17.45	12.54
Skewness	0.69	0.60	0.09	0.11	0.28	0.80
Kurtosis	2.25	1.93	1.52	2.57	1.60	2.69
Observations	718	718	718	718	718	718

We can see that the coal, oil and electricity prices fluctuate more wildly than other variables. Of all the data, the coal price fluctuate the most, the natural gas price fluctuate the least. Compare the sample sequence of kurtosis and skewness, we can find all the variables are all right, and the form of the CER and EUA are more similar.

3) The empirical process

From the point of sample price level, since the end of 2010, coal, oil and power prices are high relative to the price of carbon products and natural gas prices, and the carbon products and natural gas price is in a quite low trends from the sample. In addition, there only some correlation between carbon products, the rest of the sample has not obvious correlation.

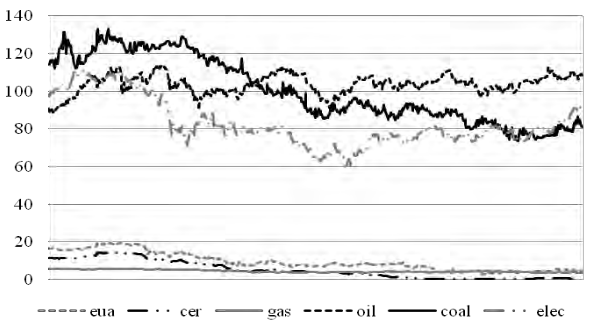

Figure 2. The sample price movements

In order to establish the VAR model, we need to implement stationary test to the sample series, due to there are no sharp fluctuations in the sample, we directly use the original sample data for processing. Through AIC criterion and SIC codes on the ADF unit root test, we found that the sample data are all first-order single, after first order difference, each sequence is smooth.

Table II ADF STATIONARY TEST RESULTS

Series	ADF T-statistic	Prob.*	1% level	5% level	10% level
EUA	-1.2392	0.6590	-3.4392	-2.8653	-2.5688
CER	-0.9066	0.7863	-3.4392	-2.8653	-2.5688
Gas	-1.1887	0.6811	-3.4392	-2.8653	-2.5688
Oil	-1.5171	0.5246	-3.4392	-2.8653	-2.5688
Coal	-0.7141	0.8409	-3.4392	-2.8653	-2.5688
Elec	-1.5796	0.4925	-3.4392	-2.8653	-2.5688
dEUA	-25.5524	0.0000	-3.4392	-2.8653	-2.5688
dCER	-14.3620	0.0000	-3.4392	-2.8653	-2.5688
dGas	-16.4021	0.0000	-3.4392	-2.8653	-2.5688
dOil	-27.2507	0.0000	-3.4392	-2.8653	-2.5688
dCoal	-19.2105	0.0000	-3.4392	-2.8653	-2.5688
dElec	-24.8198	0.0000	-3.4392	-2.8653	-2.5688

In order to further determine whether there is a long-term co-integration relationship between variables, using EG two-step, we build dCER and dEUA OLS model respectively. After doing the residual stationary test, we get the following co-integration equation:

$$dCER = -0.01+0.22dGas+0.01dOil+0.02dCoal+0.02dElec \quad (1)$$

$$dEUA = -0.02+0.18dGas+0.01dOil+0.02dCoal+0.04dElec \quad (2)$$

Test shows that the residual errors of the two OLS model are stable. Therefore, through the co-integration test, we can basically determine that there is a long-term co-integration between the dCER and dEUA respectively with dGas,dOil, dCoal and dElec, and we can establish the VAR model in the next.

Before the VAR model is established, in order to further determine the model lag order, exogenous variables and endogenous variables choice, we do the granger causality test first. The results show that the stability of the smallest lag order is fourth order, and found in many experiments, the electric power data to the CER and EUA in arbitrary order don't constitute the Granger reason, and so we consider the power data as exogenous variables into the model.

First establish the two VAR models. In the AR Roots inspection for the two models, we found its Roots are located inside the unit circle which means the model is stable respectively. And then the Granger causality test shows that dGas and dOil is the Granger reason of dCER and dOil and dCoal is the Granger reason of dEUA.

Table III GRANGER CAUSALITY TEST RESULTS

Excluded	Dependent variable: DCER			Dependent variable: DEUA		
	Chi-sq	df	Prob.	Chi-sq	df	Prob.
DGAS	13.167	4	0.0105	8.339	4	0.0799
DOIL	11.049	4	0.026	9.744	4	0.045
DCOAL	7.431	4	0.1148	10.084	4	0.039
All	34.330	12	0.0006	30.537	12	0.0023

Next, we do the VAR model impulse response analysis; further study the carbon emissions price change range with the shock reaction from different variables.

For dCER, when get the impact of dGas, it did not respond immediately in the first phase. There is a positive reaction in the second phase, and then a negative reaction in the third period. The negative reaction degree is more intense, after then, the price began to become steady slowly and be totally stable after the fifth period.

When get the impact of dOil, the reaction is almost the same as the one from natural gas, the difference is that the degree of the second phase of the positive reaction is greater than the third phase of the degree of negative reaction, and the price began to become steady in the fourth period.

When get the impact of dCoal, in the first period there was no immediate reaction, the second and third period have negative reaction, and the degree are almost close to 10, is very sensitive and overall start to become steady after the fifth period.

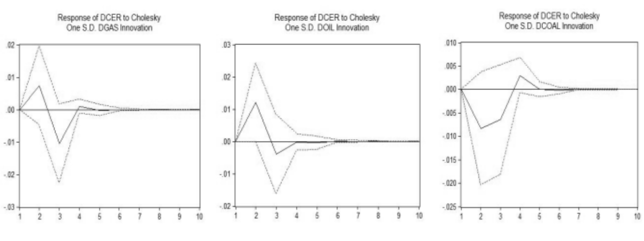

Figure 3. The impulse response analysis results of CER

For dEUA, the situation is more complex, when get the impact of dGas, it can produce a w-type shocks response starting from the second phase, among which get the most high positive point at the fourth phase and the most low negative point at the fifth phase. The whole change will become stable gradually from the sixth phase and be smooth at the tenth phase.

When get the impact of dOil, it will produce a light positive reaction at the second phase, and then from the third phase to the fifth phase, there is a continued downward negative response. It will begin to stable slowly from the sixth period and eventually get stable in the tenth phase.

When get the impact of dCoal, there is a continued negative reaction in the first five periods, the price will rebound from the lowest point in second phase and be positive at the sixth phase.

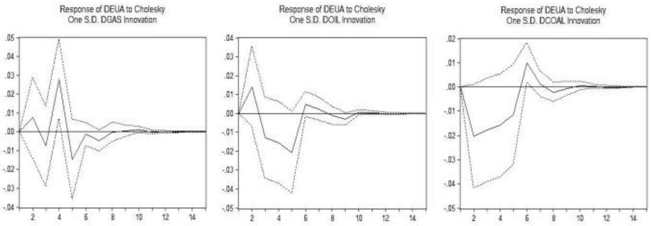

Figure 4. The impulse response analysis results of EUA

4) *Empirical findings*

Evidence shows that, there exists a long-term relationship between energy prices with CER futures and EUA futures respectively. And their futures prices have long-term co-integration and causal relationship at some degree.

Among them, natural gas and crude oil futures price is the granger reason of CER futures price, crude oil and coal futures price is the granger reason of EUA futures prices. And, when give a price shock of energy to CER futures or EUA futures, they will make corresponding responses. EUA futures price reaction is more complicated, but are controlled within the range of plus or minus 3 degree. But CER futures will get nearly 10 degree reaction in the face of the shock from coal futures price, and is more sensitive.

III. CONCLUSIONS

Combining with theoretical analysis and empirical analysis, we find the price of carbon emission products will surely be influenced by many factors. From a macro point of view, the government attitude, the degree of urban population scale, the industrial development and the financial development scale, etc., will directly or indirectly, causes the change of the price of carbon emissions products. From the angle of genesis analysis, the price of carbon emissions products will fluctuate with the impact of energy price fluctuations. From the supply and demand, the mandatory emissions share under different trading system and the effort the entities make will alter the carbon emissions and lead to fluctuations in the price.

The empirical research verifies the theoretical analysis on a certain extent, and further study the driver ability of energy prices. Power level is exogenous cause of carbon emissions trading price fluctuations, and has certain corresponding relationship with it. But the causal relationship shows that the energy variable such as coal, oil and natural gas have more clear relationship with the price volatility of carbon emissions products. As we expected, the consumption of natural gas and oil will cause much carbon emissions and finally increase the market demand of carbon emissions products. In the process of empirical, when faced with a positive impact of natural gas and crude oil, the CER and EUA prices are showing up a positive price fluctuations. But the response to the coal price attack is out of our expectation. When faced with a positive impact of coil, the CER and EUA prices all fall primarily, which needs more follow up study in the further study.

At present, the global game under the low carbon economy has been escalating. In the process of growing prosperity of international carbon emission market, China also plays an important role. Although, as a developing country, China is not on the mandatory list, China is still the world's second largest economy, and its carbon emissions is in the forefront of the world. Since 2005, China has become world's biggest seller of CDM in the primary market and has successively set up carbon emissions exchange to carry out trading activities in several big cities. However, in spite of this, China have no pricing power in the global carbon trading market, the price of CERs sold in China is obviously lower than in other countries, the exchange volume is also not very big, which makes it difficult for China to obtain the initiative position in the emerging financial market, greatly hindered the development of carbon finance in China. China should build a trading system and forming a pricing standard on the comparative study on international carbon emissions market as soon as possible to pursue the further development in our country.

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