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Is Eu-ets Future Carbon Price Mean-reversion?

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Abstract: Being one of the market-oriented methods, carbon emission trading has counted for much an economic approach of global climate change which has frequently discussed in recent years. Essentially, it is meaningful of dealing with climate change from the economic and by the economic. Study the mean-reversion character of Europe-Emissions Trading Scheme (EU-ETS) Future Carbon Price is the most important channel of knowing the affection on the actions of the global climate change and guiding the forthcoming path. The research found the price of futures contracts passes through the unit root test and autocorrelation test but the variance ratio test showed that it is mean-reversion. The conclusion is the return of future carbon price is existing autocorrelation and revise but the long time running of the market is mean-aversion, that means market-inefficiency.

Key words: Carbon emission trading, future carbon price, mean reversion

INTRODUCTION

In the past century, the global climate is undergoing the significant changes of global warming as the main feature. As a threat to the survival of human and sustainable socio-economic development seriously, it triggered a series of extreme weather and climate events. More and more people are aware of the issue of climate change and the calls for the international community on the issue of climate change are increasing. People have been seeking a good policy to solve the problem. The main ways to mitigate the climate warming is to reduce the carbon emissions and develop the economy of low-carbon. To achieve a low-carbon economy, people must play the carbon market pricing and the price should fully reflects the scarcity of carbon emissions. The issue of Carbon emissions pricing is the key point to formation and development of carbon market. Only when the carbon price, to some extent, return to the central of price and stabilize gradually, the carbon market can become a mature financial market.

Gui-Yang (2007) consider that as a property right, not only the carbon emission rights was a tool to improve the environmental objectives but also being an institutional arrangement. Juan and Jing (2009) explored the impact of China's carbon trading market price factors from aspects of the international demand and domestic supply, domestic policy limit and the international market. The Fu-Chun and Xi-Quan (2011) took the second phase of the Europe-Emissions Trading Scheme (EU ETS) carbon futures prices on account of method of Alberola and

studied the problem of carbon futures price structure mutations. They found that the price of the carbon futures contracts of European Union Allowances (EUAs) and Certified Emission Reduction (CERs) have been occurred the structure mutations and was showing a non-current characteristic as the first phase. Chevallier (2010) believes that with the linear framework the prices can have a behavioral characteristics in carbon market which began to diverge against Alberola's studies.

About the Carbon emissions pricing model, Juan and Jing (2010) found that there was a long-run equilibrium relationship between futures prices and spot prices of EUAs and CERs. The EUA futures had the function of discovering the price but the CER was not found the function not yet. Zhang and Wei (2011) introduced the theory of mean reversion, GED-GARCH model and VaR method to examine the operating characteristics of the EU ETS carbon futures market. They found that the EU ETS carbon prices had divergent characteristics and appeared the phenomenon of the mean evaded. Tian-Fei *et al.* (2008) believe that in order to do a good job to establish China's carbon emissions trading market feasibility study work as soon as possible, the country must strengthen the international research of carbon emissions. In this study, the theory and method of mean reversion was used to study the law of the carbon trading market price. The EU ETS carbon futures contract price logarithm of income has passed through the carbon unit root test and autocorrelation test which would be eligible for a reversion to the mean. However, the variance ratio test found that carbon futures prices showed a mean sidestep.

MATERIALS AND METHODS

January 23, 2008, New York-Euronext (NYSE Euronext) completed the merger and planned to set up the futures market of the second quarter of 2008 and ultimately involved in a variety of financial derivatives transactions of environment-related (Bu, 2010). As The European Union Emissions Trading Scheme (EU ETS) is a major market of carbon trading, the trading volume and transaction volume have both occupied the most part of the whole international market. According to the calculation of World Bank in 2009, the trading volume and transaction volume of EU ETS were accounted for 94.41% and 98.98% of the international carbon market. For the Powernext, Nord Pool and the European Climate Exchange (ECX) are the most influential Exchange in EU ETS. The Climate Exchange is the largest EU carbon futures market even the world's largest carbon futures market. So this study take the ECX EU ETS carbon futures market trading contracts as a study.

Then take the contract price of DEC 08~DEC14 in ECX as the sample data of contract price in EU ETS. The contract price of DEC 08~DEC11 belongs the contract delivered and the others are the undelivered. The starting point of the time zone is the starting time of contracts trading beginning in the EU ETS which the earliest is August 14, 2006. The end point of delivery contracts is the delivered time they respect and the end of the contract undelivered point is December 7, 2011. As the Fig. 1, the price trends of various carbon futures contract are consistent.

Affected by the events of verification of emissions data released for 2005, the carbon futures prices got the structural breakpoints time series in the April 20, 2006. In

October 2006, European Commission declared that the quota allocation restrictions in the period 2008-2012 should be more stringent, so the EU ETS prices rise significantly and another structural breakpoint has been bring about in the June 22, 2006. In this study, the analysis of the laws governing the operation of carbon futures prices avoids the differences of carbon futures contract price trend in the different stages, so the data of the study is only after June 22, 2006.

To avoid data redundancy, the following inspection and study select the DEC10 data as a further study, i.e., 782 data of daily closing price delivery on November 27, 2007 to December 27, 2010.

RESULTS OF EU ETS CARBON FUTURES PRICES MEAN REVERSION

The stationary test of sample sequence-including the unit root test and autocorrelation test: In general, the stationary time series are to meet the following three conditions:

- For any time t , the mean $E(X_t) = \mu$
- And its variance $var(X_t) = E[(X_t - \mu)^2] = \sigma_x^2$
- The covariance between any two dates $cov [X_t, X_{t+k}] = E[(X_t - \mu)(X_{t+k} - \mu)] = \gamma(k)$

Set the logarithm of income of the contract price for DEC 10 is:

$$y_t = \log (S_t) - \log (S_{t-1})$$

And the price sequence of DEC10 is the daily closing price of the contract of November 27, 2007 to

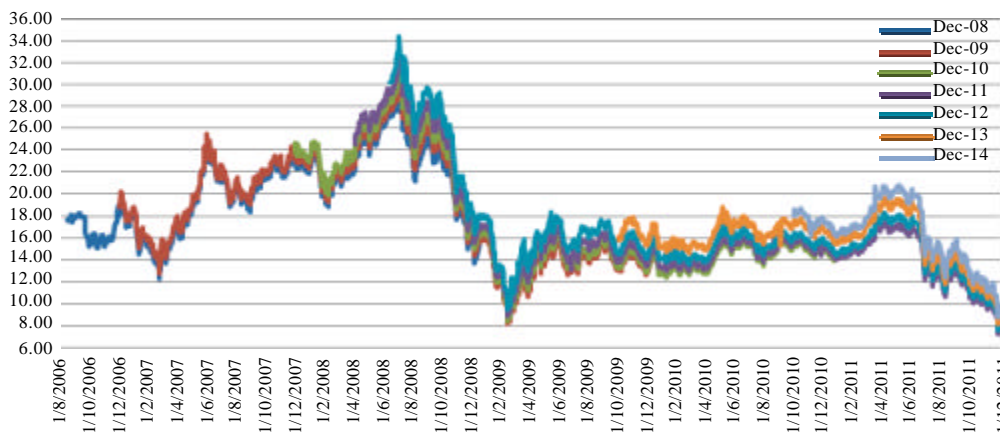


Fig. 1: Trading price movements of ECX EUA Futures DEC 08-DEC 14 in contracts day. (The parameters of the y-axis stand for the trading price in contracts day). The information comes from <http://www.ecx.eu>. The Price Unit: EUR per Ton of CO₂

Table 1: Statistics of logarithmic income price of DEC 10

Sequence	DEC10 (2007-11-27~2010-12-20)
No. of samples	782.000000
Average value	-0.000311
Middle number	-0.000270
Maximum	0.049311
Minimum	-0.040395
Standard deviation	0.010484
Skewness	-0.073997
Kurtosis	5.432197

Table 2: ADF test on logarithmic income price of DEC 10

Test	t-statistic	Prob.*
Augmented Dickey-fuller test statistic	-27.159670	0.0000
Test critical values		
1% level	-3.438309	
5% level	-2.864943	
10% level	-2.568637	

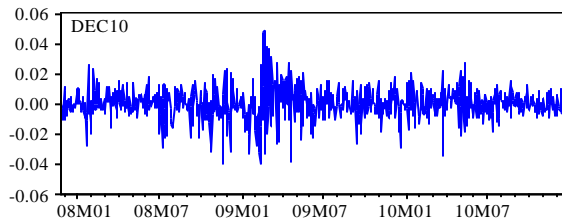


Fig. 2: Logarithmic of income price in DEC 10

December 20, 2010. Table 1 describes the data sample, whose skewness is -0.073997 and kurtosis is 5.432197 and it shows a phenomenon of Left-skewed. The samples are non-symmetry distribution and the Fig. 2 shows the logarithmic income price trends with Eviews6.0. The trend shows that the fluctuations of logarithmic income price of DEC 10 a small number of volatility which only is for -0.1 to 0.1.

The Table 2 is the result of Augmented Dickey-Fuller (ADF) test on logarithmic income price of DEC 10 of the samples and the absolute value of the t-statistics are greater than the 1, 5 and 10% level of the critical value. That is to say the results are notable in level of 1, 5 and 10%, so the sequence is stationary.

Figure 3 is the autocorrelogram of the first-order differential about the logarithmic income price of DEC 10 with Eviews6.0. Then can see that the autocorrelation coefficients and partial autocorrelation coefficient of sample data are first-order significant and not equal to 0. The coefficient from second-order to ninth-order of partial autocorrelation coefficient are not equal to 0 either. Other parts are close to zero which shows that there is a high degree of self-correlation of the DEC10 contract price. In other words, the carbon futures prices have significantly inertia and the past prices will impact on the future price.

Table 3: Variance ratio test results of futures prices logarithmic earnings of DEC10

q	N	VR	p> z
2	784	1.040	0.2603
4	784	1.021	0.7589
8	784	1.094	0.3744
16	784	1.163	0.3006

There is a significant negative autocorrelation in the difference of first-order sequence of the DEC 10 price. So the time series would appear a mean reversion trend and then can have a further study about it.

Variance ratio test: In this study, the DEC10 price selected logarithmic return series for variance ratio testing and choose the sampling interval q as 2, 4, 8 and 16. Running through the software of stata12, the results of VR(q) are shown in Table 3. Whether it is a short-term or long-term, VR(q) is greater than 1. There is the positive autocorrelation in short-term returns and the fluctuations of Short-term price are normal but Long-term showed a phenomenon of mean sidestep. For the Robustness of the test results, then calculate the data cover for each time interval. The results show that Carbon futures market prices and yields are disobedient from the mean reversion process and the data frequency does not affect the mean regression results so much. Generally speaking, the longer the period become, the performance of reversion to the mean characteristics is more obvious. There is a sample size of 800 for sample sequences of DEC 10 and the time is from November 27, 2007 to December 20, 2010 but the mean reversion still does not appear. Though the carbon futures prices on the number sequence are through by a stationary test, trend of carbon futures market continue to show a mean sidestep.

Empirical results analysis

EU ETS futures yields show a asymmetric feature: Through researching the DEC10 contract in Table 1, the parameter of the contract price logarithmic return series skewness is -0.073997. The number is less than zero which shows EU ETS futures yield having the asymmetric market characteristics.

EU ETS futures prices show a mean sidestep: With the ADF unit root test of logarithmic return series of futures contracts of DEC 10 in Table 2, the series is stationary when the test results are significantly in the degree of freedom of 1, 5 and 10% level. Then the autocorrelation test of the logarithmic gain of the first-order differential on DEC 10 shows that there is a high degree of self-correlation of the DEC10 contract price. The Carbon futures prices have the significantly inertia, so the past

¹The parameters of the y-axis stand for the logarithmic income price in contracts day

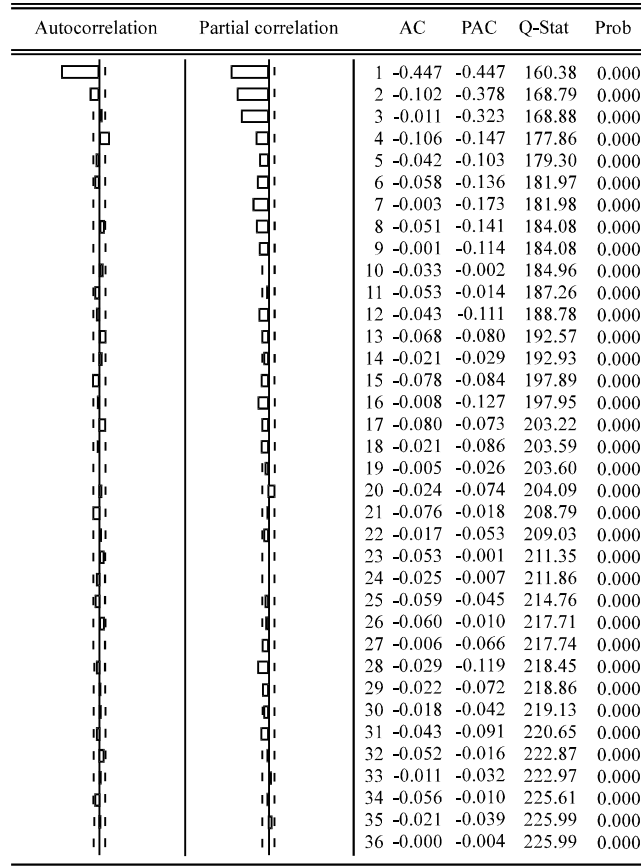


Fig. 3: Figure of autocorrelation of the first-order differential about the logarithmic price of DEC 10

prices will impact on the future price. For there is a significant negative autocorrelation in the difference of first-order sequence on the price of DEC 10, the time series may show a mean reversion trend. Through further variance ratio test, the $VR(q)$ is more than 1 when picking the sampling interval q as 2, 4, 8, 16. The result shows that the Carbon futures market prices and yields are disobedient from the mean reversion process and the data frequency does not affect the mean regression results seriously. That is to say that EU ETS futures prices are showing as a mean sidestep.

Though the international carbon market has been running for more than five years and accumulated some experience in these years, there is a certain distance of a sound and effective financial markets. When the macro-control of the government to participate in the carbon market is more reasonable and the carbon emissions quota allocation system optimization promote the carbon trading prices gradually rising. So the carbon trading short-term equilibrium price will gradually in line with the long-term equilibrium price.

The impact and the damage of extreme weather and climate becomes to the main content of the cooperation of

the international community. Especially to help the countries and regions seriously affected by climate change. So the organizations and enterprises of the international community has very high expectations on the carbon market. When the results of the negotiations become more stable and the carbon prices gradually rises, the carbon prices will tend to mean reversion.

The international carbon trading market is a complex system and the demand for carbon trading volume affect the change of carbon trading price. Only when the carbon trading mechanism is more perfect, set up the legal mechanisms, verification mechanisms and the main part of administrative supervision from the basic conditions and curb the occurrence of short-term speculative behavior, the carbon trading market can become a mature financial market.

CONCLUSION

This study studies whether the carbon price presents the mean reversion phenomenon with carbon emissions futures price data of the EU carbon emissions trading

system. With the methods of the unit root test, autocorrelation test and variance ratio test, the analyze the data of DEC10. The result shows that the Carbon futures prices logarithmic return series belongs to a smooth sequence and the results in a significant in ADF test. The first-order differential sequence of contracts logarithmic gain has got a high degree of negative autocorrelation. So the time series will appear a mean reversion trend, not only the Carbon futures prices have the significantly inertia but the past prices may influence the future price. But with the further variance ratio test, $VR(q)$ is more than 1 when picking the sampling interval q as 2, 4, 8, 16, So it means that EU ETS futures prices are showing as a mean sidestep. So Carbon trading is still the most effective low-carbon tool to mitigate climate change in present of China.

On one hand, the country takes part in the carbon trading of the international market. On the other hand, the country is trying to build a domestic carbon trading market. So to sum up the experience of the international market is important for launching an effective carbon market. From a financial point of view, the appearing of mean reversion of market prices is inevitable. But the regression cycle needs to be verified, so at this present the international market have not yet seen the phenomenon of mean reversion. That shows the carbon market is still not completely sound financial markets. Mean evasive phenomenon of the international carbon market provides the inspiration for China's carbon market development. For one thing the science macro-control of the government is the key to establish reasonable carbon emission reduction targets. Through effective communication of the government, construct the framework of the development of the country's carbon market. Thus promote the benign development of the carbon market. For the other thing, the establishment of the domestic service industry is necessary. Lots of money is obtained through the Clean Development Mechanism in China but there is a greater risk in CDM projects. And the country is lack of the right of carbon pricing which is very detrimental to the development of China's carbon

market. Through the establishment of the related service sectors and provide project consulting and information services, there will be more and more organizations to participate in the market.

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