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An empirical study on the relationship between corn futures prices of China and the United States

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Abstract. The futures prices of Chinese agricultural products are generally followed by the Chicago commodity exchange futures prices. The main reason for this study is to test the relationship between corn futures prices in China and the United States. The Johansen Co-integration test and VECM are employed in this paper. The results indicated that corn futures prices in America had a significant effect on prices of China. There is a long-term relationship of association between the two variables. By comparison, the information in the corn market of America transfers faster and the U.S. corn futures market plays a leading role. This research also put forward some suggestions about how to promote the development of China's corn futures market.

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INTRODUCTION

The United States is the world's largest producer and exporter of corn, and corn prices have an important influence in the international corn market. American corn futures are listed early in Chicago commodity futures exchange, develops quickly, and establish the leading position of agricultural futures. China's corn futures are listed in Dalian commodity exchange on September 22, 2004, which is far behind corn futures in the United States. But in recent years, with the development of agriculture and the improvement of the futures market, the trading volume in China has made great progress by leaps and bounds. China's corn futures trading volume accounted for 0.38% of the country in January to July 2015, which was in the forefront of agricultural futures.

A total of 11 exchanges for 8 countries in the world have corn futures contracts and related derivatives, of which corn futures in America have the biggest influence. In 2009, China's corn futures market turnover was only 16744000 hands, fell by 72.1%, and accounted for only 1.6% and 4% in the national and Dalian commodity exchange transactions, respectively. The number was 3% of corn futures transactions in Chicago mercantile exchange for the same period. Corn holdings continued to decline and fell to the bottom in 2009, only 1% of the CBOT corn position.

Because of the high proportion of corn production and consumption in China, the number and price of corn imports and exports in China have a significant impact on the world corn market. A great number

of Chinese scholars study the relationship between the corn prices in the United States and China. The relationship between the price of corn futures in China and the United States needs to be fully explored. It is important to study the specific interaction between the two variables via the empirical analysis, which will guide the healthy development of China's corn futures market. The Johansen Co-integration test and VECM are employed in this paper to test the relationship between variables. Additionally, Granger causality test, impulse response analysis, and variance decomposition are also introduced in this paper to further study the corn futures prices.

The paper is structured as follows: Section 1 shows the literature review. Section 2 describes the data collection and sources. Section 3 includes methodologies and empirical analysis. The results of empirical analysis are presented in Section 4. Finally, section 5 discusses the conclusions and recommendations.

LITERATURE REVIEW

In the early years of the study, the futures market is basically the insurance market as a commodity price fluctuation. Early futures research theory is mainly about the futures trading, futures contracts, hedging, speculators and the description of the transaction process. The representative figures are H.C. Emery, C.O. Hardy, J.G. Smith, G.Wright. Hoffman, and so on. Economists have made great contributions to the economic thought, analysis method, and the function and status of the futures market, such as Keyens, Hicks, Kardor, and so on.

The traditional theory for the futures market and the spot market research method mainly uses two kinds of methods: simultaneous equations of traditional econometrics and ARMA. Granger in 1982 proposed the concept of co integration, cointegration theory and error correction model based on VAR, which has become an effective model to study the long-term equilibrium and short-term interaction. Wang and Ke (2002) use the Johansen maximum likelihood estimation method for the analysis of China's soybean and wheat futures contracts. Wang Hongwei (2005) used the error correction model to study the relationship between the futures and the spot price of the stock, and found that there existed a guide relationship from the spot copper to futures copper prices. Gao Hui (2006) uses the co integration model, Granger causality test, ECM model, and GARCH model family to make an empirical analysis of futures prices and volatility in Shanghai and London.

Fang (2007) conducted an empirical study on the price discovery function of the Chinese corn futures market (DCE), and compared with the U.S. corn futures market (CBOT). Domestic spot market information is not transparent enough, the stock market information is not enough to obtain a timely and rational decision-making, which is the reason why there is a gap between China and the United States on the corn futures market. Liu Xiaoyu (2009) found that there is a long-term equilibrium relationship between the futures prices of the two markets, and the Chicago futures market plays a leading role in the influence and pricing power. In the world corn futures market, the Chicago stock exchange's influence and authority are relatively larger than the Dalian Mercantile Exchange.

Chen Jibing (2012) studied the micro structure of China's corn futures market and the information spillover effects of China's corn futures market, specifically including information spillover effect of the Chinese corn futures market and American corn futures market. Zhang Zhen (2013) made an empirical test of the relationship between the price of corn futures in China and the United States, and found that there is a two-way relationship between the two variables. Chicago corn futures prices play a guide role significantly. Huang Jianxin (2014) empirically analyzes the relationship between China's corn futures market and the spot market price, and compares with the American corn market. The results show that there is a long-term

equilibrium relationship between the futures market and the spot market, which is consistent with the United States corn market.

Through domestic and foreign research, the measurement method of the futures market is in the reference state. Foreign scholars have carried on the research to the futures market, but few studies on the Chinese futures market, and the research on the futures of agricultural products is less. In China, the research on the futures market of agricultural products is very much, but it is very little compared with the foreign market.

DATA COLLECTION AND PROCESSING

In this paper, we choose the daily trading close price of corn futures contract as the research object, and collect the data over the same period(January 1, 2012 to June 10, 2015), from Dalian commodity exchange and Chicago commodity futures exchange.

Since the date of the exchange transaction is not completely synchronized, in order to fully reflect the relationship between corn futures prices of China and the U.S., after screening, 917 pairs of data are obtained. Taking into account the differences between the corn futures prices' units of two countries, the units of corn futures prices of United States can be converted into dollars per ton. Then according to the exchange rate of the RMB and the dollar on the trading day, the dollar can be converted into yuan. FC represents the Chinese corn futures price, while FA represents the United States corn futures price.

After unifying the units of corn futures prices of two countries, in order to reduce the volatility of price time series, the natural logarithm of futures price series is taken. And two variables are named as LFC and LFA respectively.

Sect.3 will use Eviews 8.0 software to conduct the empirical analysis and estimate the relationship between LFC and LFA.

EMPIRICAL ANALYSIS

In this part, cointegration test will be used to study whether two variables have some relations in the long run. If the results indicate that there is a long-term association among variables, vector error correction model will be chosen to test the short-term relationship.

First, it is important to test the stability of the two sequences(LFA and LFC). If one sequence can pass through the unit root test, it indicates that the time series is stationary. In this part, ADF test is chosen to study the variables. The results are shown in Table 1.

Table 1

The ADF Test

Variables	t-Statistic	test critical values			Test results
		10%	5%	1%	
LFA	-0.853516	-2.568390	-2.864483	-3.437267	Not stationary
LFC	-2.377892	-2.568390	-2.864483	-3.437267	Not stationary
D(LFA)	-30.22598	-2.568392	-2.864486	-3.437275	Stationary
D(LFC)	-33.00414	-2.568392	-2.864486	-3.437275	Stationary

Source: own calculation.

From Table 1, it can be shown that the t-Statistics of LFA and LFC are more than critical values, while the t-Statistics of D(LFA) and D(LFC) are less than critical values. That is to say, LFC and LFA are both not stationary in the 1%,5% and 10% of the significance level. However, D(LFC) and D(LFA) are both stationary. LFC and LFA are both stationary in the 1%,5% and 10% of the significance level at their first difference. LFA and LFC are I(1). Based on the results of the unit root test, we can use Johansen Co-integration test to study further relations between variables. The test results are shown in Table 2.

Table 2

The Co-integration test

Hypothesized No. Of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.
None*	0.015048	16.17118	15.49471	0.0395
At most 1	0.002566	2.343058	3.841466	0.1258

Source: own calculation.

From the results of the Johansen Co-integration test, it can be seen that the test rejects the null hypothesis that there is not a Co-integration relationship between two variables under the given confidence level 95%. The test accepts the null hypothesis that there is at most a Co-integration relationship between two variables. So two variables have some relations in the long run.

LFC is chosen as the explained variable, the regression equation is as follows:

$$LFC = 7.8337 - 0.0074 * LFA + \mu$$

It can be seen from the equation that if LFA increases by 1, LFC will reduces by 0.0074. That is to say, there is a negative long-term relationship between variables. To further verify the cointegration relationship between the variables, it is necessary to test the stability of the residual. The ADF is used to test whether the residuals of the equation have a unit root, and the test results are as shown in the Table 3.

Table 3

Unit root test of residuals

Variables	t-Statistic	test critical values			Test results
		10%	5%	1%	
μ	-3.469051	-2.568390	-2.864483	-3.437267	Stationary

Source: own calculation

It can be shown that the t-Statistic of μ is less than critical values. The residual is stationary in the 1%,5% and 10% of the significance level. It can be safely concluded that there is a long-term relationship between the two variables.

To establish the VECM, we can use the Eviews software to determine the best lag period. We can choose the lag period from the Table 4.

Table 4

The lag length criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	1982.331	NA	4.39e-05	-4.357164	-4.346576	-4.353121
1	5942.970	7895.135*	7.28e-09*	-13.0626*	-13.0309*	-13.0505*
2	5946.391	6.804960	7.29e-09	-13.06137	-13.00843	-13.04115
3	5949.356	5.882774	7.30e-09	-13.05909	-12.98497	-13.03079

Source: own calculation.

The smaller the value is, the better the lag period is. From the Table 4, it can be seen that AIC and SC of Lag 1 are the least. So the best lag period is 1. Since the cointegration relationship has been verified and the lag period has been determined, VECM can be established.

VECM is proposed based on the cointegration relationship. The cointegration relationship represents long-term relations, while VECM test results represent short-term relations. VECM combines the ideas of cointegration and the error correction. Its basic form was proposed by Davison, Srba, Hendry and Yeo in 1978. So the model is often called as the DHSY model. VECM model considers that there may be a long-term stable equilibrium relationship between economic variables, but in the short term this stable equilibrium relationship is likely to be broken.

The VECM results can be shown as follows.

$$D(LFC)=-0.0217*(LFC(-1)+0.0074*LFA(-1)-7.8337)-0.0785*D(LFC(-1))+0.0022*D(LFA(-1)) + 0.000478$$

$$D(LFA)=-0.0583*(LFC(-1)+0.0074*LFA(-1)-7.8337)-0.1874*D(LFC(-1))+0.0065*D(LFA(-1)) - 0.000675$$

The error correction coefficient of Chinese corn futures price is -0.0217. This means a short run relationship between variables. If the futures price of the last period is lower than the equilibrium price level, that is, ECM value is less than zero, it will have a positive impact on the current price of corn futures, so as to make the current price of China's corn futures rise to a new equilibrium state. If the futures price of the last period is higher than the equilibrium price level, that is, ECM value is more than zero, it will have a negative effect on the current price of corn futures, so that the current price of China's corn futures falls to a new equilibrium state, playing a role in the error correction, which will lead to a long term equilibrium price level in the market. Because the error correction coefficient of American corn futures price is -0.0583, also less than zero, the above analysis also applies to the corn futures prices in America.

In order to further examine whether there is a causal relationship between corn futures prices of China and the United States, this study is based on the Granger causality test, impulse response analysis and variance decomposition. The following is to carry out Granger causality test for two variables. The result is shown as Table 5.

Table 5

Granger causality test

Null Hypothesis	F-Statistic	Prob.
D(LFC) does not Granger Cause D(LFA)	0.36331	0.6849
D(LFA) does not Granger Cause D(LFC)	4.97923	0.0087

Source: own calculation.

At 5% level of significance, the null hypothesis "LFA does not Granger Cause LFC" is rejected, while the null hypothesis "LFC does not Granger Cause LFA" is accepted. U.S. corn futures prices are the Granger causality for the price of corn futures in China. It indicates that the corn futures price of the US has single leading relations to the corn futures price in china.

Impulse response analysis is used to examine the impact response of one variable to other variables in the model, in order to understand the impact of market information on the current and future values of endogenous variables. It is known that variables must be the stable sequences to carry out impulse response analysis and variance decomposition. Because LFC and LFA are both not stable in the 1%,5% and 10% of the significance level and are I(1), DLFA and DLFC are introduced to represent LFA and LFC's first difference. Impulse response analysis for each variable of the former 10 periods and the result are shown as Fig.1.

It can be seen from the impulse response that for two sequences, the response to their own standard deviation is bigger than to other markets' standard deviation. When corn futures prices in America are subject to a standard deviation from their own, they drop quickly, and become relatively stable after the third period. When corn futures prices of America is impacted by a standard unit of China, the variable of DLFA drops by 0.001048 after the first period, and increase to the stable level at the third period. When corn futures prices of China is impacted by a standard unit of America, DLFC drops to the normal level at the second level. When corn futures prices in China are subject to a standard deviation from their own, DLFC drops quickly at fist, and then increases to the stable level at the third period. The impact of China's futures prices on U.S. futures prices last relatively longer.

The results of variance decomposition are consistent with previous test results, which can clearly explain the influence from America on corn futures prices of China. Specific results are as follows in Table 6, Table 7.

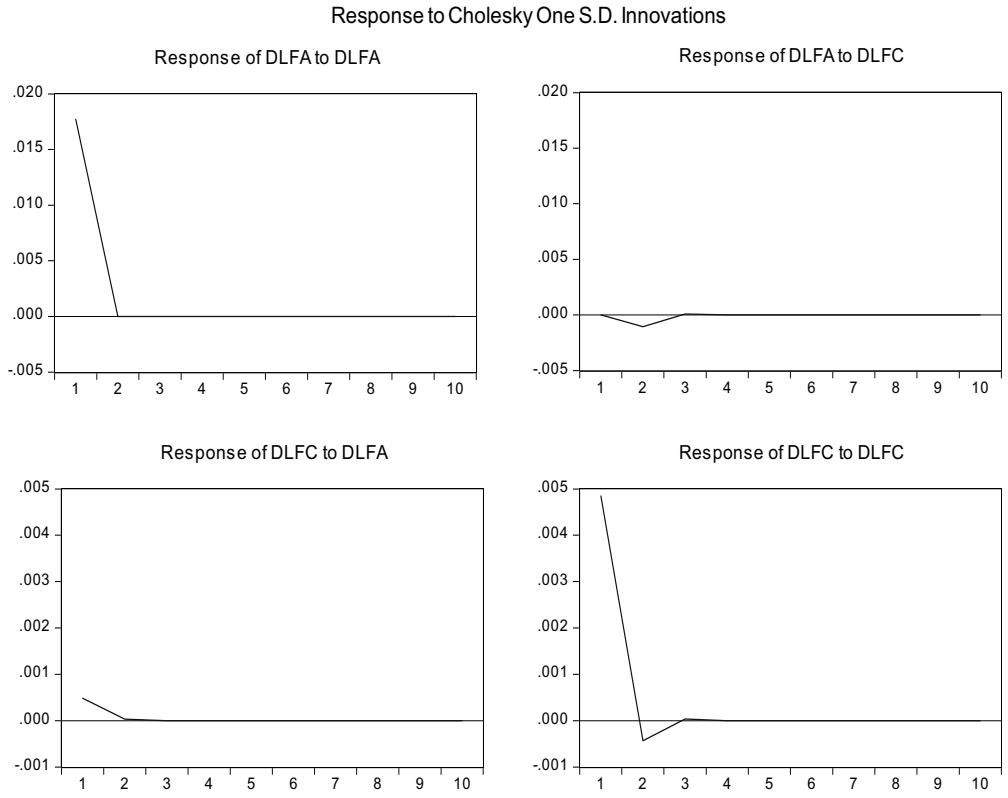

Figure 1. Impulse response analysis

Table 6

Variance decomposition of DLFA

Period	S.E.	DLFA	DLFC
1	0.017697	100.0000	0.000000
2	0.017728	99.65060	0.349400
3	0.017728	99.64817	0.351828
4	0.017728	99.64816	0.351843
5	0.017728	99.64816	0.351843
6	0.017728	99.64816	0.351843
7	0.017728	99.64816	0.351843
8	0.017728	99.64816	0.351843
9	0.017728	99.64816	0.351843
10	0.017728	99.64816	0.351843

Source: own calculation.

Table 7

Variance decomposition of DLFC

Period	S.E.	DLFA	DLFC
1	0.004870	0.989880	99.01012
2	0.004889	0.986678	99.01332
3	0.004889	0.986666	99.01333
4	0.004889	0.986666	99.01333
5	0.004889	0.986666	99.01333
6	0.004889	0.986666	99.01333
7	0.004889	0.986666	99.01333
8	0.004889	0.986666	99.01333
9	0.004889	0.986666	99.01333
10	0.004889	0.986666	99.01333

Source: own calculation.

It can be seen that for America, 99.64816% of the variance change in the data is from its own, and 0.3518% of the variance change is from corn futures price of China. Meanwhile, for China, 99.01333% of the variance change in the data is from its own, and 0.9867% of the variance change is from corn futures price of America. It can be concluded that corn futures price of America has a more significant influence on the price of China. The results indicate that there is an information spillover effect between the corn futures market of U.S. and China. So the U.S. futures market plays a leading role in price.

RESULTS

It can be concluded that if LFA increases by 1, LFC will reduces by 0.0074. That is to say, there is a negative long-term relationship between the two variables. The unit root test of residuals further verifies the long-term relations of corn futures prices in China and America. The error correction coefficient of Chinese corn futures price is -0.0217. This means a short run relationship between variables.

From the Grainger causality test, it can be seen that U.S. corn futures prices are the Grainger causality for the price of corn futures in China. It indicates that the corn futures price of the US has single leading relations to the corn futures price in china. Different from the Grainger causality, impulse response analysis indicates that the impact of China's corn futures prices on futures prices of America last relatively longer. This may be due to the defect of the data. The results of variance decomposition can be consistent with the previous results. There is an information spillover effect between the corn futures market of U.S. and China. So the U.S. futures market plays a leading role in price.

Good spot basis provides the advantage for the development of corn futures market in the United States. CBOT on behalf of the corn futures market in the United States, along with the spot market, becomes the world's benchmark for the price of corn. Production operators in the world including China rely on the price to determine and predict the future trend of the corn market, and arrange the production and business activities. Futures prices of the futures market in the United States by means of an open bid have a very high authority. So it plays a certain guiding role in the price of corn futures in China.

CONCLUSIONS AND RECOMMENDATIONS

Corn futures prices of Dalian commodity exchange and CBOT have strong relations, and there exists a co-integration relationship between them, which shows that the two markets have a close linkage relationship. Corn futures prices in the United States have a guiding role in the price of corn futures in Dalian, while corn futures prices of Dalian commodity exchange do not have a leading role in the prices of CBOT.

The more risk in the futures market, the more futures will be needed. In recent years, China's corn futures market has developed to a certain degree. Trading varieties and trading volumes of corn futures have increased, but the development of the futures market is lagging behind the economic development of our country. China's corn spots in the international market are far greater than the impact of corn futures, China's corn futures in the international market is clearly in a passive position. The maturity of its development is far lower than corn futures market of the United States.

In order to further promote the development of China's corn futures market, regulatory authorities should strengthen the supervision of corn futures investment and lead investors to make reasonable investment. It is necessary to enrich futures investment varieties and constantly improve the market rules. The following are some suggestions for the futures market of China:

Firstly, it is necessary to vigorously promote the construction of financial derivatives market, as far as possible, to reduce market risk. At the same time, through the financial derivatives, companies control their own risks and avoid excessive national macroeconomic regulation and exercise control to reduce the risk of enterprise.

Secondly, it is a reasonable choice to introduce institutional investors and establish a reasonable structure of investors. To accelerate the cultivation of investors in futures market not only needs to introduce and gradually expand the banks, funds and other institutional investors, but also needs to improve investor structures.

Thirdly, to lead agricultural orders into the agricultural futures market is also conducive to the development of China's agricultural futures market. It can not only improve the information content of the price fluctuation of agricultural products and improve the market efficiency, but also promote the development of the order agriculture.

Fourthly, agricultural futures companies should strengthen the business innovation to improve the competitiveness. In the futures industry, Futures Company and other market intermediaries play a very big role. The Futures Company, which is a characteristic of agricultural products, has a very important role in the development of the agricultural futures market. In the development of the characteristics for the Futures Company, we can learn from foreign Futures Company in terms of developing more innovative business, such as allowing the establishment and management of futures investment funds.

Fifthly, related institutions should steadily promote the internationalization of agricultural futures market. Only if the futures market of our country's agricultural products is developing into the international futures market and accepts investors from around the world, can futures prices reflect the supply and demand situation in the world and price expectations from the global investors. Thus, prices have the international authority. For agricultural futures, it is necessary to set up similar qualified foreign investors system and open up a suitable trading channel. China's futures market has been gradually liberalized, so that foreign investors enjoy national treatment, which promote the internationalization of the futures market.

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