

# Is China's Corn Price Related to International Crude Oil Price?

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**ABSTRACT:** This paper investigates the relationships between China's corn price and international crude oil price using time series technical methods, we find that, (1) There are mutual Granger Causalities between China's corn price and international crude oil price; (2) China corn price can be positively influenced by last period's corn price and international crude oil price, but the international crude oil price is only effected by its last period price;(3) A unit shock (innovation) in international crude oil prices will give an inverse "U" shape effect on China corn;(4) Before 2009, China's corn price and international crude oil price are not cointegration, but after that, China's corn price have a salient cointegration relationships with international crude oil price; (4) We predict that China corn price will slightly decrease, and international crude oil price will increase mildly in the future. Policies to evade international crude oil shock on China's corn price are proposed.

**KEYWORD:** China; corn; Crude oil; Price; Time series

## 1 INTRODUCTION

Corn is considered to be the most versatile among all crops. It is used for human consumption, animal feed and processing industry. In recent year, the increasing proportion of corn utilized in ethanol production makes corn market to be bound up with energy. Many researches have confirmed that corn market is closely related to the energy sector.

The relationship of corn prices with various fuel prices is volatile. It means the fluctuation of corn price can sensitively conduct to energy sector, mutually, the instability in energy sector can also affect corn price. The price transmission mechanism is more complicated than what we can say, but the increasingly intimate relationship between corn price and energy price can be foreseen.

Literature review reveals that most of the recent studies are focused on international prices of crude oil and corn. Some of the researchers investigated the relationship between USA domestic corn prices versus international or domestic USA oil prices (Baffes, J. & Hanriotis, T. 2010). All of the studies arrive at a consensus that there is a strong linkage between crop price and crude oil price. For example, in USA, the crude/corn price correlation is high and positive in 2006/2008 (Benavides, G. & Capistrán, C. 2009). Considering that China is one of the biggest producers and importers of corn in the world

in recent years, research investigate the relationship between international oil prices and China corn prices is important and timely.

China's corn price is expected to have certain relationship on international crude oil price (Zhang, Reed, 2008), due to two reasons. Firstly, there are conflicts between corn increasing demand and resources limitation. Although China's own grain output is at record levels, the demand growth is adding to the strain on its agricultural sector, grappling with limits on farmland acreage and water supplies, therefore adding strain on its agricultural sectors, makes China has to seek the international corn markets. Secondly, China's rising appetite for corn imports (basically driven by the increasing corn demand). According to the reports of U.S. Department of Agriculture (USDA), China's corn imports are projected to reach to 7 million tons in 2013-14 from 3 million tons in the 2012-13. By 2022, China is expected to become the leading corn importer, buying 19.6m tons from world markets.

In this paper we will empirically investigate the relationship between China's corn price and international crude oil by time series methods (ARIMA model, Grange causality, VAR model, IRF, Cointegration ,VECM, etc.), and then makes the price prediction for both of these two variables.

## 2 DATA RESOURCES AND STATISTICS

### 2.1 Data resources

The international crude oil monthly data is obtained from U.S. Energy Information Administration (EIA). The data is a times series data from January 1986 to November 2013. The monthly prices are calculated by EIA from daily data by taking an unweight average of the daily closing spot prices for a given product over the specified time period.

China's monthly corn prices from January 2001 to October 2013 are obtained from three different sources: The data between 2001 to 2011 comes from the CNAGRI agricultural company (<http://www.cna.gri.com>); the data for the year 2012 was acquired from 2013 Yearbook of China Information Industry; the rest of the data was extracted from the latest Market Monthly Report of China Swine Information Organization (<http://www.Chinaswin e.org.cn>).

### 2.2 Data Statistic

The evolution of the crude oil price can be divided into two stages. The first stage, from the year 1986 to 2000, is characterized by stability, with the mean price value of 19.81 dollars per barrel. The second stage, from 2001 to 2013, is more fluctuant, with a peak price of 133.88 dollars/barrel in July 2008. The second stage, in general, exhibits a raising trend, up to November of 2013 where the price is 93.86 dollars/barrel.

China corn price presents a mildly increasing trend from January 2001 to October 2013. After year 2009, with an increase in demand and consumption, corn prices have a much steeper growth rate and higher fluctuation frequencies. The average corn price is 1.63 yuan/kg (1 current dollar=6.04 yuan). The price reaches a peak of 2.64 yuan/kg in September 2012. Up to October of 2013, the corn price is 2.41 yuan/kg (see Figure 2).

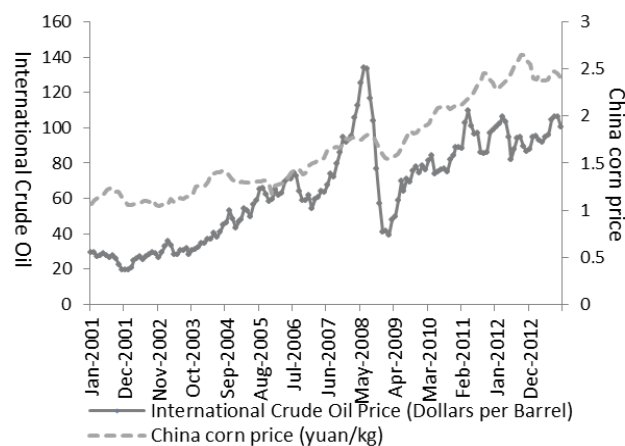


Figure 1. Monthly Trend of China corn price & international crude oil price from 2001 to 2013.

## 3 EMPIRICAL ANALYSIS

### 3.1 Stationary Analysis

Firstly, we transfer the international crude oil price and corn price into logarithm form, and then test the integration of the logarithm form prices by using unit root test. The unite root test results show that the two price variables are non-stationary, but they turn to be stationary when adding the first difference on them.

### 3.2 Granger Causalities between international crude oil and China corn price

Since the question of "true causality" is deeply philosophical, econometricians assert that the Granger test only report the "predictive causality". In this paper we test which price Granger causes the other one between crude oil and China corn price by Granger Causality test.

Before doing the Granger Causality test, we choose the proper lags of Distributed Lag models to carry out Granger Causality test. Based on AIC criterion, we select the two period lagged Distributed Lag models (DL (2) model). In table 1,  $dlcorn.0$  means the first difference of China corn price in lag of zero periods,  $dloil$  is the first difference of international crude oil prices. The null hypothesis of no Granger Causality is strongly rejected (see Table 1). It means that China corn price and international crude oil price have mutual Granger Causality with each other. A change of China corn price can vary international crude oil price, in the meanwhile, the change of international crude oil can fluctuate China corn price. Further, to prove the validity of these Granger Causality relationships, we employ the Ljung-Box test. The Ljung-Box tests are performed on the residuals of the two DL models. Both of the tests can not reject the hypothesis that the residuals are white noise, meaning the Granger Causality are plausible.

Table 1. Granger Causality test.

Test of $dloil$ Granger Cause $dlcorn$						
<i>Model 1: <math>dlcorn.0 \sim dlcorn.1 + dloil.1 + dlcorn.2 + dloil.2</math></i>						
<i>Model 2: <math>dlcorn.0 \sim dloil.1 + dloil.2</math></i>						
Res.Df	RSS	Df	Sum of Sq	F	Pr(>F)	
1	145		0.078			
2	147	0.081	-2	-0.003	2.861	0.060*
Test of $dlcorn$ Granger Cause $dloil$						
<i>Model 1: <math>dloil.0 \sim dlcorn.1 + dloil.1 + dlcorn.2 + dloil.2</math></i>						
<i>Model 2: <math>dloil.0 \sim dlcorn.1 + dlcorn.2</math></i>						
Res.Df	RSS	Df	Sum of Sq	F	Pr(>F)	
1	145		0.987			
2	147	1.090	-2	-0.104	7.599	0.00079 ***

Note: \*, \*\*, \*\*\* denote significance at 10%, 5%, 1% level separately.

### 3.3 VAR Model and Impulse Response Function

To deeper dig the linear interdependencies between international crude oil price and China corn price, we use the Vector auto regression (VAR). Further, to detect the response of these two variables on shocks and innovations, we employ the Impulse Response Functions.

Similar to Granger Causality test, firstly, we have to use automatic lag selection to select the order of the VAR model. According to the values of SC, we select a first-order VAR-model as the estimation models. Table2 provides the estimated results of first-order VAR models. ‘dl’ means first difference of logarithm form variables; ‘.11’ means one period lag; ‘corn’, ‘oil’ mean China corn price and international crude oil price separately. International crude oil price is found to be significantly affected by its last period, but not by the last period’s China corn price. However, China corn price is positively influenced by both last period’s corn price and last period’s crude oil price. In addition to that, to verify the robustness of the VAR models, we also check the residuals of these two models, from the correlogram and cross correlogram of the residuals, we cannot reject that the residuals are white noise, which means our estimation results are stable and plausible.

Table 2, VAR models estimation results

Variables	dlcorn	dloil
dloil.11	0.307*** (0.079)	0.07697** (0.022)
dlcorn.11	-0.038056 (0.277)	0.186219** (0.078)
constant	0.005669 (0.006)	0.003438 (0.002)
R-square	0.10	0.13

Note: ‘\*\*\*’, ‘\*\*’, ‘\*’ stand for the significance at 1%,5%,10% level separately.

Based on the estimated VAR models, we investigate effects of China corn price shocks and international crude oil shocks on both these price variables by using impulse response function. From figure 2, we can conclude that the innovation changes (shocks) from international crude oil have positive influence both on China’s corn price and international crude oil. Specifically, international crude oil price shock has a four-month dropping influence on itself. After 4 months, the international crude oil price shock disappears. International crude oil price shock has a very different effect on China corn prices compared to the effect on itself. The shock increases corn price in the first month and then decreases the corn price in the last three months.

As for the China corn price shock, we found the shock gives a weekly negative effect on crude oil price as expected. Specifically, the shock makes the international crude oil price decreases for a month then increases for 3 months to be zero. Similar to the crude oil’s shock to itself, we can also see that China corn price shock gives a dropping positive shock on itself, and then the shock disappears at the 4<sup>th</sup> month.

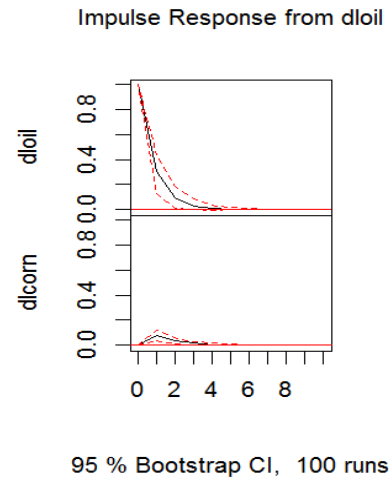


Figure 2. Impulse response function from dloil & dlcorn.

### 3.4 Cointegration and VECM

In order to testify the long term relationships between China corn price and international crude oil price, we test the cointegration using Johansen test. First, we do the cointegration on the whole monthly dataset from the year 2001 to 2013. The results show that there is no cointegration between China corn price and international crude oil price.

When we further investigate the agricultural policy, we find that the amount of corn imported before the year 2009 was strictly controlled by Chinese government, which can reasonably explain the insignificant cointegration relationships between the two prices. However after the year 2009, Chinese government loose the trade-ban policy and the quantity of corn importing increased dramatically. It means we should expect salient cointegration relationships between the two prices after 2009.

In the following analysis, we split the time period into two sub-periods by using 2009 as the cutting point, and then we do the Johansen test on both sub-periods separately. In Table 3, Test1 is the test for period 2009-2013; Test 2 is the test for period 2001-2009. The test type we use is trace statistic without linear trend and constant in cointegration. The results in Table 3 indicate that there is no cointegration between international crude oil price and China corn price in the period 2001-2009, while salient cointegration relationship between these two prices after the year 2009. It means that China’s corn price have a long run equilibrium with international crude oil price after year 2009. The significant cointegration also implies that China corn price and

international crude oil price will be mutual-effected by each other.

Table 3, Cointegration tests for two sub-periods

	Test statistic values		Critical values of test		
	Test1	Test2	10%	5%	1%
$r \leq 1$	10.91	2.17	7.52	9.24	12.97
$r = 0$	37.73	6.43	17.85	19.96	24.6

In order to find the adjustment speed to the long run equilibrium equations, the Vector Error Correction Model (VECM) is used based on the former Johansen trace test., the coefficient of ect1 (represent the adjustment speed to the long run equilibrium) on crude oil and corn price are -0.1764 and -0.0112 respectively, meaning the speed of adjustment towards equilibrium on international crude oil is much faster than adjustment speed of China corn price.

### 3.5 Prediction

Using VECM, we predict the China corn price and international crude oil price in the next 6 month. The predicted price trends are presented in Figure3. We find that China corn price will slightly decrease in the next 6 months, in the meanwhile international crude oil price will increase mildly.

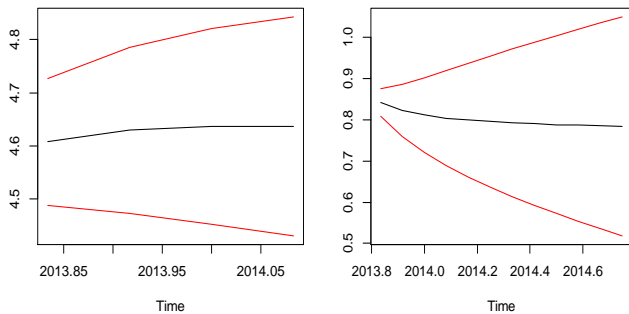


Figure 3. Prediction for future China corn& crude oil price

## 4 CONCLUSION AND IMPLICATIONS

This paper mainly discuss whether there are relationships between China's corn price and international crude oil price by implementing time series methods, and the data ranges from period 2001 to 2013, several meaningful findings are found :

The two variables are integrated of order 1 and they are all valid MA models. There are Granger China corn price and international crude oil price

have mutual Granger Causality with each other. A change of China corn price can vary international crude oil price, in the meanwhile, the change of international crude oil can fluctuate China corn price.

International crude oil price is found to be significantly affected by its last period, but not by the last period's China corn price. However, China corn price is positively influenced by both last period's corn price and last period's crude oil price.

Innovation changes (shocks) from international crude oil have positive influence both on China's corn price and international crude oil. Specifically, international crude oil price shock has a four-month dropping influence on itself. After 4 months, the international crude oil price shock disappears. International crude oil price shock has a very different effect on China corn prices compared to the effect on itself. The shock increases corn price in the first month and then decreases the corn price in the last three months.

There is no cointegration between international crude oil price and China corn price in the period 2001-2009, while salient cointegration relationship between these two prices after the year 2009. It means that China's corn price have a long run equilibrium with international crude oil price after year 2009. The significant cointegration also implies that China corn price and international crude oil price will be mutual-effected by each other.

Based on the findings in this paper, we propose that some policies should be made to evade the effects of international crude oil shock on China's corn price. Take the international crude oil price into consideration when making the corn production and trade policy.

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