

# The Price Cointegration between China's Sugar Market and World Sugar Market<sup>1</sup>

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## Abstract

Sugar has been an important commodity in the Chinese economy and as consumer income increases, China is fast becoming a major sugar consumer. Given that China is now a member of the WTO, it is thus interesting to examine the extent to which the Chinese and the world sugar markets are integrated and how price fluctuations in the world market may affect China's domestic sugar market. In this paper, we first use the Johansen co-integration method to examine whether a long-run co-integration relationship exists between main domestic sugar markets and between domestic and international sugar markets. We then use the error correction models (ECM) to analyse the likely short-run impacts of international sugar price fluctuations on China's domestic sugar market. Our study shows that there is a long-run co-integration relationship between domestic sugar markets, and between world sugar spot market and China's domestic sugar market. The world sugar market price tends to lead price changes in China's domestic sugar market. However, in the short run, changes in the world sugar price do not seem to have an immediate impact on the sugar price in China's domestic market. Implications are discussed.

**Keywords:** China Sugar Market; Cointegration; Error Correction Model

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<sup>1</sup> This Paper is based on an paper presented to the 18th ACESA International Conference: "Emerging China: Internal Challenges and Global Implications", to be held at Victoria University, Melbourne, Australia, 13-14 July 2006. We wish to thank anonymous referees for very helpful comments on an earlier draft. Funding for the research described in this paper is from National Science Foundation Committee (NSFC) of China (NO.70373033).

## Introduction

Sugar has been widely traded for its precious value since many centuries ago. Sugar is an important portion of much foodstuff production and consumption, its price has directly influenced foodstuff's production cost, therefore, the sugar market is one of the highly protected markets in world agricultural trade. China is one of the world's leading sugar producers and is often a major importer. The Chinese government is heavily involved in the sugar industry. Since the earlier 1990s, the Chinese government has taken gradual steps to loosen the control of the domestic sugar market. As part of its WTO accession commitments, China has decreased its sugar import tariff to the lowest level of all WTO members; also the lowest one among all sugar-producing countries<sup>2</sup>. Before WTO accession, the sugar trade could be controlled through tariffs and state-trading enterprises; the influence of world sugar price fluctuations on China's domestic sugar price wasn't obvious. At present, world sugar price evidently affects Chinese domestic sugar crops planting and production, most people worry that China's domestic sugar market may be shocked by the world sugar market.

Although enterprises and researchers believe that the price linkage between China's domestic sugar market and the world sugar market would be closer after WTO accession, researchers have various opinions about the possible shock from the world sugar market. In summary, it can be reduced to two types. Most people claimed the Chinese sugar industry doesn't have advantages, if China continually adjusts agriculture trade policies to implement its WTO accession schedule; imported sugar may swarm into the domestic market (Xie, 2002; Huang, 2004; Li, 2001; Liang, 2002; Jiao, 2003). Other people thought that the Chinese sugar industry has a comparative advantage, if domestic and world sugar industry policies were not distorted, China's WTO accession has little influence on the domestic sugar market (Cheng, 2000; Lian, 2000; Ke, 2003). From a methodology view, two kinds of researchers back up the former standpoint, some have measured the sugar market (or sugar crops) protection degree by employing economic models (Anderson, 2002; Liu, 2002), domestic resources cost coefficients (Zhong, 2003) and self-sufficiency rates (Huang, 2004). Others offered qualitative analyses (Li, 2001; Liang, 2002; Jiao, 2003).

The previous studies have three shortages at least. Firstly, those studies involved China's sugar market while discussing other subjects, and no special empirical study on the Chinese sugar industry. Secondly, those studies just argued the world sugar market may have (or haven't) influence on the Chinese domestic sugar market. Since raw sugar and refined sugar are traded at different markets, they didn't point out which one would shock the domestic market. Lastly, and the most important question was, two implicit assumptions were concerned when those papers discussed the impact of China's WTO accession on its sugar industry. The first one was that China's domestic sugar markets were integrated; the second one lied that the world and China's domestic sugar market were also integrated. If the two assumptions didn't exist, the conclusion may be quite different.

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<sup>2</sup> Currently, the world average sugar tariff is 50 percent. The total WTO member's average tariff is 97 percent, developed and developing countries are 122 percent, 55 percent respectively. China's in-quota tariff is only 15 percent, and out-quota has been reduced from 90 percent to 50 percent.

The present paper attempts to employ econometrics model, and evaluates integrated degree of China's domestic sugar markets, quantitatively analysis the price co integration between China sugar market and world sugar market, examines which extent the two markets are integrated, presents a fundamentally study to gain better understanding of the potential influence of China sugar industry under WTO background. To carry out these objectives, the paper is organized as follows. First, it presents a brief overview of world and China sugar market. Subsequently, model and methods are discussed. In the third section, the paper describes the data. The fourth section is empirical results. This is followed by the concluding remarks and policy implications.

## **1. Global and China Sugar Market Dynamics**

World sugar market is a huge distorted market. The world sugar market has long been characterized by volatile prices and widespread intervention. Sugar is special political economic goods. Sugar economy connects agriculture with sugar industry, and links domestic market to world market; all countries directly or indirectly impose intervention measures on their sugar industry. In order to hold domestic market balance, keep stable price and sugar industry safety, some countries, especially the developed country, transfer the supply and demand unbalance of domestic market to international market through various import barriers, huge export subsidies and domestic support policies, these have made world sugar price far lower world long term average sugar producing cost in past years. Total world raw sugar output reached about 136 million tons in 2002/2003. Raw sugar consumption was 133 to 135 million tons, and increases 1.5 per cent to 2 per cent every year. Global sugar trade quantity is about 40 million tons, which around 30 percent of world raw sugar production. However, world sugar commerce is a surplus trade under bilateral preferential agreement, the proportion is high, but free trade share is small. A little change of output will result in raw sugar price significant fluctuation.

World sugar price reached peak at 13.28 US cent per lb in 1995, then dropped to downturn, and ever dropped to minimum 5 US cents per lb from 1998 to 1999. International sugar price starts to slowly rise and reaches 10.08 US cents per lb. Since 2002, because of sugar main export countries' surplus, such as Brazil, Thailand, Australian and South Africa, supply exceeds demand, and then made world sugar prices continuously lower and the future of world sugar market became bleaker at that time. World sugar prices have increased significantly since December 2005 to present, largely due to a substantial rise in crude oil prices, as well as a world supply deficit for the third consecutive year.

China's domestic sugar market has being experienced significant evolution in recent years. Sugar output experienced different phases, from over demand to balance, oversupply, until supply falls short of demand now. China has changed its sugar policies from import controlled, producer subsidies and self-sufficient to stable market, efficiency improvement. The planting area of sugar crops reached 164 thousands hectare in 2002, it was 12.41 thousands hectare in 1949. Sugar production reached 9.995 million metric tons in 2002. In 1949, the founding of new China, Chinese sugar output was 26th in the world. China is now the world's fourth largest sugar producer, only after Brazil, India and the European Union. In terms of consumption, it is the fifth largest, after India, the EU, Brazil and the United States.

With the continual improvement of self-sufficient ability, China government gradually loosens its intervention to domestic market since 1991, opens up sugar market, so, sugar industry gets rapidly development. However, the market is not stable, and the price significantly fluctuates. Compared domestic sugar (for example, Nan Ning, Guangxi Zhuang Autonomous Region, major sugarcane producing area of China) price changing trend with world price changing trend, they are co-movement; if world sugar price increased or decreased, domestic sugar price would simultaneity response (Figure1). China is one of the world main sugar import countries. In 1995, the import quantity was 2.91 million tons and the net import was 2.46 million tons, which accounted for 30% of total consumption that year. In recent years, generally, China import about 1million tons sugar each year (Figure2).

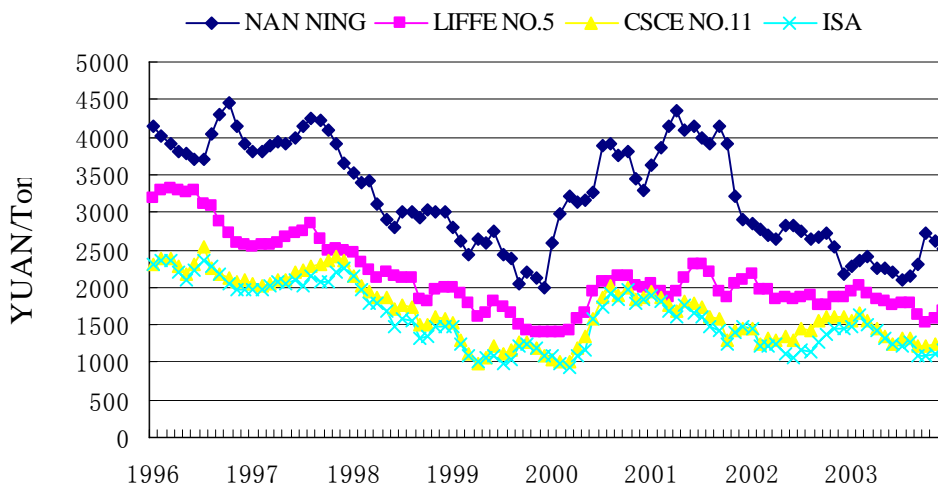


Figure1 World and China(NAN Ning) Sugar Price Dynamics

Sources: ERS website (<http://www.ers.usda.gov>) and other resources, calculated by author

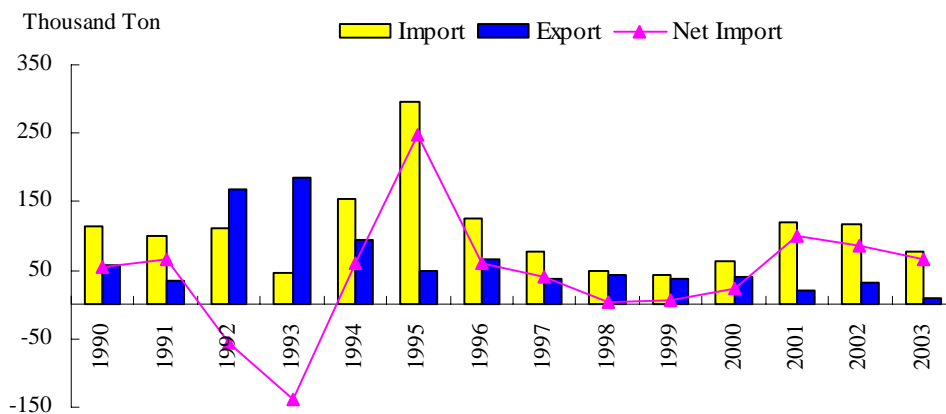


Figure2 China Sugar Import and Export

Sources: China Statistical Yearbooks (1991-2004)

As a sugar net import country (Figure2), China is always a focus of world sugar dynamics. The imported quantity of other countries is comparatively stable; however, China is quite

variable. When and how China imports sugar, has great influence on world market. Chinese sugar import would be obviously increased in future. Growth is being stimulated by growing use of sugar as an ingredient in food and beverage products as well as an additive to foods and drinks. In general cane sugar refineries are performing better than beet sugar refineries.

## 2. Methods and models

The paper focuses on investigating the price co integration among China's major sugar markets, between China's local market and world market. These involve several issues, namely, does pair-wise markets exist the causality? What's the mechanism to achieve the causality, which one is the first-mover? Who disturbs whom? Is the adjusting speed fast or slow to relatively price difference? From the view of econometrics, these questions are whether pair time-series variables are co integrated? If co integrations existed, what about do their Granger-causality?

According to economics theory, if two markets had tight price relationship, then the two markets would be co integration (Stigler, 1969). Abundantly study literatures have employed varies models to investigate the price co integration of spatial market. Johansen (Johansen. and Juselius, 1990) Cointegration analysis and error correction models (ECM) have become the widely adopted techniques for studying of price co integration since their formal development by Engle and Granger (1987). Johansen model identify potential long run co integration relation between different markets; error-correction approach to modelling short term co integration relationships, market adjusting process and mechanism after an impact happened.

### 2.1. Testing for the Stability of Time Series Variables

After  $d$  times difference, variable  $x_t$  is stable, it is called variable  $x_t$  convergence at  $d$  rank, marked  $x_t \sim I(d)$ . If two time-series variables,  $x_t$  and  $y_t$ , are  $d$  order unstable process, and function  $e_t = x_t - by_t$  is  $b$  order unstable process, and that  $b < d$ , Engle and Granger (1987) defined  $x_t$  and  $y_t$  was  $(d, b)$  co-integration. It means long-term equilibrium exists.

The economic implication of co-integration is, if long-run equilibrium relationship existed between two or more time-series variables, although time-series is not stationary, along with temporal process, and they would gradually co-movement, namely, the difference is stationary. The long-term relationship represented by equilibrium implies the system is convergent with temporal process. The errors,  $e_t$  means the distance deviated from equilibrium at time  $t$ .

Before examining integration relationships of pair wise vectors, it is essential to test unit root, and identify that all variables are integrated of at same order, so to discern time-series' stability. Augmented Dickey-Fuller (1979) approach (ADF) is widely adopted for testing Unit root. The framework of ADF methods is based on an analysis of the following model:

$$p_t = \alpha + \beta p_{t-1} + \gamma T + \sum_{k=1}^n \delta_k \Delta p_{t-k} + \mu_t \quad (1)$$

Here,  $p_t$  is the time series variable,  $T$  is time trend variable,  $\mu_t$  represents zero-mean, serially uncorrelated, random disturbances,  $k$  is the lag lengths;  $\alpha$ ,  $\beta$ ,  $\gamma$  and  $\delta_k$  are the coefficient vectors. We can do unit root tests on the  $\beta$  parameter to determine whether or not each series is more closely identified as being I(1) or I(0) process. Test Statistic is the t statistic for  $\beta$ . The null hypothesis of the equation (1) test shows the existence of a unit root when  $\beta = 1$  against alternative hypothesis of no unit root when  $\beta \neq 1$ . If  $p_t$  is non-stationary, it should exam whether or not the first difference of  $p_t$  is stationary (i.e. to test  $\Delta p_t - \Delta p_{t-1} \sim I(1)$ ) by repeating the above procedure until the data are transformed to induce stationary. If the ADF test can reject the null hypothesis, as is usually the case with price series, it verifies  $p_t \sim I(1)$ , then continue to the second step for co integration test.

## 2.2. Testing for Johansen Co integration

If two series are individually stationary at same order, The Johansen-Juselius (1990) methodology was used to estimate the long-run co integrating vector from a Vector Auto regression (VAR) model of the form

$$\Delta p_t = \alpha + \sum_{i=1}^{k-1} \Gamma_i \Delta p_{t-i} + \Pi p_{t-k} + \mu_t \quad (2)$$

Where  $p_t$  is a vector of endogenous  $n$  variables at time  $t$ .  $\Delta$  is the first difference.  $\Gamma_i$  and  $\Pi$  are

$$n \times n \text{ matrix of parameters on the } i\text{th and } k\text{th lag of } p_t, \quad \Gamma_i = \left( \sum_{i=1}^k A_i \right) - I_g,$$

$$\Pi = \left( \sum_{i=1}^k A_i \right) - I_g$$

$I_g$  is the identity matrix of dimension  $g$ .  $\alpha$  is constant term,  $\mu_t$  is  $n \times 1$  white noise vector. Throughout,  $p$  is restricted to be (at most) integrated of order one, denoted I(1), where an I( $j$ ) variable requires  $j$  th differencing to make it stationary.

Equation (2) tests the co integrating relationship between integrated series. Since  $p_t \sim I(1)$ ,  $\Delta p_t, \Delta p_{t-k} \sim I(0)$ , left hand side in (2) is stationary. If  $\Pi p_{t-k}$  is stable, then right hand side in equation (2) is also stationary. The novel feature of Johansen test is long-term parameters matrix  $\Pi$ . Rank  $r$  of matrix  $\Pi$  can be calculated through eigenvalue  $\lambda_i$  ( $0 \leq \lambda_i < 1$ ), which measures how many linear combinations of  $p_t$  are stationary, namely, how many pair-wise time series are integrated. The rank  $r$  of  $\Pi$  is equal to none zero eigenvalue number. When  $r = 0$ , no pair-wise time series are stationary; when  $r = n$ , all level pair-wise vectors are stationary. When  $0 < r < n$ ,  $r$  is the existing co integrations number. In

practice, statistic test is in the form of  $\ln(1 - \lambda_i)$ , instead of eigenvalue  $\lambda_i$ ; however, when  $\lambda_i = 0$ ,  $\ln(1 - \lambda_i) = 0$ .

Suppose that the rank of matrix  $\Pi$  is 1, then,  $\ln(1 - \lambda_i)$  is negative;  $\ln(1 - \lambda_i) = 0, \forall i > 1$ . If eigenvalue is none zero, then  $\ln(1 - \lambda_i) < 0, \forall i > 1$ . In another word, if the rank of matrix  $\Pi$  is 1, then maximum eigenvalue is not zero, other eigenvalues are zero.

The significance of eigenvalue  $\lambda_i$  is a useful tool to identify possible integration relationship. The Eigenvector corresponding to eigenvalue is the coefficient of the variables that exists integration relationship. Johansen and Juselius (1990) derives two maximum likelihood statistics for testing the rank of  $\Pi$ , and for identifying possible co integration as the following

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^m \ln(1 - \lambda_i)$$

$$\lambda_{max}(r, r+1) = -T \ln(1 - \lambda_{r+1})$$

Where  $r$  is the co-integrated number of pair-wise vector,  $\lambda_i$  is  $i^{th}$  eigenvalue's value of matrix  $\Pi$ .  $T$  is the number of observations.  $\lambda_{trace}$  is not a independent test, but a series of tests correspond to different  $r$  value.  $\lambda_{max}$  tests each eigenvalue separately. Null hypothesis of the two statistical tests becomes the existence of  $r$  co-integrated relations; alternative hypothesis is the existence of more  $r$  co-integration. If  $\lambda_{trace}$  and  $\lambda_{max}$  have different test results, Johansen and Juselius (1990) suggested  $\lambda_{max}$  may be more dependable than  $\lambda_{trace}$ , and should take  $\lambda_{max}$  statistic as reference.

In practice, comparing maximal eigenvalue and trace statistic with the critical values, we test the number of long-term co intergration. The null hypothesis test shows the pair-wise vectors are co-integration when the statistic value is more than those critical values against alternative hypothesis of no cointegration between two vectors when the statistic value is less than those critical values.

### 2.3. Error Correction Model

If two same order stationary time series are co integrated, how about the causality of the two vectors? If one of the two vectors changed, how do they return to long-term equilibrium in short-run? In order to appropriately model the full dynamic behavior of two co integrated vectors, we need to incorporate short-run adjustment factors along with the cointegration equilibrium relationship. This is best done using the error-correction model (ECM) technique. This cointegration relationship represents the foundation of a complete dynamic error correction model. We can normalize and combine them to investigate pair-wise effects

between the variables<sup>3</sup>. ECM model involving two identical order integrated time series  $P^i_t$  and  $P^j_t$  may be written as the following form:

$$\Delta p^i_t = \alpha_0 + \sum_{k=1}^m \alpha_k \Delta p^j_{t-k} + \sum_{k=1}^m \beta_k \Delta p^i_{t-k} + \gamma_1 E_{t-1} + u_t \quad (3)$$

$$\Delta p^j_t = \phi_0 + \sum_{k=1}^m \phi_k \Delta p^i_{t-k} + \sum_{k=1}^m \Phi_k \Delta p^j_{t-k} + \gamma_2 E_{t-1} + v_t \quad (4)$$

Where,  $E$  is called the error correction term, is the regressive residual error of the co integrating vectors  $P^i$  and  $P^j$ ,  $E_t = \hat{\alpha}_0 + p^i_t - \hat{\alpha} p^j_t$ .  $k$  is the lag lengths.  $\Delta$  is the first difference  $u_t$  and  $v_t$  are white noise series, they cause short-term deviation from equilibrium, and that,  $u_t, v_t \sim IN(0, \delta^2)$ .

In practice, if  $\gamma_1$  is significant, it means the Granger causality direction between  $P^j_t$  and  $P^i_t$  markets is from  $P^j_t$  to  $P^i_t$ ; if  $\gamma_2$  is significant, it might be explained that the Granger causality direction is from  $P^i_t$  to  $P^j_t$ . If the estimated parameter  $\alpha_k$  of  $\Delta p^j_{t-k}$  is significant at least one,  $P^j_t$  has Granger-type causality with  $P^i_t$  in short-term; If estimated coefficients  $\phi_k$  of  $\Delta p^i_{t-k}$  is significant at least one,  $P^i_t$  has Granger-type causality with  $P^j_t$  in short-term. If  $\alpha_k, \beta_k, \phi_k$  and  $\Phi_k$  are all statistic significant,  $P^i_t$  and  $P^j_t$  have both long-term and short-run causality in two directions.

By conducting an F-test on the model (3) and (4), we can conclude if there exists a short-run cointegration relationship for the pair of vectors. Error correction model builds a bridge between long-term (static) and short-run (dynamic). Error correction term represents level variables' long-term relation. Assumption one of the vectors changed; could these two vectors come back to cointegration? Coefficient  $\gamma$  ( $-1 \leq \gamma \leq 0$ ) shows the adjusting speed to a new equilibrium. If  $\gamma$  value close to  $-1$ , it implies the responding speed of the equilibrium correction mechanism is fast, the effect of the shock is transitory, and the long run equilibrium would be quickly restored, that adjustments toward the long-run efficient market hypothesis condition occur rapidly.

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<sup>3</sup> When two vectors exist co integrated relation, Granger causality test may cause enactment error, ECM is preferred to test causality (Granger, 1988). ECM is quite useful to test causality when pairs of variables have time trend or equilibrium relation. (Miller and Russek, 1990).

While a  $\lambda$  value close to 0, would suggest that adjustments to the long-run occur rather slowly. The higher the cointegration degree, the faster the two vectors come back to equilibrium.

### **3. Data Description**

Sugar is separated into different categories according to the difference of production technology. Sugar price depends on its category and term of trade. In general, Sugar can be divided into two categories: raw sugar and refined sugar, which is the mostly traded sugar in world market. Raw sugar and refined sugar were traded at different geographic area. Refined sugar market is subjected to the influence that European sugar beet yields. Sugar cane producing countries, like Brazil, Australia and Thai etc. affect the world raw sugar market.

There are two typical world sugar prices –CSCE (New York Board of Trade, Coffee, Sugar and Cocoa Exchange) and LIFFE(London International Financial Futures and Options Exchange). The two markets' prices are called "world sugar price", which also are the weatherglass of world sugar market. CSCE market trades NO.11 raw sugar, comes from about 30 countries, such as Brazil, Thailand and Australia. LIFFE trades NO.5 white (refined) sugar, comes from Europe Union and other developed countries. The two markets' sugar prices are all FOB bulk prices of Caribbean port. The third is ISA price, which is a daily average price of CSCE and LIFFE market, offered by International Sugar Organization (ISO) according to International Sugar Agreement.

China's domestic market sugar prices data derived from internet website ([www.gsec.com.cn](http://www.gsec.com.cn)). For testing co integration relationship in domestic market, the adopted price dates are the average prices from Monday to Friday. CSCE raw sugar spot prices data derived from website [www.ec-sugar.com](http://www.ec-sugar.com); ISA prices date came from United Nation FAO website. We take Friday price as the week average price in examining co integrated degree between world and domestic markets. Raw sugar dominates world sugar trade, China mainly imports raw sugar from world market; on the other hand, LIFFE prices are unavailable. Therefore, the paper substitutes CSCE, ISA for CSCE, LIFFE. All data are spot price observations. Sample ranges from 15, Ju. 2001 to 26, Dec, 2003. To the samples of Nan Ning, Wu Lumuqi, Chang Chun, He Fei, and Guang Zhou, the range is from 7, Jul 2000 to 26, Dec, 2003. CSCE and ISA samples range from 12, Oct, 2001 to 26, Dec, 2003.

### **4. Empirical Results**

The empirical study section follows three steps. The first stage involves testing for the order of integration, with each sugar market's price time series data defined as the logarithm of the levels of the variables, using the Augmented Dickey-Fuller (ADF) statistic. Conditional on the outcome of the tests, the second stage involves investigating pair-wise sugar market time series prices co integration utilizing the Johansen maximum likelihood approach. If pair wise markets cointegration exists, however, there is no guarantee that the two markets belong to one market (the law of one price). On the basis of the pair-wise sugar market cointegration results, the third stage, a ECM may then be investigated to examine interaction effects, taking

the error term from this cointegrating regression as a measure of the ECM term to capture the short run dynamics and analyses causality of the model.

#### 4.1. Stationarity of Price Series (Unit Root Test)

The necessary condition of testing pair-wise price series co integration is the price series' stationarity. It desires the level pair-wise vectors are non stationary, but first difference is stationary. Therefore, stationary test is preferred to identify whether or not each price series has unit root, Herewith, we utilize ADF method to test unit root. The null hypothesis shows the existence of a unit root.

Since the outcome is sensitive to lag periods when we adopt ADF method for testing unit root, it's critical on selecting lag periods. Many researchers have noticed this problem, and offered various standards to try to solve the problem. The paper takes AIC and SC standard as reference, and combines with Durbin Watson(DW) statistic, also considers the characteristic of sugar markets, through trial and error, then confirms the lag periods. The ADF tests results for the stationarity of local and world price series are reported in Table 1 separately. The results show null hypothesis is rejected after first difference. Therefore, we can conclude these price series are I (1). So we proceed to examine Johansen co integration as following.

Table 1 Results of Sugar Price Series ADF Tests

	I(0)			I(1)		
	C	C&T	N	C	C&T	N
Jing Jang	-1.331	-2.194	-0.862	-5.56	-5.552	-5.519
Zhan Jiang	-1.369	-2.232	-0.875	-8.397	-8.382	-8.399
Nan Ning	-1.984	-1.594	-1.031	-4.576	-4.858	-4.445
Dian Wei	-1.309	-2.044	-0.83	-5.107	-5.11	-5.054
Kun Ming	-1.232	-1.645	-0.946	-5.187	-5.193	-5.131
Chong Qing	-1.13	-2.083	-0.68	-6.716	-6.702	-6.691
Guang Zhou	-2.221	-1.825	-1.067	-4.539	-4.846	-4.408
Shang Hai	-1.339	-1.858	-0.897	-5.655	-5.662	-5.603
Wu Han	-1.316	-1.587	-0.798	-5.655	-5.662	-5.603
He Fei	-2.141	-1.43	-1.026	-4.673	-4.963	-4.58
Zheng Zhou	-1.141	-2.055	-1.207	-4.912	-4.876	-4.82
Xi An	-1.296	-1.925	-0.939	-4.851	-4.85	-4.789
Lang Fang	-1.283	-1.918	-0.932	-5.345	-5.337	-5.284
Chang Chun	-2.048	-0.944	-0.902	-5.187	-5.193	-5.131
Wu Lumuqi	-2.924	-2.061	-1.298	-3.767	-4.398	-3.559
CSCE	-1.172	-1.386	-0.534	-4.674	-4.697	-4.663
ISA	-1.549	-1.59	-0.752	-4.291	-4.259	-4.253
Critical Value						
1%	-3.469	-4.013	-2.577	-3.469	-4.013	-2.577
5%	-2.878	-3.436	-1.942	-2.878	-3.436	-1.942
10%	-2.575	-3.142	-1.617	-2.576	-3.142	-1.617

Notes: C is only intercept included. C&T presents both time trend and intercept included. N denotes no time trend and intercept included. The ADF test statistic in the table derived from EViews 4.0 , with a 5-period lag in China sugar market, 6- period lag in ISA and CSCE. The tested hypothesis is H0: non-stationary and H1: stationary.

## 4.2. Johansen Co-integration Tests

We test long-run co integration between China's domestic pair-wise sugar markets, between world sugar market and China's main sugar producing markets, between world sugar market and China's major sugar distributional markets. If two series are potential co integrated, one co integration relationship exists at least. Co integration may be affected by some facts, such as transportation cost, tariffs, and so on. Hence, we employ a restricted mode that includes intercept, and no time trend included, to test potential co integration. The null hypothesis is the existence of  $r$  cointegrated relationship; alternative hypothesis is available  $r+1$  cointegration relationship. Test starts from original  $H_0(0)$ , until rejects null hypothesis. Appendix 1 of the paper illustrates the test results. The results indicate that among 90 pair of markets are all co integrated. Appendix 2 and 3 separately show the cointegration results between CSCE (and ISA) and China's major sugar markets. The results show all pair-wise markets are integrated. According the results, we employ Error Correction model to analysis causality and the short run dynamics between China and world sugar markets.

## 4.3. Estimation of Error Correction Model

Engle and Granger (1987), show that if two series are individually I(1), and cointegrated, a causal relationship will exist in at least one direction. For two first order cointegrated vectors, two stages are needed to estimate error correction model. First, we estimate the two vectors linear regression equation. Since pair-wise domestic market and word market are cointegrated, false regression is excluded. In order to eliminate the possible deterministic components from price series, which are non-co integrated ingredients (for example, inflation), we add time trend variable  $T$  in the first stages' regression equation. Secondly, we take the residual error term of the forementioned linear regression equation as error correction term in (3) and (4) equations, specifically, its explicit representation as the vector error correction model is:

$$\Delta \log p_{Dt} = c + \sum_{i=1}^m \beta_i \Delta \log p_{Dt-i} + \sum_{j=1}^k \Psi_j \Delta \log p_{Ft-j} + \gamma E(-1) + u_t \quad (5)$$

Where,  $P_{Dt}$  represents certain domestic market sugar price series at time  $t$ ,  $P_{Ft}$  is world market sugar price series at time  $t$ .  $i$  and  $j$  is the lag lengths.  $\Delta$  is the first difference.  $E$  is error correction term.

Table 2 and 3 show estimation results for the vector error correction model respectively. Table 2 is the results between ISA and China's major sugar producing markets (Zhan Jiang, Nan Ning, Dian Wei and Wu Lumuqi), sugar distributional market (Chong Qing, Zhen Zhou, Lang Fang, and Chang Chun) and. According to table 2, the estimated coefficients of error correction terms are statistical significant. It not only proves again China's sugar market and world sugar market do have integration relationship, and also illustrates that price fluctuation in word market is one of the cause of China's domestic price change.

The price linkages between China's main sugar producing market and world market are closer than between major distributional market and world market. The  $\gamma$  value of error correction term are from  $-0.078$  to  $-0.147$ , away from  $-1$ , and close to 0, it implies once a

shock happened from anyone of these two markets, the adjusting speed to co-integration is very slowly. In another word, no short-run co integration exists in two markets.

The estimated coefficients of one period lag price in China's main producing market are positive and statistical significance, which indicates last weeks' sugar price change in major producing area, has positive influence on present price. one or two-period lag sugar price change in world market impacts Dian Wei (Yun Nan province) market at above 90% significant level; one- period lag is negative effect, two-period is positive. Present sugar price evolution is merely impacted by last weeks' price change in Zhan Jiang, Nan Ning, and Wu Lumuqi market. Former two weeks' price dynamics has significant positive influence on these markets' present prices (except for Zheng Zhou market) in distributional regions. The estimated parameters of lag period price in world market are not statistic significance, which imply world sugar market don't have influence on Chinese domestic markets in short time (except Yu Nan and Dian Wei). The results show that if a sudden shock occurs, error correction item adjusts to new price equilibrium at present, subsequently, one period lag price operates.

Table 2 Results of Pair-Wise China Major Sugar Markets and ISA Market

	Zhan Jiang	Nan Ning	Dian Wei	Chong Qing	Zheng Zhou	Lang Fang	Chang Chun	WULu Muqi
c	-0.0033 (-1.37)	-0.0034 (-1.44)	-0.0023 (-1.26)	-0.003 (-1.17)	-0.0026 (-0.99)	-0.0017 (-0.71)	-0.0008 (-0.34)	-0.0022 (-1.23)
$\gamma$	-0.138*** (-4.26)	-0.147*** (-4.38)	-0.078*** (-3.11)	0.088*** (-2.86)	0.119*** (-3.06)	0.105*** -3.2	-0.087** (-2.11)	-0.146*** (-3.56)
$\beta_1$	0.394*** (4.34)	0.320*** (3.57)	0.452*** (4.93)	0.122 (1.33)	0.127 (1.43)	0.161* (1.78)	0.069 (0.71)	0.232*** (2.58)
$\beta_2$	0.044 (0.48)	0.088 (0.99)	-0.012 (-0.13)	0.202*** (2.23)	0.154 (1.76)	0.312*** (3.74)	0.217*** (2.66)	0.185*** (2.07)
$\psi_1$	-0.014 (-0.27)	-0.047 (-0.93)	-0.085* (-1.75)	-0.066 (-0.23)	-0.041 (-0.73)	-0.005 (-0.11)	-0.057 (-1.07)	-0.002 -0.06
$\psi_2$	0.026 (0.49)	0.042 (0.82)	0.091* (1.85)	0.049 (0.89)	0.018 (0.31)	0.027 (0.54)	0.049 (0.9)	-0.018 (-0.45)
$R^2$	0.284	0.279	0.294	0.144	0.135	0.204	0.108	0.201

Note: \*\*\*/\*\*/\* represent significant at the level of 1%、5%and 10%respectively. T statistic is reported in the parentheses.

Table3 lists the estimated results between CSCE NO.11 raw sugar market and China's major sugar producing markets (Zhan Jiang, Nan Ning, Dian Wei and Wu Lumuqi), sugar distributional markets (Chong Qing, Zhen Zhou, Lang Fang, and Chang Chun) for VEC model. As table 3 shows, the estimated coefficients of error correction items are significant. The results not only indicate Chinese sugar market and world sugar market have long-term cointegration relationship, but also show the price fluctuation in CSCE NO.11 market result in domestic price changing, in the view of Granger-type causality. The absolute values of  $\gamma$  in main sugar producing areas are larger than the absolute values in distributional regions,

which mean main sugar producing area, have closer relationship with CSCE NO.11 raw sugar market than distributional region do. The values of  $\gamma$  are between  $-0.069$  to  $-0.153$ , away from  $-1$  and close to  $0$ . It implies once a shock happened from anyone of this two markets, the adjusting speed to co-integration is very slowly. In another word, no short-run co integration exists in two markets.

The coefficients of one period lag price are statistical significance in Chinese main sugar producing markets, which means last weeks' price has positive influence on present price. The estimated coefficients of two period lag prices are statistical significance in sugar distributional market, and positive, which implies former two weeks price bring positive influence on present price in distribution area. The estimated coefficients of one period lag price are positive significant at more than 90% level in sugar distribution areas except for Lang Fang and Chang Chun, Coefficients' estimated value of two period lag price in CSCE market also have significant interpreted ability, and the value is positive, these illuminate the price changing in CSCE market might bring some extent positive effect to China domestic sugar market in short term.

The results also show the dynamic effect process of the spot price change in CSCE market to China domestic market. In major sugar producing area, once a impact occurs, firstly, the adjustment comes from error correction item, the following adjustment is domestic one period lag sugar price, and finally is two period lag price of CSCE raw sugar market. In distribution area, the adjusting process is similar to major sugar producing area once a shock occurs.

Table 3 Results of Pair-Wise China Major Sugar Markets and CSCE Market

	Zhan Jiang	Nan Ning	Dian Wei	Chong Qing	Zheng Zhou	Lang Fang	Chang Chun	WULu muqi
$\gamma$	-0.0032 (-1.33)	-0.003 (-1.31)	-0.0026 (-1.17)	-0.0027 (-1.09)	-0.0024 (-0.91)	-0.0016 (-0.68)	-0.0008 (-0.33)	-0.0022 (-1.17)
	-0.137*** (-4.43)	-0.128*** (-4.19)	-0.069*** (-2.91)	-0.080*** (-2.76)	-0.108*** (-3.01)	-0.095*** -3.11	-0.086*** (-2.52)	-0.153*** (-4.10)
$\beta_1$	0.404*** (4.64)	0.364*** (4.18)	0.481*** (5.47)	0.157* (1.78)	0.139* (1.61)	0.172* (1.93)	0.084 (0.9)	0.259*** (2.97)
$\beta_2$	0.044 (0.5)	0.085 (0.97)	-0.027 (-0.31)	0.195** (2.18)	0.166** (1.91)	0.302*** (3.63)	0.192*** (2.41)	0.189** (2.17)
$\psi_1$	-0.006 (-0.10)	-0.049 (-0.85)	-0.102* (-1.74)	-0.098 (-1.60)	-0.036 (-0.56)	-0.019 (-0.33)	-0.018 (-0.30)	-0.001 -0.01
$\psi_2$	0.132** (2.32)	0.164*** (2.92)	0.174*** (3.25)	0.148*** (2.46)	0.137** (2.02)	0.085 (1.49)	0.113 (1.91)	0.111*** (2.54)
$R^2$	0.316	0.306	0.328	0.182	0.154	0.207	0.12	0.246

Note: \*\*\*/\*\*/\* represent significant at the level of 1%、5%and 10%respectively. T statistic is reported in the parentheses.

However, ISA and CSCE have some inequable aspects on the influence to China domestic sugar market. The common grounds are: price fluctuation in two world markets is the cause

of China domestic sugar price change; no short-run integrated relation exists between world market and Chinese market. Last weeks' price in Chinese main sugar producing area has positive influence on present price, while two weeks lag prices have influence on present price in distribution region. Compared with distribution region, the integrated degree is better between China's main producing area market and the world market. The difference is, Lag period price change in CSCE market might bring positive influence on China's domestic sugar market in short-term, but this is not true to ISA.

Because that the estimated coefficients of error correction items aren't significant, we don't show another VECM's estimation results, in these regression functions, independent variable is CSCE or ISA price series, dependent variable is China's sugar market price series. which also implies China's domestic market price fluctuation is not the cause of world sugar price change. As one of the world important sugar producing countries, China's domestic sugar price has little influence on world sugar price in short-term.

## **5. Concluding Remarks, Policy Implication and Further Discuss**

In this paper, we first use the Johansen co-integration method to examine whether a long-run co-integration relationship exists between main domestic sugar markets and between domestic and international sugar markets. We then use the error correction models (ECM) to analyses the likely short-run impacts of international sugar price fluctuations on China's domestic sugar market. Our study shows that there is a long-run co-integration relationship between domestic sugar markets, and between world sugar spot market and China's domestic sugar market. The world sugar market price tends to lead price changes in China's domestic sugar market. However, in the short run, changes in the world sugar price do not seem to have an immediate impact on the sugar price in China's domestic market.

Although China's sugar market and world sugar market are co integration, world sugar market price fluctuation wouldn't immediately transit to domestic market. However, once an impact occurred, China's major sugar producing markets would be shocked at first, subsequently, and the influence would spread to distribution market, for Chinese domestic markets are integrated. Sugar crops farmers' income would be influenced by unstable market price. Sugar crops (sugar cane and sugar beet) mostly plant in minority areas in the west of China, the farmer heavily depend on this cash crops, the income that came from sugar crops account for a larger proportion of the family's total income. On the other words, because per capital sugar consumption level is lower in China at present, glucide and other manufactured sweet taste account for quiet large proportion, and plus growing use of sugar as an ingredient in food and beverage products as well as an additive to foods and drinks, the impact from world market wouldn't be so serious.

We also employ same approach for testing the price co integration between China's local Nan Ning market and LIFFE NO.5 white sugar market, CSCE NO.11 raw sugar market from 1996 to 2003, data derived from USDA website. The results are similar to the present paper (not reported here). However, the novel thing is, when we adopt published CSCE NO.11 raw sugar futures daily closing price data in LIFFE website and Chinese sugar market price data

(China doesn't have sugar futures market yet, it is wholesale price) for testing possible co integration relationship and discoverer that no co integration relationship exists. In practise, spot sugar bargaining account for only a small proportion in world market. In China, most people take CSCE NO.11 raw sugar futures market price as reference. This paper finds out the co integration only exists between world raw sugar spot price market and China's sugar market. This is an interesting result; further study is essential to discern the matter.

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Appendix1 Co integration Test Results of Pair-wise China Major Sugar Markets

Sugar markets	Lag period	$\lambda$	$\lambda_{trace}$ (k=0)	$\lambda_{trace}$ (k≤1)	$\lambda_{max}$ (k=0)	$\lambda_{max}$ (k≤1)
<b>Jin Jiang</b>						
Zhan Jiang (0~12)	8	0.126	24.758**	1.478	23.279**	1.478
		0.009	(20.04)	(3.76)	(18.63)	(3.76)
Nan Ning (0~12)	4	0.211	34.917**	4.666	30.251**	4.666
		0.036	(20.04)	(3.76)	(18.63)	(3.76)
Dian Wei (0~11)	4	0.141	29.187**	2.221	26.966**	2.221
		0.013	(20.04)	(3.76)	(18.63)	(3.76)
Chong Qin(0~11)	4	0.176	36.262**	1.937	34.324**	1.937
		0.011	(20.04)	(3.76)	(18.63)	(3.76)
Guang Zhou(0~3)	3	0.149	25.929**	5.067	20.862**	5.067
		0.039	(20.04)	(3.76)	(18.63)	(3.76)
Shang Hai (0~12)	4	0.149	30.674**	2.033	28.640**	2.033
		0.011	(20.04)	(3.76)	(18.63)	(3.76)
Wu Han(0~11)	4	0.119	20.408**	2.009	22.399**	2.009
		0.011	(20.04)	(3.76)	(18.63)	(3.76)
Hei Fei (0~12)	4	0.161	27.205**	4.71	22.495**	4.71
		0.036	(20.04)	(3.76)	(18.63)	(3.76)
Zheng Zhou(0~12)	4	0.101	20.522**	1.784	18.738**	1.784
		0.01	(20.04)	(3.76)	(18.63)	(3.76)
XI An(0~12)	4	0.105	21.510**	2.027	19.577**	2.027
		0.011	(20.04)	(3.76)	(18.63)	(3.76)
Lang Fang(0~9)	4	0.109	22.033**	1.686	20.347**	1.686
		0.01	(20.04)	(3.76)	(18.63)	(3.76)
Chang Chun(0~2)	0	0.113	17.495*	1.691	15.804*	1.691
		0.013	(15.41)	(3.76)	(14.07)	(3.76)
WU Lumuqi (0~1)	1	0.114	23.012**	7.2	15.812*	7.2
		0.054	(20.04)	(3.76)	(14.07)	(3.76)
<b>Zhan Jiang</b>						
Nan Ning(0~1)	1	0.114	20.783**	4.941	15.842*	4.941
		0.037	(20.04)	(3.76)	(14.07)	(3.76)
Dian Wei (0~7)	3	0.108	22.444**	2.182	20.261**	2.182
		0.012	(20.04)	(3.76)	(18.63)	(3.76)
Chong Qing(0~3)	3	0.085	17.822*	2.088	15.734*	2.088
		0.012	(15.41)	(3.76)	(14.07)	(3.76)
GuangZhou(0~2)	2	0.105	19.360*	4.883	14.477*	4.883
		0.037	(15.41)	(3.76)	(14.07)	(3.76)
Shang Hai (0~12)	4	0.079	16.306**	1.882	14.424**	1.882
		0.011	(20.04)	(3.76)	(18.63)	(3.76)
Wu Han(0~12)	6	0.192	39.850**	2.026	37.824**	2.026
		0.001	(20.04)	(3.76)	(18.63)	(3.76)

**Cont.**

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He Fei (0~1)	1	0.11	20.099**	4.856	15.243*	4.856
		0.036	(20.04)	(3.76)	(14.07)	(3.76)
Zheng Zhou (0~12)	4	0.188	38.653**	1.782	36.871**	1.782
		0.01	(20.04)	(3.76)	(18.63)	(3.76)
XiAn (0~12)	4	0.183	37.678**	1.906	35.773**	1.906
		0.011	(20.04)	(3.76)	(18.63)	(3.76)
Lang Fang (0~12)	4	0.175	36.005**	1.961	34.005**	1.906
		0.011	(20.04)	(3.76)	(18.63)	(3.76)
ChangChun (0~2)	0	0.168	27.385**	3.058	24.327**	3.058
		0.023	(20.04)	(3.76)	(18.63)	(3.76)
WuLumuqi (1~2)	2	0.107	21.054**	6.384	14.670*	6.384
		0.048	(20.04)	(3.76)	(14.07)	(3.76)
<b>Nan Ning</b>						
Dian Wei (0~3)	3	0.128	23.574**	5.934	17.640*	5.934
		0.045	(20.04)	(3.76)	(14.07)	(3.76)
ChongQing (0~3)	3	0.112	21.138**	5.822	15.316*	5.822
		0.044	(20.04)	(3.76)	(14.07)	(3.76)
GuangZhou (0~4)	4	0.148	25.930**	5.425	20.506**	5.425
		0.042	(20.04)	(3.76)	(18.63)	(3.76)
Shang Hai (0~5)	5	0.146	24.278**	4.206	20.071**	4.206
		0.033	(20.04)	(3.76)	(18.63)	(3.76)
Wu Han (0~5)	5	0.107	18.042**	3.698	14.344**	3.698
		0.029	(20.04)	(3.76)	(18.63)	(3.76)
He Fei (0~4)	4	0.117	21.691**	5.74	15.951*	5.74
		0.044	(20.04)	(3.76)	(14.07)	(3.76)
Zheng Zhou (0~12)	4	0.16	27.915**	5.658	22.257**	5.658
		0.043	(20.04)	(3.76)	(18.63)	(3.76)
XiAn (1)	1	0.127	22.449**	4.613	17.836*	4.613
		0.035	(20.04)	(3.76)	(14.07)	(3.76)
Lang Fang (0~4)	4	0.109	20.423**	5.613	14.810*	5.613
		0.043	(20.04)	(3.76)	(14.07)	(3.76)
Chang Chun (0~2)	2	0.125	22.576**	5.195	17.381*	5.195
		0.039	(20.04)	(3.76)	(14.07)	(3.76)
Wu Lumuqi (1)	1	0.113	21.148*	5.425	17.836*	5.425
		0.041	(15.41)	(3.76)	(14.07)	(3.76)
<b>Dian Wei</b>						
Chong Qing (0~12)	4	0.195	40.778**	2.443	38.336**	2.443
		0.014	(20.04)	(3.76)	(18.63)	(3.76)
Guang Zhou (0~2)	2	0.118	21.564**	5.244	16.320*	5.244
		0.039	(20.04)	(3.76)	(14.07)	(3.76)
Shang Hai (0~12)	4	0.134	27.942**	2.559	25.384**	2.559
		0.014	(20.04)	(3.76)	(18.63)	(3.76)

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Cont.

Wu Han(0~10)	4	0.138 0.011	28.337** (20.04)	2.004 (3.76)	26.333** (18.63)	2.004 (3.76)
He Fei(0~3)	3	0.143 0.045	25.905** (20.04)	5.932 (3.76)	19.973** (18.63)	5.932 (3.76)
Zheng Zhou(0~12)	4	0.108 0.095	21.852** (20.04)	1.683 (3.76)	20.170** (18.63)	1.683 (3.76)
XiAn(0~12)	4	0.139 0.011	28.432** (20.04)	1.973 (3.76)	26.457** (18.63)	1.973 (3.76)
Lang Fang(0~12)	4	0.124 0.011	25.407** (20.04)	2.081 (3.76)	23.438** (18.63)	2.081 (3.76)
Chang Chun(0)	0	0.129 0.02	20.890** (20.04)	2.708 (3.76)	18.182* (14.07)	2.708 (3.76)
Wu Lumuqi	1	0.082 0.043	16.978* (15.41)	5.748 (3.76)	11.231 (14.07)	5.748 (3.76)
<b>Chong Qing</b>						
Guang Zhou(0~7)	4	0.172 0.043	29.795** (20.04)	5.585 (3.76)	24.210** (18.63)	5.585 (3.76)
Shang Hai(0~11)	4	0.168 0.012	34.597** (20.04)	2.119 (3.76)	32.478** (18.63)	2.119 (3.76)
Wu Han(0~8)	4	0.16 0.011	32.989** (20.04)	2.037 (3.76)	30.952** (18.63)	2.037 (3.76)
He Fei(0~8)	4	0.175 0.048	30.964** (20.04)	6.299 (3.76)	24.665** (18.63)	6.299 (3.76)
Zheng Zhou(0~12)	4	0.152 0.01	31.018** (20.04)	1.812 (3.76)	29.206** (18.63)	1.812 (3.76)
XiAn(0~12)	4	0.153 0.012	31.549** (20.04)	2.074 (3.76)	29.475** (18.63)	2.074 (3.76)
Lang Fang(0~12)	4	0.137 0.011	28.043** (20.04)	2.017 (3.76)	26.026** (18.63)	2.017 (3.76)
Chang Chun(0~5)	0	0.251 0.019	40.689** (20.04)	2.53 (3.76)	38.158** (18.63)	2.53 (3.76)
Wu Lumuqi(0~3)	3	0.123 0.054	24.112** (20.04)	7.199 (3.76)	16.913* (14.07)	7.199 (3.76)
<b>Guang Zhou</b>						
Shang Hai(0~4)	4	0.11 0.04	20.099** (20.04)	5.172 (3.76)	14.927* (14.07)	5.172 (3.76)
Wu Han(0~3)	3	0.167 0.035	28.185** (20.04)	4.615 (3.76)	23.571** (18.63)	4.615 (3.76)
He Fei(0~4)	4	0.106 0.036	18.937* (15.41)	4.635 (3.76)	14.302* (14.07)	4.635 (3.76)
Zheng Zhou(0~2)	2	0.105 0.037	19.056* (15.41)	4.86 (3.76)	14.197* (14.07)	4.86 (3.76)
XiAn(1)	1	0.104	19.360*	4.766	14.410*	4.766

Cont.

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		0.036	(15.41)	(3.76)	(14.07)	(3.76)
Lang Fang (0~3)	3	0.146	25.805**	5.205	20.600**	5.205
		0.039	(20.04)	(3.76)	(18.63)	(3.76)
Chang Chun (0~2)	0	0.168	27.359**	3.018	24.341**	3.018
		0.023	(20.04)	(3.76)	(18.63)	(3.76)
Wu Lumuqi (1~2)	2	0.108	21.531**	6.688	14.843*	6.688
		0.05	(20.04)	(3.76)	(14.07)	(3.76)
<b>Shang Hai</b>						
Wu Han (0~12)	4	0.155	32.006**	2.177	29.829**	2.177
		0.012	(20.04)	(3.76)	(18.63)	(3.76)
He Fei (0~12)	4	0.209	36.095**	6.101	29.994**	6.101
		0.047	(20.04)	(3.76)	(18.63)	(3.76)
Zheng Zhou (0~12)	4	0.115	23.289**	1.589	21.699**	1.589
		0.009	(20.04)	(3.76)	(18.63)	(3.76)
XiAn (0~12)	5	0.108	21.797**	1.759	20.038**	1.759
		0.01	(20.04)	(3.76)	(18.63)	(3.76)
Lang Fang (0~11)	4	0.138	28.077**	1.856	26.201**	1.856
		0.01	(20.04)	(3.76)	(18.63)	(3.76)
Chang Chun (0)	0	0.182	29.078**	2.503	26.575**	2.503
		0.019	(20.04)	(3.76)	(18.63)	(3.76)
Wu Lumuqi (0)	0	0.127	23.103*	5.167	17.936*	5.167
		0.038	(15.41)	(3.76)	(14.07)	(3.76)
<b>Wu Han</b>						
He Fei (0~3)	3	0.122	22.491*	5.677	16.814*	5.677
		0.043	(15.41)	(3.76)	(14.07)	(3.76)
Zheng Zhou (0~12)	4	0.134	27.267**	1.733	25.533**	1.733
		0.01	(20.04)	(3.76)	(18.63)	(3.76)
XiAn (0~12)	4	0.11	22.779**	2.142	20.637**	2.142
		0.012	(20.04)	(3.76)	(18.63)	(3.76)
Lang Fang (0~9)	4	0.143	29.043**	1.732	27.311**	1.732
		0.01	(20.04)	(3.76)	(18.63)	(3.76)
Chang Chun (0~4)	0	0.18	29.326**	3.063	26.263**	3.063
		0.023	(20.04)	(3.76)	(18.63)	(3.76)
Wu Lumuqi (3)	3	0.103	19.413*	5.227	14.186*	5.227
		0.039	(15.41)	(3.76)	(14.07)	(3.76)
<b>He Fei</b>						
Zheng Zhou (0~2)	2	0.11	19.608*	4.492	15.116*	4.492
		0.034	(15.41)	(3.76)	(14.07)	(3.76)
XiAn (0~3)	3	0.104	19.393*	4.856	14.190*	4.856
		0.039	(15.41)	(3.76)	(14.07)	(3.76)
Lang Fang (0~6)	6	0.128	20.794**	3.556	17.238*	3.556
		0.028	(20.04)	(3.76)	(14.07)	(3.76)

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**Cont.**

Chang Chun (0~1)	0	0.179 0.023	29.104** (20.04)	3.106 (3.76)	25.998** (18.63)	3.106 (3.76)
Wu Lumuqi (2)	2	0.106 0.04	19.927* (20.04)	5.358 (3.76)	14.570* (18.63)	5.358 (3.76)
<b>Zheng Zhou</b>						
XiAn (0~3)	3	0.098 0.01	20.005* (15.41)	1.737 (3.76)	18.268* (14.07)	1.737 (3.76)
Lang Fang (0~3)	3	0.08 0.011	16.856* (15.41)	2.048 (3.76)	14.808* (14.07)	2.048 (3.76)
Chang Chun (0)	0	0.16 0.025	26.305** (20.04)	3.271 (3.76)	23.034** (18.63)	3.271 (3.76)
Wu Lumuqi (2)	2	0.104 0.048	20.684** (20.04)	6.434 (3.76)	14.250* (18.63)	6.434 (3.76)
<b>XiAn</b>						
Lang Fang (0~4)	4	0.082 0.01	16.925* (15.41)	1.734 (3.76)	15.190* (14.07)	1.734 (3.76)
Chang Chun (0~1)	0	0.166 0.024	27.164** (20.04)	3.208 (3.76)	23.956** (18.63)	3.208 (3.76)
Wu Lumuqi (2)	2	0.104 0.048	20.684** (20.04)	6.434 (3.76)	14.250* (18.63)	6.434 (3.76)
<b>Lang Fang</b>						
Chang Chun (0)	0	0.181 0.029	30.195** (20.04)	3.884 (3.76)	26.311** (18.63)	3.884 (3.76)
Wu Lumuqi	3	0.089 0.04	17.271* (15.41)	1.734 (3.76)	11.966 (14.07)	1.734 (3.76)
<b>Chang Chun</b>						
Wu Lumuqi (0~1)	0	0.185 0.035	31.645** (20.04)	4.468 (3.76)	26.969** (18.63)	4.468 (3.76)

Appendix 2 Co integration Test Results Pair-wise CSCE and China Major Sugar Markets

	Sugar Market	$\lambda$	$\lambda_{trace}$ (k=0)	$\lambda_{trace}$ (k≤1)	$\lambda_{max}$ (k=0)	$\lambda_{max}$ (k≤1)
Major Sugar Producing Areas	Zhan Jiang (0~2)	0.16	22.900**	3.256	19.644**	3.256
		0.028	(20.04)	(6.65)	(18.63)	(6.65)
	Nan Ning (0~2)	0.136	19.852*	3.355	16.497*	3.355
		0.029	(15.41)	(6.65)	(14.07)	(6.65)
	Liu Zhou (0~2)	0.134	19.544*	3.35	16.195*	3.35
		0.029	(15.41)	(6.65)	(14.07)	(6.65)
	Dian Wei (0~1)	0.133	21.252**	3.901	16.248*	3.901
		0.034	(20.04)	(6.65)	(14.07)	(6.65)
	Wu Lumuqi (0)	0.163	20.556*	3.597	20.449*	3.597
		0.031	(15.41)	(6.65)	(14.07)	(6.65)
Major Sugar Distribution Regions	Jin Jiang (0~2)	0.13	19.207*	3.445	15.762*	3.445
		0.032	(15.41)	(6.65)	(14.07)	(6.65)
	Guang Zhou (0~2)	0.127	18.659*	3.336	15.323*	3.336
		0.029	(15.41)	(6.65)	(14.07)	(6.65)
	Chong Qing (0~1)	0.139	21.252**	4.255	16.997*	4.255
		0.032	(20.04)	(6.65)	(14.07)	(6.65)
	He Fei (0~1)	0.125	19.693*	4.425	15.268*	4.425
		0.038	(15.41)	(6.65)	(14.07)	(6.65)
	Zheng Zhou (0~1)	0.145	22.090**	4.254	17.835*	4.254
		0.037	(20.04)	(6.65)	(14.07)	(6.65)
	Xi An (0)	0.137	20.556**	3.684	16.873*	3.684
		0.032	(20.04)	(6.65)	(14.07)	(6.65)
	Lang Fang (0)	0.14	20.955**	3.65	17.305*	3.65
		0.031	(20.04)	(6.65)	(14.07)	(6.65)
	Chang Chun (0)	0.137	19.805*	2.798	17.007*	2.798
		0.024	(15.41)	(6.65)	(14.07)	(6.65)

Notes: \*/\*\*\*indicate we can reject null hypothesis at the 5% and 10% level, respectively. Numbers in parentheses under  $\lambda_{max}$  and  $\lambda_{trace}$  are critical value. Numbers in parentheses following each market are the lag periods that exists co integration.

Appendix3 Co integration Test Results Pair-wise ISA and China Major Sugar Markets

	$\lambda$	$\lambda_{trace}$ (k=0)	$\lambda_{trace}$ (k≤1)	$\lambda_{max}$ (k=0)	$\lambda_{max}$ (k≤1)	
Major Sugar Producing Areas	Zhan Jiang (0~2)	0.164	23.540**	3.331	20.209**	3.331
		0.029	(20.04)	(6.65)	(18.63)	(6.65)
	Nan Ning (0~2)	0.144	21.076**	3.523	17.553*	3.523
		0.031	(20.04)	(6.65)	(14.07)	(6.65)
	Liu Zhou (0~2)	0.156	21.864**	3.761	18.103*	3.761
		0.042	(20.04)	(6.65)	(14.07)	(6.65)
	Dian Wei (0~2)	0.13	19.566*	3.832	16.577*	3.832
		0.033	(15.41)	(6.65)	(14.07)	(6.65)
	Wu Lumuqi (0)	0.162	24.131**	3.862	20.269**	3.832
		0.033	(20.04)	(6.65)	(18.63)	(6.65)
Major Sugar Distributi on Regions	Jin Jiang (0~2)	0.135	20.040**	3.691	16.349*	3.691
		0.032	(20.04)	(6.65)	(14.07)	(6.65)
	Guang Zhou (0~2)	0.136	20.247**	3.67	16.577*	3.67
		0.032	(20.04)	(6.65)	(14.07)	(6.65)
	Chong Qin (0~2)	0.131	20.435**	4.632	15.802*	4.632
		0.04	(20.04)	(6.65)	(14.07)	(6.65)
	He Fei (0~1)	0.127	20.718**	5.235	15.483*	5.235
		0.045	(20.04)	(6.65)	(14.07)	(6.65)
	Zheng Zhou (0~1)	0.143	22.456**	4.849	17.607*	4.849
		0.042	(20.04)	(6.65)	(14.07)	(6.65)
	Xi An (0)	0.16	25.197**	5.185	20.013**	5.185
		0.044	(20.04)	(6.65)	(18.63)	(6.65)
Lang Fang (0)	0.156	24.351**	4.904	19.447**	4.904	
	0.042	(20.04)	(6.65)	(18.63)	(6.65)	
Chang Chun (0)	0.118	18.296*	3.887	14.409*	3.887	
	0.033	(15.41)	(6.65)	(14.07)	(6.65)	

Notes: \*/\*\*\*indicate we can reject null hypothesis at the 5% and 10% level, respectively. Numbers in parentheses under  $\lambda_{max}$  and  $\lambda_{trace}$  are critical value. Numbers in parentheses following each market are the lag periods that exists co integration.