International Linkages of the Chinese Futures Markets

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Abstract: The Chinese futures markets are among the fastest growing futures markets in the world. In terms of trading volume, the Chinese soybean futures market is the world's second largest, while China's copper and aluminum futures markets are the third largest in the world. The size of the Chinese futures markets, however, is not matched by the academic research on them. This paper is the first to study the relationship between the Chinese and world futures markets of copper, aluminum, soybean and wheat, using Johansen's cointegration test, error correction model, the Granger causality test and impulse response analyses. We find that the futures prices in the Shanghai Futures Exchange are cointegrated with the futures prices on the London Metal Exchange (LME) for copper and aluminum. We also find that a cointegration relationship exists for Dalian Commodity Exchange and Chicago Board of Trade (CBOT) soybean futures prices, but no such relationship for Zhengzhou Commodity Exchange and CBOT wheat futures prices. We further find that while LME has a bigger impact on Shanghai copper and aluminum futures, and CBOT a bigger impact on Dalian soybean futures, the Chinese futures markets also have a feedback impact on LME and CBOT futures. **Key words:** Futures Markets; Cointegration Test; ECM; Causality Test; Impulse Response Analysis. **JEL Codes**: G13, G15

Introduction

The objective of this paper is to understand the international linkage between the Chinese and world futures markets, in order to study the information spillover across Chinese borders. Futures markets fill two roles for economic agents: price discovery and risk management through hedging. Risk management refers to hedgers using futures contracts to minimize the risks of spot prices. Price discovery is the process by which information from one market spills over to another market. The speed of information spill-over across different markets is an important element for market efficiency. There are two forms of price discovery that have drawn researchers' attention. One is the process of revealing information about future spot prices through futures markets. The other is the information spillover across different futures markets, particularly among different nations. This paper is focused on the latter form of price discovery, studying the relationship between the Chinese and international futures markets.

Much of the empirical research on price discovery (Booth, So, and Tse, 1999; Garbade and Silber, 1983; David G. McMillan, 2005; Pattarin and Ferretti,, 2004; Pizzi, Economopoulos and O'Neill, 1998; Ryoo and Smith, 2004) has focused on investigating the relationship between futures and underlying spot prices. Surprisingly, very few studies have sought to understand the relationship between futures prices of the same underlying asset in different markets. Within this limited amount of research, Tse and Booth (1995) have found that prices of US Treasury bill futures and Eurodollar futures are cointegrated. Booth, Lee, and Tse (1996) have studied the relationship among the cross-exchange prices of Nikkei 225 Index futures that are traded on the Singapore International Monetary Exchange (SIMEX), London International Financial Futures Exchange (LIFFE), and Chicago International Money Market (IMM). They found that the prices of Nikkei 225 Index futures are cointegrated across all of these exchanges. Booth, Brockman and Tse (1998) have found a cointegration relationship between the prices of wheat futures contracts traded in the Chicago Board of Trade (CBOT) and the Winnipeg Commodities Exchange (WCE) of Canada. They have also found that the CBOT contract prices lead the WCE contract prices with no feedback.

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Since the inception of the Chinese futures exchanges in 1990, Chinese futures markets have grown rapidly and are now playing a significant role in the world commodity markets. The Shanghai Futures Exchange has the third largest copper futures market in the world and its trading volume in terms of tonnage almost rivals that of the New York Mercantile Exchange (NYMEX), the second largest copper market after the London Futures Exchange. China also has the world's second largest soybean futures market and third largest aluminum futures market. However, little research has been performed on Chinese futures markets. Only in the past few years have we seen the emergence of some studies. Wang and Ke (2002) tested the efficiency of the Chinese agricultural commodity futures markets. Hua and Chen (2003) studied the relationship between the prices of futures contracts and their underlying commodity contracts. This paper investigates the relationship between Chinese futures prices and their world counterparts. After years of development, the Chinese futures markets have matured and started to play roles in price discovery and risk management. As China is more integrated into the world economy and Chinese trade policy becomes more liberal, the relationship between the Chinese spot markets of various commodities and their world counterparts should strengthen. However, the relationship between the Chinese and world futures markets is poorly understood. While there are a priori reasons to expect the prices of Chinese and world futures contracts to move together, there are also reasons to expect otherwise, as there are still significant governmental and legal barriers. Studying such a relationship could shed light on the openness of the Chinese commodity markets and on the nature of cross-market information transmission. It could also provide important lessons for various market participants, including commodity traders, hedgers, arbitrageurs, exchanges and regulatory agencies.

Section II provides a brief description of the Chinese futures markets. In section III, we describe the data. Specifically, we select four commodity futures in the Chinese futures exchanges: aluminum, copper, soybean, and wheat. The Chinese aluminum and copper futures contracts are traded on the Shanghai Futures Exchange (SFE), soybean futures contracts on the Dalian Commodity Exchange (DCE), and wheat futures contracts on the Zhengzhou Commodity Exchange (ZCE). For the corresponding world futures, we use aluminum and copper futures contracts traded on the London Metals Exchange (LME), as well as soybean and wheat futures contracts traded on the Chicago Board of Trade (CBOT). In section IV, we test whether the Chinese and world futures prices are cointegrated. To shed light on how one market absorbs shocks from another, we also conduct a generalized impulse response analysis. Section V concludes.

I. Brief Overview of Chinese Futures Markets

There are three futures exchanges in China: the Dalian Commodity Exchange (DCE), Zhengzhou Commodity Exchange (ZCE), and Shanghai Futures Exchange (SFE). All three exchanges use electronic trading systems. Each exchange also maintains a trading floor, because orders must be input through trading terminals located on the trading floors to be matched by servers. Trades are then cleared by each exchange's clearing department. The trading systems all utilize high-capacity optical cables, dedicated data lines and two-way satellite to ensure real time, security and reliability of order processing. Table 1 shows the structures of the futures contracts of copper, aluminum, soybean and wheat traded in these three exchanges.

ZCE is China's first futures exchange, established in 1990. The Chinese government has approved four commodity futures contracts to be listed on ZCE, but only wheat and mung bean futures are currently traded. Wheat futures dominate trading on ZCE. Though China's tariff rate on wheat imports is set at a very low level (1% since 1999), its import quota is highly restrictive. To import wheat, one has to first apply for quota and a permit. All imports have to go through China National Cereals, Oils and Foodstuffs Import and Export Corp. Probably due to its restrictive trade policy, China became a net exporter of wheat in 2002.

Founded in 1993, DCE is approved for listing soybean, soybean meal and beer barley, but only soybean and soybean meal futures are currently traded. Soybean futures dominate trading volumes on

DCE, the largest futures exchange for non-genetically modified (non-GM) soybeans in the world and second only to the Chicago Board of Trade in terms of soybean (both GM and non-GM) futures trading volume. In 2002, the trading volume of soybean futures on DCE was over $250 billion, about 25% of the CBOT soybean futures volume but 7 times that of the third largest market, Tokyo Grains Exchange. China abolished its import quota on soybeans in 1996, but its export quota still exists. China is now the world's largest soybean importing country, while the U.S. is the largest soybean producer and exporter. Conditions in the U.S. soybean market, combined with U.S. agricultural trade policy, can presumably have a significant impact on soybean prices in the Chinese market. Therefore, it is reasonable to hypothesize that U.S. soybean futures prices can also influence Chinese soybean futures prices in a significant way.

Shanghai had six futures exchanges, each trading futures on metals, petroleum, building materials, chemicals, agricultural resources, and grains, until 1995, when they were consolidated into one: Shanghai Futures Exchange (SFE). Currently SFE only trades futures on aluminum, copper and natural rubber contracts. These commodities are regarded by the Chinese government as strategically important industrial inputs, and are thus subject to no import quotas or duties. Export of these commodities is still restricted, though export duties have been reduced significantly since 1999.

During the last ten years, the Chinese copper consumption has grown at about 2.4 times the world average. China is now the second largest copper consumer in the world. Consequently, the trading volume in terms of tonnage on the Shanghai Futures Exchange has grown to a level that almost rivals that of the New York Mercantile Exchange (NYMEX), the second largest copper futures exchange next to the London Metal Exchange (LME). In 2002, the trading volume of copper futures contracts in terms of tonnage on SFE was 57 million tons while NYMEX and LME were responsible for 63 million tons and 1,164 million tons, respectively. Prices of copper futures traded on SFE, together with the prices on LME and NYMEX, are now important indicators to copper mining companies around the world.

As with copper futures contracts, SFE ranks behind only LME and NYMEX in aluminum futures contracts. In 2001, China consumed about 3.4 million tons of aluminum, more than 50% of what the U.S. consumed, making China the world's second largest aluminum consumer. Aluminum production in China was 2.8 million tons, while production in the U.S. and Russia was 3.7 and 3.6 millions tons, respectively.

Table 1 Specification of Futures Contracts in China

Commodity	Copper cathode	Aluminum	Soybean	Wheat
Exchange	SFE	SFE	DCE	ZCE
Trading unit	5 tons/lot	5 tons/lot	10 tons/lot	10 tons/lot
Quotation unit	Yuan (RMB)/ton	Yuan (RMB)/ton	Yuan (RMB)/ton	Yuan (RMB)/ton
Tick size	10 yuan/ton	10 yuan/ton	1 yuan/ton	1 yuan/ton
Daily price limit	<3% of the previous settlement price	<3% of the previous settlement price	<3% of the previous settlement price	<3% of the previous settlement price
Contract months	Jan. – Dec.	Jan. – Dec.	Jan., March, May, July, Sept., Nov.	Jan., March, May, July, Sept., Nov.
Trading hours	9:00 – 11:30 AM 1:30- 3:00 PM	9:00 – 11:30 AM 1:30- 3:00 PM	9:00 – 11:30 AM 1:30- 3:00 PM	9:00 – 11:30 AM 1:30- 3:00 PM
Last trading	15^{th} of the spot	15^{th} of the spot	10^{th} of the spot	The last 7^{th}

day	month (postponed on holidays)	month (postponed on holidays)	month (postponed on holidays)	trading day of the spot month
Delivery period	16-20th of the spot month (postponed on holidays)	16-20th of the spot month (postponed on holidays)	7th day after the last trading day of the spot month	1st to last trading day of the spot month
Deliverable grades	Standard copper cathode, GB/T467-1997 copper+silver>99.95% Substitutions: 1. high grade copper, GB/T467-1997 2. LME registered brand, Cu-CATH-1, BSEN, 1978-1998	Aluminum ingot, GB/T1196-93, AL99.7, main ingredients>99.7% Substitutions : LME registered brand, P1020A	Identity preserved Non-GMO yellow soybean gradation tally with National Standard. Grade 3 Yellow at par.	Standard goods: Northern hard soft white winter wheat, grade two (GB1351-1999) Substitutions: Northern hard soft white winter wheat, grade one and grade three (GB1351-1999)
Delivery sites	Approved warehouse	Approved warehouse	Approved warehouse	Approved warehouse
Transaction margin	5% of contract value	5% of contract value	5% of contract value	5% of contract value
Transaction fee	<0.02% of the trading value	<0.02% of the trading value	RMB 4 yuan per contract	RMB 2 yuan per contract
Delivery method	Physical delivery	Physical delivery	Physical delivery	Physical delivery

II. Data

We identified aluminum, copper, soybean and wheat futures as useful examples for studying the cointegration relationship between Chinese and world futures markets. We chose prices of copper and aluminum futures contracts traded on LME and prices of soybean and wheat futures traded on CBOT to represent the world futures prices of each of our selected commodity contracts. Table 2 compares the opening and closing times of the Chinese futures exchanges with LME and CBOT. There are time difference between the trading times of LME or CBOT and the Chinese futures exchanges. While LME and CBOT are still trading futures, the three exchanges in China are closed already.[2]

Table 2 Opening and Closing Times of Exchanges

Exchange	Opening	Closing
SFE	9:00	15:00
DCE	9:00	15:00
ZCE	9:00	15:00
LME	19.55	1:00*
CBOT	23.30	3:15*

Note: The openings and closings of LME and CBOT have been converted into Beijing times. * refers to the next day.

[2] This will affect our analyses and will be clear in the next section.

Using daily closing futures prices for copper and aluminum contracts traded on LME and SFE, soybean contracts traded on CBOT and DCE, and wheat contracts traded on CBOT and ZCE, we constructed several continuous futures price series. For copper and aluminum, we used 3-month futures prices on LME. We also constructed a comparable time series for SFE in the following way. For a given trading month, called M, we collected the daily closing prices for a contract deliverable in M+3 month. On the first day of the next calendar trading month (M+1), we rolled over to the next contract deliverable in M+4 month. For example, if the calendar trading month was February, the daily closing prices of the contract deliverable in May were collected. On the first day of March, we rolled over to the daily closing prices of the contract deliverable in June; the daily closing prices of the contract deliverable in June were collected.

For the prices of soybean and wheat futures, we constructed a nearby futures price series. First, we identified the nearby futures contract, which is an actively traded contract with a delivery month nearest to the spot month. Then, we used prices for the nearby futures contract until the contract reached the first day of the delivery month. At that point, we used the prices of the next nearby contract. For example, the delivery months for the CBOT wheat futures contracts are March, May, July, September, and December.[3] Suppose we are currently in January. The nearby futures contract is the March contract, and we would use the daily closing prices of the March contract for our data. When it reaches the first trading day of March, we would then use the prices of the next nearby futures contract, the May contract, for our data. We used the nearby contracts because, in general, they are the most liquid and most actively traded contracts.[4] By constructing the nearby futures price series, we obtained a continuous time series of futures prices of soybean and wheat contracts traded on CBOT, DCE and ZCE.[5]

Our sample runs from January 5, 1998 to December 31, 2002.[6] We deleted non-matching data caused by holidays and non-trading dates in order to make the data of the Chinese and world futures prices comparable. In doing so, we obtained our data samples for copper, aluminum, soybean and wheat futures, with sample sizes 1189, 1178, 1171 and 1148, respectively.

We also consolidated the quotation units for our data. The quotation unit for copper and aluminum futures contracts traded on LME is US$/ton and the quotation units for soybean and wheat futures on CBOT are cents/bushel. All the Chinese futures contracts are quoted as RMB/ton. For consistency, we converted all the LME and CBOT quotation unit into RMB/ton.[7]

For convenience, we use S, D, and Z to refer to SFE, DCE and ZCE, and L and C to refer to LME and CBOT. Notations CU, AL, SS and WT refer to copper, aluminum, soybean and wheat. Thus, SCU indicates the price series of the copper futures contract in SFE. Similarly, CSS is the price series of soybean futures on CBOT. For convenience, we list all the notations in Table 3.

Table 3 Explanation of the Symbols

SCU	Copper futures on SFE (Shanghai Futures Exchange)

[3] The delivery months for the ZCE wheat futures contracts are January, March, May, July, September, and November. They are not exactly the same as the delivery months of CBOT for wheat futures contracts. Thus the constructed nearby futures price series for the wheat contracts are not exactly matched.
[4] This method of constructing nearby futures contract series can also be found in Yang, Bessler and Leatham (2001), Lee and Mathur (1999).
[5] The soybean futures contracts in CBOT deliver in January, March, May, July, August, September, and November, while in DCE deliver in January, March, May, July, September, and November. To be consistent, we construct the nearby futures price series based on the common delivery months: January, March, May, July, September, and November.
[6] Our data samples are collected from Shihua Financial Analysis Databank, which contains futures prices from both Chinese and non-Chinese futures exchanges.
[7] We used the daily exchange rate to convert dollars into the Chinese currency RMB yuan. The exchange rate between the dollar and the Chinese RMB yuan fluctuates within a very narrow band around RMB8.26 yuan/$. We also used 1 ton = 36.744 bushel to make all the units the same for these futures contracts.

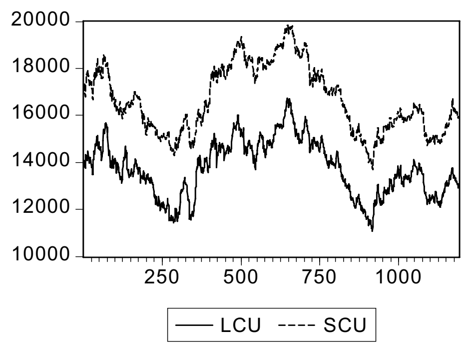
LCU	Copper futures on LME (London Metal Exchange)
SAL	Aluminum futures on SFE (Shanghai Futures Exchange)
LAL	Aluminum futures on LME (London Metal Exchange)
DSS	Soybean futures on DCE (Dalian Commodity Exchange)
CSS	Soybean futures on CBOT (Chicago Board of Trade)
ZWT	Wheat futures on ZCE (Zhengzhou Commodity Exchange)
CWT	Wheat futures on CBOT (Chicago Board of Exchange)

Because on any given day, the Chinese futures exchanges are closed when CBOT and LME are still open, the non-synchronous trading problem is always an issue. Following the suggestions of Booth et al. (1996), we construct two pairs of time series for each commodity to deal with this non-synchronous trading problem. For example, the first pair of time series for copper is SCU_t and LCU_t, where SCU_t and LCU_t are the futures prices of copper at day t traded in SFE and LME. The second pair of time series is SCU_{t+1} and LCU_t, where SCU_{t+1} is the t+1 futures price of copper in Shanghai. Our empirical analyses are conducted based on both pairs of time series.

III. Empirical Results

Figures 1 – 4 show price movement for futures contracts traded on the Chinese and selected world exchanges based on the first pair of time series.[8] The prices of copper, aluminum, and soybean futures contracts in China tend to follow their world counterparts

very closely. This cannot be said for the prices of wheat futures contracts.



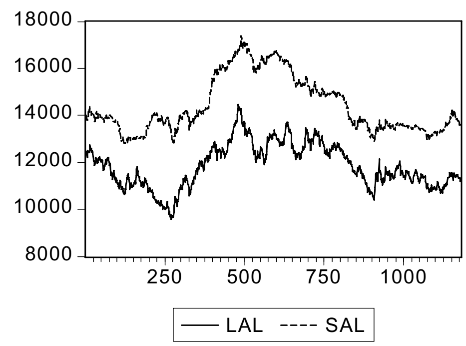
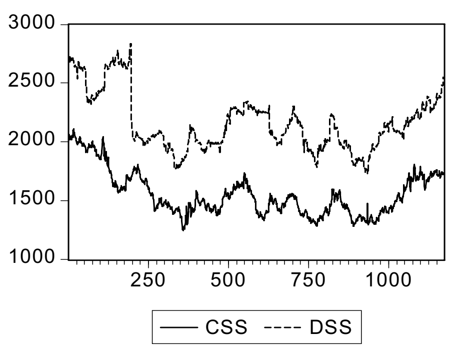
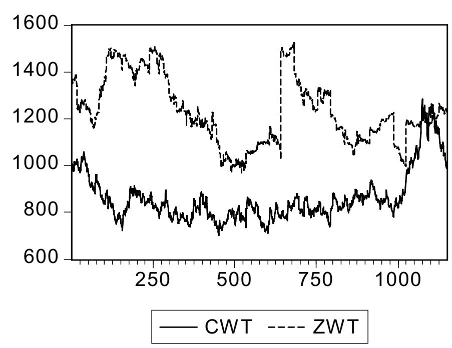


Figure 1 Copper Futures Prices Figure 2 Aluminum Futures Prices





[8] Notice that the price differences between the Chinese and non-Chinese futures prices can be quite large. For example, the difference between the SFE and LME copper futures prices on average is over RMB2000 yuan (approximately $250). The price differences are due to transaction costs, trade barriers, and financing costs.

Figure 3 Soybean Futures Prices   Figure 4 Wheat Futures Prices

Table 4 lists the correlation coefficients of the futures price changes in the Chinese and world markets. We find that the prices of the Chinese and world copper, aluminum, and soybean futures are highly correlated. There is little correlation between the prices of Chinese wheat futures and CBOT wheat futures.

Table 4 Correlation Coefficients

	First Pair	Second Pair
SCU and LCU	0.9633	0.9662
SAL and LAL	0.8405	0.8417
DSS and CSS	0.7485	0.7477
ZWT and CWT	0.0077	0.0098

Unit root tests

In order to perform the cointegration test, we first needed to determine the order of integration of each price series. We used the standard Augmented Dickey-Fuller (ADF) test to determine if the unit root existed in each time series. The ADF test for the null hypothesis of unit root tends to have low power against the alternative hypothesis of stationarity (Diebold, Husted and Rush, 1989). Thus, deciding whether a time series is integrated or not based on the Augmented Dickey-Fuller test may be inadequate. To address this inadequacy, we used a test developed by Kwiatowski, Phillips, Schmidt and Shin (1992).[9] This test (KPSS test) complements the ADF test for unit root by testing the null hypothesis of stationarity. By testing both the unit root hypothesis and the stationarity hypothesis, we were able to distinguish time series of futures prices that appeared to be unit root, series that appeared to be stationary, and series for which data were not sufficiently informative to be sure whether the series were integrated or stationary. Thus, using both the ADF and KPSS tests should make the findings of unit root in our time series more robust.

The results indicate that all the time series of futures prices are non-stationary, but that their first differences are stationary. This implies that all the futures prices follow the I(1) process. To increase the confidence in this conclusion, we next performed the test on the null hypothesis of stationarity against the alternative of nonstationarity.

The KPSS test results are consistent with the conclusions we reached with the augmented ADF test. Combining these two tests, we can confidently conclude that all the time series of futures prices follow I(1) processes. This conclusion makes the following cointegration test possible.

Cointegration test

Since all the time series of futures prices follow I(1), we could test the cointegration relationship between the futures prices of a contract traded in a Chinese exchange and the world futures exchange. The test shows the cointegration results given by the Johansen tests (Johansen, 1991) based on the first pair of time series. Our conclusion does not change if we use the second pair of time series. Both the λ_{trace} and λ_{max} statistics indicate that the Chinese futures prices of copper, aluminum, and soybeans are cointegrated with their world counterparts. However, we could find no

[9] The KPSS test statistic is calculated as $\eta_\tau = T^{-2}\Sigma^T_{t=1} S^2_t/S^2(L)$, where $S_t=\Sigma^t_{i=1}v_t$. v_t is the residual from a regression of the series on a constant and a linear trend. $S^2(L)$ is the consistent estimator of the "long run variance" $\sigma^2=\lim_{T\to\infty}T^{-1}E(S^2_T)$. It is given by $S^2(L) = T^{-1}\Sigma^T_{t=1}v^2_t + 2\Sigma^L_{s=1}w(s, L)T^{-1}\Sigma^T_{t=s+1}v_tv_{t-s}$, where w(s, L) is the weighting function that corresponds to the choice of the spectral window. We use Barlett's window of the form w(s, L) = 1 – s/(L+1), where L is the lag truncation parameter.

cointegration relationship for the wheat futures; the Chinese wheat futures prices do not seem to be cointegrated with the CBOT wheat futures prices. These results suggest that even though futures prices of copper, aluminum, and soybean are non-stationary and therefore in the short run the futures prices in the Chinese and non-Chinese exchanges can diverge, there is a long-term equilibrium relationship that binds the movement of the futures prices in these different markets. For the wheat futures, on the other hand, there is no such long-term equilibrium relationship.

Figures 5 and 6 show how the futures prices in one market respond to one standard error shock from the other market using the error terms in the error correction model.

When shocks from the LME copper futures market arrive, the response of the SFE copper futures prices is very strong in the following two trading days (figure 5). The impact of the LME shock on SFE copper futures diminishes after the third day. Though the impact rebounds after day four, it never recovers to the level of the second day. On the other hand, the response of the LME copper futures market to the shock from SFE diminishes significantly at the second trading day, though rebounds can be found in days three through six. These figures further prove that the LME and SFE copper futures markets mutually influence each other, and that there is a two-way feedback relationship between them. These figures also suggest that the response of the SFE copper market to a shock from LME is stronger than the response of the LME copper market to a shock from SFE. This implies that the LME copper futures market has a stronger influence than the SFE market.

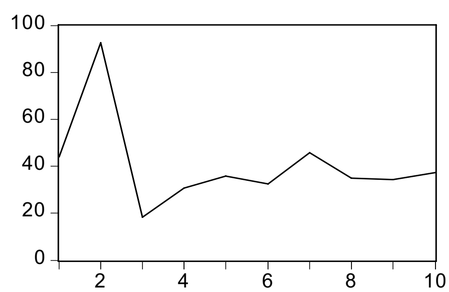


Figure 5 Response of SFE Copper to Shocks from LME Copper

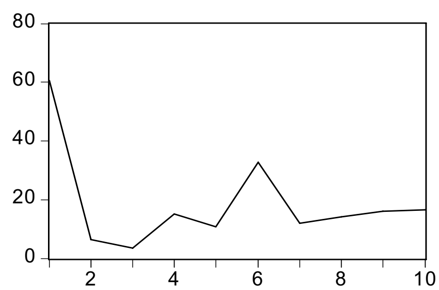


Figure 6 Response of LME Copper to Shocks from SFE Copper

The ECM and Granger causality tests for aluminum are based on the first pair of data. We found that at a 5% level of significance, only the coefficient of the error correction term, Z_{t-1}, in the LAL equation is significant, while the coefficient of the error correction term in the SAL equation is not significant. However, the coefficients $\alpha_{12}(i)$ (i=1,2) in equation (1) are significant. These results imply that the LME aluminum futures market leads the SFE aluminum futures market, and vice versa; each market influences the other market.

The ECM and Granger causality tests for soybean are based on the first pair of time series. We found that at a 5% level of significance, the coefficients of the error correction term, Z_{t-1}, in both the DSS and CSS equations are significant. However, the coefficients $\alpha_{12}(i)$ (i=1,2) in equation (1) and $\alpha_{21}(i)$ (i=1,2,3,4) are all insignificant. Thus there is a feedback relationship between the Dalian and Chicago soybean futures markets, though the feedback is mainly through the error correction term. This implies that investors may be able to predict price variations of soybean futures in both markets by simply observing the error correction term Z_{t-1}.

Figures 7 and 8 provide an intuitive view on how the futures prices in one soybean futures market respond to a shock from the other soybean futures market. We found that the soybean futures market in Dalian is more responsive to a shock from the CBOT soybean futures market at the second day after the "news" arrives. The impact of the CBOT shock on DSS diminishes after the third day. On the other hand, the impact of the DSS shock on the CBOT soybean futures market is relatively weak and diminishes immediately after the "news" arrives. These results suggest that the Dalian soybean futures market is more sensitive to "news" from CBOT, while "news" from Dalian has a very limited impact on CBOT soybean futures prices.

IV. Conclusion

China has the fastest growing futures markets in the world. Though these markets have grown in importance, they have yet to be intensively studied in academic circles. The purpose of this paper is to contribute to the research on these markets by investigating the relationships between the Chinese copper, aluminum, soybean and wheat futures and their world counterparts. Specifically, we attempt to shed light on the cointegration relationships between SFE (Shanghai Futures Exchange) and LMF futures prices of copper and aluminum, between DCE (Dalian Commodity Exchange) and CBOT futures prices of soybean, and between ZCE (Zhengzhou Commodity Exchange) and CBOT futures prices of wheat.

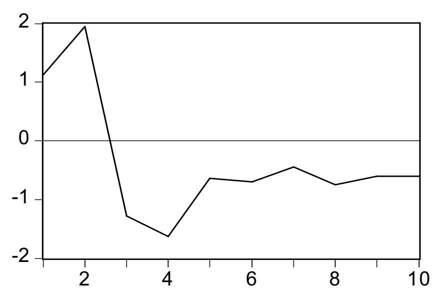


Figure 7 Response of DCE Soybean to Shocks from CBOT Soybean

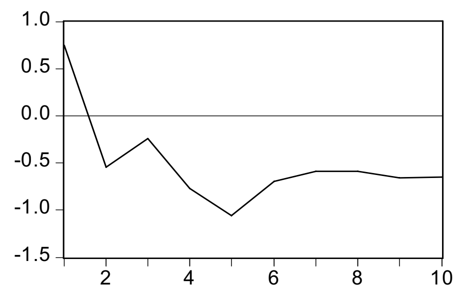


Figure 8 Response of CBOT Soybean to Shocks from DCE Soybean

The findings of this paper can be summarized as follows.

1. The futures prices of the selected commodities, copper, aluminum, soybean and wheat, traded in SFE, DCE, ZCE, LME and CBOT are not stationary.
2. There is a long run relationship between the SFE and LME copper futures prices. The SFE and LME copper futures markets influence each other. For the copper contract, the influence of LME on SFE is bigger than that of SFE on LME. These conclusions can also be made for SFE and LME aluminum contracts.
3. The price series of soybean futures traded in DCE and CBOT are cointegrated. As with copper and aluminum, the DCE and CBOT soybean futures influence each other. DCE soybean futures prices are more responsive to news from CBOT while news from DCE has limited impact on CBOT.
4. There exists no long run relationship between the ZCE and CBOT wheat futures prices.

We can infer the following implications based on these findings:

1. The Chinese copper, aluminum, and soybean futures markets are integrated with the world markets in the sense that there is a long run relationship between the Chinese futures prices of these commodities and their world counterparts. News from the world futures market can have a big impact on Chinese copper, aluminum and soybean futures prices. The results also dovetail the casual observations that the commodity markets of copper, aluminum and soybean in China are becoming more open, as China has abolished import quotas and reduced the import tariffs to almost insignificant levels.
2. The wheat futures prices of the world market have limited impact on Chinese wheat futures prices.

The Chinese wheat futures prices are more likely to be determined by domestic demand and supply conditions. This is consistent with the observation that imports and exports of wheat are highly restricted with high tariff rates and quotas in China.

3. To the hedgers, it may be possible to hedge Chinese copper or aluminum futures contracts with an LME copper or aluminum contract, and to hedge the Chinese soybean with a CBOT soybean contract over a long hedging horizon. Short term hedging using either LME or CBOT contracts may not be very effective, as Chinese futures prices may deviate from their world counterparts in the short run.
4. To the market makers and speculators in world copper and aluminum markets, news from the Chinese futures markets should be taken seriously. As the Chinese futures markets are growing rapidly and shock from the Chinese markets impact the world's futures, news affecting Chinese copper, and aluminum will increasingly become an important factor in influencing the price movement of copper and aluminum in LME.

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