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PRICE DISCOVERY INVESTIGATION BETWEEN THE CHINESE SOYBEAN AGRICULTURAL FUTURES AND SPOT MARKETS

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ABSTRACT

Currently, the Chinese soybean market is the 2nd largest soybean market around the world in terms of trading volume and growth opportunities. However, the number of relevant academic researches is not sufficient to investigate the fast growing Chinese futures markets. This thesis investigates the price discovery function and cointegration relationship between the soybean spot and futures markets in China from 2009 to 2013. The analysis in this thesis is conducted by using daily data. In the empirical results, lead and lag relationship between spot and futures is demonstrated. Besides, heteroskedasticity test, ADF unit root test, cointegration test, vector error correction model (VECM) estimation, and Granger causality test are conducted in sequence. In addition, impulse response function and variance decomposition are illustrated. The comprehensive results show that cointegration relationship does exist between the soybean spot and futures markets in China, and unidirectional causality between the markets is identified. Futures tend to Granger cause and price discovers spot, though spot suggests insufficient evidence to Granger cause and price discover futures.

KEYWORDS: Futures, Spot, Chinese soybean market, Price discovery, Cointegration relationship, Granger causality.

1. INTRODUCTION

The futures market has been playing highly important role in the ever-developing economy during the world's economic evolution. Futures market is regarded as one of the most important modern financial market compositions in the present world. Currently, since China is the largest developing country as well as the second economy in the world in terms of the Gross Domestic Product (GDP), it can be indicated that the development of the Chinese markets has significant impact on the world's markets system. Besides, as futures markets play important roles in the world's markets, it is of highly significance to investigate the performance with respect to futures and its corresponding markets (the spot markets) in China. In particular, price discovery function and cointegration relationship between the Chinese futures and spot markets need to be investigated. In this chapter, the thesis will describe purpose of the study, and it will also illustrate the background behind this.

1.1. Purpose of the thesis

To the best of my knowledge, this thesis will be the first research to examine price discovery function and cointegration relationship between the soybean futures and spot markets in China by using Engle and Granger (EG) cointegration approach as well as the Dynamic Simultaneous Equation Models (DSEM) from year 2009 to 2013. The thesis intends to investigate the existence of price discovery function and cointegration relationship between futures and spot markets of soybean in China. Besides, the degree of interactive market impact exerted by both markets to each other will also be illustrated

The research question for the thesis is "do cointegration relationship and Granger causality exist between the soybean futures and spot markets in China?" The main null and alternative hypotheses are illustrated as follows.

H_0: Cointegration relationship and Granger causality do not exist between the soybean futures and spot markets in China.

H_1 : Cointegration relationship and Granger causality do exist between the soybean futures and spot markets in China.

1.2. Background

The efficiency of the futures market has always been the key issue which determines price discovery function efficiency between futures and spot markets. Previously, many scholars examined the efficiency of Chinese futures markets. Xu (1995) was one of the earliest scholars who studied the efficiency of Chinese futures market. The research motivated many other scholars to focus on futures market studies. Ouyang (2012) examined the market efficiency in the Chinese soybean futures market by using nonlinear unit root estimation. The results of the study suggested that the soybean futures market in China was at weak form of the market efficiency level. It was indicated that linear return rate and unit root process existed in the market, the results were presented based on the examination of the smooth transition threshold approach in unit root test. Wei and Gao (2012) investigated the price deviation between dominant contracts and other related contracts in Chinese futures markets. Lu (2003) indicated that the inherent strength of futures markets could offset the inherent defects of spot markets. Similarly, price discovery function and hedging could also offset the inherent defects of spot market. In addition, the futures market played significant roles in explaining long-run cointegration relationships between the markets. He, Zhou and Wen (2011), examined price discovery function efficiency of the cointegration relationship between futures and spot in Chinese zinc markets. Furthermore, Xiao and Wu (2009) compared the microstructure of futures market with that of the spot market, which indicates the fact that the distinctions on microstructure between Chinese futures and spot markets exist.

However, as Chinese futures market has been only emerging for a few years, the studies regarding Chinese futures and spot markets are quite limited. Since the previous studies have not yet examined the price discovery function efficiency of cointegration relationship between Chinese soybean futures and spot markets, this thesis will examine the lead and lag relationship between Chinese soybean futures and spot markets. It can be concluded that it is important to examine price discovery function and cointegration relationship between the markets since futures and spot prices frequently vary over time.

The futures market has two functions. These functions are price discovery and hedging. Specifically, price discovery is the premise of hedging. If price differences exist between futures and spot markets, arbitrage can adjust the differences to the equilibrium level, this refers to the fact that the prices of futures and spot can converge (Merton 1999: 48-49). As a result, it also makes the arbitrage strategy difficult to perform. In addition, in order to exert high efficiency performance of price discovery and hedging functions, futures markets must be established based on the fact that they are efficient, it is indicated that only if the futures markets perform efficiently can the changes of spot price be accurately reflected by that of the futures. For spot markts, in this case, the delivery price with respect to certain commodity can be accurately predicted by its corresponding futures price (Fama 1997: 3-7). By following this theorem, futures markets can provide either market traders or investors with valuable market speculation accurately. Hence, futures markets can only reflect the real price level when the market is efficient.

Moreover, it is also important to explain the distinctions between futures and spot markets in China. Spot refers to commodities that can be traded, stored and put into use for manufacturing. The real commodities available for delivery can be transferred into cash based on either immediate delivery or future delivery in spot markets. All the transactions implemented in spot markets must be accomplished with the action of immediate delivery. Spot markets differ from futures market in terms of delivery. For futures markets delivery, date of delivery can be determined by certain forward date in the future. Thus, it can be obviously concluded that futures markets are different from spot markets. The real commodities which used for trade are transacted in spot markets. Whereas, the future contracts and the financial instruments transactions still take dominant position from the whole prospect of business transaction activities. (Lu 2003: 35-36).

Furthermore, the phenomenon of low trading volume and low market liquidity in futures markets need to be notified as well. Restricted by the policies, only few commodity varieties have high market liquidity. Most of the other commodity varieties are rarely traded. This prevents price discovery function from running efficiently in Chinese futures markets. (DCE, www.dce.com.cn/)

Besides, characteristics of Chinese futures and spot markets need to be introduced. Firstly, futures markets with Chinese characteristics need to be illustrated. Low volume of trading commodity varieties must be mentioned. There are 12 varieties of commodities in the Chinese futures market in total, but only 7 of them are tradable. Unbalanced development process exists between the Chinese economy and its corresponding markets. (Lu 2003).

Secondly, characteristics of the Chinese spot markets also need to be described. As the standard to enter spot markets in terms of equity is low, this low amount of investment fund requirements attracts many investors to come to the markets for profits. Besides, it is easy to enter a trade for all the investors due to the existence of t+0 delivery policies. This policy indicates that investors are able to perform buy and sell actions on the same day without time limitation. The investors do not have to wait until the next day to execute different trading strategies. (Lu 2003).

It has been investigated that 20% margin trading system has been implemented in the Chinese spot market. In this case, funds enlargements effects have been magnified, this effect has given rise to high volatility when trading volume is high. Thus, there are theoretically more potential opportunities for investors to earn profits. (DCE, www.dce.com.cn/)

Bilateral trade system can be used by all investors in the agricultural produce spot markets. Bilateral trading indicates the approach that can be conducted either by selling (short position) or buying (long position). Investors have possibilities to earn profits by using both these trade strategies. It is necessary to be indicated that there is one significant difference between spot and stock markets in China. In stock markets, investors can take only long position to earn profits, in other words, they can only buy the stock when there is an increase in terms of price. However, if the stock price decreases, investors cannot conduct the trade but have to expect the price to increase. Whereas, investors in spot markets can take both short and long positions freely. The transaction frequency in agricultural spot markets is quite high. Hence, this gives rise to high volatility in terms of spot price changes and also increases arbitrage opportunities. (DCE, www.dce.com.cn/)

On the other hand, the reason why soybean is applied to this thesis needs to be demonstrated. The origin of the soybean comes from China and it is also the most important bean kind in the world. The soybean variety in Chinese spot and futures markets accounts for not only the highest amount of trading volume but also the highest level of market trading liquidity. In this case, the research can be conducted in an efficient way by using just soybean samples instead that of any other commodities. Besides, the soybean contains high economic value. It is not only edible but also can be used in industries as raw materials for manufacturing. (DCE, www.dce.com.cn/)

There are many external markets which affect the price of soybean futures besides the Chinese market itself. These important external markets are: downstream product market of soybean futures, genetically modified soybean market and soybean market in Chicago Board of Trade (CBOT). (CBOT, www.cmegroup.com/)

The soybean meal and oil are soybean’s downstream products. These are the soybean’s main consumption products in the whole world. Due to the reason that the direct consumption volume of soybean is not considered as major volume of the total consumption, the price change of soybean meal and oil may impose substantial impact on price of the soybean. The price change of rapeseed and maize oil can cause price change in soybean oil. For example, the decrease of production yield in rapeseed oil can cause the soybean price to change in a positive way. (DCE, www.dce.com.cn/)

The genetically modified soybean also needs to be taken into consideration. The soybean futures contracts in the market of Dalian Commodity Exchange (DCE) are divided into two different varieties: the soybean contract No.1 and No.2. Soybean contract No.1 refers to the non-genetically modified soybean, and contract No.2 refers to the genetically modified soybean which includes the universally produced soybean. These two varieties of soybean futures contracts are competitors against each other to some extent, it can be assumed that the price quotations from these two contracts are cointegrated. (DCE, www.dce.com.cn/)

Soybean futures market in CBOT from the U.S. has major impact on the prices in the worldwide soybean futures market. If the amount of the soybean imported from other countries to China is more than two-thirds of the total volume capacity, the price change of soybean futures in CBOT will have significant impact on that of the Chinese domestic soybean futures markets. (CBOT, www.cmegroup.com/)

The remainder of this thesis is organized as follows. Chapter II will describe literature review. Chapter III will illustrate the theory related to the general futures markets as well as the futures and markets of Chinese characteristics. Chapter IV will describe the data used in the empirical analysis. It will contain information regarding the data source, attributes, frequency, method of collection, and number of observations. Chapter V will describe the methodology which is used in the empirical analysis. Chapter VI will discuss the empirical results.. Finally, chapter VII will conclude all the empirical results for thesis, which is followed by the references.

2. LITERATURE REVIEW

Many researchers have conducted the investigation of cointegration relationship between specific economic variables in the past few years. Garbade and Silber (1983) have indicated that cointegration relationship exists between futures and spot markets. It has been implied that the efficiency of futures market is also influenced by this relationship. If the price discovery function of the futures market conducts in an efficient way, the consequences leading futures and spot markets to respond to new information will be quite similar. In other words, under the condition that the price discovery function reflects the real price level of the market, the price movements of the futures and the spot markets will drift towards the same direction.

It can be assumed that there is long-run equilibrium relationship between futures and spot markets. Engle and Granger (1987) have examined the equilibrium relationship by using extended cointegration and error correction models. Johansen and Juselius (1990) argued that problems may be encountered if long-run economic models were used during the estimation procedure. The purpose of this estimation is to test long-run efficiency of the equilibrium relationship. Cheng (2006) has estimated the equilibrium relationship between the Chinese copper futures and spot markets by using cointegration analysis. The study has indicated that equilibrium relationship does not exist between the Chinese copper futures and spot markets. Yin, Ke and Huang (2012) have studied the equilibrium relationship between the price of real estate and land price based on Granger causality test for Changsha, China. Qu, Zhuang, Su and Guan (2011) have investigated the futures discovery function on gold, oil, silver, aluminum and copper by applying to correlation analysis, the Granger test, the EG two-step test, Johansen cointegration test, the impulse response function and the variance decomposition. It has been indicated from the tests that the futures leads the spot in short term, but not in long term. Cointegration relationship does not exist in gold futures and spot markets. Futures leads spot in the short term, and cointegration relationship does not exist between futures and spot with respect to silver, oil, aluminum and copper. Ma, Wang and Feng (2011) have discovered the risk spillover effect between soybean futures and spot markets in China. It has been indicated that there is causal relationship existing between the futures and the spot markets. This relationship cannot be explained by external markets, and therefore, indicating that risk spillover effect existing between futures and spot markets must be reflected by domestic market. Liu (2006) has examined the equilibrium relationship between futures and spot markets in China by applying to the dynamic simultaneous equation model (DSEM) (Min and Najand 1999: 222-223) and the vector autoregressive model (VAR) (Du and Zhang 2011).

Besides, many researchers have used stationarity test to examine the stationarity for time series models before they have estimated equilibrium relationship by cointegration analysis. Dickey and Fuller (1981) have examined their presented likelihood ratio statistics with unit root test. Du and Zhang (2011) have used Augmented Dickey-Fuller (ADF) unit root test to examine the stationarity for the VAR model.

Moreover, some other scholars have studied efficiency of futures markets extensively from other prospects. Xiao and Liu (2008) have examined the efficiency of soybean futures markets by testing three different hypotheses: price stabilization effect, cooling off effect and volatility spillover effect. Ye and Yu (2012) have examined the external factors which affect the efficiency of futures markets by using principal component analysis, the findings have indicated that the short-term price changes in the soybean futures market is affected mainly by two external factors: global factors and substitution factors. Hua and Zhong (2002) have investigated Chinese futures market based on the price discovery function with respect to copper and aluminum in Shanghai Futures Exchange (SFE).

Wang and Zhang (2005) have investigated the issue regarding hedging efficiency of Chinese futures markets. They suggest that the hedging ratio of nonferrous metal futures exceeds that of the agricultural futures. Specifically, it is indicated by this study that ECHM and EC-GARCH models account for more information in measuring the hedging ratio efficiency in metal futures products than that of agricultural futures products. Similarly, Chi and Yang (2009) have analyzed the arbitrage model which leads to optimum hedging effect based on lowest risk in futures market. It is demonstrated that the model established in this study accounts for more evident information in hedging. Besides, the degree of Chinese market efficiency has also been investigated. Based on the studies contributed by Hogan, Jarrow, Teo and Warachka (2004), Wu and Chen (2007) have introduced the concept of arbitrage with respect to statistical instruments. The study has implied that efficient market and arbitrage conflict against each other. This leads to the conclusion that the weak form of market efficiency does exist in the Chinese A-share market.

Similarly, Wei and Gao (2012) have argued that the China Securities Index (CSI 300) futures only have unilateral arbitrage regime compared to that of the foreign bilateral arbitrage. Relationship between long-term anomalies regarding abnormal return and market efficiency has been studied by Fama (1997). The study has indicated that the long-term anomalies of return is weak and unstable, it changes with respect to the method which is applied to estimation.

Many other foreign scholars also have investigated the relationship between futures and spot markets. Before the time period when cointegration theory has not been proposed, several foreign scholars have already examined this relationship by conducting econometric analysis. Kawaller, Koch and Koch (1987) have preliminarily studied the lead and lag relationship between futures and spot markets. They have depicted the cointegrated relationship in price volatility between futures and spot markets from S&P500 indexes by using simultaneous equation model. Moreover, Ordinary Least Squares (OLS) has been used by them as the analytic methodology to accomplish the regression model estimation. It has been denoted that both the price coefficients from futures ans spot markets are highly significant. In this case, it can be indicated that both futures and spot markets price exert impact on each other and the simultaneous information transfer does exist across the two markets. Besides, according to the study, they also have confirmed that the variables in lead and lag relationship commonly exist across futures and spot markets. It has been suggested that futures market leads spot market evidently in terms of volatility information transfer and spillover effect. Furthermore, Kaverwaller, Koch and Koch (1993) have confirmed that futures and spot markets tend to be cointegrated when the markets prices move dramatically. The speed that futures and spot respond to the same information is the same in this case.

Approaches used for the study of relationship between futures and spot markets had been applied before the theory of cointegration was proposed. The approaches were Ordinary

Least Squares (OLS) and Autoregressive Moving Average (ARMA) model. For the study regarding regression analysis, autocorrelated variables were applied to the models in lead and lag forms. One of the most important assumptions in traditional econometrics analysis was that the data used for regression analysis must be stationary. At that time, however, the scholars did not pay much attention to the degree of stationarity in their economic and financial data collection. Instead, it was assumed that all the economic and financial data sets were stationary and they followed the normal distribution. The scholars used OLS and ARMA methods to regress the data sets which were not stationary. This approach used by all the scholars had been prevalent in the past until the theory of stochastic unit root process was applied to the research, and the concept of time series analysis was proposed. For time series analysis, the selection of analytic approaches depends on the degree of stationarity of the data sets. The application limitation of econometric study is that the stationarity of data sets must be tested first in order to conduct cointegratioin analysis.

After the cointegration method had been proposed by Granger in 1982, the Error-Correction Model (ECM), which based on cointegration and VAR theories, was proposed. For now, as these models account for much information related to equilibrium relationship between markets, they have become the most important and efficient approaches in studying the price discovery function. The first case which applied cointegration theory to the investigation of futures markets was in year 1991. Bessler and Covey (1991) applied Johansen Maximum Likelihood estimation to conduct cointegration analysis of young cattle futures in U.S. futures market. Lai and Lai (1991) applied Engle-Granger cointegration analysis to examine the cointegration relationship between spot and forward exchange markets. Chowdhury (1991) examined the price relationship of non-ferrous metal between futures and spot markets in U.S. It was indicated in this study that futures market had evident price lead advantages against spot market. Wahab and Lashgari (1993) found that futures market led spot market in both S&P 500 and FTSE 100 markets. Besides, the efficiency that spot market led futures market was also evident in terms of price volatility. Brockman and Tse (1995) examined the agricultural futures markets from Canada. Furthermore, Kim, Szakmary and Schwarz (1999) examined the composite index futures from MMI and NYSE. Booth, So and Tse (1999) examined the DAX index futures in Germany. Min and Najand (1999) studied futures markets in KOSPI 200.

The Chinese commodity futures market has been opening for over ten years. However, the contribution of the study related to the relationship between futures and spot markets is not abundant. Zhang and Li (1994) have analyzed the price relationship between futures and spot among Chinese green soybean markets. The conclusion of their study indicates that the volatility in futures and spot markets are strongly related to each other. The earliest study of cointegration theory regarding futures market research was conducted by Wu and Wang (1997). They examined cointegration relationship in Chinese futures and spot cooper markets by using Granger causality test and other relevant analysis. Yan and Liu (1999) examined cooper and green bean varieties in Chinese futures markets by using cointegration analysis and ECM model. They proposed the conclusion that different commodity futures exert different lead and lag relationship on their corresponding commodity spot. Wang, Jiang and Wu (2001) studied the price relationship between futures and spot markets in Shanghai Stock Exchange by using ECM. According to their finding, lead and lag relationship was confirmed to exist in futures and spot cooper. In terms of price for spot cooper, the causal effect caused by futures cooper is not evident. Hua and Zhong (2002) have also done studies similar to that of Wang, Jiang and Wu.

It can be indicated from the studies in China that the research regarding cointegration relationship between markets is still developing, and its development has just begun. Although methodologies in foreign study have been applied to corresponding domestic fields, thet are still used only in ordinary approaches in general.

3. DESCRIPTION OF CHINESE FUTURES MARKETS

During the process of economic development, human being has strengthened social productivity. Besides, social responsibility has also been diversified, and the varieties of labor have been divided. Afterwards, production of commodities has become the most common approach of social economy growth. Many varieties of products have entered the commodity market as source for consumption. The emergence of production commercialization and business marketalization indicate the emergence of market economy. The development of market economy relies on the degree of maturity in spot and futures market. In order to study the long-term equilibrium relationship between futures and spot markets, the development condition in Chinese domestic markets need to be illustrated. Specifically, the features of futures and spot markets in China will be interpreted. （Xu 1993: 9)

The emergence of futures market in China is the inevitable result of the economy transformation. This economy transformation stage starts from the planned economy stage to market economy stage. Furthermore, the development of the Chinese futures market indicates the degree of improvement and maturity for Chinese market economy. The regime of economy development and resource allocation in market economy system has to be supported by operation of matured market system. This indicates that both spot and futures market need to be developed simultaneously. On one hand, the feature of spot market should be fully used. , Specifically, the short-term transaction in spot market can be fully used to support the daily transactions in the market. The economy opertation efficiency can also be guaranteed in this case. On the other hand, the price discovery and hedging function in futures market can be fully used to supplement its corresponding spot market. Thus, the emergence and development of futures market is closely related to that of Chinese market economy. It can be concluded that the stable development of futures market has positive impact on the development of the Chinese market economy. （Xu 1993: 9-10)

Futures market in China started to emerge in the early 1990s. Its emergence was directly caused by the “reform and open up” policy in China. The policy was released by the

Chinese government in 1980s. During the stage of reform and open up, the degree of transformation caused by development of market economy was substantial. Due to the reason that original Chinese market could not adapt to this volatile change, it suggested that certain new market was needed in order to adapt to the changes. Thus, futures market emerged, and it consolidated the operation of economy and market resource allocation for spot market. Specifically, four factors were regarded as initial factors which stimulated the emergence of futures market. They were market enterprise system, pricing system, liquidity system, and foreign trade system. (Xu 1993: 12-14).

Market enterprise system stimulated the emergence of futures market. Futures market helps enterprises to avoid price volatility risk. The price discovery function in the system implies the price information, which is transferred from the market. This helps enterprises to make their corresponding adjustments related to pricing and production. Besides, the efficiency of hedging function in futures market provides enterprises with approach to diversify price volatility risk. Thus, futures market can serve the enterprises significantly in positive manner. On the contrary, the development of enterprises can also stimulate the emergence of futures market. Before the reform and opening up policy is released, all the Chinese enterprises operate under the ownership of the whole public, in other words, the enterprises are owned by the whole Chinese people. The production and management of the enterprises are strictly controlled by the government under the regime of Chinese planned economy. (Xu 1993: 14)

Actually, the enterprises at that time were not real enterprises, they did not participate any market economic activities. Thus, the enterprises were not responsible for any risk related to profit or loss. Systematic restructuring project for enterprises was released by the government since 1980s. This project suggested that varieties of enterprise restructuring were recruited by many new economic components. Specifically, the enterprises were divided into two varieties according to distinct formation of ownerships. These two kinds of enterprises are nationalized enterprises and private enterprises. Nationalized enterprises were still owned by the government and they did not have to undertake any risk in profit or loss. However, for the private enterprises, all the risk related to profit or loss have to be undertaken by themselves instead of the government. The modification of the ownership property changed the Chinese enterprise system essentially. For example, the nonnationalized enterprises, such as collective enterprises and joint-venture enterprises were not controlled by the government directly. For enterprises which were not operated by the government, they had to undertake their own risk in business. Furthermore, when the enterprise system reform progressed into depth to maturity, the degree of support and protection given by the government declined gradually. As a consequence, nationalized enterprises started to be exposed to the threat in operating risk eventually. (Chen 1995: 51-52)

To sum up, the enormous change of the market regime has forced the domestic enterprises to take serious consideration into operating risk. Hence, the demand for risk diversification and hedging has increased intensively.

Pricing system stimulated the emergence of futures market. The Chinese pricing reform went through 3 stages as a whole. These 3 stages are state-adjusted pricing reform stage, double-track pricing reform stage (the coexistence stage of state fixed price and market price), and the actual execution stage of the market pricing reform. Since year 1978, the Chinese government started to conduct pricing system reform. The initiative was to adjust the planned price for the government administration. But this measure did not change the unreasonable pricing problems in China fundamentally. In this case, the government began to conduct the double-track pricing reform, and the reform released almost all the price regulations for commodities. (Zhang 1993: 10-11)

This stage enhanced the development of production significantly. However, the measure of pricing system release did not suggest that the pricing system reform was accomplished. Whether the pricing system reform was accomplished or not depended on the reaction efficiency of market information towards price volatility in commodities. In other words, after the pricing system reform was accomplished, the market was efficient enough to react to price changes in the market comprehensively, timely and accurately. The reform indicated that market with price discovery and forward price expectation functions needed to be formed. Besides, spot market also needed its corresponding futures market to form the forward price. Therefore, the emergence of futures market was highly expected. (Zhang 1993: 10)

Liquidity system stimulated the emergence of futures market. During the long-term pricing system reform, the long-term execution of double-track pricing system had significant impact on the liquidity system. Due to the reason that state-fixed pricing and market pricing existed simultaneously in the double-track pricing system, the phenomenon of transformation from planned pricing to market pricing became a problematic issue. Enormous pricing differences existed between planned and market pricing, and for the enterprises which were in charge of commodity production, they had to conduct their production plan by following two different pricing standards. However, as the enterprises did not have one unified pricing standard to follow, many varieties of agricultural and industrial commodities were highly volatile in terms of pricing. Besides, large amount of unethical and illegal transactions were also revealed in the market. The market regulation was quite chaotic. Hence, both price discovery and hedging functions were needed to solve this issue, and the emergence of futures market is highly demanded. (Zhang 1993: 10)

Foreign trade system reform stimulated the emergence of futures market. As the reform and opening up policy continued, the Chinese economy attempted to open its new approach for development. From the beginning of 1980s, The Chinese coastal area started to develop the special economy zone and economic development zone. Large numbers of foreign enterprises began to invest their business in China, and large varieties of international trading approach were introduced. The enterprises in China began to become more internationalized than ever. This phenomenon led to the consequence that the enterprises specialized in international trading relied much more on international market than they used to. Thus, these enterprises also had to encounter the risk given rise to by the international market. Gradually, the Chinese economy would rely more on export. The risk and challenge undertaken by the Chinese domestic enterprises increased substantially, and all the risk caused by internationalization needed to be taken into serious consideration by enterprises during the development progress. To conclude, in order to adapt to the foreign market, the Chinese futures market needed to be developed. (Zhang 1993: 11)

The emergence of futures market is motivated by 2 potential reasons. The 1st reason is that demand for futures market establishment is intensive. The 2nd reason is that when Chinese spot market becomes matured, it can lay solid foundation on the establishment of futures market. Besides, the preparations for the establishment of futures market are carefully conducted by Chinese government. Finally, the start-up of Zhengzhou grain wholesales market stimulates market economy to boom. On the other hand, futures trade mechanism is introduced and adopted by the market. This event indicates that Chinese futures market is established, and the development of futures market has successfully completed all the four stages required by market economy transformation. These four stages are spot experimental unit stage, futures experimental unit stage, rectification stage, and planning and development stage. (Xu 1993: 12-13)

The spot experimental unit stage started from 1990 to 1992. During this stage, the spot market exchange was preliminarily established, and varieties of futures trade system were introduced afterwards. In addition, many other exchange markets were consecutively established. These exchange markets were Zhengzhou grain wholesales market, Beijing futures commodity exchange, Shenzhen nonferrous metal exchange, Wuhu rice wholesales market, and Jilin corn wholesales exchange market. The responsibility of all these markets was to provide the public with forward contract services regarding spot commodity exchanges. Besides, the forward contract exchanges in these markets were also efficiently and strictly supervised. Thus, the orderly market regime for futures exchange could be formed gradually. (Zhang 1993: 8-9)

Futures experimental unit stage started from 1992 to 1994. During this stage, the orderly operation of spot market laid solid foundation on establishment of futures market exchange. Since 1992, futures market exchanges in China were continuously established during the following three years. The general pattern of Chinese futures market was formed gradually. After the agricultural commodity trials in spot market became successful, futures exchanges related to industrial raw materials also became prevalent. Many futures exchanges offering industrial-related exchanges were established. These markets were Shenzhen nonferrous metal exchange, Shanghai metal exchange, Suzhou supplies exchange, and Tianjin metal exchange. Simultaneously, several agricultural spot exchange markets also accomplished the transformation from spot commodity exchange to that of the futures. Hence, the Chinese futures commodity market developed rapidly during this stage. (Zhang 1993: 8-9)

Rectification stage started from 1994 to 1999. As the Chinese government had insufficient administrative and development experience in operating futures market during this time, many underlying effects and phenomenons occurred, and these underlying effects gave rise to negative impact on the construction of Chinese futures market. Typical examples of the negative underlying phenomenons were blind construction and overheating development. Besides, large amount of wasted sources were caused by massive establishment in futures exchange markets. In addition, insufficient regulation of the law caused many speculative transactions to occur in futures markets. Thus, the order of futures markets operation was violated. For this, the Chinese government began to rectify the futures market in the end of 1993. In terms of the following 6 years, the Chinese Securities Regulatory Commission had totally confirmed 15 futures exchange in the whole country. Eventually, 15 futures exchange were confirmed to be established in different cities. The final 3 futures exchanges were Zhengzhou Commodity Exchange, Shanghai Futures Exchange and Dalian Commodity Exchange. The number of tradable commodity varieties is 12. (Zhang 1993: 8-10)

Specification and expansion stage has stated from 1999 and it lasts until today. Chinese futures market has been developing steadily during the 21st century. The trade scale and volume have become higher than ever. Simultaneously, various contracts of futures commodities have become matured for transaction. Currently, it has been indicated that futures market in China has been closely connected with spot market. As official regulatory system has been established by the government, the professional staffs who work in the fields of futures and spot can also be supervised and regulated.effectively. Hence, it is evident that the Chinese futures market has become more matured during its development progress. (Zhang 1993: 9-10)

The analysis of futures trade system in China is also of vital importance. Futures trade system has been formulated during the transaction operation process in the 3 major Chinese futures exchanges. Among the whole trade system, many subordinated systems have been divided and specified in detail in order to contribute regulatory power to futures market transactions. These subordinated systems are membership system, deposit system, standardized futures contract system, public bidding transaction system, price volatility limit system, large trading position limits and reporting system, settlement system, information disclosure system, and finally, physical delivery system. The responsibility for all these subordinated systems is to minimize the potential transaction risk with respect to price volatility in transaction competition, The other responsibility of the systems is to guarantee the efficiency and security of operation for the Chinese futures markets. (Zhang 1993: 9-10)

The membership system is the futures transaction system, and it is only valid for futures exchanges inside the membership criteria. According to the regulation, the professional eligibilities and qualifications for transaction dealers are identified and evaluated. The evaluation on futures exchanges can facilitate the administration and supervision for dealers' transactions. By conducting the membership system, the divisions of diversified transaction dealers can be classified more efficiently by futures exchanges. All the dealers are assigned to execute specified transactions respectively in terms of different transaction varieties, volume and place. The dealers who do not have eligibilities of transaction executions are assigned to other occupations which are conductable. Besides, the regime of membership system can also be used to control the transaction scale of hedging and market speculation. Currently, the membership system has already been executed in Chinese futures exchanges comprehensively. (Zhang 1993: 10)

Moreover, the standardized futures contract system also has significant impact on the whole transaction system in Chinese futures market. The criterion differing futures, spot, and forward spot markets from each other is the standardized contract. In particular, both spot and forward spot markets do not have contracts which are as standardized as that of futures market. In terms of futures contract, all the specifications related to transactions are identified. These specifications include accurate regulated transaction scale, quality level, delivery time and place, minimum quotation and value of unit change, price volatility limit, transaction fee, and contract title. (Zhang 1993: 11)

Furthermore, the security deposit system needs to be emphasized. The responsibility of this system is to secure the interests for the transaction parties. Both right and obligation terms are included in futures contract. The terms are binding according to the law. Thus, common transactions for futures contract can be assured, and the transaction parties' interests can be protected. For obligations of transaction responsibilities, they are also controlled by the system. The security deposit system in Chinese futures market is divided into 4 parts. The 4 parts are security-based deposit, transaction deposit, delivery deposit, and risk fund. Security-based deposit is the risk reserve fund which needs to be paid when the transaction members obtain the qualification of trade and settlement. The risk reserve fund is saved into the transaction members' accounts. In case that the transaction security deposit is insufficient, this amount of deposit can be paid by the risk reserve fund, and the payment is executed by its corresponding futures exchange. The transaction deposit is the mortgage payment paid by the members during transactions. The mortgage payment is charged at 5% to 20% level from the whole amount of transaction. The delivery deposit is the mortgage deposit which secures real commodity delivery process. The amount of delivery deposit is relatively higher than that of transaction deposit. Risk fund is the fund raised by futures exchange. The fund is charged from the transaction members and is used to hedge unpredictable risk emerged from futures markets. (DCE, www.dce.com.cn)

In addition, the public bidding transaction system should be underlined. The transaction approaches of futures contract can be classified into 2 divisions from international level. These 2 divisions are real traders' competition and automatic bidding via computer. For now, automatic bidding is applied to all of the 3 futures exchanges in China. It enhances trade efficiency and liquidity for futures contract transactions. (DCE, www.dce.com.cn)

4. THEORIES OF FUTURES MARKETS

In this chapter, the thesis firstly describes the futures market in general. Secondly, it illustrates hedging strategies in futures. Thirdly, it introduces origin and function of futures markets; finally, it demonstrates the significances in studying cointegration relationship between futures and spot markets.

4.1. Futures

Futures contracts are agreements which are reached by two parties in order to conduct asset transactions at certain future time by certain price. The contracts specify certain standardized provisions which are relevant to transactions, and these provisions are binding on the transaction parties. Futures transactions are conducted in futures exchange markets. The responsibility for the exchanges is to find the pair parties that are interested in conducting futures transactions with each other. In addition, it also provides the parties with security policies which allow them to secure their transactions. Therefore, the futures transactions can be conducted steadily. (Hull 2008: 6).

Many exchanges in the world can prepare the futures contracts trade for parties that intend to find their partners. It is noteworthy that Chicago Board of Trade (CBOT) and Chicago Mercantile Exchange (CME) are the 2 largest futures contracts exchanges in the world. The other important exchanges for futures are: New York Board of Trade (NYBOT), New York Mercantile Exchange (NYMEX), Hong Kong Futures Exchange (HKFE), Sydney Futures Exchange (SFE), Eurex (EUREX), and Tokyo Financial Exchange (TFX). (Hull 2008: 6).

The underlying assets corresponding to futures contracts include several of commodities and financial assets. These commodities can be agricultural products, such as cotton, wheat. They also can be livestock, such as cattle and hogs, or they can be industrial products, such as crude. Metals such as gold, copper are also included in the criterion of commodities. In terms of financial assets, currencies and stock indices are typical examples. (Hull 2008: 6).

The trade price used by the parties, which excludes commissions, is determined and quoted by the exchange. If on September 1, for instance, the December futures price of gold is quoted as $680, this is the price that traders agree to buy or sell gold for December delivery (Hull 2008: 6). In order to become the pair traders, the parties must take opposite trade positions (i.e., if one takes long position, the other should take short position). Generally, if the majority of traders take long positions, the price increases, and if the majority of traders take short positions, the price decreases. (Baxter and Rennie 1996)

There are generally three types of traders in futures markets. Futures contract is used by hedgers to reduce the risk, futures is also used by speculators to predict market future movements. (Hull 2008: 15-16) For arbitrageurs, they use futures to create profit. Thus, it can be indicated that futures is of vital importance in financial markets. (Baxter and Rennie 1996)

Besides, as specifications can directly affect trade execution for the parties, the specifications for futures contracts should be mentioned in detail.. In general, exact and detailed context relevant to transaction between the parties should be specified by the exchange. Specifically, the variety of underlying assets, and the exact amount of the assets to be delivered (contract size), together with the exact delivery time and place, should be specified in the contracts. In terms of the contract size, the specification regarding the amount of assets to be delivered under each contract is supposed to be revealed. It is one of the regulations determined by the exchange. (Hull 2008: 23)

The contract size can be either large or small. Traders intending to hedge only small risk exposure may be unable to conduct the trade if the contract size is very large. This is because they only prefer to take small amount of trade positions for the underlying asset in order to hedge small risk exposure. On the other hand, the trade cost can be very high for each contract based on the small amount of contract size (Hull 2008: 24.)

The delivery month is also important. The exact time for delivery during the month is supposed to be specified by the exchange. Delivery period can last for the whole month for many future contracts. For instance, the delivery months for corn futures on Chicago Board of Trade are March, May, July, September and December. (Hull 2008: 24) In addition, the place for delivery is necessary to be notified. Particularly, it is important for traders to notify the delivery place for contracts that contain large amount of logistics cost. The place where delivery occurs should be specified by the exchange. For example, in terms of New York Board of Trade (NYBOT), the delivery place for frozen concentrate orange juice contracts is the exchange-licensed warehouses in Florida, New Jersey, or Delaware (Hull 2008: 24.) Moreover, the quotes of price need to be specified. The price quotes are determined by the exchange. For example, on the New York Mercantile Exchange (NYME), crude oil prices are quoted in dollars and cents (Hull 2008: 25.)

Furthermore, price and position limits for futures should be illustrated.. The daily price movements are restricted and specified by the exchange For example, if the price decreases compared to the previous day's closing price, and the amount of the price decreased is equal to the amount of daily price limit, then the contract is called "limit down". (Chance 1994). If the price increases by the amount of daily price limit, the contract is called "limit up". In other words, the move is defined as "limit move"， which either increase or decrease by the amount of daily price limit. Once the contract is limit up or down, the trade stops under usual circumstances. (Baxter and Rennie 1996)

Moreover, it is important to indicate the price relationship between futures and spot. Futures price is more likely to move towards spot price when the maturity dates of the delivery approaches. Futures price is supposed to be equal or close to its corresponding spot price if the delivery date is due. (Hull 2008: 26).

4.2. Hedging strategies in futures

The basic strategies in hedging are long and short hedges. In the long hedge, companies or individuals take long positions in futures contracts. In other words, they promise to buy certain assets in the future at certain fixed price on today. In the short hedge, companies or individuals take short positions in futures contracts. In other words, they determine to sell certain assets in the future at certain fixed price on the same day. For example, one soft drink company determines to sell 200 boxes of soft drink to the local retailer. Contracts are reached by the parities signifying that the soft drink company can conduct short hedging by expecting to deliver the drinks tomorrow at 9 a.m. Short hedge can also be applied if the assets are not obtained currently, but will be obtained later. (Hull 2008: 46-47)

For either company or individual, the purpose of hedging is to maximize the degree of neutralization, and to reduce the risk as much as possible. For example, a company expect to obtain $8,000 each time when the underlying asset price increases by each 1 cent during the next 2 months, and lose $8,000 each time for each 1 cent decrease in the price on the asset during this 2 months. In this case, the hedging can be conducted by using short futures position. The short position is supposed to cause loss of each $8,000 for each 1 cent increase in the price on the asset, and to cause profits of each $8,000 for each 1 cent decrease in the price on the asset. The duration for hedging and trade should be exactly the same. (Hull 2008: 45-46)

4.3. Cause and function of futures market

Applying to the market economy, the market adjustments have been playing significant role in controlling social economy activities. The determination concerning production management decision-making and social allocation of resources has exerted dominant impact on market price changes to some extent. All the economic activities in the markets are, in fact, determined by the most basic discipline of principles in economics, and this principle implies the relationship between demand and supply. In addition, the social production and exchange activities that depend on price volatility impact from the market also vary frequently,. This factor has objectively, exerted certain risk and opportunity on social production and exchange activities. Taking social exchange activity as an example, it is supposed that if two parties involved in certain transaction, and these two parties are denoted as the party A and B respectively, then, it is obvious to indicate that the risk that party A undertakes, on the other hand, becomes the opportunity for party B. The exchange activities of the social commodity are accomplished in the process of the conflict transformation between risk and opportunity. (Hull 2008: 6).

By using the development of the commodity economy, the scale of production is increasing enormously.Meanwhile, market space is continuously expanded and the structure of consumption enhances frequently. These factors can always affect the extent of implied risk which caused by commodity exchange. With the ever-increasing opportunities emerging, the ever-increasing risk in commodity exchange is also focused on by the rational investors. It can be implied that implied volatility of price changes also tends to increase the transaction risk substantially when opportunity increases. (Lu 2003: 35-36).

Although the investors may reduce transaction risk by signing and following guaranteed contract legally during the process of transactions in spot market, they are eager to find the variety of commodities which allows them to discover the prices in the future by conducting buy and sell strategies. By using this approach, the impact that prices affected by risk in the process of transaction can be decreased. Thus, the variety of forward contract with pre-buy and pre-sell strategies emerges. This contract can be merchandised publicly by the investors under certain standardized regulations, and the contract can be merchandised in substantial amount. The contract is called “futures contract”. This contract indicates that one party shall be capable of completing the delivery obligation in the future. Whereas, both buyer and seller have rights to release their futures contract obligations before the expiration date by hedging and transferring their contracts, and these actions can be done without obtaining permission from the other party. The places where the futures contracts are transferred or hedged become the futures exchange markets. Besides, the prices of the futures contracts settled by competition and transaction are called futures market price. The environment of the commodity transaction has become matured than ever due to the establishment and maturity of the futures market. On the other hand, the market structure has been strengthened. Futures market can be depicted as the supplementary part of spot market. The functions that futures markets possess are price discovery and hedging. (Wang and Zhang 2005: 20-25).

Hedging denotes the circumstance in which investors may execute certain offset transaction strategy via futures and its corresponding spot market in order to minimize or eliminate the risk caused by price volatility and fluctuations. Specifically, investors can buy and sell certain variety of commodity with the same amount simultaneously in both spot and futures markets. If an investor buys commodity A with the amount of B in spot market, in order to offset the transaction risk caused by price volatility, this person should sell commodity A with the amount of B in futures market. Likewise, if this person sells commodity A with the amount of B in spot market, the purchase of commodity A with the amount of B in futures market can be used to offset the risk that has been undertaken in spot market. The hedging function of futures market has provided spot market with new approach to minimize transaction risk or to execute risk transfer (DCE, www.dce.com.cn). For the futures market, speculative transactions have taken dominant possession of futures market instead of risk hedging activities. The speculative investors are profit-oriented persons who are also willing to undertake high potential risk for the profits earned by transactions in futures market. In this case, the transaction activities with substantial volume and high liquidity always exist in futures market. Simultaneously, futures market price is also universally reflected under real price volatility circumstances, and each transaction executed by speculative investors affects the formation of the real commodities price. Furthermore, futures market price volatility is not as sensitive as that of spot market. Thus, the hedging function of the futures market can be fully used and developed.

Why speculative investors are willing to take transaction risk in future market? Because the investors assume that there will be price deviation existing between futures and spot markets. It is possible that arbitrage strategy can be manipulated. For example, time effect can cause price deviation. In another case, lead and lag relationship can be implied by price discovery function of futures market (Hull 2008: 11-14). Price discovery function refers to the process that certain news announcement is absorbed by several interrelated markets, thus, the information will give rise to corresponding changes of the market transaction with respect to the price. The new information emerges stochastically from the market. Thus, when a dealer obtains certain new information, the corresponding action to this new information will be affected by this information as well. The degree that this dealer is affected by the information depends on the transaction behaviour of this person, and the transaction performance will be reflected directly by the market transaction price. This is the process which the price is discovered by the market. If the whole process proceeds smoothly, for each market that absorbs new information, the influence exerted on market by information and the act of market information response will occur synchronously. This is denoted as the strong form of the efficient market hypothesis (EMH) , which has been proposed by Fama (1970). However, it has been known that the real market condition cannot reach this strong efficient level. Furthermore, there is also circumstance existing, indicating that the speed which certain market price reacts to new information is often faster than that of the other markets. Garbade and Silber (1979) have denoted the market with price discovery advantages as the "dominant market", other markets interrelated to the dominant one are referred to as the "satellite markets". The dominant market reflects new information via the market price modifications and the other satellite market prices are considered as references to the dominant market price. In terms of the market price volatility and the speed of information transfer, lead and lag conditions exist in both dominant and satellite markets. Additionally, it has been investigated that long-term equilibrium relationship exist between dominant and satellite markets in terms of the price. In the short term, the price volatilities from the dominant and satellite markets affect each other and their reactions towards new information almost converge. In the long term, however, price volatilities relationship between these two markets is illustrated as lead and lag relationship. This relationship remains unchanged through time as cointegration relationship.

There is close relationship existing between futures and spot markets. Thus, the equilibrium relationship has always been focused on by the scholars as investigation issue. Besides, varieties of lead and lag relationships between futures and spot markets shall be taken into consideration. These varieties are: futures market leads spot market, spot market leads futures market, futures and spot markets lead each other , and finally, futures and spot markets do not lead each other (Liu 2006: 38-39).

The equilibrium relationship between futures and spot markets is of vital significance,. However, it is difficult to analyze the economic variables with any technique because economic variables are defined as non-stationary time-series variables. On the other hand, as Granger (1987) has proposed the theory of cointegration, new approach has been developed to deal with non-stationary time-series variables. The innovation of this new approach stimulates further studies to reach unknown knowledge thoroughly. The research results contributed by cointegration theory also have highly important significance for the development in futures and spot markets. Its importance can be denoted as the following three aspects. Firstly, it helps to examine the performance of price discovery function in futures market under condition of divergent trade systems. In other words, the performance of price discovery function in futures market can be affected by different trade systems. Secondly, it helps to examine the speed deviation of information transfer under condition of different market structures in futures market. This indicates that when the same new information comes to futures markets with different structures, the speed of the information transfer in different market structure can be different. The speed of the information transfer is affected by the market structure condition in the futures markets. Finally, it helps to examine the efficiency of price correction caused by arbitrage strategy, and simultaneously, it helps to analyze the effect of price discovery function caused by transaction behaviour (Liu 2006: 39-41).

The investigation of long-term equilibrium relationship on prices between futures and spot markets can help to examine the performance of price discovery function in futures market under the condition of different trading systems. In those futures and spot markets which are matured, the relative transaction costs and transaction limits of futures and spot are key factors that determine price discovery function performance in futures and spot markets. For futures market itself, transaction cost is directly affected by trade system. In addition, futures transaction also becomes limited due to the constraint in trade system. The examples of constraints are limits such as deposit system, settings of transaction fee, capital gain taxes collected from futures transactions, regulation of maximum trade volume and variety restrictions for individual and corporate investors. Substantial distinctions exist between newly-emerging futures market and matured futures market in trade system (DCE, www.dce.com.cn). Both market regulations and trade systems vary from field to field and they have their own regional features. The strength and defect of different transaction systems can be identified by the study results from price discovery function. Thus, the performances of different trade systems can be analyzed.

The study of long-term equilibrium relationship between futures and spot markets helps to examine and analyze the speed differences for new information transfer under conditions of different market structures. These studies identifies the strength and defect for the varying market structures and also reflects the degree of efficiency for the market information transfer among distinct market structures. Compared to trade system, the futures market structure exerts direct impact on price discovery function. (Xiao and Wu 2009: 93-94).

The study of long-term equilibrium relationship between futures and spot markets helps to examine market price correction effect caused by arbitrage strategy, and it also helps to analyze the degree of impact exerted by transaction behaviour on price discovery function. Arbitrage strategy is the important mechanism which maintains consistency of price discovery function between futures and spot markets. The price equilibrium relationship between futures and spot markets can be accounted for by mathematical model containing factor of transaction costs. If there is no market friction, and the prices of futures and spot markets differ from the value explained by the model, then investors can conduct arbitrage strategy by using reverse transactions respectively from futures and spot markets. Thus, risk-free profit can be obtained by this hedging transaction. The phenomenon of arbitrage strategy completion reflects that the market price correction modification is completed. It indicates that if new information is absorbed by certain market, the price volatility also changes. Simultaneously, the arbitrage behaviour transfers the information to the other markets, forcing the original price in this market to change. The change of the market price adjusts the price of both markets to the equilibrium level. If the arbitrage behaviour cannot be conducted in time, there is no approach to transfer price variation information from dominant market to price from satellite markets. This gives rise to lead and lag relationship in these 2 markets. (Xiao and Wu 2009: 93-94).

4.4. The necessities of long-term equilibrium relationship study between futures and spot markets in China

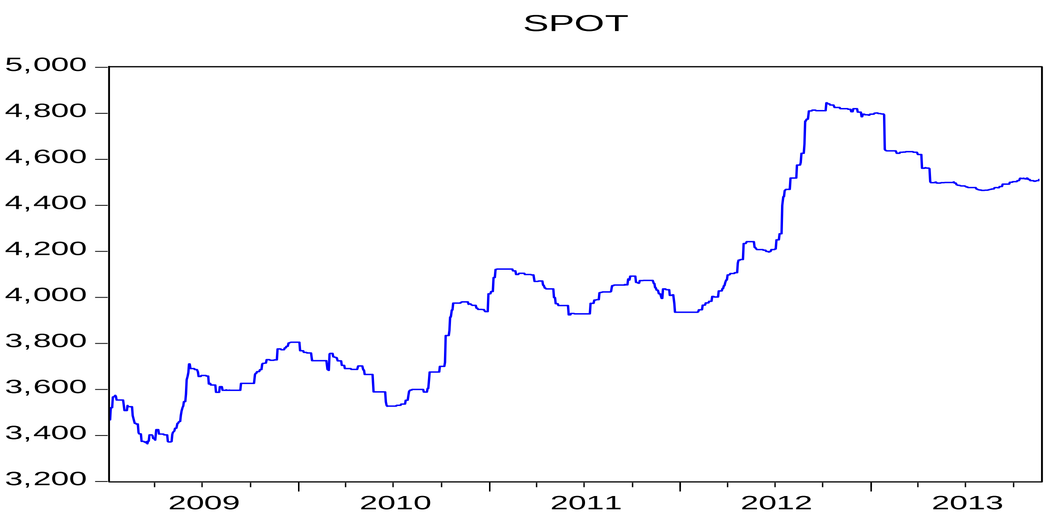
The hedging and price discovery functions of futures market impose significant positive impact on enhancing the market price volatility stabilization and it also helps spot market to survive from transaction risk suppression. As the Chinese economy has been developing under the process of transformation from planned to market economy, it is apparently understandable that the relationship of demand and supply can be affected by degree of marketalization. The variation possibility of spot market price volatility can increase substantially when affected by discipline of the market demand and supply as well as the law of value. For certain unmatured market itself in China, high level of price volatility risk can even be more detrimental. Besides, the matured futures markets in any other developed countries have more developed operating systems than that of in China. In terms of futures markets in developed countries, all the functions of futures market itself can be fully used under the high-level development of futures market operating system. The degree of futures market functions utility affects the development stability and the market structure modification of spot market substantially. In general, much more concentration has been put effort into in order to coordinate the relationship between futures and spot markets by the Chinese officials, and the development of futures market is also a key issue for the development of Chinese economy (Liu 2006: 38-47).

Hence, Chinese futures market has only been considered as new one compared to that of in many developed countries. There are still defects which the Chinese market can enhance. The transaction systems, the futures market structure, selection of futures contract, and even supervision of market transactions are all examples of futures market establishment defects. Additionally, these defects need to be improved in Chinese futures market. For compared to matured futures market in developed countries, the unmatured Chinese market is not efficient. In terms of the most important functions in futures market, price discovery and hedging have been preliminary formed during regulation and development in the past 10 years. Futures market provides spot market with new approaches to transfer risk. Furthermore, the predicted reference price determined by futures market has also provided spot market with reference transaction price. Thus, it can be indicated that future and spot markets in China are correlated, they are supplementary market for each other and they are also coordinated by each other. It is implied that the correlated and supplementary market system in China is preliminarily formed. The form of performance in this preliminary market system has significant impact on the development of Chinese market economy (Xiao and Wu 2009: 93-94). The key issue which needs to be concentrated on in the market system is futures market system. Specifically, the study of futures market can be conducted by investigating equilibrium relationship between futures and spot markets. The price volatility relationship between futures and spot markets can be reflected in case that equilibrium relationship study is accomplished. Thus, by implementing the equilibrium relationsihp study, the degree of performance efficiency for price discovery and hedging functions can be examined. All the study performances can provide Chinese economy with valuable information for the market development.

5. DATA

The empirical analysis in this thesis is conducted by using daily data (five days per week) obtained from Dalian Commodity Exchange (DCE) and China Feed Industry Information Network (CFIIN). Specifically, soybean contract No.1 from DCE is used as the type of commodity for futures data, spot data is obtained from CFIIN.

The daily quoted closing prices are used for data collection in both futures and spot. The soybean daily data for futures prices are obtained in each month annually from 2009 to 2013. Likewise, the closing price data is also used for spot data series. The data collection approach of spot prices is exactly the same with that of futures prices. Generally, both futures and spot price data can form two data series separately and consecutively. The strength of this data collection approach is that continuous daily price consists of large numbers of observations. Hence, the empirical analysis implemented based on large amount of observations can be more accurate. By adapting to DSEM, this thesis conducts empirical analysis by using 1275 observations. Spot and futures refer to spot and futures time series respectively. Both graphical illustrations and descriptive statistics of the time series are demonstrated as follows.



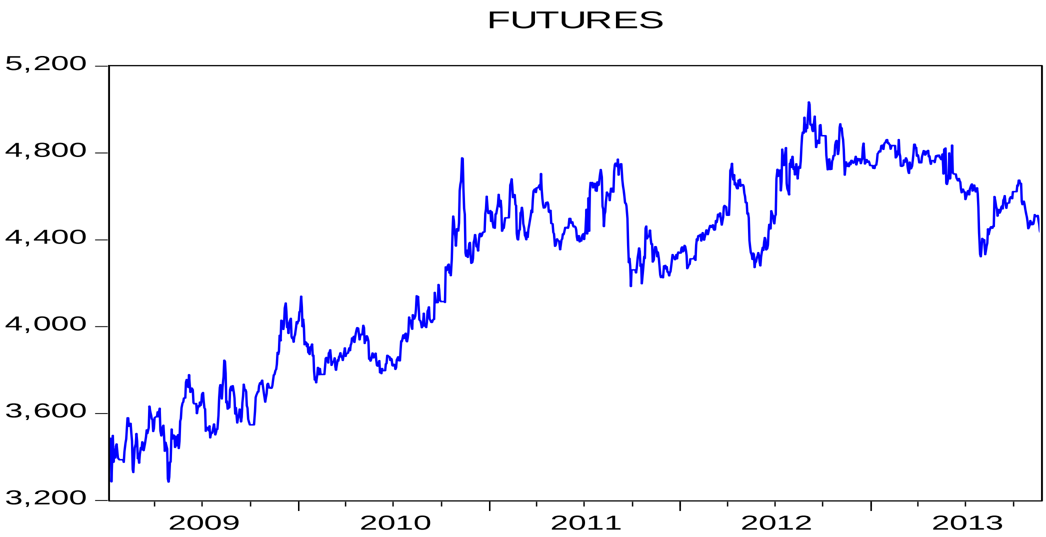


Figure 1. Time series of spot and futures.

Table 1. Descriptive statistics for futures and spot.

	FUTURES	SPOT
Mean	4278.55	4047.97
Median	4411.00	4001.58
Maximum	5035.00	4845.79
Minimum	3285.00	3363.00
Std. Dev.	437.57	412.02
Skewness	-0.50	0.36
Kurtosis	2.00	2.04
Jarque-Bera	106.26	77.00
(p-value)	(0.00)	(0.00)
Observations	1275	1275

It can be observed from the table that futures data has higher mean value than that of spot data. Also, futures data has higher maximum and lower minimum value compared to that of spot data. Besides, according to standard deviation, futures data is more volatile than spot data, both futures and spot data have 1275 observations respectively.

6. METHODOLOGY

In this chapter, dynamic simultaneous equation models equations (DSEM) proposed by Min and Najand (1999) is demonstrated. Furthermore, the properties related to vector autoregression are mentioned. Besides, heteroscedasticity properties are also illustrated. Afterwards, properties of stationarity and unit root test are described. Moreover, various types of cointegration tests including Johansen method are described. Afterwards, Granger causality test is conducted, followed by impulse response function and variance decomposition.

6.1. Dynamic simultaneous equation models

If cointegration relationships exist between futures and spot markets, the existence of price discovery function between soybean futures and spot price changes can be explained by using DSEM (Min and Najand 1999). The model demonstrates cointegration relationships in terms of price changes between futures and spot as follows:

$$(1) \quad S_t = c_s + \sum_{k=1}^{p} \alpha_{s,k} S_{t-k} + \sum_{k=0}^{q} \beta_{s,k} F_{t-k} + \varepsilon_{s,t}$$

$$(2) \quad F_t = c_f + \sum_{k=1}^{p} \alpha_{f,k} S_{t-k} + \sum_{k=0}^{q} \beta_{f,k} F_{t-k} + \varepsilon_{f,t} ,$$

where S_t and F_t denote the price of soybean spot and futures respectively; $\varepsilon_{s,t}$ and $\varepsilon_{f,t}$ are white noise and they are not correlated. p and q are determined by both correlated function and Akaike Information Criterion (AIC). Subscript t denotes the present time level, subscript s and f denote spot and futures respectively, subscript k denotes lag order.

Particularly, price discovery function and cointegration relationship can be interpreted by (1) and (2). If there is certain $\beta_{s,k}$ existing and it does not equal to 0, F_t is defined to lead

S_t; similarly, if there is certain $\alpha_{f,k}$ existing and it does not equal to 0, S_t is defined to lead F_t; if certain $\beta_{s,k}$ and $\alpha_{f,k}$ exist simultaneously and none of them is equal to 0, it is implied that S_t and F_t lead each other.

Similarly, the series are cointegrated and price discovery function exists between them. It can be illustrated that soybean spot price discovers soybean futures and vice versa. The distinctions of lead and lag relationships interpret distinctions of information transfer efficiency between futures and spot markets.

Both (1) and (2) are applied to estimation by using Two Stage Least Square (TSLS). TSLS can eliminate the biased estimators examined by Ordinary Least Square (OLS), TSLS can be used as methodology to eliminate autoregressive correlations between explanatory variable and the error term. The application software used in this thesis is Eviews 6.0.

The number of lags used in Dynamic Simultaneous Equation models (DSEM) regressions is determined by the Akaike Information Criterion (AIC). The selected lag length (1st lag) in the regression system is determined by its corresponding AIC value which minimizes the criterion. Also, the Wald test is applied to the estimation.

6.2. Vector autoregression

If cointegration relationship exists between futures and spot markets, the existence of price discovery function between soybean futures and spot changes can be explained by using vector autoregression (VAR). The model demonstrates cointegration relationship in terms of price changes between futures and spot

$$(3) \quad y_t = \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \cdots + \alpha_p y_{t-p} + \beta_1 x_t + u_t \text{, (t=1, 2… n) ,}$$

where p -period lagged observation y_{t-p} is called the p th lag of y, α_p is a time-invariant $k*k$ matrix and μ_t is a $k*1$ vector of error terms. A p th order VAR is also called a VAR with lag length of p . （Du and Zhang 2011）

6.3. Heteroscedasticity

In regression analysis, if phenomenon exist that all the error term values in certain regression model generate different variances on observations from each other across varying degrees of data set (i.e., cross-sectional and time-series data), then this phenomenon is defined as heteroscedasticity, and this regression model with nonconstant error variances is defined to be heteroscedastic. One typical example of analysis related to heteroscedasticity can be family consumptions. It can be indicated that families which have higher income also have higher consumption power than that of families with lower income. Particularly, for example, the variation of luxury products consumption power between these 2 family types can be quite significant, but the variation of non-luxury products consumptions between them is not that significant. (Greene 2008:158-159)

For univariate regression models, if there are

$$(4)\ Var[u_i] = \sigma_i^2,\ (i = 1, 2, 3, \ldots.., n),$$

it can be indicated that heteroscedasticity exists in the random error terms. The mathematical expression above denotes that the variances of u_i always vary according to variations of the explanatory variable, and thus lead to occurrence of heteroscedasticity. (Wooldridge 2009: 264 -283)

For multivariate regression models, if:

$$(5)\ Var[u] = \sigma^2\,\Omega = \sigma^2 \begin{vmatrix} \gamma_{11} & 0 & \ldots & 0 \\ 0 & \gamma_{22} & \cdots & 0 \\ \vdots & \vdots & \gamma_{33} & \vdots \\ 0 & 0 & 0 & \gamma_{nn} \end{vmatrix} \neq \sigma^2 I,$$

it can be indicated that heteroscedasticity exists in the random error terms. The mathematical expression illustrates that for the covariance matrix of Var (u) above, the values of elements from the main diagonal are not constant. (Wooldridge 2009: 264 - 283)

6.4. Stationarity process and unit root test

This section is divided into 2 parts. In the 1st part, some properties related to stochastic process of stationarity are illustrated. These properties are (covariance) stationary process (in general form), white noise process (one example of stationary process, denoted as WN process), as well as random walk process (one example of nonstationary process, denoted as RW process). In the 2nd part, augmented Dickey-Fuller (ADF) test is introduced with its three types of versions

6.4.1. Properties of stochastic processes

Define time series y_t as (covariance) stationary process if

(6) $E[y_t] = \mu$, for all t

(7) $Cov[y_{t,}y_{t+k}] = \gamma_k$, for all t

(8) $Var[y_t] = \sigma^2 < \infty$, for all t,

it can be interpreted from the definition above that one series has to fulfill 3 conditions simultaneously in order to become stationary process. Firstly, all the means of this series have to be the same certain specific number. Secondly, all the covariances in the series have to be the same constant number. All the covariances, in this case, are related to variation of the lag length instead of time variation. Thirdly, all the variances have to be constant, which indicate the property of homocedasticity. (Greene 2008: 718-719)

Define time series u_t as white noise (WN) process if

(9) $E[u_t] = 0$, for all t

(10) $Cov[u_s, u_t] = 0$, for all $s \neq t$

(11) $Var[u_t] = \sigma_u^{\ 2} < \infty$, for all t,

where u_t is the error term, and it is generally assumed in (5), (6), and (7) that $\mu = 0$ .Thus, it can be obviously indicated from the definition above that white noise process is stationary. (Greene 2008: 718)

x_t is defined as random walk (RW) process if

(12) $x_t = x_{t-1} + \varepsilon_t$,

where ε_t is considered as the error term, or likewise, innovations. Thus, process of random walk with drift can be interpreted as

(13) $x_t = \mu + x_{t-1} + \varepsilon_t$

(14) $x_t = \sum_{i=0}^{\infty} (\mu + \varepsilon_{t-i})$,

where it can be identified that the variance of x_t can be infinite if the error terms are generated from constant-variance distribution with the same zero-mean. Thus, the random walk process is defined as nonstationary process. (Greene 2008: 739)

However, z_t, as the first differencing for series x_t , can be depicted as

(15) $z_t = x_t - x_{t-1} = \mu + \varepsilon_t$,

where it can be indicated that z_t is stationary. Because $\mu+\varepsilon_t$ is simply equivalent to the mean plus random errors, which has been assumed to be stationary already. In this case, for series x_t, it is defined to be integrated of order one or $I(1)$. In addition, by taking the first differencing, the nonstationary series become stationary. (Greene 2008: 740)

6.4.2. Unit root test

Similarly, if certain series must be differentiated d times in order to become stationary, this series is difined as series integrated of order d or $I(d)$. Only time series with the same order of integration have cointegration relationship. Hence, it is important to conduct unit root test priorly before cointegration test.

In order to do this, the stationarity of the time series itself must be examined. Generally, there are 2 approaches enabling us to conduct the examination of stationarity for time series. These 2 approaches are Dickey-Fuller (DF) and augmented Dickey-Fuller (ADF) tests. The 2 approaches are used to apply to first-order autoregressive and dth-order autoregressive variables respectively. Particularly, ADF test (Dickey and Fuller 1981) is more widely used and its corresponding regression can be depicted as

(16) $$\Delta x_t = \alpha + \beta t + \lambda x_{t-1} + \gamma_1 \Delta x_{t-1} + ... + \gamma_p \Delta x_{t-p} + \varepsilon_t ,$$

it can be interpreted from the model above that α denotes the intercept term, β denotes the coefficient of time trend. p denotes number of orders and it can be measured by both Schwarz-Bayesian Information Criterion (BIC) and Akaike Information Criterion (AIC). As the coefficient of x_{t-1}, the t- statistics of λ can be measured by using the t -distribution (Dickey-Fuller table)..

Several models can be used to test the existence of unit root. The first model does not contain intercept and trend terms, the second model contains intercept term, but does not contain trend term. The third model contains both intercept and trend terms. (Yin, Ke and Huang 2012: 14)

The first model is denoted as

$$(17)\quad \Delta x_t = \lambda x_{t-1} + \sum_{t=1}^{p} \gamma_t \Delta x_{t-1} + \varepsilon_t \ ,$$

where both α and β equal to 0 in this case. Thus, it can be indicated that the regression above is pure random walk process with neither drift nor trend, for it does not contain any intercept or time trend term.

The second model is denoted as

$$(18)\quad \Delta x_t = \alpha + \lambda x_{t-1} + \sum_{t=1}^{p} \gamma_t \Delta x_{t-1} + \varepsilon_t \ ,$$

where only certain nonzero α exists in the regression without β .It indicates that the regression is a random walk process with drift.

The third model is denoted as

$$(19)\quad \Delta x_t = \alpha + \beta t + \lambda x_{t-1} + \sum_{t=1}^{p} \gamma_t \Delta x_{t-1} + \varepsilon_t \ ,$$

where it contains both nonzero value of α and β . It indicates that the regression is random walk with trend.

6.5. Cointegration

In this section, the illustrations of cointegration in general as well as various types of related tests are described. The tests related to cointegration are Engle-Granger two-step method and Johansen cointegration test.

6.5.1. Cointegration in general

Consider the regression model

(20) $y_t = \beta x_t + u_t$,

where u_t is the error term, and it is assumed that this residual series u_t is white noise proces. It can be denoted as

(21) $u_t \sim WN(0, {\sigma_u}^2)$,

where it indicates that the residual series u_t of (20) follows the white noise process, from which is normally distributed with 0 mean and constant error variance of certain value. It also indicates the properties of homocedasticity.

However, for (20), if series x_t and y_t are integrated, the assumption above will be not effective. If two series are integrated of different orders, the linear combination of them is supposed to be with the same order of integration as that of the higher one. For example, for certain y_t and x_t , which are both $I(1)$, u_t can also be $I(1)$. By following (20), its representation of residual can be interpreted as

(22) $u_t = y_t - \beta x_t$,

where u_t is $I(1)$,which interprets the general case that both y_t and x_t are $I(1)$, it is normally expected that u_t is also $I(1)$ regardless the value of β .

However, it is possible that (22) can be $I(0)$ even if y_t and x_t are both $I(1)$. It is assumed that the differences between y_t and βx_t shall be stable regardless the variation of time. In this case, it is expected that y_t and x_t shall approximately drift towards the same direction by the same rate. For β , it indicates the correlation coefficient between these 2 variables. This long-term correlated drifting relationship between variables can be denoted as cointegration. In other words, these variables are defined to be cointegrated. (Greene 2008:756-757)

6.5.2. Engle-Granger two-step method

Assuming y_t and z_t are 2 cointegrated series, the linear combinations of these 2 series are stationary. It can be denoted by the regression as

$$(23)\ z_t - \beta y_t = u_t ,$$

where u_t is stationary. When u_t is known, its stationarity can be tested by using ADF test. For example, if the parameter β is unknown, it must be estimated forehand. The estimation method in general can be OLS, The stationarity test can be conducted based on the error term series of the OLS estimation that are commonly denoted as $\hat{u}_t$. (Engle and Granger 1987)

6.5.3. Johansen cointegration test

Johansen cointegration test is a procedure that is used to test cointegration of I(1) processes in time series. The advantage of this test is that more than 1 cointegration relationships can be allowed to exist in the testing procedure. Hence, it is the method more applicable than Engle-Granger approach. The 2 different approaches used in Johansen test are trace and eigenvalue. (Johansen 1991)

The general vector autoregressive model (VAR(p)) of pth order can be defined as

(24) $$X_t = \beta_0 + \beta_1 t + \sum_{k=1}^{p} \Pi_k X_{t-k} + \varepsilon_t \text{, } (t = 1,...,T),$$

where X_t is $I(1)$ series of n-dimensional vector. β_0 is the intercept term, $\beta_1 t$ is the time trend term, both β_0 and β_1 are $n \times 1$ dimensional constant vectors. $\Pi_1 ... \Pi_k$ are parameter matrix of $n \times n$ dimension, ε_t is the n-dimensional Gaussian distribution. (Johansen 1991)

The two specification approaches of error correction are defined as vector error correction models (VECM). Respectively, the long-term and transitory VECMs are (Johansen 1991)

(25) $$\Delta X_t = \beta_0 + \beta_1 t + \Pi X_{t-p} + \Gamma_1 \Delta X_{t-1} + ... + \Gamma_{p-1} \Delta X_{t-p+1} + \varepsilon_t \text{, } (t = 1,...,T),$$

where $\Gamma_k = \Pi_1 + ... + \Pi_k - K,\ k = 1,...p-1.$

(26) $$\Delta X_t = \beta_0 + \beta_1 t + \Pi X_{t-1} - \Gamma_1 \Delta X_{t-1} - ... - \Gamma_{p-1} \Delta X_{t-p+1} + \varepsilon_t \text{, } (t = 1,...,T),$$

where $\Gamma_k = (\Pi_{k+1} + ... + \Pi_p),\ k = 1,..., p-1.$

6.5.4. Error correction model

If spot and futures are cointegrated, their error correction model (ECM) can be depicted as:

$$(27)\ \Delta S_t = \alpha_{10} + \alpha_S Z_{t-1} + \sum_{i=1}^{p} \alpha_{11}(i)\Delta S_{t-i} + \sum_{i=1}^{p} \alpha_{12}(i)\Delta F_{t-i} + \varepsilon_{1t}$$

$$(28)\ \Delta F_t = \alpha_{20} + \alpha_F Z_{t-1} + \sum_{i=1}^{p} \alpha_{21}(i)\Delta S_{t-i} + \sum_{i=1}^{p} \alpha_{22}(i)\Delta F_{t-i} + \varepsilon_{2t},$$

where S indicates spot prices in Chinese soybean market and F represents the corresponding futures prices. Z_{t-1} is the error correction term. ε_{1t} and ε_{2t} are joint white noise. If futures prices of S_t can be predicted by using previous prices of F_t, then F_t is defined to Granger cause S_t. Particularly, F_t Granger causes S_t if the $\alpha_{12}(i)$ coefficients $(i = 1, 2, ..., p)$ are nonzero and α_S is significant at certain conventional level. If F_t and S_t Granger cause each other, two-way feedback relationship is discovered between futures and spot markets. (Hua and Chen 2007)

6.6. Granger causality

The Granger causality test is a statistical test regarding hypothesis. Its aim is to indicate that by applying values from 2 time series, whether the values from 1 series are useful to predict the values from the other or not. Specifically, there are 2 time series x_t and y_t, if the past values from x_t is useful to predict the future value of y_t, then x_t is defined to Granger causes y_t, which is denoted as $x_t \Rightarrow y_t$. This is defined as the unidirectional causality. Similarly, $y_t \Rightarrow x_t$ suggests that y_t Granger causes x_t. Accordingly, if x_t and y_t Granger cause each other, the notation can be depicted as $x_t \Leftrightarrow y_t$, which indicates bi-directional causality. (Granger 1969) The regression interpretations of Granger causality are demonstrated as follows

(29) $S_t = \sum_{i=1}^{m} \alpha_{1,i} S_{t-i} + \sum_{j=1}^{m} \beta_{1,j} F_{t-j} + \varepsilon_{1,t}$

(30) $F_t = \sum_{i=1}^{m} \alpha_{2,i} S_{t-i} + \sum_{j=1}^{m} \beta_{2,j} F_{t-j} + \varepsilon_{2,t}$,

where S_t and F_t denote the prices of spot and futures respectively, $\varepsilon_{1,t}$ and $\varepsilon_{2,t}$ indicate white noise processes, and they are not correlated. If there is certain $\beta_{1,j} \neq 0$ existing, F_t is defined to Granger cause S_t . Similarly, if there is certain $\alpha_{2,i} \neq 0$ existing, S_t is defined to Granger cause F_t . Hence, if both $\beta_{1,j}$ and $\alpha_{2,i}$ are not equal to 0, S_t and F_t are defined to Granger cause each other. (Hua & Zhong 2002)

6.7. Impulse response function

Impulse response function (IRF) depicts the circumstance how 1 variable can respond to exogenous impacts over time. The impulse is described as shocks in terms of financial researches. IRF can be interpreted in the form of vector autoregression, many economic variables fitting the regressions can be regarded as exogenous impulses. Several examples of exogenous impulses are changes of monetary policy, government spending, and tax rates. For the endogenous impulses, employment rate and consumption can be used. The observations for employment rate and consumption can be collected before, during, and after the changes of exogenous shocks. (He 2011)

6.8. Variance decomposition

For multivariate time series analysis, variance decomposition (forecast error variance decomposition) is applied to VAR models to explain the contributed information exerted from 1 variable to others. The variance decomposition interprets amount of information each variable accounts for that of the others. It suggests by how much the forecast error variance of each variable can be explained by exogenous shocks to the other variables. (Lütkepohl, 2007). If there is VAR (p) model

$$(31)\ y_t = v + \alpha_1 y_{t-1} + ... + \alpha_p y_{t-p} + u_t .$$

It can be transformed to VAR (1) structure by interpreting in companion form

$$(32)\ Y_t = V + \alpha Y_{t-1} + U_t .$$

Where $\alpha = \begin{matrix} \alpha_1 & \alpha_2 & \dots & \alpha_{p-1} & \alpha_p \\ I_k & 0 & \dots & 0 & 0 \\ 0 & I_k & & 0 & 0 \\ \vdots & & \ddots & \vdots & \vdots \\ 0 & 0 & \dots & I_k & 0 \end{matrix}$, $Y = \begin{matrix} y_1 \\ \vdots \\ y_p \end{matrix}$, $V = \begin{matrix} v \\ 0 \\ \vdots \\ 0 \end{matrix}$, and $U_t = \begin{matrix} u_t \\ 0 \\ \vdots \\ 0 \end{matrix}$. y_t , v and u are k dimensional column vectors, α is kp by kp dimensional matrix, and Y , V and U are kp dimensional column vectors. (Lütkepohl, 2007).

For the h-step forecast of variable j, the mean squared error can be interpreted as

$$(33)\ MSE[y_{j,t}(h)] = \sum_{i=0}^{h-1}\sum_{k=1}^{k}(e'_j \Theta_i e_k)^2 = (\sum_{i=0}^{h-1}\Theta_i\Theta'_i)_{jj} = (\sum_{i=0}^{h-1}\Phi_i\Sigma_u\Phi'_i)_{jj} ,$$

where e_j indicates the j^{th} column of I_k , and the subscript jj refers to that element of the matrix. $\Theta_i = \Phi_i P$, and P is a lower triangular matrix obtained from Cholesky decomposition of Σ_u such that $\Sigma_u = PP'$, in which Σ_u is the covariance of the errors u_t . $\Phi_i = J\alpha^i J'$, in which $J = [I_k \quad 0 \quad \cdots \quad 0]$, so that J is a k by kp dimensional matrix. (Lütkepohl, 2007). For the amount of forecast error variance of variable j , this amount of explaination contributed by exogenous shocks to variable k can be interpreted as

(Lütkepohl, 2007)

$$(34)\quad \omega_{jk,h} = \sum_{i=0}^{h-1} (e'_j \Theta_i e_k)^2 / MSE[y_{j,t}(h)].$$

7. EMPIRICAL RESULTS

In this chapter, the results are presented in the forms of tables and figures. For the tables, firstly, lead and lag relationship between spot and futures is presented, followed by heteroskedasticity test. Afterwards, the results of unit root test are illustrated, followed by cointegration test and vector error correction model estimation. Afterwards, Granger causality test is presented as the final table. For the figures, impulse response function and variance decomposition are demonstrated in sequence after the tables. According to the Akaike Information Criterion (AIC), variables with the 1st lag are determined to conduct the estimation. Also, the Wald test is used in the analysis.

Table 2. Lead and lag relationship between spot and futures using Dynamic Simultaneous Equation Models (DSEM).

Dep. Var.	Spot		Futures	
	Coefficient	t-value	Coefficient	t-value
Constant	1.03	0.30	19.15	1.77*
Spot (t-1)	0.99	560.48***	0.01	1.58
Futures (t-1)	0.01	3.41***	0.99	189.48***
Wald test				
Futures on Futures	1.00			
Futures on Spot	0.88***			
Spot on Spot	1.00			
Spot on Futures	0.88***			

Notes: The Wald test statistic is $\chi^2(m) \sim [SSE(reduced) - SSE(full)]/MSE(full)$, where

$SSE(reduced)$ = sum of squares of errors under restricted model

$SSE(full)$ = sum of squares of errors under full model

m = number of restricted coefficients.

*, **and*** indicate the significance level at 10%, 5%, and 1% respectively.

In general, the results in the table above indicate strong relationship between spot and futures markets. Besides, it can be reported that futures leads spot significantly at the significance level of 1%. Whereas, insuffícent evidence suggests that spot leads futures. The overall results indicate that lead and lag relationship between futures and spot is only unidirectional. This conclusion supports the results proposed by Liu (2006).

Table 3. Heteroskedasticity test.

	Obs*R-squared	F-statistics
DSEM (1)	1.60	0.80
DSEM (2)	67.82***	35.73***

Notes: *, **and*** indicate the significance level at 10%, 5%, and 1% respectively.

It can be observed from the table above that Obs*R-squared is not significant, which indicates the null hypothesis is accepted. Thus, heteroskedasticity does not exist in (1). However, as Obs*R-squared for (2) is highly significant, the null hypothesis is rejected. Accordingly, heteroskedasticity exists in (2)

Table 4. ADF unit root test.

	lwt	lwnt	fdwt	fdwnt
Spot	-2.40	-1.03		
	(0.38)	(0.74)		
D(Spot)			-7.51***	-7.51***
			(0.00)***	(0.00)***

Table 4 (Continued) . ADF unit root test.

	lwt	lwnt	fdwt	fdwnt
Futures	-2.61	-2.13		
	(0.27)	(0.23)		
D(Futures)			-19.63***	-19.60***
			(0.00)***	(0.00)***

Notes: lwt, lwnt, fdwt, and fdwnt indicate at level with trend, at level without trend, at first difference with trend, and at first dfference without trend respectively. P-values are shown in the parentheses. *, **and*** indicate the significance level at 10%, 5%, and 1% respectively.

It can be concluded from the table above that for spot and futures, the t-values do not suggest any statistical significance level, indicatiing that the null hypothesis of ADF tests are not rejected. For both spot and futures with differencing, however, all the t-values are at 1% significance level, which indicate high significance. The overall results suggest that spot and futures series can become stationary after the first differencing is conducted.

Table 5. .Cointegration test.

H0	Trace statistics	Maximum eigenvalue statistics
r=0	15.29*	13.54*
	(13.43)*	(12.30)*
r<=1	1.75	1.75
	(2.71)	(2.71)

Note: r indicates the number of long-term relationship. 10% critical values are reported in the parentheses. *, **and*** indicate the significance level at 10%, 5%, and 1% respectively.

It can be observed from the table above that both trace and the maximum eigenvalue statistics show identical result. The table suggests that the null hypothesis of Johansen cointegration test is rejected at 10% level when cointegration equation does not exist. This also indicates that long-term relationships exist. On the other hand, when the number of cointegration equation is at most 1, the null hypothesis is not rejected at 10% level, and this indicates that only 1 cointegration equation exists at 10% level. Thus, both trace and the maximum eigenvalue statistics indicate that 1 long-term relationship exists between spot and futures, spot and futures market prices are cointegrated.

Accordingly, the finding regarding long-term relationship is consistent with that of many previous studies, e.g., Garbade and Silber (1983), Cheng (2006), Yin, Ke and Huang (2012), Qu, Zhuang, Su and Guan (2011). This thesis is applied to the most recent 5-year period data (2009-2013). By combing the finding with the relevant previous ones, it also can be indicated that though the long-term relationship is not as strong as before, it tends to be stable after the 2008 financial crisis in China. This also suggests that the relationship between spot and futures prices is so strong that it can still recover relatively fast from the crisis.

Table 6. Vector error correction model (VECM) estimation.

Dep. Var.	D(Spot)		D(Futures)	
	Coefficient	t-value	Coefficient	t-value
C	0.5600	1.6573	0.8132	0.7666
Z(-1)	-0.0037***	-2.5336	0.0107***	2.3014
D(Spot(-1))	0.1067**	3.7754	-0.0731*	-0.8237
D(Futures(-1))	0.0324***	3.5956	0.0316**	1.1181

*, ** and*** denote the significance level at 10%, 5% and 1% respectively.

The table above shows the test results of vector error correction model. Since the coefficients of Z (-1) regarding both of the dependent variables are highly significant, the error correction term Z (-1) exerts substantial influence on spot and futures prices. If Z (-1) is positive, negative error correction is expected to be adjusted during the next period. Similarly, if Z (-1) is negative, positive error correction is expected to be adjusted during the next period. Generally, the error correction term is able to adjust the deviations of market prices to equilibrium level if the deviations occur. Besides, the table suggests strong evidence that futures leads spot. However, the evidence showing spot leads futures is relatively weak.

Table 7. Granger causality test.

	Chi-sq	p-value
H0		
futures -/→spot	15.5178***	0.0037***
spot -/→futures	4.3836	0.3566

Notes: "-/→" indicates the hypthesis of no Granger causality. *, ** and*** denote the significance level at 10%, 5% and 1% respectively.

For futures Granger causes spot, it can be indicated from the table that p-value is highly significant at 1% level. Thus, the null hypothesis is rejected and storng evidence suggests that futures prices can Granger cause spot prices. Accordingly, the past values from futures can be useful to predict future values of spot.

Unexpectedly for spot Granger causes futures, p-value is not significant. The cause of this phenomenon can be related to the financial crisis in 2008 and the temporaty adjustments of market regime. Besides, although the linkage between spot and futures markets in China is strong, it can still be weakened by the impact imposing from the crisis, and this long-term relationship needs time to recover from the recession.

The result shows the existence of unidirectional causality. This is identical to many previous relevant studies. For example, Liu (2006) suggests that only futures Granger causes spot regarding th Chinese wheat market. In addtion, it is also discovered by Liu that only futures price discovers spot regarding the Chinese soybean markets, and insufficient evidence suggests spot discovers futures.

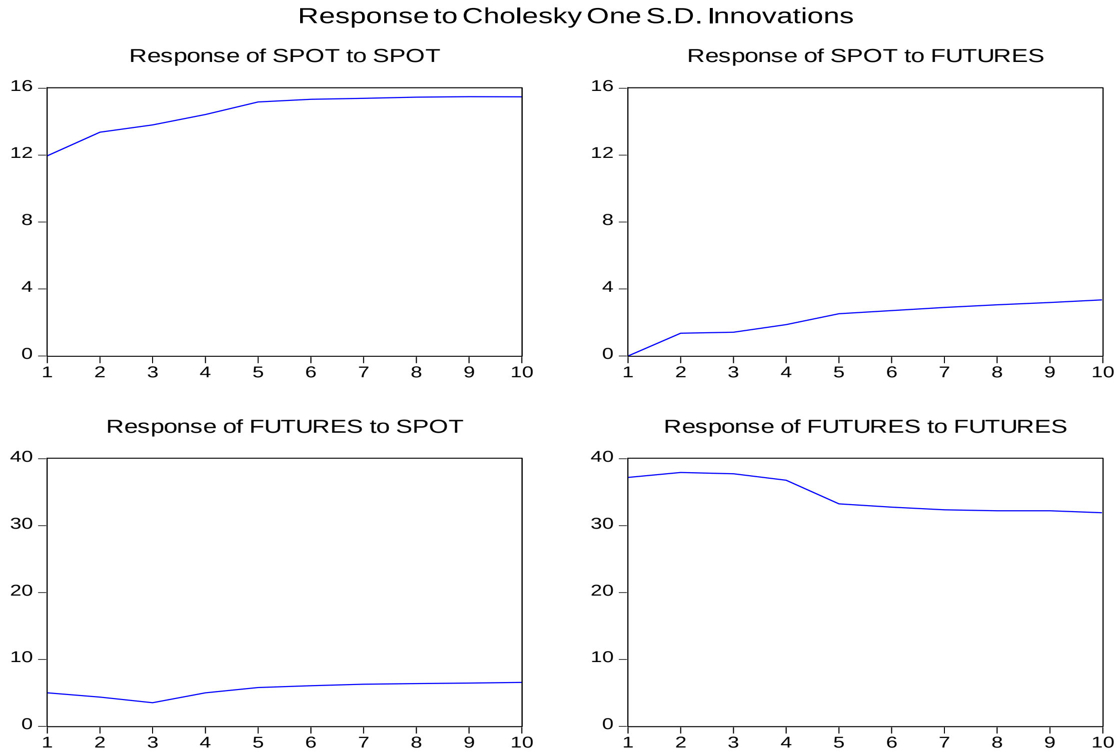


Figure 2. Graphical illustrations of impulse response functions.

In general, it can be indicated from the figure above that the response of futures to spot is weak, stable, and not significant in general. This weak impact can be effective for the next 10 periods. However, the response of spot to futures is strong, unstable, and highly significant. The impact can be effective for long-term period.

It can be observed from response of futures to spot that futures is positively impacted by spot. For the first 3 periods, futures is negatively impacted by spot and the relationship decreases consecutively for 3 periods to the lowest point. Afterwards, from the early stage of the 3rd period, postive impact is exerted on futures, and the relationship lasts for 7 periods, though the impact is very weak. However, the response of spot to futures behaves differently. Spot is significantly impacted by futures positively from start of the 1st period, and this impact lasts until the 3rd period starts. After the 3rd period, the impact from futures still shows significant influence and it continues to increase for the next 2 periods. From the early stage of period 5, spot is still positively impacted by futures and this impact lasts steadily and significantly till period 10. Thus, though the response of futures to spot is insignificant, the response of spot to futures is highly significant.

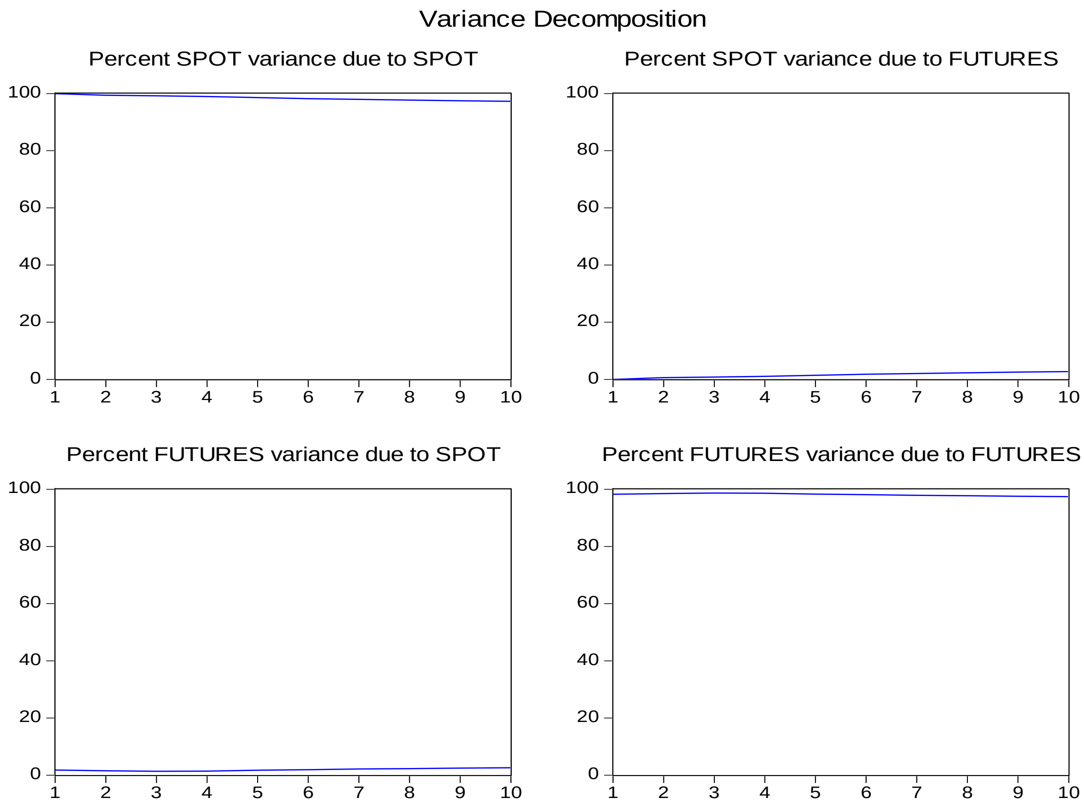


Figure 3. Variance decomposition.

It can be indicated from the figure above that the percent spot variance due to spot decreases. Besides, no sufficient evidence suggests that percentage variation regarding futures variance is contributed by variation of spot. Thus, it can be suggested that percentage of variance changes regarding future prices cannot be explained by spot prices. However, it can be observed from percent spot variance due to futures that percentage of spot variance increases steadily after 3 periods. Specifically, it can be concluded that percentage of variance changes regarding spot prices can be significantly explained by that of the futures, the percentage which can be explained is approximately 5%.

8. CONCLUSION

The thesis examines price discovery function and cointegration relationship between soybean spot and futures markets in China from 2009 to 2013. For time series of spot and futures, 1275 observations are applied to data as sample size respectively.

The empirical findings in this thesis indicate that long-term equilibrium relationship exists in Chinese soybean markets during the most recent 5 years after the 2008 financial crisis. Significant evidence is shown in the results that soybean futures tend to price discover soybean spot. The change of soybean futures market prices can significantly affect the price level in the corresponding spot markets. Sufficient evidence indicates that futures Granger causes spot, and unexpectedly, spot prices do not Granger cause futures price. Hence, the finding shows that only unidirectional causality exists in this long-term relationship, which is consistent with the results presented by Liu (2006).

From the perspective of practice, this unidirectional causality in the Chinese soybean market indicates that the market is still developing and unmatured. The regime and system of spot and futures markets in China also demand more time to develop, especially after the financial recession. In order to keep the market system functioning orderly and efficiently, both efficient protections from the government and the active cooperation from market participants are expected to be enhanced.

REFERENCES

Baxter, M & Rennie, A (1996). *Financial calculus: an introduction to derivative pricing.* 1. ed. Cambridge. 233p. ISBN 0-521-55289-3.

Bessler, D. A. & Covey, T (1991). Cointegration: some results on U.S. cattle prices. *The Journal of Futures Markets* 11, 461-474.

Booth, G. G., So, R. W & Tse, Y (1999). Price discovery in the German equity index derivatives markets. *The Journal of Futures Markets* 1999, 619-643.

Brockman, P. & Tse, Y (1995). Information shares in Canadian agricultural cash and futures markets. *Applied Economics Letters* 2, 335-338.

Chance, D. M (1994). Futures pricing and the cost of carry under price limits. *Journal of Futures Markets* 14, 813-836.

Chen, Z. N (1995). On the choice of the ways of development of futures markets with Chinese features. *Journal of Tianjin University of Commerce* 2, 51-59.

Cheng, S. F (2006). Cointegration analysis between copper futures and spot price in Chinese market. *Market Modernization* 6, 59-60.

Chi, G. T. & Yang, Z. Y (2009). Optimal model of strip-and-roll hedge based on the min-variance. *System Engineering-Theory & Practice* 29:12, 163-174.

Chowdbury, A. R (1991). Futures market efficiency: evidence from cointegration Tests. *The Journal of Futures Markets* 11, 577-589.

Dickey, D. A. & Fuller, W. A (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica,* 49:4, 1057-1072

Du, N. & Zhang, G.W (2011). Soybean futures price discovery function investigation based on VAR modeling. *China Collective Economy* 4, 113-114

Engle, R. F. & Granger, C, W, J (1987). Cointegration and error correction: representation, estimation, and testing. *Econometrica* 55:2, 251-276.

Fama, E. F (1997). Market efficiency, long-term returns, and behaviour finance. [Working paper]. *University of Chicago*, 1-31. Available from World Wide Web: <URL: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=15108>.

Garbade, K. D. & Silber, W. L (1983). Price movements and cash discovery in futures and cash markets. *Review of Economics and Statistics* 65, 289-297.

Greene, W. H (2008). *Econometric Analysis*. 6.ed. Pearson Education, Inc. 1154p. ISBN 978-0-13-513740-6.

He, Z. C., Zhou, X. J & Wen, X. M (2011). Price discovery analysis of zinc market and spot market based on SVAR model. *Journal of Hunan University* 38:7, 87-92

Hogan, S., Jarrow, R., Teo, M & Warachka, M (2004). Testing market efficiency using statistical arbitrage with applications to momentum and value strategies. *Journal of Financial Economics* 73, 525-565.

Hua, R. H & Chen, B. Z (2007). International linkages of the Chinese futures markets. *Applied Financial Economics* 17, 1275-1287.

Hua, R. H & Zhong, W. J (2002). An empirical analysis on price discovery in our futures markets. *Nankai Business Review* 5, 57-61.

Hull, J. C (2008). *Options, futures, and other derivatives*. 7. ed. Harlow: Pearson Education Limited. 822 p. ISBN 978-0-13-601586-4.

Johansen, S (1991). Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. *Econometrica* 59:6, 1551-1580.

Johansen. S. & Juselius. K (1990). Maximum likelihood estimation and inference on cointegration-with application to the demand for money. *Oxford Bulletin of Economics and Statistics* 52:2, 169-210.

Kawaller, I., Koch, P & Koch, T (1987). The temporal price relationship between S&P 500 futures and the S&P 500 index. *Journal of Finance* 59, 1551-1580.

Kawaller, I., Koch, P & Koch, T (1993). Intraday market behavior and the extent of feedback between S&P 500 futures prices and the S&P index. *Journal of Financial Research* 16, 107-121.

Kim, M., Szakmary, A. C & Schwarz, T. V (1999). Trading costs and price discovery across stock index futures, and cash markets. *The Journal of Futures Markets* 19, 475-498.

Lai, K. S. & Lai, M (1991). A cointegration test for market efficiency. *The Journal of Futures Markets* 11, 567-575.

Liu, X. X (2006). Lead relation research in the spot-futures markets in China. *South China Journal of Economics* 6, 38-47.

Lu, J. F (2003). The function of agricultural futures market in the agricultural production. *On Economic Problems* 4, 35-36.

Lütkepohl, H (2007). *New Introduction to Multiple Time Series Analysis*. 1.ed. Springer. 764p. ISBN 3-540-40172-5.

Ma, S. Z., Wang, J. J & Feng, H (2011). A study of risk spillover between futures and spot markets-an empirical analysis on China's soybean market. *Journal of Guizhou Normal University* 3, 37-43.

Merton, R. C (1999). Finance theory and future trends: The shift to integration. *Risk* 12:7, 48-51.

Min, J. H. & Najand, M (1999). A further investigation of the lead-lag relationship between the spot market and stock index futures: early evidence from Korea. *The Journal of Futures Markets* 19, 217-232.

OUYANG, M. H (2012). Weak form of soybean futures market in China: a nonlinear unit root test. *Shangye Jingji* 2, 112-114

Qu, H. T., Zhuang, X. T., Su, Y. L & Guan, J (2011). Empirical study on price discovery function of commodity futures market. *Journal of Northeastern University* 32:9, 1364-1368.

Wahab, M. & Lashgari, M (1993). Price dynamics and error correction in stock index and stock index futures markets: a cointegration approach. *The Journal of Futures Markets* 13, 711-742.

Wang, H. W., Jiang, F & Wu, J. C (2001). Study of causal relationship between copper futures and cooper spot prices. *Predictions* 20, 75-77.

Wang, J & Zhang, Z. C (2005). Hedging ratio effectiveness in Chinese futures markets. *Securities Market Herald* 11, 20-25.

Wei, Z. X & Gao, Y (2012). Hedging studies of dominant and nearby contracts in Chinese agricultural futures market. *Microstructure* 2, 36-41

Wooldridge, Jeffrey M (2009). *Introductory Econometrics*. 4. ed. South-Western. 865p. ISBN 978-0-324-78890-7.

Wu, Z. X. & Chen, M (2007). The weak efficiency test of Chinese stock market by statistical arbitrage. *Systems Engineering-Theory & Practice* 2, 92-98.

Wu, C. F., Wang, H. C & Xing, Y (1997). Study of lead-lag correlation and mutual harmonic relationship from futures copper market. *Methodology Application of System Engineering Theory* 6, 1-9.

Yan, T. H., Meng, W. D & Liu, X. Y (2000). Futures and spot markets study of cointegration correlation for copper and green bean prices. *Journal of Chongqing University* 23, 115-119.

Ye, S. & Yu, L (2012). Analysis of price fluctuation factors for soybean futures in China's market based on principal component analysis method. *Journal of Harbin University of Commerce* 28:1, 110-114

Yin, W., Ke, W. M & Huang, J (2012). Dynamic correlation of price between real estate and land in Changsha: a Granger Causality Test. *Journal of Changsha University* 26:1, 13-15

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Xiao, H. & Wu, C. F (2009). Study on microstructures comparison between cash market and futures market. *Journal of Management Sciences in China* 12:1, 94-136

Xiao, J. X. & Liu, W. L (2008). The study of efficiency issues of price changing limits system from futures markets: evidence from soybean contract No.1 in Dalian Commodity Exchange. *Special Zone Economy* 4, 97-99

Xu, J. G (1995). Investigation of futures market efficiency in our country. *Financial*

Economics 8, 14-19.

Xu, J. Y (1993). Market mechanism, spot markets and futures markets. *Journal of Guizhou College of Finance and Economics* 2, 9-14.

Zhang, D. P (1994). Price volatility analysis of green soybean futures. Journal of *Henan Agricultural University* 28, 327-331.

Zhang, M. X (1993). On problems of development of futures markets. *Journal of North China University of Technology* 5: 2, 6-11.