



Emerging Impact of Chinese Commodity Futures Market on Domestic and Global Economy

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Abstract

In this paper we construct a set of indices that capture the special features of the Chinese commodity futures market for the period from January 2000 to December 2011 to analyze the general properties of China's commodity futures market. Using these indices we investigate the risk premiums of Chinese commodity futures and verify that the commodity futures can act as an effective diversification tool for Chinese asset management. It is found that the commodity futures can hedge both expected and unexpected inflation in China, and agricultural commodity futures are found to signal inflation 2 months beforehand. Finally, we explore the relationship between Chinese and US commodity futures markets in the years 2000 and 2010, and find that their interactions strengthen over time. Our research reveals an increasingly important role of the Chinese commodity futures market in both the domestic and the global economy. Some policy changes are suggested in response to this trend.

Key words: Chinese commodity futures, property

JEL codes: G10, G11

I. Introduction

The global commodity markets have undergone profound changes over the past decade. Commodities prices have been increasing, particularly those of crude oil and metals. Growing numbers of institutional investors are including commodity futures in their portfolios as part of the asset allocation, and the fast growth of the Chinese commodity market has

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attracted global investors' attention.

China is a traditional investment-driven economy, and is well known for its huge commodity demand (see Lu *et al.*, 2009). The first commodity exchange in China, the Shenzhen Metal Exchange, was established in 1991. In the following 4 years, more than 50 commodity exchanges were set up. Because of the immature market structure and regulations in place, market speculation and manipulation were rampant, and, consequently, triggered strict rectification by the government. After 1995, most commodity exchanges were shut down and only three remained: the Shanghai, Dalian and Zhengzhou Exchanges. By 2004, the market had been reshaped with more complete laws and regulations. After that, government policy shifted from consolidating commodity exchanges to promoting commodity futures markets.¹

Table 1 provides some basic statistics for China's commodity futures market. From 2004 to 2010, the number of listed commodity futures products more than doubled, increasing from 11 to 23. The turnover and volume of commodity futures trading in 2010 were approximately 15 and 10 times that in 2004, respectively. By 2009, the total trading volume of China's commodity futures market exceeded that of the USA, and ranked first in the world, accounting for 43 percent of the global commodity futures trading volume (PBOC, 2010).

With the continuous introduction of more commodity futures, market openness (e.g. the plan for oil futures to open to international investors) and more complete laws and regulations, China's commodity futures market is playing an increasingly important role in the world. Table 2 lists all the commodity futures traded in China in 2012. They are included in the indices that we will introduce in the following section.

In addition to the rapidly growing volume of the market, China's commodity futures market exhibits some unique features in terms of market microstructure: (i) the major participants of Chinese market are individual investors, while in the international market, institutional investors account for the largest trading volume;² (ii) at this stage, the Chinese

Table 1. Statistics of China's Commodity Futures Market, 2004–2010

Year	2004	2005	2006	2007	2008	2009	2010
Number of listed products	11	13	16	19	20	23	23
Turnover (RMBtn)	14.69	13.45	21.01	40.97	71.9	130.5	227.0
Volume (billion, lot)	0.31	0.32	0.45	0.73	1.36	2.16	3.04

Source: Almanac of China's Finance and Banking Editorial Office, 2011.

¹Xin *et al.* (2006) provide a detailed description of the historical development of China's commodity futures market.

²For example, in 2007, individual investors accounted for 90 percent of the total trading volume in the Zhengzhou Exchange (according to Zhengzhou Exchange official statistics).

Table 2. Commodity Futures Traded in China, 2012

Sector	Commodity	Exchange	Time of listing
Agriculture	Soybean 1	DCE	March 2002
	Soybean 2	DCE	December 2004
	Yellow maize	DCE	September 2004
	Soybean pulp	DCE	July 2000
	Palm oil	DCE	October 2007
	Soybean oil	DCE	January 2006
	Cotton	CZCE	June 2004
	Early rice	CZCE	April 2009
	Colza oil	CZCE	June 2007
	Sugar	CZCE	January 2006
	High quality wheat	CZCE	March 2003
	Hard white wheat	CZCE	March 2008
Chemical	Metallurgical coke	DCE	April 2011
	LLDPE	DCE	July 2007
	PVC	DCE	May 2009
	PTA	CZCE	December 2006
	Methanol	CZCE	October 2011
	Fuel oil	SHFE	August 2004
	Natural rubber	SHFE	November 1993
	Glass	CZCE	December 2012
Metal	Silver	SHFE	May 2012
	Aluminum	SHFE	October 1992
	Gold	SHFE	January 2008
	Copper	SHFE	March 1993
	Lead	SHFE	March 2011
	Deformed steel bars	SHFE	March 2009
	Wire rod	SHFE	March 2009
	Zinc	SHFE	March 2007

Sources: Official websites of DCE, CZCE and SHFE.

Notes: CZCE, Zhengzhou Commodity Exchange; DCE, Dalian Commodity Exchange; LLDPE, linear low-density polyethylene; PTA, purified terephthalic acid; PVC, polyvinyl chloride; SHFE, Shanghai Futures Exchange.

market is open to domestic investors only; (iii) investors are not able to earn interest on the futures margin; (iv) futures contracts with different expiration dates have different transaction fees and position limits; and (v) the active trading contracts are normally not those approaching expiration. All these features are worthy of further study. More importantly, they may affect the performance of the market. Therefore, it is crucial to obtain a solid understanding of the general properties of the Chinese commodity futures market. This will provide a useful backdrop for various policy assessments.

Most published literature on commodity futures focuses on international markets, and on the US market in particular (e.g. Erb and Harvey, 2006; Gorton and Rouwenhorst, 2006). There is limited research on the institutional characteristics of the Chinese commodity futures markets (e.g. Williams *et al.*, 1998; Xin *et al.*, 2006) and on specific commodity products and phenomena (e.g. Shyy and Butcher, 1994; Fung *et al.*, 2010). As the Chinese commodity futures market has undergone continuous changes, very few papers focus on

the general properties of Chinese commodity futures. Therefore, we will conduct this research using the long-term accumulated data.

In the present paper, we analyze the overall market properties by constructing a set of indices that incorporate the special features of the Chinese futures market. Constructing indices to study commodity futures at the portfolio level is an approach used extensively in the analysis of futures' general properties (e.g. Bodie and Rosansky, 1980; Fama and French, 1987; Gorton and Rouwenhorst, 2006). The advantage of this approach is that index diversification among a set of commodity futures can reduce the noise inherent in individual commodity futures data. Therefore, the obtained result can better reflect the properties of the whole commodity futures market. The present paper contributes to the literature on emerging markets in the following way: we first modify the traditional index methodology and incorporate the special features of Chinese commodity futures, which enables us to measure Chinese futures market properties more accurately; we also analyze those properties, such as the return distribution, the risk premium, the diversification function, inflation hedges and international linkages, revealing an increasingly more important role of the Chinese futures market in both the domestic and the global economy.

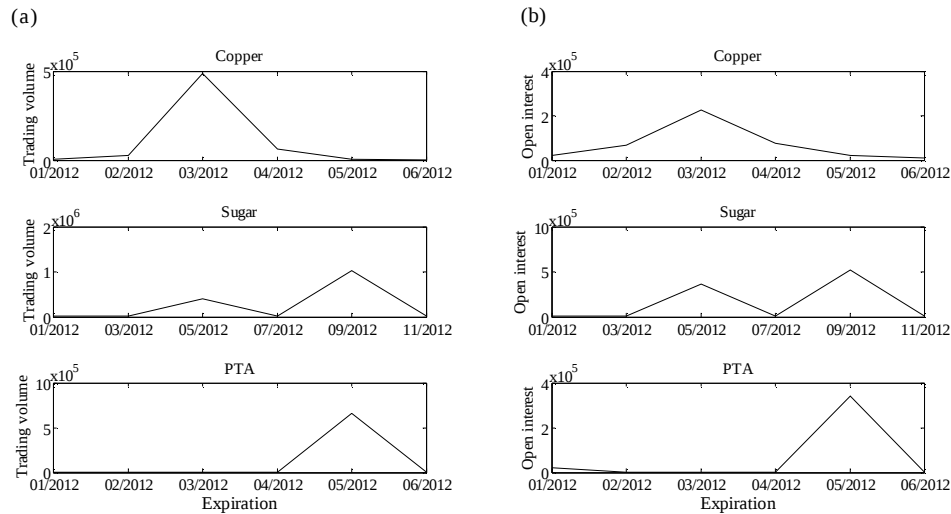
The remainder of the present paper is structured as follows. Section II introduces the methodology of the construction of Chinese commodity futures indices. In Section III, we outline the historical performance of China's commodity futures market. Section IV measures Chinese commodity futures' risk premiums. Section V analyzes the commodities' asset diversification function in China. In Section VI, the connection between the commodity futures market and the macroeconomic variables is explored. Section VII studies the lead-lag relationship between China's commodity futures market and the world market. Finally, Section VIII concludes, and some policy implications are provided.

II. Methodology and Data

The commodity futures indices have been widely adopted in the published literature, and they mostly share two common features: the index is equally weighted and the price of the nearest contract is used for the index construction. An equally-weighted index generally reflects the performance of "average" commodity futures. The nearest contract price for each commodity is used because the most active contract is usually the nearest, and, therefore, will provide the most typical price information for that commodity.

When constructing the Chinese commodity futures indices in the present paper, we follow the equal-weight method typically applied in the published literature. However, we will not follow the traditional method that uses the nearest contract price in index construction

Figure 1. Trading Volume (a) and Open Interest (b) of Copper, Sugar and Purified Terephthalic Acid (PTA), 30 December 2011



Source: WIND database.

Notes: This figure depicts the trading volume and open interest of all contracts for copper, sugar and PTA on 30 December 2011. The spike of the line in each graph represents the increase of volume or open interest for a particular contract relative to other contracts. This figure shows that the active contracts are not those approaching expiration, and for different commodities, the active contract months are also different. For example, the most active contract month for sugar is much later than that for copper.

because in China the nearest contracts of most commodities are very illiquid due to the strict position control policy for contracts approaching expiration (Jiang and Wu, 2007). Therefore, the prices of the nearest contracts are not typical, and they do not accurately reflect the corresponding commodities' performance. To tackle this problem, we construct our indices using the prices of the two most active contracts instead of those approaching expiration. We define a commodity's contract to be the most active one in a particular trading day, if the average of its daily volume and open interest is the largest among all contracts of the commodity in that day. Note that the most active contract month varies across the commodities. Figure 1 provides such an example of several commodities on 30 December 2011.

We construct five total return indices in the present paper to study the general properties of Chinese commodity futures: two composite indices representing the whole commodity futures market, and three sub-indices representing three sub-sectors (agriculture, chemical and metal). First, for each commodity, we compute its daily total return as the average of the

total returns of its first two most active contracts in a given trading day.³ The two returns are averaged to reduce the trading noise embedded in the most active contracts (Hong and Yogo, 2012). Second, we use an equally-weighted portfolio of all commodities in each sector to construct the sub-sector index. It is an equal average of the daily total return of each commodity within the given sector. Third, we construct the composite index using an equally-weighted portfolio across all three sub-sectors. It averages the total returns of the three sector indices (Hong and Yogo, 2012). As a robustness check, we further construct an alternative composite index by equally weighting across all individual commodities in the market (Gorton and Rouwenhorst, 2006). It averages the total returns of all commodities. Our results show no qualitative differences between these two composite indices when examining the Chinese market properties. The formula of the sector index is provided as follows. The composite index is just the equal average of three sector indices:

$$Index_t = \frac{1}{N} \sum_{i=1}^N (RA1_{it} + RA2_{it}) / 2, \quad (1)$$

where N is the number of commodities included in the sector, $RA1_{it}$ is the daily total return of the first most active contract of commodity i and $RA2_{it}$ is the daily total return of the second most active contract of commodity i .

The reason we present our analysis using the composite index with equal weight across sectors is that the number of agricultural products is nearly half that of the total number of products traded in China's commodity futures market, while their turnover is much lower. The equal-weighting across commodities might overestimate the influence of the agricultural sector.

To better reflect the short-term characteristics of the commodity futures returns, we use daily data (Kat and Oomen, 2006a,b) to construct all indices, which means that we need to carry out daily rebalancing for all the indices. All trading data of the Chinese commodity futures market are from the WIND database.⁴ The timeframe of our analysis is from January 2000 to December 2011. Chinese futures data become more reliable after 2000 because the *Temporary Decree on Futures Transactions* was promulgated by the State Council in this year, which symbolized the establishment of a unified, consistent and complete trading standard in the Chinese commodity futures market. Therefore, we adopt 12-year data (2000–2011) to conduct our research, which is long enough to measure the risk premiums of the commodity futures market.

³The daily total return of each contract is computed as the arithmetic return plus the current account interest rate.

⁴WIND is a major financial data provider in China.

III. Performance of Chinese Commodity Futures Market

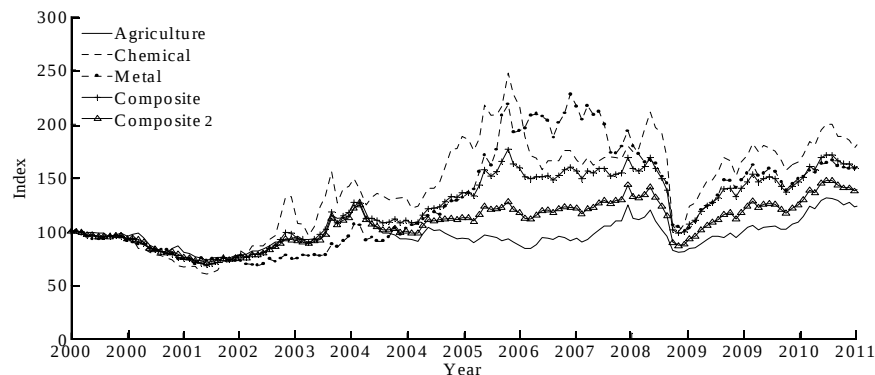
To obtain a general picture of the Chinese commodity futures market over the past 12 years, we first look at the trends of five total return futures indices, depicted in Figure 2.

From January 2000 to December 2011, the development of the whole Chinese commodity futures market shows an upward trend, with the chemical and the agricultural sectors displaying the highest and the lowest rises, respectively. In terms of volatility, both the chemical and the metal sectors are much more volatile than the agricultural sector. Two composite indices perform closely before year 2004, and then the equally-weighting-sector index moves above the equally-weighting-commodity index consistently thereafter because of the relatively weaker performance of agricultural commodities after 2004.

How do the commodity futures perform in comparison to the other assets in China? Table 3 provides descriptive statistics for three major assets in China: commodity futures, stocks and bonds. Note that Chinese stocks and bonds are relatively more independent from the world market than the commodity futures; it is interesting to examine whether the relations among these assets have common features of the world market.

As reported in Table 3, the composite commodity index, with a daily return of 0.000161, earns a higher return than the composite bond index (0.000106), but a smaller return than the composite stock index (0.000394). Higher return corresponds to higher risk. Not surprisingly, its volatility (standard deviation) also falls between them. Within the commodities, the chemical and agricultural indices generate the highest and the lowest return, and also the highest and the lowest volatility, respectively. Among the three asset

Figure 2. Trends of Five Total Return Commodity Futures Indices of Chinese Market, January 2000–December 2011



Source: All indices are calculated by the authors based on the methodology in Section II.

Notes: In Figure 2, “composite” is the composite index obtained by equally weighting each sector, and “composite 2” is the composite index obtained by equally weighting each commodity.

Table 3. Descriptive Statistics of Daily Returns of Futures, Bonds and Stocks in China, 2011

First observation	Index	Arithmetic mean	Standard deviation	Skew	Kurt	Signed rank test (<i>p</i> -value)
1 June 2000	Commodity composite	0.000161	0.007932	-0.506810	6.427558	0.007863
1 June 2000	Agriculture	0.000088	0.007233	-0.351445	6.557868	0.066225
1 May 2000	Chemical	0.000220	0.011457	-0.446026	5.794071	0.007263
1 April 2000	Metal	0.000176	0.010459	-0.309023	5.295558	0.022887
1 April 2000	Stock composite	0.000394	0.017545	-0.137062	6.553704	0.004424
1 March 2004	Small cap stock	0.000582	0.021224	-0.518748	5.341132	0.000191
1 March 2004	Large cap stock	0.000463	0.018772	-0.120401	5.709015	0.083359
5 August 2002	Bond composite	0.000106	0.000855	-0.436966	18.026664	0.000000
1 June 2000	Government bond	0.000146	0.001320	-0.773613	46.980564	0.000000
1 April 2000	Corporate bond	0.000189	0.001615	-0.477051	26.688348	0.000000
27 March 2002	Interbank bond	0.000115	0.001196	0.134408	34.697038	0.000000
2 April 2003	Convertible bond	0.000487	0.010722	-0.669246	12.382199	0.000392
Correlation matrix						
Commodity composite	Agriculture	Chemical	Metal	Total stock	Composite bond	
1.000000	0.733325	0.857849	0.827731	0.205518	-0.024534	
0.000000	1.000000	0.481926	0.448550	0.158779	-0.044510	
0.000000	0.000000	1.000000	0.522597	0.144599	-0.026466	
0.000000	0.000000	0.000000	1.000000	0.199260	0.002200	
0.000000	0.000000	0.000000	0.000000	1.000000	0.023106	
0.000000	0.000000	0.000000	0.000000	0.000000	1.000000	

Source: Calculated by authors.

Notes: Table 3 reports the mean, the standard deviation, the correlation and other statistical attributes for the three major asset classes (stock, bond and commodity futures) in China. The data used for generating daily returns start at different dates for different assets, but all end in December 2011. The first observation of each index is reported in the first column of the table. Except for those commodity indices, all other indices are from the S&P/CITIC index series from the WIND database.

classes, the commodity futures' return is the most left-skewed, and the least peaked. This feature contrasts sharply with overseas counterparts. For example, Gorton and Rouwenhorst (2006) find that the commodity futures' returns are the most right-skewed, and the most peaked compared with stocks and bonds in the US market. It is the small individual investors who dominate the Chinese futures market, and this may be caused by the different behavior of traders between two countries. In terms of asset correlation, the commodity index weakly correlates with the stock index and negatively correlates with the bond index. This finding concurs with the published literature (e.g. Gorton and Rouwenhorst, 2006; Kat and Oomen, 2006a,b), although the correlations of commodity futures with stocks and bonds appear to be relatively larger in China. The futures market microstructure may explain those performance differences across countries. In the next section, we will measure the risk premiums of commodity futures in China.

IV. Risk Premium

Commodity futures are zero cost securities; namely, they do not require an initial investment. Returns on commodity futures are related to the risk premiums and the performance of buyers and sellers. The theory of normal backwardation states that the risk premium will, on

average, accrue to buyers (e.g. Keynes, 1930; Hicks, 1939). In the backward market, commodity hedgers would offer a positive risk premium to speculators for bearing the price fluctuation risk.

The common measure of the risk premium of commodity futures is the excess return; namely, the percentage change in prices of the futures contract. For each commodity, we obtain the excess return using the total return abstracting the interest rate. Table 4 provides the basic statistics of excess returns for 26 commodity futures traded in the Chinese market.

The composite commodity index shows a significantly positive risk premium, which is mainly attributed to the chemical and metal sectors. The agricultural sector produces the lowest risk premium. Kat and Oomen (2006a,b) also find that most agricultural commodity futures had no significant risk premium in both the US and London markets.

Table 4. Descriptive Statistics of Daily Excess Returns
of 26 Commodity Futures Traded in China, 2000–2011

Commodity	Arithmetic mean	t-statistics	Standard deviation	Skewness	Kurtosis	Sharpe ratio	Signed rank test (p-value)
Composite index	0.000161	1.093438	0.007932	-0.506810	6.427558	0.015129	0.007863
Agricultural index	0.000088	0.656144	0.007233	-0.351445	6.557868	0.011429	0.066225
Soybean 1	0.000439	2.039585	0.010517	-0.328531	6.162331	0.041742	0.001146
Soybean 2	0.000718	2.632132	0.011281	-0.178630	4.516643	0.063647	0.000441
Yellow maize	0.000035	0.226602	0.006586	-0.046049	8.495312	0.005314	0.555978
Soybean pulp	0.000284	1.318434	0.011385	-0.134589	5.389051	0.024945	0.087293
Palm oil	0.000039	0.081632	0.015344	-0.382058	4.464616	0.002542	0.128764
Soybean oil	0.000469	1.359612	0.013165	-0.490645	5.516675	0.035625	0.000634
Cotton	-0.000060	-0.254961	0.010065	-0.339618	12.260018	-0.005961	0.797933
Early rice	-0.000183	-0.763718	0.006149	0.737232	10.027945	-0.029761	0.064842
Colza oil	0.000005	0.011474	0.013590	-1.005159	8.669660	0.000368	0.029045
Sugar	0.000026	0.077302	0.012631	-0.131936	5.034565	0.002058	0.730140
High quality wheat	-0.000286	-1.866621	0.007075	-0.099814	6.852446	-0.040424	0.216279
Hard white wheat	-0.000246	-2.152480	0.006178	-0.306173	7.667366	-0.039819	0.073381
Chemical index	0.000220	1.034704	0.011457	-0.446026	5.794071	0.019011	0.007263
Metallurgical coke	-0.001627	-2.123629	0.010222	0.104411	7.752607	-0.159167	0.023258
LLDPE	-0.000354	-0.762524	0.015266	-0.328261	4.390652	-0.023189	0.724581
PVC	-0.000372	-0.941566	0.009980	-0.612468	6.131448	-0.037275	0.936061
PTA	-0.000078	-0.213926	0.012717	-0.027792	5.258321	-0.006134	0.908091
Methanol	-0.003440	-2.754950	0.008468	-1.115145	6.228291	-0.406235	0.007314
Fuel oil	0.000354	1.055025	0.014180	-0.378863	5.231007	0.024965	0.015591
Natural rubber	0.000361	1.334234	0.014602	-0.275091	5.109820	0.024723	0.010534
Metal index	0.000176	0.908332	0.010459	-0.309023	5.295558	0.016827	0.022887
Aluminum	-0.000061	-0.354918	0.009255	-0.484125	7.799607	-0.006591	0.317310
Gold	0.000306	0.717660	0.013297	-0.284642	5.786529	0.023013	0.049821
Copper	0.000559	2.024520	0.014902	-0.108976	4.797962	0.037512	0.004061
Lead	-0.001108	-1.089831	0.014083	-0.328168	5.493899	-0.078676	0.307986
Deformed steel Bars	-0.000054	-0.150323	0.009324	-0.082103	7.398349	-0.005792	0.327989
Wire rod	-0.000524	-1.127016	0.012097	-0.698272	9.394070	-0.043317	0.882842
Zinc	-0.000635	-1.212227	0.017879	-0.294972	3.578320	-0.035517	0.812198

Source: Calculated by authors.

Notes: Table 4 summarizes the basic statistics for 26 futures in China during 2000 to 2011 based on daily excess return. Silver futures and glass futures are omitted because their listings are too recent (on 10 May 2012 and 3 December 2012, respectively). LLDPE, linear low-density polyethylene; PTA, purified terephthalic acid; PVC, polyvinyl chloride.

If we look at the specific commodities, among 26 commodities listed in Table 4, there are 13 that display significant excess returns. Among 13, 9 have positive excess returns, and 4 report negative excess returns. Within each sector, those commodities that produce the largest risk premiums (daily excess returns) are: soybean 2 in the agricultural sector (0.000718), copper in the metal sector (0.000559) and rubber in the chemical sector (0.000361). Soybean pulp is highly correlated with soybean 2, while much more liquid than it. It has a daily excess return of 0.000284. Soybean pulp, copper and rubber are the three most heavily traded products in the Chinese commodity futures market, taking 57.7 percent of the total market turnover in the first half of 2012. In contrast, four commodities with significantly negative excess returns (early rice, hard wheat, metallurgical coke and methanol) take only 0.22 percent of the total market turnover during the same period.⁵ Obviously, the Chinese commodity futures market displays a strong feature of normal backwardation. A long position of a commodity futures portfolio in China will generally yield a positive risk premium.

V. Asset Allocation

Commodity futures have long been considered an effective diversification tool for traditional asset portfolios. In the related published literature, Lintner (1983) finds that portfolios of stocks and bonds diversified with managed commodity futures show substantially less risk in terms of expected return. The underlying reason is that commodity futures funds usually have low correlations with other traditional assets. In China, the managed futures funds are few in number because they are not explicitly allowed under the current regulatory framework. In 2012, the China Securities Regulatory Commission issued asset management licenses to qualified futures companies, which may lead to a quick boom of commodity trading advisor funds in China in the near future.

The traditional assets in China, such as stocks and bonds, show substantially weaker international correlation than commodities futures. It is not clear whether the widely accepted diversification function of commodity futures is also applied in the Chinese market, which is what we focus on in this section. Because there are no managed futures data currently available for the Chinese market, we use our total return index to carry out the asset allocation analysis for both the active and the passive traditional assets portfolios.

The total return index represents a passive long-position-only strategy. Because the total return index is composed of liquid active contracts, it can be replicated easily in the form of a real portfolio. We will first test whether this commodity index can diversify those

⁵These figures are calculated by the authors using data from the WIND database.

mutual funds of stocks that follow active strategies. Elton *et al.* (1987) show that an asset should be added into the optimal portfolio as long as:

$$\frac{R_c - r}{s_c} \geq r_{cp} \frac{R_p - r}{s_p}, \quad (2)$$

where R_c represents the expected return of the commodity index, r is the risk-free rate, s_c denotes the standard deviation of the commodity index, R_p stands for the expected return of the mutual fund portfolio, s_p is the standard deviation of the portfolio, and r_{cp} represents the correlation coefficient between the commodity index and the portfolio.

We choose 10 best-performed mutual funds over 2009 to 2010, and investigate the possibility of enhancing the mutual funds' performance by incorporating commodity futures. From Table 5, we can find that the 10 best-performing mutual funds can be further improved by incorporating the commodity index.

Then we consider a virtual portfolio that includes all kinds of market indices in China. The role of the commodity futures in the optimal portfolio is further investigated, which may be of interest to institutional investors in terms of optimizing their asset allocation. We use the S&P/CITIC Large Cap 100, the S&P/CITIC Small Cap, the S&P/CITIC Government Bond Index, the S&P/CITIC Corporate Bond Index and the total return commodity index to represent different asset classes. The optimal portfolios are calculated with and without the short-sale constraint, both of which turn out to produce the same result. Table 6 presents the optimal allocation of different asset classes holding the portfolio standard deviation at 0.0012. Compared to Table 3, the optimal portfolio improves the Sharpe ratio for every single asset. The bonds take the largest percentage of the portfolio, and the commodity futures index takes 0.82 percent only (see Table 6), leading to a daily portfolio return of 0.000175. Setting a higher portfolio return target, using a managed futures index or utilizing the commodity index with other weighting standards may substantially increase the

Table 5. Diversification Function of Commodity Index to Mutual Funds of Stocks, 2009–2010

Exchange codes of mutual funds	Annualized daily return of net value (%)	$\frac{R_p - r}{s_p}$	r_{cp}	$\frac{R_c - r}{s_c} \geq r_{cp} \frac{R_p - r}{s_p}$
150001.SZ	79.0299	0.1364	0.3783	Yes
000011.OF	45.4510	0.1902	0.4164	Yes
519087.OF	44.0715	0.1880	0.3846	Yes
519001.OF	43.5578	0.1835	0.4033	Yes
519696.OF	42.3537	0.1637	0.4056	Yes
180013.OF	41.8785	0.1620	0.3712	Yes
320006.OF	40.8372	0.1726	0.3517	Yes
002031.OF	40.3690	0.1775	0.3767	Yes
260109.OF	39.8206	0.1581	0.3852	Yes
400003.OF	39.5395	0.1672	0.4364	Yes
150001.SZ	79.0299	0.1364	0.3783	Yes

Source: Calculated by authors.

Table 6. Optimal Portfolio with Commodities

Assets	Weights (%)
Commodity futures composite	0.82
S&P/CITIC Large Cap 100	0.66
S&P/CITIC Small Cap	0.61
S&P/CITIC Government Bond	57.95
S&P/CITIC Corporate Bond	39.96
Average return	0.000175
Standard deviation	0.0012
Sharpe ratio	0.1437

Source: Calculated by authors.

Notes: The average return, standard deviation and Sharpe ratio are daily. The estimation window is the same as that in Table 3.

commodity's allocation share in the optimal portfolio. Commodity futures have become a non-negligible asset class for the Chinese asset management industry.

VI. Function of Hedging and Inflation Signaling

Many studies show that commodity futures can be used as a hedging tool against inflation (e.g. Greer, 1978; Gorton and Rouwenhorst, 2006). On the one hand, the prices of commodity futures represent the expected future spot prices. If the expected inflation increases, the prices of futures will increase accordingly. On the other hand, the relatively short-term contracts of commodity futures can absorb new market information timely; therefore, they are able to react to changes in the unexpected inflation. Gorton and Rouwenhorst (2006) decompose the inflation into expected and unexpected inflation. They find that commodity futures are sensitive to both expected and unexpected inflations, but more sensitive to unexpected inflation. We carry out a similar analysis here for the Chinese market with two differences: we slightly change our measures of expected and unexpected inflation and not only analyze the composite commodity index but also the three sector indices.⁶

The commodity returns are regressed based on the two components of inflation according to the following equation (Adams *et al.*, 2008):

$$r_t = b_0 + b_1 E(p_t) + b_2 (p_t - E(p_t)) + e_t, \quad (3)$$

where r_t is the return of the commodity futures index, $E(p_t)$ is the expected inflation and $p_t - E(p_t)$ represents unexpected inflation. b_1 and b_2 measure the effectiveness of the hedge against expected and unexpected inflation, respectively. Following Kat and Oomen

⁶Gorton and Rouwenhorst (2006) use the short-term T-bill rate as a measure for expected inflation. As the Chinese interest rate is not fully marketized, we will follow Kat and Oomen (2006b) by using the current period inflation as the measure for the next period expected inflation.

Table 7. Estimation Results of Inflation Hedge Property of Commodity Futures

	Constant	Expected inflation	Unexpected inflation
Composite index	0.0014	1.4197**	1.4364***
Metal sector	0.0041	0.8404	1.3171*
Chemical sector	0.0046	1.6238	1.8465*
Agricultural sector	0.0009	1.3367**	1.1150**

Source: Calculated by authors.

Note: ***, ** and * denote that the estimated coefficients are significant at the 1, 5 and 10-percent level, respectively.

(2006b), we use the current period inflation as the best expectation for the next period inflation assuming a naïve projection. Hence, $E(p_t) = p_{t-1}$, and $p_t - E(p_t)$ equals $p_t - p_{t-1}$. The composite index and three sector indices are regressed separately according to Equation (2). We use monthly data instead of daily data from January 2000 to December 2011 because the inflation rate is only reported monthly. Table 7 shows the results.

It is evident that the composite index provides significant hedging against both expected and unexpected inflation, and the hedging effect is even larger for unexpected inflation with a significant coefficient (1.4364) in Table 7. The agricultural sub-index has a similar result to the composite, but it better hedges against the expected inflation than unexpected inflation. This is because food and beverage takes the largest weight in China's CPI composition.⁷ In contrast, metal and chemical sub-indices only offer significant hedging against unexpected inflation, but not against expected inflation.

We also test whether stocks or bonds in China have the inflation hedging property. The results in Table 8 show that neither stocks nor bonds are significantly related to either expected or unexpected inflation. This is quite different from the results in the US market. Gorton and Rouwenhorst (2006) find that stocks and bonds are negatively influenced by inflation in a relatively short holding period, while Bekaert and Engstrom (2010) point out that the equity yields are positively affected by inflation in a longer horizon.

The insensitiveness of stocks and bonds to inflation in China is the result of less efficient Chinese stock and bond markets.⁸ Therefore, the information concerning the aggregate price level cannot be effectively transformed into the asset returns. In contrast, commodities are more directly linked to the aggregate price level. In particular, the weight of food and beverage in the CPI composition in China reached 33 percent in 2010 (see footnote 7),

⁷According to the National Bureau of Statistics of China, in 2010, CPI in China consisted of housing (16 percent), food and beverage (33 percent), transport (10 percent), medical care (8 percent), apparel (9 percent), entertainment (6 percent), home appliances (4 percent) and other (12 percent).

⁸For example, the Chinese stock market is plagued with various institutional and corporate problems, and the Chinese bond market does not have a fully marketized interest rate yet.

Table 8. Estimation Results of Inflation Hedge Property of Stock and Bond

	Constant	Expected inflation	Unexpected inflation
Stock	0.0006*	1.5167	0.2213
Bond	0.0031***	−0.1255	0.1255

Source: Calculated by authors.

Notes: Regression results are obtained using the same methodology and time window as in Table 7. ***, ** and * denote that the estimated coefficients are significant at 1, 5 and 10-percent level, respectively.

more than two times the weight in the USA.⁹ This makes the agricultural commodity futures the most effective asset to hedge the inflation in China.

Besides the instant correlation with inflation, commodity futures also indicate future inflation (e.g. Bordo, 1980; Garner, 1995).¹⁰ We use a VARX model to investigate the commodity futures' inflation forecasting ability. We regress the vector of excess returns of metal, chemical and agricultural sectors, and the inflation rate, using foreign exchange reserves as the exogenous control variable, because foreign exchange reserves can reflect the effect of so called “imported inflation” via China's current or capital account. All returns are calculated monthly based on the daily excess returns, and the inflation rate is calculated from monthly CPI over the period of January 2000 to December 2011. All variables pass the augmented Dickey–Fuller unit-root test for stationarity. Furthermore, by using the Akaike information criterion and analyzing the estimated residuals to avoid significant autocorrelation, a VARX (3, 0) model is specified. Let $Y_t = (r_t^m, r_t^c, r_t^a, i_t)'$, where the elements in the vector are the excess returns of metal, chemical and agricultural sectors, and the inflation rate, respectively. Then the regression is:

$$Y_t = a_0 + a_1 Y_{t-1} + a_2 Y_{t-2} + a_3 Y_{t-3} + a_4 Re_t + e_t, \quad (4)$$

where Re_t is the vector of foreign exchange reserves. Table 9 shows the regression results.

From Table 9, we find that there exists a one-way relationship between the inflation rate and the agricultural futures return. The coefficient of the second lagged agricultural futures return is very significant, implying that the agricultural futures return can indicate the inflation 2 months ahead. In contrast, the lagged inflation rate does not affect the agricultural futures return. Neither metal nor chemical returns can significantly influence the inflation rate.

⁹The US CPI composition for 2010 can be found from the Bureau of Labor Statistics, US Department of Labor. Available from: www.bls.gov.

¹⁰Some explanations include: commodity futures trade in highly efficient auction markets, so commodity futures prices can move more quickly in response to actual or expected changes in supply or demand than other indicators. By contrast, prices of most final goods and services are restrained by contractual arrangements and other transaction frictions, so they respond more slowly to supply and demand pressures (Garner, 1995).

Table 9. Estimation Results of Inflation Indicating Property of Commodity Futures, 2000–2011

	Metal	Chemical	Agricultural	Inflation
Metal				
Lag (1)	0.1751	0.0967	0.0354	0.0045
Lag (2)	−0.1040	−0.0617	−0.0631	−0.0103
Lag (3)	−0.0422	0.0016	−0.0634	−0.0066
Chemical				
Lag (1)	−0.0701	0.0644	0.0744	0.0030
Lag (2)	0.1103	0.0650	0.0296	−0.0099
Lag (3)	0.0518	−0.2595**	−0.1115	−0.0009
Agricultural				
Lag (1)	−0.0832	−0.0437	0.0642	0.0023
Lag (2)	0.0546	0.2801	0.0251	0.0481***
Lag (3)	0.0172	0.434**	0.1271	−0.0065
Inflation				
Lag (1)	−0.2950	−0.4378	−0.1481	0.3363
Lag (2)	0.4112	−0.9776	0.5702	−0.0902
Lag (3)	−0.5195	−0.5454	−0.0393	−0.0482
Reserve	0.7463**	0.8798**	0.4108*	0.082**
Constant	−0.0111	−0.0095	−0.0067	−0.0005

Source: Calculated by authors.

Note: ***, ** and * denote that the estimated coefficients are significant at the 1, 5 and 10-percent level, respectively.

VII. Lead–lag Relationship with Foreign Market

The above illustrates how the Chinese commodity futures market functions domestically; we will delve into its international linkage in this section. The Chinese commodity futures market is isolated from the world market to a large extent. Because of the current regulations, few Chinese investors can invest in foreign commodity markets and, similarly, few foreign investors can enter the Chinese market. Despite such a segregated environment, the scale of the Chinese commodity futures market is growing persistently.

Most studies on international linkages with Chinese futures market are explored mainly from the angle of specific commodities or sectors. For example, Hua and Chen (2004) find that the bean futures from Dalian Exchange had a cointegration relationship with bean futures from the Chicago Exchange in the long run. Zhang *et al.* (2006) find that the correlation of metal futures between Chinese and the US markets is more significant than the correlation of agricultural futures. We will address this question from the dynamic perspective of the overall market. We carry out a lead–lag analysis with both the composite and the sector commodity indices, and compare the changes in the market interaction over the period of 2000–2010.¹¹

The Chinese commodity futures market opens approximately 6 hours earlier than the European market, and 12 hours earlier than the US market. We focus on the short-term interaction (information transmission) between the Chinese and US markets; therefore, we use daily return series. We study the lead–lag relationship within a 1-week trading period.

¹¹We only present the regression result for the composite index here. The results for the other three sub-indices exhibit the same pattern as the composite index, so they are omitted for brevity.

The basic model is expressed as follows:

$$r_{C,t} = b_0 + \sum_{k=-1}^{-5} g_k r_{F,t+k} + \sum_{k=-1}^{-5} b_k r_{C,t+k} + u_t, \quad (5)$$

$$r_{F,t} = b_0 + \sum_{k=-1}^{-5} g_k r_{F,t+k} + \sum_{k=0}^{-4} b_k r_{C,t+k} + u_t, \quad (6)$$

where $r_{C,t}$ is the return of Chinese commodity futures and $r_{F,t}$ is the return of the US commodity futures. The third term on the right-hand side of Equation (6), $\sum_{k=0}^{-4} b_k r_{C,t+k}$, starts from zero lag. This is because $r_{C,t}$ leads $r_{F,t}$ for the same time t due to the time difference between China and the USA.

To make the commodity indices comparable between the two countries, we construct a composite index and three sector indices for the US commodity market using the same methodology used by Chinese indices in the present paper. The compositions of the US sector indices are reported in Table 10.

To capture the dynamics of the two markets' interaction, we carry out a lead–lag analysis for years 2000 and 2010, respectively. All the daily return series are stationary. Table 11 presents the overall lead–lag results between the Chinese and the US commodity futures markets using the composite indices.

From Table 11, it is evident that in year 2000, the US market's 1-day lead return had a significantly positive effect on the market, but the Chinese market had no significant effect on the US market, indicating only a one-way information transmission. In 2010, the US 1-day lead return had a more significant effect on the Chinese market, and the estimated coefficient became even larger. At the same time, the Chinese 1-day lead return also exerted a significantly positive effect on the US market. These results imply that the interaction between Chinese and US commodity futures markets not only strengthened, but also changed from a one-way direction (from the USA to China only) in 2000, to a two-way direction (from the USA to China and from China to the USA) in 2010.¹² The increased information transmission between these two commodity futures markets may be mainly because of the increased linkage of supply and demand between their spot markets. For example, Chinese beans are increasingly

¹²We also carry out the same lead–lag analysis for every year between 2000 and 2010. The results reveal the same gradual changing pattern of the market interaction: from a one-way direction to a two-way direction.

Table 10. Composition of Sectors Indices for the US Market

Commodity	Exchange	First observation
Chemical		
Crude oil	NYMEX	April 1983
Gasoline	NYMEX	January 1985
Heating oil	NYMEX	April 1979
Natural gas	NYMEX	May 1990
Gas-oil-petroleum	ICE	January 1989
Propane	NYMEX	September 1987
Agriculture		
Coffee	ICE	September 1972
Rough rice	CBOT	January 1987
Orange juice	ICE	March 1967
Sugar	ICE	February 1961
Lumber	CME	November 1969
Cocoa	ICE	August 1959
Milk	CME	February 1996
Soybean oil	CBOT	August 1959
Soybean meal	CBOT	August 1959
Soybeans	CBOT	January 1965
Corn	CBOT	August 1959
Oats	CBOT	August 1959
Wheat	CBOT	August 1959
Canola	WCE	February 1977
Barley	WCE	June 1989
Flaxseed	WCE	January 1985
Cotton	ICE	August 1959
Feeder cattle	CME	December 1971
Live cattle	CME	December 1964
Lean hogs	CME	March 1966
Pork bellies	CME	February 1964
Metal		
Gold	NYMEX	February 1977
Silver	NYMEX	February 1972
Copper	NYMEX	October 1972
Palladium	NYMEX	February 1977
Platinum	NYMEX	August 1972

Sources: The data used to construct the US indices are from the US Commodity Research Bureau, supplemented with the data from the Futures Industry Institute of the USA.

Notes: CBOT, Chicago Board of Trade; CME, Chicago Mercantile Exchange; ICE, Intercontinental Exchange; NYMEX, New York Mercantile Exchange; WCE, Winnipeg Commodity Exchange.

heavily dependent on imports.

Note that the ever-increasing linkage between Chinese and US markets over the past decade may not necessarily result from the increased information transmission. Rather, because the Chinese market continuously lists more and more commodity futures products,

Table 11. Lead–lag Analysis of Chinese and US Commodity Futures Markets:
Composite Indices, 2000 and 2010

Ch-composite	2000			2010		
	Coefficient	Standard error	p-value	Coefficient	Standard. error	p-value
Ch-lag(1)	0.1483	0.0648	0.023	–0.0253	0.0679	0.710
Ch-lag(2)	0.0622	0.0657	0.344	0.1153	0.0678	0.090
Ch-lag(3)	0.0887	0.0656	0.178	–0.0103	0.0686	0.881
Ch-lag(4)	–0.1035	0.0655	0.115	–0.0300	0.0683	0.660
Ch-lag (5)	–0.0914	0.0645	0.158	–0.1094	0.0566	0.054
US-lag(1)	0.0767	0.0366	0.037	0.6085	0.0622	0.000
US-lag(2)	0.0462	0.0369	0.212	–0.0595	0.0742	0.423
US-lag(3)	0.0458	0.0370	0.217	–0.2078	0.0741	0.779
US-lag(4)	0.0019	0.0368	0.957	–0.0022	0.0737	0.976
US-lag(5)	0.0125	0.0367	0.734	0.0222	0.0731	0.761
Constant	–0.0005	0.0002	0.030	–0.0002	0.0004	0.730
US-composite	2000			2010		
	Coefficient	Standard error	p-value	Coefficient	Standard error	p-value
Ch-lag(0)	0.0588	0.1155	0.611	0.3608	0.0680	0.000
Ch-lag(1)	0.1155	0.1162	0.321	–0.0889	0.0714	0.214
Ch-lag(2)	0.1258	0.1168	0.282	0.1245	0.0717	0.084
Ch-lag(3)	–0.0392	0.1171	0.738	–0.0097	0.0719	0.893
Ch-lag (4)	0.0178	0.1159	0.878	–0.0222	0.0718	0.757
US-lag(1)	–0.0040	0.0657	0.950	–0.9115	0.0775	0.241
US-lag(2)	–0.0574	0.0660	0.384	0.0488	0.0780	0.532
US-lag(3)	0.0071	0.0660	0.914	–0.0803	0.0776	0.301
US-lag(4)	–0.0105	0.0655	0.873	–0.0149	0.0771	0.846
US-lag(5)	0.0417	0.0655	0.525	–0.0524	0.0734	0.476
Constant	0.0010	0.0004	0.016	0.0009	0.0005	0.058

Source: Calculated by authors.

it may make the Chinese market increasingly resemble the US market. Indeed, over the past decade, the Chinese commodity futures market listed many commodities that are already traded in the US market, and are mainly in the agricultural sector. However, through a closer comparison of Tables 2 and 10, we find that the Chinese futures market also listed many products that were not traded in the USA. Take the chemical sector, for example: in year 2000, the Chinese market only listed rubber. By 2010 an additional four commodities were listed: fuel oil, LLPPE, PVC and PTA. Only fuel oil resembles heating oil in the US market, and the other three are not listed in the US market.

Because our indices adopt the equal-weight methodology, the Chinese chemical index is more different from that in the USA in terms of its composition in year 2010 than year 2000. However, from the lead–lag analysis using the chemical indices, we find that the chemical indices between the two countries displayed the same pattern as the composite indices: one-way influence in year 2000 and two-way influence in 2010. This pattern also applies to the other sector indices. These results strongly suggest that over the past decade, the information linkage between the Chinese commodity futures market and the world market has strengthened considerably. The Chinese market now becomes a non-negligible factor in global commodity price formation.

VIII. Conclusions and Some Policy Implications

The present paper constructs a set of indices that capture the special features of the Chinese commodity futures market, and carry out a rigorous analysis for the properties of commodity futures during the period of January 2000 to December 2011.

We first present the general trend of the Chinese commodity futures market, and compare its performance relative to the other traditional assets. Then, we investigate the risk premiums for the commodity futures and find that although the risk premiums vary across individual commodities, overall Chinese commodity futures produce a significantly positive risk premium, indicating that the commodity futures market is generally backwardated. We verify that the commodity futures can act as an effective diversification tool in the Chinese asset management industry. We also show that the commodity futures can hedge both expected and unexpected inflation in China. Agricultural futures are found to be a signal for inflation 2 months earlier. We finally explore the relationship between Chinese and US commodity futures markets for the years 2000 and 2010. The results reveal an increasingly interactive pattern between these two markets, indicating enhanced information transmission. Our analysis may not only be useful for scholars working on more narrow questions concerning Chinese commodity markets, but also valuable for practitioners interested in investing in the Chinese market, as well as policy-makers. The following are some policy suggestions based on our analysis.

First, the empirical evidence shows that the Chinese commodity futures market can affect the US market, but with less influence from the US market. Therefore, the greatest policy concern is improving the Chinese commodity market's pricing power. Two problems curtailing the market's pricing power should be paid more attention: the low open interest of the Chinese market and that international investors are not allowed access to the Chinese futures market.

Low open interest with a high trading volume implies that the Chinese futures market is too speculative. Some measures can be adopted to solve this problem, including raising the contract size and providing preference to hedgers (e.g. lowering their margin requirements and introducing more institutional investors).

Not permitting international investors to enter the Chinese futures market not only prevents international information transmission, but also reduces the potential capital invested in the Chinese market, which consequently weakens the Chinese market's pricing power. Therefore, we should open the Chinese commodity futures market to the international investors gradually. The design of the oil futures in the Shanghai Futures Exchange, which is open to international investors, is a promising first step.

Second, Chinese commodity futures could both hedge and indicate inflation, while the stocks and bonds do not have this function. As inflation is one of the most important monetary policy targets, incorporating the information from Chinese commodity futures market could help the central bank to improve the efficacy of monetary policy.

Third, establishing the passive commodity futures index portfolio could diversify the portfolios of traditional assets in China. However, the percentage of commodity futures in the optimal portfolio is still as low as 0.82 percent (see Table 6). To provide more choices for Chinese commodity investors, the active commodity trading advisor should be introduced to the Chinese market.

References

- Adams, Zeno, Roland Fuss and Dieter G. Kaiser, 2008, "Macroeconomic determinants of commodity futures returns," in *Handbook of Commodity Investing*, USA: John Wiley & Sons.
- Almanac of China's Finance and Banking Editorial Office, 2011, *Almanac of China's Finance and Banking 2011*, Beijing: Almanac of China's Finance and Banking Magazine.
- Bekaert, Geert and Eric Engstrom, 2010, "Inflation and the stock market: Understanding the 'Fed Model'," *Journal of Monetary Economics*, Vol. 57, No. 3, pp. 278–94.
- Bodie, Zvi and Victor I. Rosansky, 1980, "Risk and return in commodity futures," *Financial Analysts Journal*, Vol. 36, No. 3, pp. 27–39.
- Bordo, Michael David, 1980, "The effects of monetary change on relative commodity prices and the rule of long-term contracts," *Journal of Political Economy*, Vol. 88, No. 6, pp. 1088–109.
- Elton, Edwin J., Martin J. Gruber and Joel C. Rentzler, 1987, "Professionally managed, publicly traded commodity funds," *Journal of Business*, Vol. 60, No. 2, pp. 175–99.
- Erb, Claude B. and Campbell R. Harvey, 2006, "The strategic and tactical value of commodity futures," *Financial Analysts Journal*, Vol. 62, No. 2, pp. 69–97.
- Fama, Eugene F. and Kenneth R. French, 1987, "Commodity futures prices: Some evidence on forecast power, premiums, and the theory of storage," *The Journal of Business*, Vol. 60, No. 1, pp. 55–73.
- Fung, Hung-Gay, Qingfeng Liu and Yiuman Tse, 2010, "The information flow and market efficiency between the US and Chinese aluminum and copper futures markets," *Journal of Futures Markets*, Vol. 30, No. 12, pp. 1192–209.
- Garner, Alan C., 1995, "How useful are leading indicators of inflation?" *Federal Reserve Bank of Kansas City Economic Review*, Vol. 80, No. 2, pp. 5–18.
- Gorton, Gary and Geert K. Rouwenhorst, 2006, "Facts and fantasies about commodity futures," *Financial Analysts Journal*, Vol. 62, No. 2, pp. 47–68.
- Greer, Robert J., 1978, "Conservative commodities: A key inflation hedge," *Journal of Portfolio Management*, Vol. 4, No. 4, pp. 26–9.
- Hicks, John R., 1939, *Value and Capital*, Oxford: Oxford University Press.

- Hong, Harrison and Motohiro Yogo, 2012, "What does futures market interest tell us about the macroeconomy and asset prices?" *Journal of Financial Economics*, Vol. 105, No. 3, pp. 473–90.
- Hua, Renhai and Baizhu Chen, 2004, "International linkages of the Chinese futures market," *Jingjixue Jikan (Quarterly Journal of Economics)*, Vol. 3, No. 3, pp. 727–42.
- Jiang, Shu and Chongfeng Wu, 2007, "The efficiency of China's futures market: A study based on overreaction and domestic and international market linkage," *Jinrong Yanjiu (Financial Research)*, Vol. 320, No. 2, pp. 49–62.
- Kat, Harry M. and Roel C. A. Oomen, 2006a, "What every investor needs to know about commodities I: Univariate return analysis," *Working Paper*, City University, London, UK.
- Kat, Harry M. and Roel C. A. Oomen, 2006b, "What every investor needs to know about commodities II: Multivariate return analysis," *Working Paper*, City University, London, UK.
- Keynes, John Maynard, 1930, *A Treatise on Money*, London: Macmillan.
- Lintner, John, 1983, "The potential role of managed commodity-financial futures accounts in portfolios of stocks and bonds," paper present at the Annual Conference of the Financial Analysts Federation, Toronto, Canada, 16 May 1983.
- Lu, Feng, Yuanfang Li and Liu Liu, 2009, "International commodity prices fluctuations and China factor – The new problems faced by the growth of Chinese open economy," *Jinrong Yanjiu (Financial Research)*, Vol. 352, No. 10, pp. 38–56.
- PBOC (People's Bank of China), 2010, *Operation Report of Regional Finance in China in 2009* [online; cited 9 June 2010]. Available from: <http://www.pbc.gov.cn>.
- Shyy, Gang and Bob Butcher, 1994, "Price equilibrium and transmission in a controlled economy: A case study of the metal exchange in China," *Journal of Futures Markets*, Vol. 14, No. 8, pp. 877–90.
- Williams, Jeffery, Anne Peck, Albert Park and Scott Rozelle, 1998, "The emergence of a futures market: Mungbeans on the China Zhengzhou Commodity Exchange," *Journal of Futures Markets*, Vol. 18, No. 4, pp. 427–48.
- Xin, Yu, Gongmeng Chen and Firth Michael, 2006, "The efficiency of the Chinese commodity futures markets: Development and empirical evidence," *China & World Economy*, Vol. 14, No. 2, pp. 79–92.
- Zhang, Qishan, Yi Fang and Kun Huang, 2006, "An empirical study on the function and international influence of Chinese futures market," *Guanli Shijie (Management World)*, Vol. 151, No. 4, pp. 28–34.

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