# RISK PREMIA IN CHINESE COMMODITY MARKETS

May 5, 2016

**Abstract**

This paper investigates risk premia in Chinese commodity markets. We accomplish that by decomposing the returns of commodity futures into spot and term premia following Szymanowska, De Roon, Nijman and Van Den Goorbergh (2014). We find that a three factors model that includes equally-weighted market factor, carry and time-series momentum explains spot premia. The term premium, which represents a deviation from the expectation hypothesis, is weak, in contrast with the significant premium in the US commodity markets associated with the average t-statistic of 4.32 and explained by two investable factors that are derived using calendar spreads. We demonstrate that the term premia are not driven by liquidity and are negatively related to basis likely due to mean-reversion in basis.

**Keywords:** Chinese markets, commodity futures, spot premium, term premium

## 1 Introduction

*The fear that China's appetite for commodities, from copper to coal, is falling after a decade of breakneck growth has sent prices tumbling, but the country's sheer scale in these markets means that China will continue to shape them in the long term, even if at a slower speed.*-Wall Street Journal, Aug 25, 2015, "China remains a key commodities player, despite waning appetites".

In addition to being a major player in international commodity markets, China has its own commodity futures markets that are very liquid. According to Futures Industry Association's (FIA) Annual Volume Survey 2014, China's only three commodity futures exchanges, Shanghai Futures Exchange (SHFE), Dalian Commodity Exchange (DCE) and Zhengzhou Commodity Exchange (ZCE), are global leading derivative exchanges in providing trading of commodity futures, such as agricultural, metal and energy contracts.[1] For instance, ZCE's Rapeseed Meal and White Sugar, DCE's Soy Meal and RBD Palm Olein, and SHFE's Rubber are ranked as the 5 most popular agricultural contracts in global markets with respect to trade volume; SHFE's Rebar and Silver, DCE's Iron Ore, and SHFE's Copper are the 4 most heavily transacted worldwide metal futures contracts.[2] Though Chinese commodity futures markets are sizable and arguably very important due to the role of China in international commodity markets, they have not been thoroughly investigated.[3]

The purpose of this paper is to investigate the return drivers of the Chinese commodity markets and compare them to those in the US commodity markets. We accomplish that by first decomposing futures returns into spot and term premia as suggested in Szymanowska, de Roon, Nijman and Van Den Goorbergh (2014) and then examining those premia separately. The spot premia are associated with moves in underlying commodities and can be captured by taking directional long-short positions in the nearby futures contracts. The term premia that are largely ignored in academic literature are associated with the shape of the forward curve and changes in basis. The term premia can be captured by trading calendar spreads that combine long exposures in longer maturity contracts and short exposures in nearby contracts. Our contribution is twofold. First, we find that the cross-section in spot premia in both markets can be explained by three investable factors: market, carry and time-series momentum[4]. By contrast, the term premium, which is statistically significant and orthogonal to spot premia factors in the US markets is not present in Chinese markets. This finding is important because it suggests that, unlike the US markets, the Chinese commodity markets behave consistently with the expectation hypothesis. Two investable term premia factors, based

[1]As the biggest commodities exchange, Shanghai Futures Exchange (SHFE) facilitates trading of 12 commodity contracts, encompassing futures on Gold, Silver, Copper, Aluminum, Zinc, Lead, Steel Rebar, Steel Wire Rod, Fuel Oil, Natural Rubber, Bitumen and Hot Rolled Coil. Recently, the SHFE launched overnight trading of Gold, Silver and non-ferrous metal futures, which has substantially increased SHFE's trading volume. Zhengzhou Commodity Exchange (ZCE), as the first pilot futures market in China, provides futures contracts on Strong Gluten Wheat, Common Wheat, Early Long Grain Non-glutinous Rice, Late Indica Rice, Japonica Rice, Cotton, Rapeseed, Rapeseed Oil, Rapeseed Meal, White Sugar, Steam Coal, Methanol, Pure Terephthalic Acid (PTA), Ferroalloy and Flat Glass. Dalian Commodity Exchange (DCE) provides trading of 16 commodity futures contracts, which are corn, corn starch, No. 1 Soybean, No. 2 Soybean, Soybean Meal, Soybean Oil, RBD Palm Olein, Egg, Fiberboard, Blockboard, Linear Low Density Polyethylene (LLDPE), Polyvinyl Chloride (PVC), Polypropylene (PP), Coke, Coking Coal and Iron Ore. In 2014, DCE achieved 770 million contracts and RMB 41.5 trillion (on a unilateral basis) in trading volume and turnover, respectively.

[2]Shanghai Futures Exchange (SHFE), Dalian Commodity Exchange (DCE) and Zhengzhou Commodity Exchange (ZCE) are ranked 9th, 10th and 13th by trading volume of all sorts of futures contracts, which include but not limited to commodity futures, out of the global leading derivative exchanges respectively.

[3]There have been some interesting studies of Chinese financial markets that focused on the interaction within Chinese markets such as Yang, Yang and Zhou (2010) who document a strong bidirectional dependence in the intraday volatility of the Chinese stock index and the stock index futures contract or the interaction between the US and Chinese markets as in Fung, Liu and Tse (2010) who report that the US and Chinese futures markets are closely related for aluminum and copper.

[4]Market factor is an equally-weighted index of commodities described in Erb and Harvey (2006). Carry factor, extensively covered in Szymanowska, de Roon, Nijman and Van Den Goorbergh (2014), is a zero-investment portfolio formed by going long high-basis commodities and short selling low-basis commodities. Time-series momentum is discussed in detail in Moskowitz, Ooi and Pedersen (2012). All the factor portfolios are fully collateralized and rebalanced monthly.

on simple calendar spread strategies as suggested in Blocher, Cooper and Molyboga (2016), explain the cross-section of term premia in US commodities. Second, we show that the term premia are not driven by market liquidity whereas the basis provides a significant explanatory value with a positive relationship to spot premia and negative to term premia. This finding is consistent with Szymanowska, de Roon, Nijman and Van Den Goorbergh (2014) who document a negative relationship between spot and term premia. We show that this negative relationship is driven by basis.

Our results are based on the cross-section of 25 Chinese commodity contracts between January 1999 and December 2014 and 30 US commodity futures contracts between Sept 1987 and December 2014 making our study the most comprehensive study of US and Chinese commodities to date. There is substantial cross-sectional variation in commodity returns in both US and Chinese markets. When sorting on basis, we find that a high-minus-low portfolio of top and bottom quartiles delivers approximately 8.4% per annum in the US market and 6.1% in Chinese markets. Similar momentum sorts based on the most recent 12-months performance result in a premium of 11.3% in the US market and 17.5% in Chinese commodities.

The spot premia behave similarly in both markets. The market factor in the US market has delivered a negative return of 1.8% per annum falling short of the predictions of Erb and Harvey (2006) and Gorton and Rouwenhorst (2006) who argue that equally-weighted portfolio of commodities should deliver a Sharpe ratio that is comparable to that of the equity market.[5] Similarly, the market factor in Chinese commodities has lost approximately 3.6% per annum. This negative performance is likely driven by negative values of roll yield in commodities, consistent with Ilmanen (2011), who shows that long run average returns of commodities are closely related to their average roll yields (or basis), but in contrast to Samuelson (1965) who argues that properly anticipated prices fluctuate randomly. The basis-performance relation is as well suggested by the theory of storage (Working, 1949; Brennan, 1958; Telser, 1958) and the sequent empirical studies on the theory (e.g. Fama and French (1987) and Fama and French (1988)), which forecast lower futures prices during business-cycle booms, due to inversions of "normal" futures-spot price relations (Fama and French, 1988). The mechanism is threefold: 1) convenience yield increasingly decreases with inventory; 2) inventory decreases around business-cycle peaks; 3) basis negatively relates to convenience yield.

Time-series momentum, introduced in Moskowitz, Ooi and Pedersen (2012) is strong in both markets delivering approximately 10.6% per annum in the US markets and 14.5% per annum in Chinese commodities. This factor cannot be explained by the single carry factor of Szymanowska, de Roon, Nijman and Van Den Goorbergh (2014). Blocher, Cooper and Molyboga (2016) demonstrate that for the US markets and we find the same phenomenon in Chinese markets. Moreover, even though carry is sufficient to explain

[5] Albeit commodity futures returns and equity returns are negatively correlated (Gorton and Rouwenhorst, 2006).

cross-sectional momentum in the US commodity markets, as documented in Szymanowska, de Roon, Nijman and Van Den Goorbergh (2014), that is not the case in Chinese markets where three spot premia factors including time-series momentum, carry and market are required to fully explain momentum returns.

The positive relationship of basis and spot premia is consistent with predictions of Campbell and Shiller (1988) and has been documented in Fama(1984), Erb and Harvey (2006) and Gorton and Rowenhorst(2006). The negative cross-sectional relationship between basis and term premia in US commodity markets have not been previously documented. The relation between basis and risk premia, with basis and spot premia being positively correlated and basis and term premia being negatively linked, could reflect a mean-reverting tendency of risk premia, similar to the finding of Fama and French (1987) with respect to interest rate forwards[6].

Our findings add to the literature on cross-sectional predictability across markets by showing that a model with a small number of factors can explain both US and Chinese commodity markets. We extend the findings of Szymanowska, de Roon, Nijman and Van Den Goorbergh (2014) and Blocher, Cooper and Molyboga (2016) by investigating the negative relationship of basis and term premia, not previously documented in the literature; and examining the time-series characteristics of basis, which is predictive of both spot and term premia. Our study is the first comprehensive study of drivers of returns in Chinese commodity markets that behave consistently with the expectation hypothesis, unlike the US markets.

The rest of the paper is structured as follows. Section II describes the data and methodology; Section III presents empirical results; and Section IV concludes.

# 2 Data and Methodology

## 2.1 Data

This paper examines 30 US commodity futures obtainable from CSI (Commodity Systems Inc.) during September 1987 – December 2014 and 25 Chinese commodity futures retrieved from CSMAR (China Stock

[6]Given the predictive value of basis, we further investigate the cross-sectional and time-series variation of basis as well as its serial correlation structure for the US and Chinese markets. Both, the cross-sectional and time-series variation of basis is more significant in the US market. The difference between the highest and the lowest average basis is approximately 12.6% in Chinese commodities and 18.5% in the US markets. The average time-series variation is approximately 70% in Chinese markets and 132% in the US commodities. Since higher heterogeneity in basis potentially provides better opportunities for carry trade, one would expect that carry trade would be more profitable in the US markets. We find that the carry factor in the US market is more statistically significant than it is in Chinese markets. Moreover, we find that the basis in the US markets is very persistent while basis in Chinese markets seems to be less autocorrelated. Ljung-Box test rejects no serial correlation hypothesis at 99% confidence level for all commodities, whereas the same test cannot be rejected for 84% of Chinese commodities. This suggests that basis in Chinese markets is less predictive, which might be one of the reasons why term premia are insignificant in that market.

Market & Accounting Research) during January 1999 – December 2014.[7] Time series of futures prices and returns are required to be no less than 4 years for both US and Chinese commodities, and as a result, we rule out 18 Chinese contracts due to insufficiency of data. The frequency of data is monthly. Prices (or returns) of distant contracts, defined as those that will mature in at least two months after the spot contract expires, are not necessarily available for the whole cross section due to lack of trading activity.[8]

The final sample contains 30 different US commodity futures and 25 distinct Chinese contracts.[9] The 30 US commodities include Soybean Oil, Corn, Cocoa, Crude Oil Light, Cotton, Milk, Feeder Cattle, Gold, Copper HG, NY Harbor ULSD, Coffee, Wheat Kansas City, Lumber, Cattle Live, Crude Brent Oil, Light Gas Oil, Hogs Lean, Red Spring Wheat, Natural Gas, Oats, Orange Juice, Palladium, Platinum, Gasoline RBOB, Rice Rough, Soybeans, Sugar, Silver, Soybean meal and Wheat. The 25 Chinese futures are No. 1 Soybean, Aluminum, Gold, No. 2 Soybean, Corn, Cotton, Copper, Fuel Oil, Mung Bean, linear low density polyethylene (LLDPE), Soybean Meal, Rapeseed Oil, RBD Palm Olein, Lead, Steel Rebar, Early Indica Rice, Natural Rubber, Sugar, Pure Terephthalic Acid (PTA), Polyvinyl Chloride (PVC), Strong Gluten Wheat, Steel Wire Rod, Hard White Wheat, Soybean Oil, Zinc.[10] Appendix C presents Bloomberg codes, transaction codes and exchanges associated with each instrument.

## 2.2 Decomposition of Futures Return: Spot and Term Premiums

### 2.2.1 Key Definitions

In this paper, we utilize standard conventions to define key variables[11]:

1. *Spot Price*. Spot price is defined as the price of the first contract to mature at least two months from the current month, or namely the price of the nearest-dated contract. This is to eliminate potential liquidity problems associated with the pricing of shorter maturity contracts.

2. *Spot Premium*. We define the realized spot premium of a commodity $i$, $\hat{\pi}_{s,i}(t)$, as the change in the

[7] In August 1998, China went through a drastic change in the structure of the futures market: 14 original futures exchanges were merged into 3 final exchanges, which are the 3 only commodity futures exchanges, which are Shanghai Futures Exchange (SHFE), Dalian Commodity Exchange (DCE) and Zhengzhou Commodity Exchange (ZCE). 1998 also witnessed major official revisions on the following 6 contracts: soybean, wheat, mung beans, copper, aluminum, and natural rubber. We therefore utilize China's futures data from January 1999 to December 2014.

[8] For some commodities, such as palladium, generally no more than 2 contracts are traded at certain distant maturities.

[9] In addition to the 21 US commodities in Szymanowska et al. (2014), we also incorporate 9 U.S. commodities examined in Moskowitz et al. (2012).

[10] Mung Bean was delisted from Zhengzhou Commodity Exchange on May 5, 2009.

[11] For example, see Szymanowska et al. (2014) and Blocher et al. (2016).

logarithm of the spot price $s_i(t)$.

$$\hat{\pi}_{s,j}(t) = ln\left[s_i(t)\right] - ln\left[s_i(t-1)\right] \quad (1)$$

Spot premia are excess returns because they exclude collateral portion of returns.

3. *n-month Contract*. Analogous to the nearest-dated contract, the two-month, four-month, and six-month contracts are defined as the first contract to expire at least two months, four months, and six months after the spot contract expires. In our settings, we denote the two-month, four-month, and six-month contracts as n=2, n=3 and n=4 respectively.[12]

4. *Cost of carry basis*. Cost of carry basis is defined as the logarithm (or percentage) difference between the futures price and the spot price following Szymanowska et al. (2014). Specifically, the cost of carry basis for commodity $i, y_i^n(t)$, is computed as the logarithm difference between the n-month futures price, $f_i^n(t)$, and the spot price,

$$y_i^n(t) = ln\left[f_i^n(t)/s_i(t)\right] \quad (2)$$

In this paper, we use the spot cost of carry basis $y_i^2(t)$ but term basis can also be incorporated in future research by considering $y_i^n(t)$ for $n > 2$.

The change in the cost of carry basis is further defined as the term premium,

$$\hat{\pi}_{y,i}^n(t) = y_i^n(t) - y_i^{n+1}(t-1) = ln\left[f_i^n(t)/f_i^{n+1}(t-1)\right] - ln\left[s_i(t)/s_i(t-1)\right], \quad (3)$$

where $n \geq 2$. As discussed in Blocher et al. (2016), term premium can be captured by a calendar spread strategy that goes long a longer dated futures contracts and shorts a nearby (spot) contract.

5. *Basis*. We define the basis, or roll yield, as the negative of the cost of carry basis. This definition is particularly useful because of the well documented evidence (see Ilmanen (2011), for example) that suggests that long run returns in commodities are closely related to the roll yield. Positive roll yield is associated with commodities in backwardation whereas negative roll yield is associated with markets in contango.

[12] For commodities with monthly expirations, we follow Blocher et al. (2016) and Szymanowska et al. (2014) to skip the expiration dates that fail to satisfy the definitions.

### 2.2.2 Decomposition of Futures Returns

We follow Szymanowska et al. (2014) and Blocher et al. (2016) in decomposing returns into spot and term premia using the cost-of-carry relationship in the futures markets. Specifically, for commodity $i$ we formulate the expected spot premium $\pi_{s,i}(t)$ as

$$\pi_{s,i}(t) = E_t \left[ ln(s_i(t+1)) - ln(s_i(t)) - y_i^1(t) \right], \tag{4}$$

which measures the spot premium as the difference between the expected change in the spot price and the one-period cost of carry basis, and the expected term premium as

$$\pi_{y,i}^n(t) = E_t \left[ y_i^{n-1}(t) + y_i^1 \right] - y_i^n, \tag{5}$$

which represents a deviation from the expectation hypothesis. The summation of the expected spot premium and the expected term premium gives the expected futures return as follows:

$$E_t \left[ r_{f,i}^n(t+1) \right] = E_t \left[ f_i^{n-1}(t+1) - f_i^n(t) \right] = \pi_{s,i}(t+1) + \pi_{y,i}^n(t+1) \tag{6}$$

## 2.3 Factor Selection and Construction

Previous studies have suggested that returns of futures contracts at different points on the forward curve can be driven by different sets of risk factors. Szymanowska et al. (2014) argue that a single carry factor can explain spot premia and two factors, a high term and a low term factors, are sufficient to price term premia for a given point of a forward curve (n=2, 3 or 4)[13] Bakshi, Gao Bakshi, and Rossi (2014) and Gorton, Hayashi, and Rouwenhorst (2012) find that market and momentum factors are also necessary in estimating spot premia. Blocher, Cooper and Molyboga (2016) show that time-series momentum is superior to cross-sectional momentum in explaining spot premia in conjunction with carry and market factors and two term premia factors are sufficient to price term premia for all three points of the forward curve (n=2, 3 and 4)[14].

### 2.3.1 Spot Premium Factors

To explain spot premia, we assemble three spot factors: carry, market and time-series momentum. Specifically, we follow Bakshi, Gao Bakshi, and Rossi (2014), Szymanowska et al. (2014), and Blocher, Cooper

[13] Expected futures returns are actually risk premia in that no initial investment is required (Szymanowska et al., 2014). Even if the required margin is regarded as initial investment, it generally accounts for only 5%–10% of the value of a futures contract.

[14] This is in contrast with Szymanowska et al. (2014) who require the total number of 6 factors instead of 2.

and Molyboga (2016) in defining carry, or high-minus-low, factor, follow Gorton, Hayashi, and Rouwenhorst (2012) and Bakshi, Gao Bakshi, and Rossi (2014) to derive the market factor, and follow Blocher, Cooper and Molyboga (2016) to construct the TSMOM factor. The three factors are defined as follows:

1) Carry, high-minus-low, spot factor (HML) is the average spot return of commodities with above median basis minus the average spot return of commodities with below median basis;

2) Market factor (MKT) is an average spot return of all commodities.

3) Time series momentum factor (TSMOM) is the average return of all commodities with positive cumulative returns over the previous twelve months minus the average return of all commodities with negative cumulative returns over the previous twelve months.

The HML factor is captured by a portfolio strategy with monthly rebalancing that goes long commodities with above-median basis and shorts commodities with below-median basis. Note that a positive (negative) basis is indicative of a backwardation (contango) market, the HML, or carry, strategy therefore would suggest buying low cost of carry basis commodities and selling high cost of carry basis commodities. The TSMOM factor is built using the cumulative raw return over the last 12 months without skipping the most recent month's return. Skipping one month is not uncommon in the literature (e.g. Jegadeesh and Titman (1993), Fama and French (1996), and Grinblatt and Moskowitz (2004)) in capturing cross-sectional momentum but is irrelevant for commodity futures (Asness et al., 2013). We include cross-sectional momentum in our analysis but find that it provides less explanatory value for spot premia than the time-series momentum when used in conjunction with market and carry.

### 2.3.2 Term Premium Factors

Szymanowska et al. (2014) find that term premia can be explained with a high term premium factor and a low term premium factor while a single high minus low term premium factor is not sufficient. Blocher et al. (2016) confirm that but suggest an alternative definition of the two term premium factors that is simple and allows for replication. The two term premium factors in Blocher et al. (2016) are assembled as follows:

1) High term premium factor ($H_{term}$) is computed as the equal-weighted average of the 2-month, 4-month, and 6-month realized term premia (or calendar spread returns) for the commodities with above-median (or the highest 50%) spot basis;

2) Low term premium factor ($L_{term}$) is measured as the equal-weighted average of the 2-month, 4-month, and 6-month realized term premia (or calendar spread returns) for the commodities with below-median (or the lowest 50%) spot basis;

3) $HML_{term}$ is the difference between $H_{term}$ and $L_{term}$.

In this paper, we follow Blocher et al. (2016) to construct the term premium factors.[15] Each month we sort commodities based on basis and divide them into above-median (backwardation or high basis) commodities and below-median (contango or low basis) commodities. Then for each maturity we build two equally weighted portfolio of calendar spreads - one for the above-median commodities group and the other one for the below-median commodities group. A calendar spread represents a long exposure in longer dated futures contracts and a short exposure in nearby (spot) contracts. We repeat the procedure for four-month (n=3) and six-month (n=4) term premia and arrive at H3, L3, H4, L4 respectively. Then, as in Blocher et al. (2016), we define $H_{term} = (H2 + H3 + H4)/3$ and $L_{term} = (L2 + L3 + L4)/3$. In this study, we use the same factors $H_{term}$ and $L_{term}$ to explain term premia for all maturities (i.e., n=2, 3, and 4), in contrast to Szymanowska et al. (2014) who use term premia factors of the particular maturity to explain the term premia for that maturity (for example, H2 and L2 explain term premia for n=2)[16].

#### 2.3.3 Factor Summary Statistics

Table 1 reports the summary statistics and cross-correlations of the 5 candidate factors which are selected to explain the cross-section of commodity risk premia in both the US and Chinese commodities markets. The market factor is negative in both markets. The market factor in the US market has yielded a negative return of 1.8% per annum falling short of the predictions of Erb and Harvey (2006) and Gorton and Rouwenhorst (2006) who argue that equally-weighted portfolio of commodities should deliver a Sharpe ratio that is comparable to that of the equity market. Similarly, the market factor in Chinese commodities has lost approximately 3.6% per annum. This negative performance is likely driven by negative values of roll yields in commodities and highlights the potential benefit for investors in commodities of looking beyond long-only market exposure. Both, HML and TSMOM, deliver strong returns in both markets whereas the term premia factors are weak in the Chinese markets in contrast with the US markets. The factors are only modestly correlated with each other, with the highest correlation in the entire matrix for US commodities equal to

[15] Albeit the term premium factors formed following Szymanowska et al. (2014) will also be tested for comparison purpose.

[16] Blocher et al. (2016) show that their term premia factors have the explanatory power that is comparable to that of the term premia factors of Szymanowska et al. (2014). Our empirical analysis confirms that finding.

0.46 and 0.40 for Chinese commodities. This once again suggests that investors in commodity markets can benefit from diversifying their portfolios away from long-only exposures in commodities.

# 3 Main Empirical Results

## 3.1 Spot Premia

First, we present evidence of carry and momentum premia in both the US and Chinese markets by investigating performance of portfolios sorted on basis and momentum. As demonstrated in Table 2, there is a significant positive relation between commodity spot returns and both basis and time series momentum. For US commodities, for example, the spot premia increase monotonically from -0.59% on the bottom basis portfolio B1 to 0.13% on the top basis portfolio B4, or from -0.63% on the bottom momentum portfolio M1 to 0.94% on the top momentum portfolio M4. The difference in returns between top and bottom momentum portfolios is strong in both markets. Evidence of carry is weaker in the Chinese markets but the HML factor, suggested in Szymanowska et al. (2014), still generates statistically significant positive returns because it looks beyond top and bottom quartiles.

## 3.2 Asset Pricing Tests of Spot Premia

First, we test the value of HML, Market and TSMOM in explaining returns of the four portfolios sorted on basis, following Blocher et al. (2016). We accomplish that by running regressions of portfolios sorted on basis with respect to a sub-set of candidate spot premia factors

$$r(t) = \alpha + \beta^T f(t) + \epsilon(t), \tag{7}$$

with $r(t)$ representing monthly returns of portfolios sorted on basis, $\alpha$ is the intercept of the regression, $\beta$ is the slope coefficient with respect to candidate factors $f$, and $\epsilon$ is the residual. Newey-West adjustment with 12 lags is used to correct for seasonality, heteroskedasticity and serial correlation. Results of the asset pricing tests of spot premia are summarized in Table 3. The table reports values of alpha, t-stats of alpha, adjusted $R^2$ and the GRS test that is used to test for the hypothesis of the alphas jointly equal to zero. The table includes both the F statistic and P value of the GRS test. Table 3 shows that any single factor performs poorly in pricing spot premia on both US and Chinese commodities as indicated by low adjusted $R^2$. For example, the $R^2$ of the one-factor regressions against HML or TSMOM in the US markets is no higher than 0.25 and those in the Chinese futures are less than 0.30. By contrast, the Market factor gives both high $R^2$

and statistically significant non-zero alphas with the GRS test rejecting the joint zero alpha hypothesis at the 10% confidence level.

Combing the Market factor with either HML or TSMOM results in higher adjusted $R^2$, lower p-values of the GRS test and lower t-stats of alphas but a combination of all three factors is superior with the GRS p-value of 0.78 for the US markets and 0.29 for the Chinese markets, adjusted $R^2$ of at least 0.64 for the Chinese markets and 0.77 for the US markets. Replacing time-series momentum with cross-sectional momentum does not improve the explanatory value of the three factor model [17].

Szymanowska et al. (2014) show that a single HML factor explains sorts on basis, momentum, volatility, inflation, hedging pressure and liquidity, that are associated with risk premia in commodity markets. In this paper, we demonstrate the robustness of the three factor model by investigating portfolio sorts on momentum because it is a well documented return driver in commodities, as shown in Erb and Harvey (2006), Gorton et al. (2012) and Asness et al. (2013). Table 2 shows that the high-minus-low spread of momentum portfolios has an average excess return of 1.46% in Chinese markets with the t-stat of 3.52 and 0.94% with the t-stat of 2.38 in the US commodity markets. To test whether performance of portfolios sorted on momentum can be explained by the three spot risk factors, we perform the asset pricing tests using the Market, HML and TSMOM factors. We accomplish that by regressing portfolios sorted on momentum with respect to a sub-set of candidate spot premia factors $r(t) = \alpha + \beta^T f(t) + \epsilon(t)$, with $r(t)$ representing monthly returns of portfolios sorted on momentum, $\alpha$ is the intercept of the regression, $\beta$ is the slope coefficient with respect to candidate factors $f$, and $\epsilon$ is the residual.

Table 4 presents results of asset pricing tests applied to portfolios sorted on momentum. As in the case of portfolios sorted on bases, a combination of all three factors is required to sufficiently explain performance of portfolios. The three factor model results in high adjusted $R^2$ of 0.64 or higher for the Chinese markets and 0.74 or higher for the US markets. The GRS tests fails to reject the hypothesis of all alphas equal to zero for both markets.

### 3.3 Redundancy tests of the spot premia factors

We have shown that returns of portfolios sorted on basis and momentum can be explained by Market, HML and TSMOM both in the Chinese and US commodity markets. We further validate the model by performing a factor redundancy test. The purpose of the test is to investigate whether some of the factors can be explained by a sub-set of the other factors or whether the cross-sectional momentum factor that was dismissed due to lack of additional explanatory value cannot be explained by the other factors. Table 5

[17] Results of tests that include cross-sectional momentum are excluded for brevity but available upon request.

reports results of the redundancy tests. The cross-sectional momentum is a redundant factor because its alpha is not statistically significant with the corresponding t-stat of -1.18 in the US markets and -0.32 in the Chinese markets. By contrast, both TSMOM and HML cannot be explained by the remaining two factors because their alphas are positive and statistically significant in both markets though less so for carry in the US markets. The redundancy tests confirm that cross-sectional momentum is redundant and that Market, HML and TSMOM are required for explaining spot premia in both Chinese and US commodity markets[18].

### 3.4 Term premia

In the previous subsection, we have examined spot premia in commodity returns. In this subsection, we investigate the term premia returns. As in the case of spot premia, commodities are sorted based on basis and assigned into quartiles first but then term premia portfolios are formed and their performance is evaluated. Table 6 reports performance of term premia for the three maturities: two-month (n=2), four-month (n=3) and six-month (n=4). Unlike the spot premia that were very similar between the US and Chinese markets, there is a striking difference in term premia. The term premia in the US markets are significant with the majority of term premia portfolios delivering positive returns that are statistically significant for 9 out of 12 portfolios. By contrast, only 1 out of 12 portfolios in the Chinese markets delivers a positive return that is statistically significant. This result is significant because it suggests that the Chinese commodities behave consistently with the expectation hypothesis.

In the following sections we examine the term premia in the US markets and show that they are distinctly different from spot premia. We show that a parsimonious two factor model can explain term premia and investigate potential drivers of term premia that include illiquidity and mean-reversion in basis.

### 3.5 Asset Pricing Tests of Term Premia

Term premia reported in Table 6 indicate deviations from the expectation theory in US commodities returns. We investigate whether term premia portfolios can be explained by the spot premia by performing the asset pricing tests from the previous sections. We accomplish that by running regressions of term premia portfolios with respect to a sub-set of candidate spot premia factors

$$r_n(t) = \alpha_n + \beta_n^T f(t) + \epsilon_n(t), \tag{8}$$

[18]We don't perform a redundancy test for the Market factor because it has not performed well historically but plays an important role in the factor model by increasing the adjusted $R^2$ and substantially reducing the absolute value of alphas in asset pricing tests.

with $r_n(t)$ representing monthly returns of term premia portfolios with maturities two-month (n=2), four-month (n=3) and six-month (n=4), $\alpha_n$ is the intercept of the regression, $\beta_n$ is the slope coefficient with respect to candidate factors $f$, and $\epsilon_n$ is the residual. Table 7 reports results of the asset pricing tests. The majority of alphas are positive and statistically significant suggesting that spot premia cannot explain term premia. This finding is consistent with Szymanowska et al. (2014) and Blocher et al. (2016). Even the combination of Market, HML and TSMOM that fully explains spot premia fails to explain performance of term premia portfolios regardless of the maturity. For example, term premia portfolios B1 produce alphas (t statistics) that are equal to 0.15% (2.35), 0.18% (1.77) and 0.25% (2.07) for n=2, n=3 and n=4, respectively. Moreover, low adjusted $R^2$ indicate that term premia are highly uncorrelated with the spot premia factors. also casts discredit upon the explanatory power of the spot factors. Out of the 84 asset pricing regressions contained in Table 7, the adjusted $R^2$ of 53 regressions is lower than 0.1 and the highest adjusted $R^2$ is as low as 0.24.

Table 8 reports the results of the asset pricing tests that use the term premia factors introduced in Blocher et al. (2016).[19] The results are derived from regressions of term premia portfolios on two sets of term premia factors $r_n(t) = \alpha_n + \beta_n^T f(t) + \epsilon_n(t)$, with $r_n(t)$ representing monthly returns of term premia portfolios with maturities two-month (n=2), four-month (n=3) and six-month (n=4), $\alpha_n$ is the intercept of the regression, $\beta_n$ is the slope coefficient with respect to candidate factors $f$, and $\epsilon_n$ is the residual. Regressions in Panel A, C and E use $HML_{term}$ as the single factor while Panels B,D and F use $H_{term}$ and $L_{term}$. The results suggest that two factors are required to price term premia. This finding is consistent with Szymanowska et al. (2014) and Blocher et al. (2016). The two factor model results in higher adjusted $R^2$ and alphas that are statistically insignificant. By contrast the tests that use a single factor result in lower adjusted $R^2$ and alphas that are mostly statistically significant. For instance, alpha on B4 based on HML is 0.14% (t-stat of 3.19) for n=2, 0.22% (t-stat of 3.71) for n=3, and 0.28% (t-stat of 3.70) for n=4. These results suggest that term premia for the all maturities can be explained by two term factors $H_{term}$ and $L_{term}$[20].

### 3.6 The impact of basis and illiquidity on spot and term premia

There is significant cross-sectional and time-series variation in basis. Appendix A presents empirical data that suggests that both cross-sectional and time-series variation of basis is more significant in the US markets. For instance, the difference between the highest and the lowest average basis, or the cross-sectional

[19]Refer to Section 2.3.2 for details regarding the methodology for forming the parallel shift term factors.

[20]We follow Szymanowska et al. (2014) and show that two factors are needed to explain term premia for each maturity even if the factors are based on calendar spread strategies for that maturity. We exclude this result for brevity but it is available upon request.

variation of basis, is approximately 12.6% in Chinese commodities and 18.5% in the US markets. The time-series variation of basis is roughly 70.2% for Chinese commodities and 132.1% in the US commodities. The time-series standard deviation of basis is approximately 17.6% for US commodities and 10.4% in Chinese markets. Sorting results summarized in Table 2 also offer support to higher variation of basis in the US markets. The excess portfolio return of B4-B1, for instance, is as high as 0.7% with statistical significance in the US markets but weak in Chinese markets.

Previous tests have shown that there is a significant positive relationship between basis and spot returns. Moreover, since contracts with longer maturities are likely to be less liquid than nearby contracts, it is possible that the term premia are driven by illiquidity. In this subsection, we investigate the impact of basis and illiquidity on spot and term premia. We accomplish that by cross-sectionally regressing spot premia and term premia of individual commodities against their roll yield and a liquidity factor[21] as follows

$$Risk\ premia_i = b_0 + b_1 \times roll\ yield_i + b_2 \times liquidity_i + \epsilon_i, \tag{9}$$

where $Risk\ premia_i$ represents either spot premium of commodity $i$, measured as the average return of the spot contract, or term premium of commodity $i$, defined as the average return of a calendar spread portfolios that goes long the n-month futures contract and shorts the spot futures contract, liquidity of a commodity $i$ is measured as the ratio of the volume of the spot contract of that commodity and the total volume across all maturities of the same commodity, roll yield is the spot basis, or the logarithm difference of the spot price and the futures price. Spot refers to the nearest to expiration contract which will expire at least two months from the current month. n=2, n=3 and n=4 respectively refer to the first contract to expire at least two months, four months and six months after the spot contract expires. Ave Term is the arithmetic average value of the three term premia that correspond to n=2, n=3 and n=4.

The regression results (Table 9) illustrate that basis is a strong driver of spot returns whereas liquidity is insignificant. The t-statistic of the basis slope coefficient is 4.8 for Chinese markets and 10.6 for the US markets. By contrast, the t-statistic of the slope coefficient is 0.52 for the US markets and -1.78 for the Chinese markets. This marginally significant value suggests that Chinese commodity contracts with a higher proportion of volume in longer dated maturities tend to appreciate more given the same level of basis. Adjusted $R^2$ of the regressions are high with 49.6% for the Chinese markets and 83.2% for the US markets. The finding of a positive relationship of spot premia and basis is consistent with previous research and serves as the empirical rational for carry trade in commodities.

[21]We define liquidity factor as the percentage of volume that is traded in the nearby contract. For example, if the majority of trading is done in the nearby contract, the longer-dated contracts are less liquid.

The results of the cross-sectional regressions of term premia[22] are striking because of the highly significant relationship of basis and term premia that is robust across maturities. Interestingly, this result is also significant for Chinese markets even though the term premia on their own are weak. Since the term premium is associated with changes in basis, the negative relationship between basis and term premia implies a cross-sectional mean-reversion in basis[23]. Morever, liqudity does not seem to drive term premia because the slope coefficients are statistically insignificant for all maturities.

The term premium is negatively related to basis (as is shown in Table 6 and Table 9) while the spot premium and basis are positively correlated. The relationship between basis and risk premium (spot and term) is similar to that between interest rate and foreign exchange rate (spot and forward) in foreign exchange markets, with spot and term (forward) premium (rate) going in opposite directions. In contrast to the well documented positive relation between spot premium and basis, the negative correlation between term premium and basis is an important finding which to our knowledge has never been documented.

## 4 Conclusion

This paper reports results of a comprehensive study of risk premia in the Chinese commodity markets and compares them to those in the US commodity markets. We find that spot premia are relatively similar and can be explained by three investable factors: market, carry and time-series momentum. By contrast, the term premium, which is statistically significant and distinctly different from spot premia in the US markets, is weak in the Chinese markets. This finding suggests that, unlike the US market, the Chinese commodity markets behave consistently with the expectation hypothesis. We find that term premia are not driven by market liquidity whereas basis provides a significant explanatory value with a positive relationship to spot premia and negative relationship to term premia. Given the predictive value of basis we investigate the cross-sectional and time-series variation of basis and its serial correlation structure. We find that both the cross-sectional and time-series variation is higher in the US commodity markets leading to potentially better

[22] As indicated in previous sections, the term premia of US commodities are both economically and statistically significant whereas term premia in Chinese markets are weak. The sharp contrast is summarized in Appendix A that presents a summary of term premia returns for individual commodities. Over maturities of two months, four months and six months, for instance, the average percentage of US commodities that have a statistically non-zero term premium is as high as 50.8%, and the average term premium is 1.4%; by contrast, the average percentage of Chinese commodities with a statistically non-zero term premium is 14.7%, and the average term premium is 0.1%. Moreover, the average term premium on US commodities increase with maturity, from 0.09% for two-month maturity to 0.15% for six-month maturity, while the expected term premium in Chinese markets decrease with maturity, from 0.09% to 0.05%.

[23] We further investigate the serial correlation structure of basis for the US and Chinese markets and find that the basis in the US markets is very persistent whereas basis in Chinese markets does not exhibit serial correlatoin. Ljung-Box test with 12 lags rejects the no serial correlation hypothesis at 99% confidence level for all US commodities whereas it cannot be rejected at the same confidence level for 84% of Chinese commodities.

opportunities for carry trade as reflected in its relative performance. Our findings add to the literature on cross-sectional predictability across markets by showing that a small number of factors can explain both US and Chinese commodity markets. This paper has practical importance for investors as it provides insight into the drivers of performance of largely unexplored Chinese commodity markets.

Table 1: **Performance measurement model summary statistics.**
This table reports summary statistics and the cross-correlations of 5 candidate factors to explain the cross-section of commodity risk premia of the US commodity futures during September 1987-December 2014 (Panel A) and the Chinese commodity futures during January 1999-December 2014 (Panel B), respectively. The market factor is an equally weighted average of all futures contracts. The HML factor is the difference between the above and below median portfolios sorted on spot basis. TSMOM is an equally weighted return of commodities with positive 12 month trailing return less those with negative trailing 12 month return. $H_{term}$ and $L_{term}$ are constructed from three equally weighted calendar spread portfolios of two, four, and six months, with High being above the median and Low being below the median.

| Factor Portfolio | Monthly Excess Return | Std Dev | t-stat for Mean = 0 | Cross-Correlations | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Market | HML | $H_{term}$ | $L_{term}$ | TSMOM |
| Panel A. U.S. Commodity Futures | | | | | | | | |
| Market | -0.15% | 3.85% | -0.61 | 1.00 | | | | |
| HML | 0.64% | 3.34% | 2.98 | 0.10 | 1.00 | | | |
| $H_{term}$ | 0.18% | 0.77% | 3.69 | -0.20 | -0.40 | 1.00 | | |
| $L_{term}$ | 0.20% | 0.62% | 4.94 | -0.39 | 0.40 | 0.17 | 1.00 | |
| TSMOM | 0.88% | 4.04% | 3.36 | 0.21 | 0.46 | -0.27 | 0.11 | 1.00 |
| Panel B. Chinese Commodity Futures | | | | | | | | |
| Market | -0.30% | 3.26% | -1.24 | 1.00 | | | | |
| HML | 0.54% | 2.99% | 2.41 | 0.28 | 1.00 | | | |
| $H_{term}$ | 0.08% | 1.28% | 0.81 | 0.08 | -0.24 | 1.00 | | |
| $L_{term}$ | 0.12% | 1.02% | 1.51 | 0.11 | 0.14 | 0.09 | 1.00 | |
| TSMOM | 1.21% | 3.40% | 4.79 | 0.40 | 0.26 | 0.12 | 0.09 | 1.00 |

Table 2: **Spot returns of portfolios sorted on basis and momentum.**
This table reports summary statistics for portfolios sorted based on spot basis and momentum. The US commodity data is from September 1987 through December 2014 and the Chinese commodity data is from January 1999 through December 2014. Basis is measured as the logarithm difference between the spot price and the futures price. Momentum is computed based on 12 month trailing return. Each US portfolio (in Panel A) contains on average 7 commodities and each Chinese portfolio (in Panel B) contains on average 6 commodities. Portfolios are rebalanced monthly. All returns are excess returns because they don't include the collateral return portion.

| Basis Portfolio | Monthly Excess Return | Std Dev | t-stat for Mean = 0 | Momentum Portfolio | Monthly Excess Return | Std Dev | t-stat for Mean = 0 |
|---|---|---|---|---|---|---|---|
| Panel A. US Commodity Portfolios | | | | | | | |
| B1 (bottom) | -0.59% | 4.27% | -2.14 | M1 (bottom) | -0.63% | 4.85% | -2.02 |
| B2 | -0.37% | 4.70% | -1.23 | M2 | -0.42% | 4.28% | -1.53 |
| B3 | 0.21% | 4.69% | 0.68 | M3 | 0.14% | 4.35% | 0.48 |
| B4 (top) | 0.13% | 5.05% | 0.38 | M4 (top) | 0.31% | 5.69% | 0.84 |
| B4 – B1 | 0.71% | 5.02% | 2.21 | M4 – M1 | 0.94% | 6.11% | 2.38 |
| Panel B. Chinese Commodity Portfolios | | | | | | | |
| B1 (bottom) | -0.73% | 3.61% | -2.71 | M1 (bottom) | -0.99% | 3.70% | -3.57 |
| B2 | -0.43% | 3.94% | -1.48 | M2 | -0.41% | 3.50% | -1.56 |
| B3 | 0.07% | 4.08% | 0.22 | M3 | -0.23% | 4.09% | -0.74 |
| B4 (top) | -0.22% | 4.66% | -0.62 | M4 (top) | 0.47% | 5.48% | 1.16 |
| B4 – B1 | 0.51% | 4.92% | 1.40 | M4 – M1 | 1.46% | 5.57% | 3.52 |

Table 3: **Asset pricing tests of portfolios sorted on basis.**
This table reports asset pricing tests of spot returns when markets are sorted on spot basis. The results are derived from regressions of portfolios sorted on basis with respect to a sub-set of candidate spot premia factors $r(t) = \alpha + \beta^T f(t) + \epsilon(t)$, with $r(t)$ representing monthly returns of portfolios sorted on basis, $\alpha$ is the intercept of the regression, $\beta$ is the slope coefficient with respect to candidate factors $f$, and $\epsilon$ is the residual. Data is the monthly spot returns of 30 US commodities from September 1987 to December 2014 and 25 Chinese commodities from January 1999 to December 2014. Basis is measured as the logarithm difference between the spot price and the futures price. The market factor is an equally weighted average of all futures contracts. The HML factor is the difference between the above and below median portfolios sorted on spot basis. TSMOM is an equally weighted return of commodities with positive 12 month trailing return less those with negative trailing 12 month return. Each US portfolio (in Panel A) contains on average 7 commodities and each Chinese portfolio (in Panel B) contains on average 6 commodities. Portfolios are rebalanced monthly. All returns are excess returns because they don't include the collateral return portion. T-statistics are computed based on standard errors with a Newey-West correction of 12 lags. F-stat and P-value respectively denote the F statistics and p values of the GRS tests. A1 through A7 and B1 through B7 on Panel C refer to sub-panels A1 through A7 on Panel A and sub-panels B1 through B7 on Panel B, respectively.

Panel A. US Commodity Markets

| | alpha | t-stat | Adj-R2 | alpha | t-stat | Adj-R2 | alpha | t-stat | Adj-R2 | alpha | t-stat | Adj-R2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A1. HML | | | A2. Market | | | A3. TSMOM | | | A4. Market and HML | | |
| B1 | -0.29% | -0.87 | 0.13 | -0.46% | -2.38 | 0.57 | -0.49% | -1.27 | 0.01 | -0.09% | -0.60 | 0.76 |
| B2 | -0.17% | -0.54 | 0.05 | -0.21% | -1.28 | 0.75 | -0.47% | -1.33 | 0.01 | 0.08% | 0.60 | 0.85 |
| B3 | -0.10% | -0.30 | 0.11 | 0.37% | 2.82 | 0.75 | -0.04% | -0.12 | 0.06 | 0.13% | 1.11 | 0.82 |
| B4 | -0.37% | -1.27 | 0.25 | 0.28% | 1.69 | 0.61 | -0.33% | -1.15 | 0.17 | -0.15% | -1.12 | 0.80 |
| | A5. Market and TSMOM | | | A6. HML and TSMOM | | | A7. Market, HML and TSMOM | | | | | |
| B1 | -0.20% | -1.03 | 0.64 | -0.34% | -0.94 | 0.13 | -0.04% | -0.25 | 0.77 | | | |
| B2 | -0.12% | -0.77 | 0.76 | -0.32% | -0.97 | 0.10 | 0.03% | 0.25 | 0.85 | | | |
| B3 | 0.30% | 2.27 | 0.75 | -0.17% | -0.44 | 0.12 | 0.17% | 1.50 | 0.82 | | | |
| B4 | -0.01% | -0.08 | 0.67 | -0.51% | -1.75 | 0.29 | -0.20% | -1.50 | 0.80 | | | |

Panel B. Chinese Commodity Markets

| | B1. HML | | | B2. Market | | | B3. TSMOM | | | B4. Market and HML | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B1 | -0.51% | -2.12 | 0.11 | -0.53% | -2.31 | 0.35 | -1.04% | -3.70 | 0.05 | -0.12% | -0.61 | 0.63 |
| B2 | -0.39% | -0.81 | 0.00 | -0.13% | -0.67 | 0.71 | -0.76% | -1.69 | 0.05 | 0.14% | 0.82 | 0.81 |
| B3 | -0.34% | -0.95 | 0.30 | 0.39% | 3.09 | 0.73 | -0.44% | -1.36 | 0.12 | 0.11% | 0.91 | 0.84 |
| B4 | -0.67% | -1.93 | 0.29 | 0.13% | 0.54 | 0.64 | -0.87% | -2.09 | 0.15 | -0.20% | -1.17 | 0.75 |
| | B5. Market and TSMOM | | | B6. HML and TSMOM | | | B7. Market, HML and TSMOM | | | | | |
| B1 | -0.54% | -2.70 | 0.35 | -0.91% | -3.43 | 0.22 | -0.26% | -1.21 | 0.64 | | | |
| B2 | 0.07% | 0.35 | 0.73 | -0.71% | -1.44 | 0.06 | 0.24% | 1.36 | 0.81 | | | |
| B3 | 0.38% | 2.66 | 0.73 | -0.62% | -1.88 | 0.34 | 0.18% | 1.49 | 0.84 | | | |
| B4 | -0.02% | -0.13 | 0.65 | -1.06% | -2.73 | 0.36 | -0.24% | -1.47 | 0.75 | | | |

Panel C. GRS Tests

| | A1 | A2 | A3 | A4 | A5 | A6 | A7 | B1 | B2 | B3 | B4 | B5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F-stat | 0.53 | 2.62 | 1.47 | 0.33 | 1.03 | 0.86 | 0.44 | 1.99 | 2.18 | 4.30 | 1.05 | 1.89 |
| P-value | 0.72 | 0.04 | 0.21 | 0.86 | 0.39 | 0.49 | 0.78 | 0.10 | 0.07 | 0.00 | 0.38 | 0.11 |

| | B6 | B7 |
|---|---|---|
| F-stat | 4.07 | 1.26 |
| P-value | 0.00 | 0.29 |

Table 4: **Asset pricing tests of portfolios sorted on momentum.**
This table reports asset pricing tests of spot returns when markets are sorted on momentum. The results are derived from regressions of portfolios sorted on momentum with respect to a sub-set of candidate spot premia factors $r(t) = \alpha + \beta^T f(t) + \epsilon(t)$, with $r(t)$ representing monthly returns of portfolios sorted on momentum, $\alpha$ is the intercept of the regression, $\beta$ is the slope coefficient with respect to candidate factors $f$, and $\epsilon$ is the residual. Momentum is computed based on 12 month trailing return. Data is the monthly spot returns of 30 US commodities from September 1987 to December 2014 and 25 Chinese commodities from January 1999 to December 2014. Basis is measured as the logarithm difference between the spot price and the futures price. The market factor is an equally weighted average of all futures contracts. The HML factor is the difference between the above and below median portfolios sorted on spot basis. TSMOM is an equally weighted return of commodities with positive 12 month trailing return less those with negative trailing 12 month return. Each US portfolio (in Panel A) contains on average 7 commodities and each Chinese portfolio (in Panel B) contains on average 6 commodities. Portfolios are rebalanced monthly. All returns are excess returns because they don't include the collateral return portion. T-statistics are computed based on standard errors with a Newey-West correction of 12 lags. F-stat and P-value respectively denote the F statistics and p values of the GRS tests. A1 through A7 and B1 through B7 on Panel C refer to sub-panels A1 through A7 on Panel A and sub-panels B1 through B7 on Panel B, respectively.

Panel A. US Commodity Markets

| | alpha | t-stat | Adj-R2 | alpha | t-stat | Adj-R2 | alpha | t-stat | Adj-R2 | alpha | t-stat | Adj-R2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A1. HML | | | A2. Market | | | A3. TSMOM | | | A4. Market and HML | | |
| M1 | -0.41% | -1.33 | 0.05 | -0.49% | -2.90 | 0.53 | -0.30% | -0.93 | 0.09 | -0.19% | -1.03 | 0.63 |
| M2 | -0.44% | -1.39 | 0.00 | -0.28% | -1.79 | 0.73 | -0.42% | -1.15 | 0.00 | -0.23% | -1.57 | 0.73 |
| M3 | -0.01% | -0.02 | 0.03 | 0.28% | 2.05 | 0.73 | -0.14% | -0.38 | 0.08 | 0.21% | 1.40 | 0.74 |
| M4 | -0.04% | -0.12 | 0.10 | 0.49% | 2.14 | 0.63 | -0.45% | -1.41 | 0.38 | 0.22% | 1.34 | 0.69 |
| | A5. Market and TSMOM | | | A6. HML and TSMOM | | | A7. Market, HML and TSMOM | | | | | |
| M1 | 0.04% | 0.25 | 0.76 | -0.25% | -0.75 | 0.10 | 0.10% | 0.56 | 0.77 | | | |
| M2 | -0.10% | -0.66 | 0.76 | -0.44% | -1.20 | -0.01 | -0.11% | -0.73 | 0.76 | | | |
| M3 | 0.17% | 1.15 | 0.74 | -0.16% | -0.43 | 0.08 | 0.15% | 1.02 | 0.74 | | | |
| M4 | -0.12% | -0.96 | 0.84 | -0.48% | -1.46 | 0.38 | -0.14% | -1.22 | 0.84 | | | |

Panel B. Chinese Commodity Markets

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B1. HML | | | B2. Market | | | B3. TSMOM | | | B4. Market and HML | | |
| M1 | -1.12% | -3.76 | 0.04 | -0.76% | -4.16 | 0.44 | -0.76% | -2.58 | 0.02 | -0.77% | -3.78 | 0.44 |
| M2 | -0.53% | -1.76 | 0.03 | -0.15% | -0.97 | 0.62 | -0.61% | -2.10 | 0.02 | -0.14% | -1.03 | 0.62 |
| M3 | -0.33% | -0.70 | 0.01 | 0.09% | 0.46 | 0.72 | -0.78% | -1.81 | 0.14 | 0.18% | 0.92 | 0.73 |
| M4 | 0.13% | 0.32 | 0.12 | 0.86% | 3.00 | 0.59 | -0.84% | -2.39 | 0.45 | 0.70% | 2.31 | 0.60 |
| | B5. Market and TSMOM | | | B6. HML and TSMOM | | | B7. Market, HML and TSMOM | | | | | |
| M1 | 0.01% | 0.04 | 0.67 | -0.84% | -2.77 | 0.08 | -0.05% | -0.28 | 0.68 | | | |
| M2 | 0.10% | 0.67 | 0.64 | -0.66% | -2.21 | 0.04 | 0.09% | 0.79 | 0.64 | | | |
| M3 | 0.01% | 0.07 | 0.72 | -0.80% | -1.71 | 0.14 | 0.08% | 0.43 | 0.73 | | | |
| M4 | -0.08% | -0.37 | 0.75 | -0.93% | -2.68 | 0.48 | -0.14% | -0.62 | 0.75 | | | |

Panel C. GRS Tests

| | A1 | A2 | A3 | A4 | A5 | A6 | A7 | B1 | B2 | B3 | B4 | B5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F-stat | 1.33 | 2.80 | 0.86 | 1.37 | 0.58 | 0.91 | 0.69 | 4.79 | 4.30 | 2.54 | 3.74 | 0.23 |
| P-value | 0.26 | 0.03 | 0.49 | 0.25 | 0.68 | 0.46 | 0.60 | 0.00 | 0.00 | 0.04 | 0.01 | 0.92 |

| | B6 | B7 |
|---|---|---|
| F-stat | 3.09 | 0.26 |
| P-value | 0.02 | 0.91 |

Table 5: **Tests for redundancy of spot premia factors.**
This table reports regression results for a subset of individual factors that are tested for redundancy. If a factor has a zero intercept with respect to the other factors, the factor is considered redundant. The momentum factor (MOM) is a cross-sectional momentum factor defined as the top quartile portfolio less the bottom quartile portfolio of commodities sorted on 12 month trailing return. The market factor (MKT) is an equally weighted average of all futures contracts. The HML factor is the difference between the above and below median portfolios sorted on spot basis. Basis is measured as the logarithm difference between the spot price and the futures price. TSMOM is equally weighted return of commodities with positive 12 month trailing return less those with negative trailing 12 month return. T-statistics are computed based on standard errors with a Newey-West correction of 12 lags.

| Dependent Variable | Intercept | t-stat | Adj-R2 | Independent Variables |
|---|---|---|---|---|
| Panel A. US Futures Markets | | | | |
| MOM | -0.23% | -1.18 | 0.69 | MKT, HML and TSMOM |
| TSMOM | 0.61% | 3.31 | 0.19 | MKT and HML |
| HML | 0.31% | 1.86 | 0.15 | MKT and TSMOM |
| Panel B. Chinese Futures Markets | | | | |
| MOM | -0.10% | -0.32 | 0.60 | Market, HML and TSMOM |
| TSMOM | 1.23% | 4.71 | 0.17 | Market and HML |
| HML | 0.41% | 2.06 | 0.10 | Market and TSMOM |

Table 6: **Term premia of portfolios sorted on basis.**
This table reports term premia of portfolios sorted on basis with the maturity period of two-, four-, and six-month. Basis is measured as the logarithm difference of the spot price and the futures price. Data is 30 US commodities two-, four- and six-month term premia from September 1987 to December 2014, and 25 Chinese commodities two-month (n=2), four-month (n=3) and six-month (n=4) term premia from January 1999 to December 2014. Each U.S. portfolio contains on average 7 commodities and each Chinese portfolio contains on average 6 commodities. The portfolios are rebalanced monthly. T-statistics are computed based on standard errors with a Newey-West correction of 12 lags.

| | U.S. Commodities | | | | Chinese Commodities | | |
|---|---|---|---|---|---|---|---|
| | Monthly Excess Return | Std Dev | t-stat for Mean = 0 | | Monthly Excess Return | Std Dev | t-stat for Mean = 0 |
| Panel A. Two-Month Term Premia (n=2) | | | | | | | |
| B1 | 0.20% | 0.63% | 4.97 | B1 | 0.18% | 1.32% | 1.83 |
| B2 | 0.09% | 0.52% | 2.77 | B2 | 0.03% | 0.93% | 0.43 |
| B3 | 0.03% | 0.43% | 1.16 | B3 | 0.11% | 1.08% | 1.35 |
| B4 | 0.24% | 1.01% | 3.64 | B4 | 0.04% | 1.37% | 0.44 |
| Panel B. Four-Month Term Premia (n=3) | | | | | | | |
| B1 | 0.27% | 1.00% | 4.22 | B1 | 0.32% | 1.78% | 2.40 |
| B2 | 0.14% | 0.70% | 3.01 | B2 | 0.04% | 1.29% | 0.46 |
| B3 | 0.06% | 0.63% | 1.37 | B3 | 0.16% | 1.56% | 1.40 |
| B4 | 0.32% | 1.49% | 3.37 | B4 | -0.04% | 2.01% | -0.30 |
| Panel C. Six-Month Term Premia (n=4) | | | | | | | |
| B1 | 0.38% | 1.36% | 4.35 | B1 | 0.19% | 2.04% | 1.27 |
| B2 | 0.15% | 0.95% | 2.37 | B2 | 0.07% | 1.78% | 0.51 |
| B3 | 0.05% | 0.84% | 0.96 | B3 | 0.08% | 2.00% | 0.53 |
| B4 | 0.43% | 1.84% | 3.66 | B4 | -0.22% | 2.32% | -1.25 |

Table 7: **Asset pricing tests of US commodity term premia portfolios sorted on basis using spot factors.**
This table reports asset pricing tests for term premia with maturities of two-month (n=2), four-month (n=3), and six-month (n=4) when futures are sorted on spot basis The results are derived from regressions of term premia portfolios with respect to a sub-set of candidate spot premia factors $r_n(t) = \alpha_n + \beta_n^T f(t) + \epsilon_n(t)$, with $r_n(t)$ representing monthly returns of term premia portfolios with maturities two-month (n=2), four-month (n=3) and six-month (n=4), $\alpha_n$ is the intercept of the regression, $\beta_n$ is the slope coefficient with respect to candidate factors $f$, and $\epsilon_n$ is the residual. Basis is defined as the logarithm difference of the spot price and futures spot price. Data is the two-, four- and six-month term premia of 30 US commodities from September 1987 to December 2014. Each US portfolio contains on average 7 commodities and is rebalanced monthly. The market factor is an equally weighted average of all futures contracts. The HML factor is the difference between the above and below median portfolios sorted on spot basis. TSMOM is an equally weighted return of commodities with positive 12-month trailing return less those with negative trailing 12-month return. T-statistics are computed based on standard errors with a Newey-West correction of 12 lags.

| | n=2 | | | n=3 | | | n=4 | | |
|---|---|---|---|---|---|---|---|---|---|
| | alpha | t-stat(alpha) | Adj-R2 | alpha | t-stat(alpha) | Adj-R2 | alpha | t-stat(alpha) | Adj-R2 |
| Panel A. HML | | | | | | | | | |
| B1 | 0.17% | 2.62 | 0.08 | 0.21% | 2.05 | 0.11 | 0.29% | 2.25 | 0.13 |
| B2 | 0.07% | 1.78 | 0.04 | 0.10% | 2.04 | 0.06 | 0.10% | 1.61 | 0.05 |
| B3 | 0.04% | 1.00 | 0.02 | 0.07% | 1.14 | 0.02 | 0.08% | 1.05 | 0.02 |
| B4 | 0.30% | 3.80 | 0.12 | 0.43% | 4.14 | 0.14 | 0.57% | 4.75 | 0.14 |
| Panel B. Market | | | | | | | | | |
| B1 | 0.20% | 3.08 | 0.04 | 0.26% | 2.63 | 0.08 | 0.37% | 3.00 | 0.09 |
| B2 | 0.09% | 2.40 | 0.02 | 0.13% | 2.64 | 0.08 | 0.13% | 2.07 | 0.12 |
| B3 | 0.03% | 0.74 | 0.00 | 0.05% | 0.84 | 0.00 | 0.05% | 0.60 | 0.02 |
| B4 | 0.23% | 2.89 | 0.02 | 0.31% | 2.93 | 0.03 | 0.42% | 3.57 | 0.04 |
| Panel C. TSMOM | | | | | | | | | |
| B1 | 0.18% | 2.70 | 0.01 | 0.24% | 2.21 | 0.02 | 0.34% | 2.49 | 0.02 |
| B2 | 0.09% | 2.22 | 0.00 | 0.13% | 2.47 | 0.00 | 0.15% | 2.19 | 0.00 |
| B3 | 0.04% | 0.79 | 0.00 | 0.06% | 0.92 | 0.00 | 0.07% | 0.88 | 0.01 |
| B4 | 0.29% | 3.83 | 0.06 | 0.41% | 3.97 | 0.07 | 0.55% | 4.70 | 0.08 |
| Panel D. Market and HML | | | | | | | | | |
| B1 | 0.16% | 2.47 | 0.14 | 0.19% | 1.89 | 0.21 | 0.26% | 2.15 | 0.24 |
| B2 | 0.06% | 1.59 | 0.08 | 0.09% | 1.75 | 0.15 | 0.08% | 1.24 | 0.19 |
| B3 | 0.04% | 1.03 | 0.01 | 0.07% | 1.13 | 0.02 | 0.07% | 0.95 | 0.04 |
| B4 | 0.30% | 3.70 | 0.13 | 0.42% | 3.98 | 0.16 | 0.55% | 4.63 | 0.17 |
| Panel E. Market and TSMOM | | | | | | | | | |
| B1 | 0.17% | 2.52 | 0.07 | 0.21% | 2.01 | 0.12 | 0.30% | 2.34 | 0.13 |
| B2 | 0.08% | 1.99 | 0.03 | 0.11% | 2.14 | 0.08 | 0.12% | 1.77 | 0.12 |
| B3 | 0.04% | 0.82 | 0.00 | 0.06% | 0.89 | 0.00 | 0.06% | 0.74 | 0.02 |
| B4 | 0.28% | 3.70 | 0.06 | 0.39% | 3.76 | 0.08 | 0.53% | 4.50 | 0.10 |
| Panel F. HML and TSMOM | | | | | | | | | |
| B1 | 0.17% | 2.55 | 0.08 | 0.21% | 2.00 | 0.10 | 0.29% | 2.27 | 0.13 |
| B2 | 0.07% | 1.86 | 0.04 | 0.11% | 2.18 | 0.06 | 0.12% | 1.89 | 0.07 |
| B3 | 0.04% | 0.93 | 0.01 | 0.07% | 1.07 | 0.01 | 0.08% | 1.05 | 0.02 |
| B4 | 0.32% | 4.07 | 0.13 | 0.45% | 4.38 | 0.14 | 0.60% | 5.08 | 0.16 |
| Panel G. Market, HML and TSMOM | | | | | | | | | |
| B1 | 0.15% | 2.35 | 0.13 | 0.18% | 1.77 | 0.21 | 0.25% | 2.07 | 0.24 |
| B2 | 0.07% | 1.63 | 0.07 | 0.09% | 1.80 | 0.15 | 0.10% | 1.41 | 0.19 |
| B3 | 0.04% | 0.96 | 0.01 | 0.07% | 1.04 | 0.01 | 0.07% | 0.91 | 0.04 |
| B4 | 0.31% | 3.96 | 0.13 | 0.43% | 4.16 | 0.16 | 0.58% | 4.88 | 0.17 |

Table 8: **Asset pricing tests of US commodity term premia portfolios sorted on basis using "parallel shift" term factors**
This table reports asset pricing tests for term premia with maturities of two-month (n=2), four-month (n=3), and six-month (n=4) when futures are sorted on spot basis. The results are derived from regressions of term premia portfolios on two sets of term premia factors $r_n(t) = \alpha_n + \beta_n^T f(t) + \epsilon_n(t)$, with $r_n(t)$ representing monthly returns of term premia portfolios with maturities two-month (n=2), four-month (n=3) and six-month (n=4), $\alpha_n$ is the intercept of the regression, $\beta_n$ is the slope coefficient with respect to candidate factors $f$, and $\epsilon_n$ is the residual. Regressions in Panel A, C and E use $HML_{term}$ as the single factor while Panels B,D and F use $H_{term}$ and $L_{term}$. Basis is defined as the logarithm difference of the spot price and futures spot price. Data is the two-, four- and six-month term premia of 30 US commodities from September 1987 to December 2014. Each US portfolio contains on average 7 commodities and is rebalanced monthly. $H_{term}, L_{term}$ and $HML_{term}$ are constructed following Blocher et al. (2016). Specifically, $H_{term}$ is an equal-weighted average of two-, four-, and six-month calendar spread returns of the two highest (or above median) basis portfolios. Mathematically, $H_{term} = (H2 + H3 + H4)/3$, where H2, H3 and H4 respectively refer to the two-, four- and six-month calendar spread returns of the two highest basis portfolios (B3 and B4). $L_{term}$ is defined analogously except using calendar spread returns of the two lowest basis portfolios. The $HML_{term}$ factor is the difference between $H_{term}$ and $L_{term}$. T-statistics are computed based on standard errors with a Newey-West correction of 12 lags.

| | alpha | t-stat (alpha) | Adj-R2 | | alpha | t-stat (alpha) | Adj-R2 |
|---|---|---|---|---|---|---|---|
| | Panel A. $HML_{term}$, n = 2 | | | | Panel B. $H_{term}$ and $L_{term}$, n = 2 | | |
| B1 | 0.12% | 3.22 | 0.16 | B1 | 0.04% | 1.71 | 0.55 |
| B2 | 0.04% | 1.71 | 0.08 | B2 | -0.01% | -0.47 | 0.30 |
| B3 | 0.02% | 0.81 | 0.12 | B3 | -0.02% | -1.05 | 0.27 |
| B4 | 0.14% | 2.96 | 0.42 | B4 | 0.03% | 0.95 | 0.67 |
| | Panel C. $HML_{term}$, n = 3 | | | | Panel D. $H_{term}$ and $L_{term}$, n = 3 | | |
| B1 | 0.19% | 3.24 | 0.20 | B1 | 0.04% | 1.29 | 0.67 |
| B2 | 0.07% | 1.74 | 0.09 | B2 | -0.03% | -1.06 | 0.45 |
| B3 | 0.03% | 0.81 | 0.14 | B3 | -0.04% | -1.28 | 0.33 |
| B4 | 0.22% | 3.59 | 0.46 | B4 | 0.04% | 1.04 | 0.77 |
| | Panel E. $HML_{term}$, n = 4 | | | | Panel F. $H_{term}$ and $L_{term}$, n = 4 | | |
| B1 | 0.25% | 3.33 | 0.20 | B1 | 0.04% | 1.17 | 0.68 |
| B2 | 0.06% | 1.18 | 0.09 | B2 | -0.06% | -1.71 | 0.43 |
| B3 | 0.03% | 0.54 | 0.13 | B3 | -0.07% | -1.68 | 0.32 |
| B4 | 0.29% | 3.95 | 0.48 | B4 | 0.07% | 1.50 | 0.77 |

Table 9: **Drivers of risk premia: liquidity or roll yield.**
This table reports results of cross-sectional regressions of spot and term premia against roll yield and liquidity: $Risk\ premia_i = b_0 + b_1 \times roll\ yield_i + b_2 \times liquidity_i + \epsilon_i$, where spot premium of commodity $i$ is average return of the spot contract, term premium of commodity $i$ is the average return of a calendar spread portfolios that goes long the n-month futures contract and shorts the spot futures contract, liquidity of a commodity $i$ is measured as the ratio of the volume of the spot contract of that commodity and the total volume across all maturities of the same commodity, roll yield is the spot basis, or the logarithm difference of the spot price and the futures price. Spot refers to the nearest to expiration contract which will expire at least two months from the current month. n=2, n=3 and n=4 respectively refer to the first contract to expire at least two months, four months and six months after the spot contract expires. Ave Term is the arithmetic average value of the three term premia that correspond to n=2, n=3 and n=4. Data is the monthly spot returns of 30 US commodities from September 1987 to December 2014 and 25 Chinese commodities from January 1999 to December 2014.

| | US Markets | | | Chinese Markets | | |
|---|---|---|---|---|---|---|
| | Roll Yield | Liquidity | R2 | Roll Yield | Liquidity | R2 |
| Spot | 0.5461 | 0.0014 | 83.2% | 0.4491 | -0.0070 | 49.6% |
| | (10.6) | (0.52) | | (4.8) | (-1.78) | |
| n=2 | -0.1797 | 0.0023 | 41.9% | -0.1047 | -0.0012 | 24.7% |
| | (-4.67) | (1.13) | | (-2.93) | (-0.9) | |
| n=3 | -0.2470 | 0.0022 | 50.4% | -0.2460 | -0.0006 | 58.5% |
| | (-5.37) | (0.89) | | (-5.92) | (-0.4) | |
| n=4 | -0.2536 | 0.0003 | 42.5% | -0.3208 | -0.0028 | 53.6% |
| | (-4.39) | (0.09) | | (-5.2) | (-1.2) | |
| Ave Term | -0.2268 | 0.0016 | 46.6% | -0.2238 | -0.0015 | 59.5% |
| | (-4.94) | (0.65) | | (-5.9) | (-1.08) | |

## Appendix A: Expectation Hypothesis Tests

Data is 30 commodities monthly spot returns from September 1987 to December 2014 for US markets and is 25 commodities monthly spot returns from January 1999 to December 2014 for Chinese markets. pct. of significance is the percentage of all markets that have a statistically non-zero term premium. For example, 57% means that 57% (or about 18) of the 30 US markets have a non-zero term premium. We proceed sign-ranked test for each market with the null hypothesis being "term premium is zero". Term premium is the average absolute value of annualized term premia. Time-series variation of roll yield is the time-series average of the (cross-sectional) differences between maximum roll yields and minimum roll yields. Cross-sectional variation of roll yield is the cross-sectional difference between the maximum and minimum time-series average roll yields. Time-series standard deviation of roll yield is the time-series average of (cross-sectional) roll yield standard deviations. Average is the average of values when n=2, n=3, and n=4. Specifically, n=2, n=3, and n=4 respectively refer to the two-month, four-month, and six-month contracts defined as the first contract to expire at least two months, four months, and six months after the spot contract (a.k.a. nearest to expiration contract) expires.

| | Term | | | | Variation in Roll Yield | | Time-Series |
|---|---|---|---|---|---|---|---|
| | n = 2 | n = 3 | n = 4 | Average | Time-Series | Cross-Sectional | Std of Roll Yield |
| **Panel A. US Commodity Markets** | | | | | | | |
| pct. of significance | 57% | 52% | 43% | 50.79% | 132.11% | 18.45% | 17.64% |
| Term Premia | 0.09% | 0.12% | 0.15% | 1.42% | | | |
| **Panel B. Chinese Commodity Markets** | | | | | | | |
| pct. of significance | 12% | 16% | 16% | 14.67% | 70.19% | 12.57% | 10.35% |
| Term Premia | 0.09% | 0.07% | 0.05% | 0.07% | | | |

## Appendix B: Autocorrelation Tests

Ljung-Box tests are conducted to detect possible autocorrelations existing in the 25 Chinese and 30 US commodity futures time series. The null hypothesis of the tests is that there exists no autocorrelation among 12 lags of roll yield in the case of AR(1) models. The numbers expressed in percentage terms are P values of the Ljung-Box tests.

| | US Commodities | | | | Chinese Commodities | | | |
|---|---|---|---|---|---|---|---|---|
| Lag | P value | Percent | P value | Percent | P value | Percent | P value | Percent |
| 1 | $< 10\%$ | 100% | $< 1\%$ | 100% | $< 10\%$ | 96% | $< 1\%$ | 92% |
| 2 | $< 10\%$ | 100% | $< 1\%$ | 100% | $< 10\%$ | 96% | $< 1\%$ | 88% |
| 3 | $< 10\%$ | 100% | $< 1\%$ | 100% | $< 10\%$ | 96% | $< 1\%$ | 88% |
| 4 | $< 10\%$ | 100% | $< 1\%$ | 100% | $< 10\%$ | 96% | $< 1\%$ | 80% |
| 5 | $< 10\%$ | 100% | $< 1\%$ | 100% | $< 10\%$ | 96% | $< 1\%$ | 80% |
| 6 | $< 10\%$ | 100% | $< 1\%$ | 100% | $< 10\%$ | 96% | $< 1\%$ | 80% |
| 7 | $< 10\%$ | 100% | $< 1\%$ | 100% | $< 10\%$ | 96% | $< 1\%$ | 80% |
| 8 | $< 10\%$ | 100% | $< 1\%$ | 100% | $< 10\%$ | 96% | $< 1\%$ | 84% |
| 9 | $< 10\%$ | 100% | $< 1\%$ | 100% | $< 10\%$ | 92% | $< 1\%$ | 84% |
| 10 | $< 10\%$ | 100% | $< 1\%$ | 100% | $< 10\%$ | 96% | $< 1\%$ | 84% |
| 11 | $< 10\%$ | 100% | $< 1\%$ | 100% | $< 10\%$ | 96% | $< 1\%$ | 80% |
| 12 | $< 10\%$ | 100% | $< 1\%$ | 100% | $< 10\%$ | 92% | $< 1\%$ | 84% |

# Appendix C: The 30 US Commodities and 25 Chinese Commodities

| US Futures Contracts | | | | Chinese Futures Contracts | | |
|---|---|---|---|---|---|---|
| Contract Name | Exchange | Bloomberg Code | CSI Code | Contract Name | Exchange | Transaction Code |
| Soybean Oil | CBOT | BO | BO2 | No. 1 Soybean | DCE | A |
| Corn | CBOT | C | C2 | Aluminum | SHFE | AL |
| Cocoa | ICE-US | CC | CC2 | Gold | SHFE | AU |
| Crude Oil Light | NYMEX | CL | CL2 | No. 2 Soybean | DCE | B |
| Cotton | ICE-US | CT | CT2 | Corn | DCE | C |
| Milk | CME | DA | DA | Cotton | ZCE | CF |
| Feeder Cattle | CME | FC | FC | Copper | SHFE | CU |
| Gold | COMEX | GC | GC2 | Fuel Oil | SHFE | FU |
| Copper HG | COMEX | HG | HG2 | Mung Bean | ZCE | GN |
| NY Harbor ULSD | NYMEX | HO | HO2 | LLDPE | DCE | L |
| Coffee | ICE-US | KC | KC2 | Soybean Meal | DCE | M |
| Wheat Kansas City | KCBT | KW | KW2 | Rapeseed Oil | ZCE | OI |
| Lumber | CME | LB | LB | RBD Palm Olein | DCE | P |
| Cattle Live | CME | LC | LC | Lead | SHFE | PB |
| Crude Brent Oil | ICE-UK | CO | LCO | Steel Rebar | SHFE | RB |
| Light Gas Oil | ICE-UK | QS | LGO | Early Indica Rice | ZCE | RI |
| Hogs Lean | CME | LH | LH | Natural Rubber | SHFE | RU |
| Red Spring Wheat | MGE | MW | MW2 | Sugar | ZCE | SR |
| Natural Gas | NYMEX | NG | NG2 | PTA | ZCE | TA |
| Oats | CBOT | O | O2 | Polyvinyl Chloride (PVC) | DCE | V |
| Orange Juice | ICE-US | OJ | OJ2 | Strong Gluten Wheat | ZCE | WS |
| Palladium | NYMEX | PA | PA2 | Steel Wire Rod | SHFE | WR |
| Platinum | NYMEX | PL | PL2 | Hard White Wheat | ZCE | WT |
| Gasoline RBOB | NYMEX | XB | RB2 | Soybean Oil | DCE | Y |
| Rice Rough | CBOT | RR | RR2 | Zinc | SHFE | ZN |
| Soybeans | CBOT | S | S2 | | | |
| Sugar | ICE-US | SB | SB2 | | | |
| Silver | COMEX | SI | SI2 | | | |
| Soybean meal | CBOT | SM | SM2 | | | |
| Wheat | CBOT | W | W2 | | | |

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