The Impact of Chinese Interbank Liquidity Risk on Global Commodity Markets

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ABSTRACT

We show how interbank liquidity risk in China impacts the commodity futures risk premium across the world through commodity financing deals. Investors import commodities, collateralize them, and invest high-yielding shadow banking products to exploit the high-interest rate differences under capital controls and financial frictions in China. We reveal that the Chinese commercial banks act as market makers of the shadow banking system in China, and they use the interbank market to resolve the associated maturity mismatch. If maturity mismatch risk intensifies, the demand for commodities as collaterals would reduce. To sum up, we empirically show both predictive and contemporaneous relations when interbank liquidity risk in China increases, measured by the 3-month and the overnight interbank loan rates, the commodity futures risk premium decreases due to contractions in the hedging demands for commodity financing deals. Our findings are robust with regard to other channels not related to commodity financing deals.

JEL classification: G12, F31, F38, G23, Q02

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I. Introduction

On March 5, 2014, a Chinese solar equipment producer, Shanghai Chaori Solar unexpectedly defaulted on its corporate bonds. Solar equipment producers require copper in their manufacturing process, but given the relatively small size of the firm, Chaori's default should not have significantly affected copper's global demand. However, over the next week, copper futures price in London Metal Exchange (LME) plunged by 8.9%.[1]

Motivated by this event and others alike, in this paper, we look at how conditions in the Chinese shadow banking can influence commodity markets. Specifically, we propose and test that short-term interbank liquiditiy risk in China can affect global commodity futures markets, via Chinese Commodity Financing Deals (CCFDs).

In typical CCFDs, Chinese investors start the process by importing commodities. Then, these investors obtain loans using the commodities as collateral. The goal of these loans is to invest the proceeds in high-yielding shadow banking products in China. To hedge their commodity positions, the CCFDs investors use commodity futures markets. Chinese commercial banks play crucial roles in CCFDs: (i) they issue letters of credit that allow commodities imports, (ii) they loan against pledged commodities, and (iii) they provide the unsecured high-yielding shadow banking products.

Tang and Zhu (2016), using the same setting of CCFDs, show that the demand for commodities as collateral impacts commodity spot prices in global commodity markets. However, they simply use the carry trade return, which is the sum of the 3-month Shanghai interbank loan rate (SHIBOR) - London interbank loan rate (LIBOR) differential and the hedged currency returns between USD and CNY, as a proxy for the demand for commodities as collateral. We add to the discussion by investigating if changes in risk in the Chinese shadow banking can also affect this demand and, thus, commodity markets. Specifically, the risk we have in mind is funding liquidity risk in the Chinese interbank system. Commercial banks in China frequently use the interbank market to resolve maturity mismatch of the shadow banking products. Thus, an increase in the interbank liquidity risk in China can lead to an increase in the risk of shadow banking system. This, in turn, reduces the collateral and hedging demand for commodities affecting commodity markets. Moreover, according to the theory of normal backwardation (Keynes, 1930), this decrease in hedging demand results in a decrease in the commodity futures risk premium.

We empirically test the relation between the interbank liquidity risk in China and commodity futures excess returns for the period starting in October 2006 and ending in March

[1] K. Gittleson, "Chaori Solar in landmark Chinese bond default", BBC, May 7, 2014. X. Rice, J. Smyth, and L.Hornby "Copper futures fall by daily limit", Financial Times, May 12, 2014.

2016. As a proxy for short-term funding liquidity risk in the Chinese interbank market, we use the weekly spread between the 3-month SHIBOR and the overnight SHIBOR. We compute weekly futures excess returns for sixteen commodities that have active futures in both developed countries (e.g., the United States, the United Kingdom, and Japan) and China. We then investigate how our measure of risk relates to the commodity futures excess returns in developed markets as well as in China.

We find strong supportive evidence that short-term funding liquidity risk in the Chinese interbank system affects commodity markets. First, we find that the weekly spread between the 3-month SHIBOR and the overnight SHIBOR is negatively correlated with the contemporaneous commodity futures risk premium in both developed and Chinese commodity markets. More interestingly, we find that our measure of risk is able to predict next week's commodity futures risk premium, again for both markets. As expected, a week of high risk is followed by a week of negative commodity futures risk premium.

Our results hold when we control for macroeconomic conditions and the Tang and Zhu (2016) proxy for the demand for commodities as collateral. Our measure of risk in the Chinese shadow banking system consistently affects the commodity futures risk premium, while the Tang and Zhu (2016) measure is occasionally not significant or with the wrong sign. Interestingly, we discover interaction effects between our measure and Tang and Zhu (2016) proxy. We find that interbank liquidity risk in China impacts the commodity futures risk premium more severely when the gains from trading CCFDs (as measured by the carry trade return) are low. In times when the potential gains are high, we find that the commodity futures risk premium is less affected than in normal times.

Following Tang and Zhu (2016), we distinguish between metal and nonmetal commodities. If the interbank liquidity risk in China is affecting commodity markets through CCFDs, we should see a stronger effect on commodities that are good collateral. Metals, due to their physical characteristics, are more suited to be collateral than nonmetals. As expected, we find a much stronger effect of our measure of risk on commodity futures excess returns for the metal commodities.

Next, we split our sample into two sub-periods: before and after July 2009. The reason to do so is twofold. First, we want to test that our results are not driven by the financial crisis period. Second, there is some anecdotal evidence that CCFDs only started to become popular in 2009 onwards. Hence, we expect the relationship between our risk measure and commodity markets to be stronger for the subperiod after July 2009. We find empirical evidence supporting this.

This paper complements the theory of commodities as collaterals (Tang and Zhu (2016)) by investigating the limits to funding liquidity as a new channel to affect the collateral and hedging demand for commodities. Tang and Zhu (2016) show the relationship between demand for collaterals and commodity spot prices, but they do not cover the commodity futures risk premium. We focus on the fact that commodity financing deals created the interconnectedness between Chinese commercial banking sector, Chinese shadow banking sector, and global/Chinese commodity futures markets. Such interconnectedness is a key to understand the influence of the financial intermediaries in China with maturity mismatch and the limits to funding liquidity on the commodity futures risk premium.

Our finding is new evidence supporting the financialization of commodities, contributing to the related literature. Tang and Xiong (2012) find that as the investment in commodities indexes such as S&P GSCI and DJ-UBSCI has been popular since 2004, commodity markets have tended to be synchronized rather than segmented as before. They also show that crude oil which makes up the largest share of the commodity indices are more correlated with indexed commodities than non-indexed commodities since 2004. Singleton (2013) shows that changes in index investors and managed-money spread positions predict the excess returns of crude oil futures especially during the period of the 2008 oil price boom and bust using Commodity Futures Trading Commission (CFTC) data.[2] Henderson, Pearson, and Wang (2014) document new evidence of the financialization of commodities using the commodity-linked notes (CLNs) data. They show that there are two channels that affect the commodity futures returns: the issuers hedging demand for their commodity exposures and the amount of unwinded their positions at the end of their contracts. Basak and Pavlova (2016) provide a theoretical model of the relationship between institutional investment flows into commodity indices and commodity futures markets.

Moreover, our evidence on the financialization of commodities gives new insights to the literature on the theory of normal backwardation (see Keynes (1930), Hicks (1946), Stoll (1979), Carter, Rausser, and Schmitz (1983), Chang (1985), Hirshleifer (1988, 1990), Bessembinder (1992), De Roon, Nijman, and Veld (2000), and Cheng, Kirilenko, and Xiong (2014), among others). Based on the theory of normal backwardation, commodity futures risk premium comes from the commodity producers' demand for hedging against commodity price fluctuations. On the opposite side, speculators are compensated for taking the risk of long positions. While financial investors have been considered as playing a role of speculators in the recent literature (e.g., Acharya, Lochstoer, and Ramadorai (2013), Etula (2013)), our results imply that they also take short positions, thereby adding additional hedging demand to the original hedging demand from commodity producers. This suggests that hedging demand of financial investors should be additionally considered when studying the commodity

[2]Büyükahin and Robe (2014) and Hamilton and Wu (2015) find that there is little evidence of the correlated relationship between index traders positions and commodity futures risk premium.

futures risk premium.

Lastly, our results are related to the literature on the role of financial intermediaries and liquidity in asset pricing. The literature on the role of financial intermediaries in asset pricing document that the financial intermediaries are influential marginal investors in asset markets. Because they trade many assets in better conditions than households in many ways such as having low transaction cost, having a trade priority over transactions, and using sophisticated decision models. (see Adrian and Shin (2010), Etula (2013), Adrian, Etula, and Muir (2014), and He, Kelly, and Manela (2017) among others). When funding conditions deteriorate, financial intermediaries expose to downsize their risky assets, and then asset risk premiums would increase. However, the added insight from our results comes from financial intermediaries in China play a role as market makers in CCFDs rather than marginal investors. As a result, we have distinct the results from the literature. When short-term interbank funding conditions tighten, commodity futures risk premium would decrease.

II. Chinese Commodity Financing Deals and Chinese Shadow Banking System

In this section, we discuss how potential changes in the conditions of the Chinese shadow banking system can affect the global commodity markets. We first describe the institutional details of CCFDs showing how the Chinese shadow banking system can affect global commodity markets through CCFDs. Next, we discuss that the Chinese shadow banking system is vulnerable to risks in the commercial banking sector. These risks can affect the demand for CCFDs as well as demand for hedging against commodity price risk. This, in turn, impacts commodity futures risk premium in developed markets and China.

A. Chinese Commodity Financing Deals (CCFDs)

There are many variations of CCFDs[3], but here we describe the standard conditions of such deals (for more details on CCFDs, see Layton, Yuan, and Currie (2013), Garvery and Shaw (2014)). For the purpose of ppaer, the standard deal is sufficient to illustrate the financial attractiveness and the risks of CCFDs as well as their relationship with the Chinese shadow banking. Figure 1 depicts multiple steps that make up one cycle of the typical CCFD.

The deal is initiated by an investor, usually a commodity importer in China, who contracts to import a commodity into China with an offshore commodity exporter. To guarantee the payment, the investor opens a letter of credit (LC) in US dollars at LIBOR plus spread for a 3-6 months period with an onshore bank. This letter is then issued to the offshore commodity exporter (Step 1). The offshore commodity exporter then sells the commodity by sending a commodity warrant to the investor (Step 2). This gives the owner the right to hold the commodity in a bonded warehouse. Note that this bonded warehouse is outside of the Chinese customs territory. If the investor wants to take advantage of just the price spread between foreign commodity markets and domestic commodity markets, the investor can import the commodity into China and sell it to the domestic markets rather than holding the commodity warrant in the bonded warehouse.[4]

In the standard case, the investor further exploits the interest rate differentials between US dollars and Chinese Yuan Renminbi (CNY) by taking the following steps. In Steps 3 and 4, the investor approaches another onshore bank and using the commodity warrant as

[3]See Garvery and Shaw (2014) and Lewis, Hsueh, and Fu (2014) for many variations of CCFDs.

[4]Yuan, Layton, Currie, and Cai (2014a) argue that there are bidirectional trading incentives to capture the spread between London Metal Exchange (LME) and Shanghai Futures Exchange (SHFE).

collateral, gets a CNY loan.[5] To be precise, the CNY loan is a form of a repurchase agreement (Repo) where the investor sells the commodity warrant to the bank and then repurchases it when the CNY loan expires. The size of the repo CNY loan is the risk-adjusted market value of the pledged commodity.[6] At the same time, the investor hedges against the collateralized commodity price by taking a short position in the commodity futures market (Step 5). In our standard case, the investor will take a short position in the commodity futures market outside of China as the commodity warrant is for commodities in an offshore bonded warehouse.

Steps 6 shows how the investor can boost the return from the CCFD. Using this CNY repo funding, the investor makes domestic investments, usually in high-yielding unsecured shadow banking assets such as Wealth Management Products (WMPs). WMPs are composed of pooled time-deposit accounts to invest in a variety of assets, such as bonds, trust products, repurchase agreements, real estate loans, private equity funds, and Local Government Financing Vehicles (LGFVs) loans, providing the main source of credit to nonbank credit intermediaries such as trust companies, brokerage firms, guarantee companies, and unofficial lenders. Higher returns of WMPs (over 5% on average in 2014) than capped deposit interest rates (ranged 2-3% in 2014) attract investors to WMPs. (Perry and Weltewitz (2015))

Before the CNY loan matures, the investor pays it off from the proceeds of the WMPs (Steps 7 and 8). The investor then liquidates the commodity warrant and finishes the commodity financing deal by paying off the initial letter of credit (Step 9). This one cycle of the standard CCFD can be repeated many times. Layton et al. (2013) presume the investor repeats one cycle of CCFDs 10-30 times during a 6-month period.

The financial attractiveness of CCFDs is twofold. First, CCFDs can provide attractive high returns. According to Garvery and Shaw (2014), the investor can earn about 11% return over a 6-month period with the standard CCFDs. Layton et al. (2013) estimate that the interest rates arbitrage from trading LME copper using CCFDs is at least 3.5% over six months. This is a conservative estimate given that the deal does not consider investing in high-yielding unsecured assets in China. Ultimately, CCFDs allow investors to capture the interest difference between the domestic market (high) and foreign market (low) that is derived from capital controls in China.

The second advantage of CCFDs is the access to cheaper financing. Chinese companies

[5] Commodity inventory has been allowed to use as loan collateral by the new property rights law in China that went into effect on October 1, 2007. The new property rights law made it possible to use movable properties such as accounts receivables and inventories as collateral. For additional information of the China's property rights law reform, see Marechal, Tekin, and Guliyeva (2009).

[6] The risk-adjusted market value is obtained by the difference between the market value of the pledged commodity (%) and the repo margin (haircut) (%).

that cannot access formal lending channels due to poor collateral quality can engage in CCFDs to get better financing conditions. For instance, Zhang (2012) refers that the lending rate of informal financing for small and medium enterprises in the city Wenzhou was 24.4% in mid-2011. Ping (2013) notes that the average lending rates of banks for micro and small enterprises in 2012 were 20-40 percentage points higher than the interbank benchmark lending rates. Furthermore, CCFDs provide not only commodity collaterals to access formal lending channels but also a vehicle to deal with urgent liquidity needs. In sum, the seemingly profitable returns of the CCFDs, as well as the demand for extra liquidity circumventing capital controls, drive the demand for commodities as collateral and hedging.

One potential concern is whether CCFDs are prevalent enough to have a sizeable impact on commodity markets. However, Yuan, Layton, Currie, and Courvalin (2014b) estimate that, in 2013, about 31% of China's total FX short-term debts are related to CCFDs (the LC in Step 1). Tang and Zhu (2016) estimate that, in 2012, 5.7% of China's annual copper demand (or, equivalently, 2.4% of the world's copper demand) is linked to CCFDs. Taking into account the cases of multiple CCFDs with one commodity warrant, these estimates can be conservative. Moreover, there are several events which show that the Chinese regulators and banks are concerned about the ramifications of CCFDs on the financial markets. For example, in May, 2013, the State Administration of Foreign Exchange in China announced that they would start to limit banks' short positions, while thoroughly monitoring the details of the commodity transactions of the importing/exporting companies.[7] The culminating event was the Qingdao port probe in 2014 and the following crackdown on commodity financing by Chinese authorities, which investigated fake copper warehouse receipts made for multiple loans. These fraudulent practices hit many global banks such as HSBC, Standard Chartered, Citi, and others. In addition, copper prices in London fell for a few weeks after the report of the probe.[8] As a result, banks largely exposed to CCFDs in terms of CNY loans pledged by commodities, saw the quality of their collateral deteriorate due to the plunging of commodity prices.[9]

A more direct evidence of the impact of CCFDs on commodity markets is given by Tang and Zhu (2016). They use the carry trade return, which is the sum of the SHIBOR-LIBOR interest rate differential and the forward premium between USD and CNY, as a proxy for the collateral demand for commodities. They show that the demand for commodities as collateral in China affects commodity prices in developed markets and China.

[7] S. Rabinovitch, "China to crack down on faked export deals", Financial Times, May 6, 2013.

[8] L. Hornby, "China probe sparks metals stocks scramble", Financial Times, June 10, 2014. X. Rice and L. Hornby, "Ripples spread from China metals probe", June 12, 2014.

[9] C. Sau-wai, "Commodity financing exposure in Asia-Pacific hits banks hard", South China Morning Post, January 25, 2015.

B. Risks in Chinese Interbank Market and Shadow Banking, and Their Impact on CCFDs and Commodity Futures Markets

As described above, in one cycle of the typical CCFD, the final return from CCFDs can be decomposed into two parts: (i) the difference between the return from the domestic investment and the interest rate of the USD loan, and (ii) appreciation of CNY. If the domestic investment is made in the riskless assets such as government bonds, the return will closely follow the usual carry trade return. However, the domestic investments in CCFDs are usually made in shadow banking products. These are high-yielding unsecured assets that cannot be hedged. Therefore, the risks in the shadow banking sector can be another important driving factor of the collateral demand for commodities (Tang and Zhu (2016)) and subsequent demand for hedging.

For example, on March 5, 2014, a relatively small Chinese solar equipment producer, Shanghai Chaori Solar unexpectedly defaulted on its corporate bonds. Over the next week copper futures price in LME plunged by 8.9%. The tumble in copper price is likely to be the result of investors reevaluating default risk of shadow banking products due to the first Chinese corporate bond default. The perceived higher risk might have reduced the demand for copper as collateral, hence copper price dropped.

Moreover, the risks in the shadow banking sector can also affect commodity futures risk premium through the CCFDs channel. When the collateral demand for commodities decreases due to higher risk in the shadow banking sector, the investors' demand for hedging against commodity prices declines. This leads to a decline in the commodity futures risk premium according to the theory of normal backwardation. This decline in the futures premium should be observed both in China and other global markets as the investors can hedge in either market depending on the location of their warranted commodities. Investors are likely to hedge in global markets if they do the standard CCFDs, while they are likely to hedge in the Chinese futures market if they do some variations of CCFDs which use commodities stocked in China.

What then constitutes risks in the Chinese shadow banking system? We discuss now that the maturity mismatch risk in WMPs, which is linked to the liquidity risk in the interbank money market, is a major risk in the Chinese shadow banking system (Elliott, Kroeber, and Qiao (2015) and Li (2014)). Since most of the WMPs expire ahead of the underlying assets[10], the issuers, typically the commercial banks and trust companies, are exposed to a maturity mismatch risk and have to frequently roll over WMPs. The maturity mismatch risk brings

[10] According to Li (2014), the maturity of about 80% of bank-issued WMPs is shorter than 6-month in 2012.

about an urgent liquidity problem to pay back the principal and interests or to patch up some defaulted underlying assets. It was reported by a local press that about 27-29 trillion yuan, about 55% of GDP in 2012, was at maturity mismatch risk in the Chinese shadow banking system in 2012.[11]

The liquidity or default problems in WMPs then should be resolved in the interbank money market.[12] This is because commercial banks are heavily involved in the operation and management of WMPs. The commercial banks directly issue to investors and manage WMPs (pure bank WMPs) or sell WMPs to trust companies (bank-trust cooperation WMPs). Even in the latter case, the banks conventionally enter into repurchase agreements in the WMPs. According to Perry and Weltewitz (2015), outstanding WMPs as of June 30th, 2014 which account for 17.2 trillion CNY, consist of pure bank WMPs (11%), direct bank-trust cooperation WMPs (16%), indirect bank-trust cooperation WMPs (9%), collective trust products (19%), and other channel WMPs (45%). Except for the collective trust products, the commercial banks are to manage risks of 81% of all the WMPs. Therefore, liquidity problems in the interbank money market can lead to defaults in WMPs, which make the shadow banking system vulnerable and, ultimately, affecting the commodity markets through CCFDs.

It may be helpful to note that WMPs are quite similar to asset-backed commercial paper (ABCP) conduits in their asset compositions: the ABCP conduits are composed of medium-to long-terms assets funded by short-term asset-backed commercial papers, and WMPs are composed of medium-to long-term assets funded by pooled time-deposit accounts. Due to their composition structures with short-term debts, both ABCP and WMP bear maturity mismatch risks. This maturity mismatch risk was the main reason why ABCP aggravated the financial crisis of 2007-2008 (Covitz, Liang, and Suarez (2013), Goldsmith-Pinkham and Yorulmazer (2010), and Gorton and Metrick (2012)).

In this paper, we focus on the potential impact of Chinese shadow banking system on commodity markets through CCFDs. The vulnerability of the shadow banking system heavily depends on the liquidity in the interbank money market. If banks cannot resolve maturity mismatch of WMPs in the interbank money market, the shadow banking sector faces higher default risk. Increased risk in the banking system can make the system more vulnerable, which would then decrease the demand for CCFDs and, hence, demand for commodities as

[11] W. Lihua, "Nearly 30 trillion shadow banking mismatches accumulate", Economic Information Network, January 30, 2013.

[12] "China's banks: Ten days in June", July 6 2013, The Economist, reports "...Wealth-management products raise money, mostly from better-off individuals, for fixed periods (often less than six months). The cash is invested in a variety of assets, some of them riskier than others. These products added to the cash crunch because they often matured before the underlying assets did. The banks grew used to borrowing money in the interbank market to redeem maturing products until they could sell new ones..."

collateral. Furthermore, when the interbank market is unstable, banks would downsize the CNY loans backed by commodity collaterals or at least reluctant to enlarge their CNY loan positions. All the reactions converge to decrease the investor's hedging position (short the commodity futures) in the commodity futures markets. This eventually leads to decline in commodity futures risk premium.

III. Data

A. Proxy variables for the risk of the Chinese interbank market

We use the spread between the 3-month SHIBOR and the overnight SHIBOR as a proxy for the short-term interbank liquidity risk in China. A large spread between the 3-month SHIBOR and the overnight SHIBOR indicates that is harder for a bank to borrow from other banks. This, in turn, can make the shadow banking system unstable due to the maturity mismatch risk in WMPs. Ultimately this leads to a decrease in the collateral and hedging demand for commodities.

Large spreads between 3-month SHIBOR and the overnight SHIBOR indicate problems for the Chinese shadow banking system. However, a negative spread might also be problematic and this has happened a few times in China. The Chinese interbank money market is not fully mature and a sudden freeze in the short term interbank money market can lead to a moment of market failure. This leads to a negative spread in the interbank money market.[13] For example, China Everbright Bank Co. Ltd., China's 11th largest bank by assets, announced that they defaulted on 6.5 billion yuan on the overnight loan from China Industrial Bank Co. Ltd. on June 5th, 2013. At the end of the week, the spread between the 3-month SHIBOR and the overnight SHIBOR was -3.72. The negative spread continued for the following two weeks.[14]

To address this issue, from the spread between the 3-month and the overnight SHIBOR, we construct two proxy variables, *Slope* and *Negative Dummy*. If the spread is positive, *Slope* is defined to be the difference between the 3-month and the overnight SHIBOR and *Negative Dummy* is set to 0. Conversely, if the spread is negative, *Slope* becomes 0 and *Negative Dummy* is set to 1.[15]

Figure 2 shows *Slope* and *Negative Dummy* from October 2006 to March 2016. During this period, the spread between the 3-month SHIBOR and the overnight SHIBOR was negative for 19 times. In other words, our *Negative Dummy* has a value of 1 for 19 weeks.

[13] There was a view that those market failures were intended by the Chinese government to raise the alarm over the commercial banks' moral hazard. See "Re-education through SHIBOR", June 29th, 2013, The Economist and Farhi and Tirole (2012).

[14] D. McMahon, "China Everbright Admits to Interbank-Loan Default", The Wall Street Journal, December 16, 2013. M. Zhang. "China Everbright Bank Co. Ltd (SHA:601818) 'Admits' To 6.5 Billion Yuan Interbank Loan Default", International Business Times, December 16, 2013

[15] Our methodology follows Fama and French (1992) who use a positive earnings ratio and a negative dummy for negative ratios. As a robustness, we have used the original difference between 3-month SHIBOR and the overnight SHIBOR as our main proxy for short-term liquidity risk and also absolute value of the difference. The findings presented in the paper are robust to these different measures.

B. Commodity futures excess returns, basis, and aggregate controls

We obtain from Datastream commodity futures end-of-week prices from October 9th, 2006 to March 25th, 2016.[16]

To compare similar sets of commodities across markets and following Tang and Zhu (2016) we only keep commodities that have active futures in both developed countries (e.g., the United States, the United Kingdom, and Japan) and China.[17] We end up with sixteen commodities, which we divide into the metal group (aluminum, copper, lead, zinc, gold, and silver) and the nonmetal group (corn, soybeans, soybean meal, soybean oil, wheat, cotton, palm oil, rubber, sugar and fuel oil).

Next, for each commodity, we compute futures excess returns and basis following Gorton and Rouwenhorst (2006) and Gorton, Hayashi, and Rouwenhorst (2013). To be precise, the excess return of commodity futures i over week t to week $t+1$, $Excess\ Return^i_{t+1}$, is given as follows:

$$Excess\ Return^i_{t+1} = \frac{F^i_{t+1,T_1} - F^i_{t,T_1}}{F^i_{t,T_1}}, \tag{1}$$

where F^i_{t,T_1} is the price of the commodity i nearest futures (among the futures contracts that do not expire during the next month) at the end of week t with the expiration date T_1. We only use futures prices from the leading exchanges in developed markets and in China.

Yang (2013) and Szymanowska, Roon, Nijman, and Goorbergh (2014) among others show that the basis has predictive power for commodity futures risk premium. Hence, we consider the basis as a commodity-specific control and construct the annual basis for commodity i in week t, $Basis^i_t$, as

$$Basis^i_t = \frac{F^i_{t,T_1} - F^i_{t,T_2}}{F^i_{t,T_2}} \times \frac{365}{D^i_{t,T_2} - D^i_{t,T_1}}, \tag{2}$$

where F^i_{t,T_2} is the price of the second nearest commodity futures contract at the end of week t with the expiration date T_2 , and D^i_{t,T_1} and D^i_{t,T_2} are the remaining days of each futures until the last trading date.[18]

As a control, we also include the currency-hedged carry trade returns which Tang and Zhu (2016) used as a proxy for the collateral demand for commodities. The currency-hedged

[16]The beginning of our sample period is restricted by the availability of SHIBOR data.

[17]One exception is fuel oil futures that are available only in China. We do not drop this commodity as we use CME heating oil futures to proxy the fuel oil futures in developed markets. This seems reasonable as fuel oil is one type of heating oil.

[18]Fama and French (1987), Gorton and Rouwenhorst (2006), Singleton (2013), and Hong and Yogo (2012) use the basis as a proxy for the convenience yields or a control for the effect of the hedging pressure hypothesis.

carry trade returns are calculated as the sum of the interest rate difference between the 3-month SHIBOR and 3-month LIBOR and the hedged currency returns from the official USD-CNY spot exchange rate and the USD-CNY 3-month nondeliverable forward (NDF) exchange rate. We call the currency-hedged carry trade returns as *TZ*. Figure 3 shows the evolution of *TZ* during our sample period.

To ensure that our measures of the interbank liquidity risk are not capturing macroeconomic conditions, we control for macroeconomic fundamentals. General economic conditions affect both commodity producers' and speculators' fundamental hedging demand, thereby affecting commodity futures risk premium.[19]

Following Tang and Xiong (2012), Acharya et al. (2013), Singleton (2013), and Henderson et al. (2014), we include *MSCI* – the difference between MSCI Emerging Markets Asia Index weekly return and the weekly USD LIBOR. This captures the growth of emerging Asian economies. In the same spirit, we control for the excess returns of developed countries with *SPX* – the difference between the weekly return of the S&P 500 index and the weekly USD LIBOR. As Tang and Xiong (2012), we add the returns to the U.S. Dollar Index futures. This controls for fluctuations in commodity prices due to changes in exchange rates. Following Bakshi, Panayotov, and Skoulakis (2011), we use the log changes in the Baltic Dry Index (BDI) to proxy for the aggregated commodity demand.

Lastly, we add controls for general funding liquidity shocks from global markets. These can have an impact on assets' risk premium (Brunnermeier, Nagel, and Pedersen (2008), Asness, Moskowitz, and Pedersen (2013), and Gârleanu and Pedersen (2013)). We use two common liquidity risk measures in the literature: (i) the TED spread, which is the difference between the 3-month Eurodollars and the 3-month Treasury Bill; (ii) the LIBOR-Repo spread, which is the spread between the 3-month USD LIBOR and the 3-month USD term repurchase agreement rate.

Table I shows the summary statistics for *Slope* and *Negative Dummy*, weekly excess returns and annual basis of aggregate commodities (all, metals, and nonmetals), and for our control variables.[20] During the sample period, most of the commodities are in contango, as they have a negative basis on average. Consistent with the theory of storage and Fama and French (1987) and Gorton et al. (2013), the standard deviation of basis is lower for more storable commodities such as metals than nonmetals. It is also noteworthy that the 3-month currency-hedged carry trade returns (*TZ*) show 0.72% quarterly excess returns on average. This is fairly high, and since the carry trade return is a conservative estimate of the returns

[19]Concerning the speculators' reactions to macroeconomic fundamentals, Acharya et al. (2013) note that the commodity risk premium is related to equity holders' marginal rate of intertemporal substitution. Singleton (2013) considers cross-market trading strategies between equity and commodity markets.

[20]The summary statistics for each individual commodity are shown in Table A1.

from CCFDs it suggests that CCFDs have been quite lucrative.

IV. Empirical Evidence

In this section, we test if our proxies for the short-term interbank liquidity risk in China, *Slope* and *Negative Dummy* have an impact on the commodity futures risk premium. Following Hong and Yogo (2012), Acharya et al. (2013), and Singleton (2013), we test if our measures predict one-week ahead the commodity futures excess returns. We also look at the contemporaneous relationship between our proxies and commodity futures excess returns. The analysis is done both for the commodity futures markets in the developed markets and for the commodity futures market in China. Moreover, we test if the predictability and the contemporaneous effect of our proxies differ in metal commodities and non-metal commodities. We end this section with two robustness tests. First, we examine whether our results are stronger when CCFDs were reported to be more prevalent. Second, we show that the predictive and explanatory power of our short-term interbank liquidity risk remains significant after considering general funding liquidity risks in the Chinese interbank market. This implies that our measures are capturing something different from the general funding liquidity risk, which we suppose the risk spillover from the short-term liquidity risk in the interbank market and the risk in the Chinese shadow banking sector.

A. Commodity futures risk premium by market

We start our empirical analysis by looking into the commodity futures risk premium in the developed markets with all commodities (aluminum, copper, lead, zinc, gold, silver, corn, soybeans, soybean meal, soybean oil, wheat, cotton, palm oil, rubber, sugar, and heating oil[21]). We do so by regressing commodity futures excess returns for week $t+1$ of commodity i onto our variables of interest, *Slope* and *Negative Dummy* while controlling for the *Basis* of each commodity as follows:

$$Excess\ Returns_{i,t+1} = \beta_0 + \beta_1 Slope_t + \beta_2 Negative\ Dummy_t + \beta_3 Basis_{i,t} + \gamma X_t + \epsilon_{i,t+1}, \quad (3)$$

where X_t is a vector of aggregate control variables including TZ and $\epsilon_{i,t+1}$ is an error term. We repeat the exercise with the contemporaneous excess returns instead of one-week ahead excess returns:

$$Excess\ Returns_{i,t} = \beta_0 + \beta_1 Slope_t + \beta_2 Negative\ Dummy_t + \beta_3 Basis_{i,t} + \gamma X_t + \epsilon_{i,t+1}. \quad (4)$$

[21] This corresponds to the fuel oil in the Chinese commodity futures market.

In both regressions, we perform a panel regression including individual commodity fixed effects and an AR(1) disturbance. Table II shows our main results: Panel A presents the predictive regression results while Panel B shows the contemporaneous results.

In columns (1) and (5) of Table II where we do not have any aggregate controls, we see that *Slope* shows, as expected, the negative and statistically significant effect at the 1% level. An increase of 78 basis points of *Slope*, one standard deviation of *Slope*, predicts a decrease of 0.31 percentage points (0.78×0.40) in one-week ahead commodities futures excess returns, which is equal to a decrease by 17.5 percentage points annually. This effect is virtually the same for the contemporaneous returns. These results are in line with our expectation that the short-term interbank liquidity risk in China negatively impacts commodity futures risk premiums. .*Negative Dummy*, however, is not significant without aggregate controls.

In columns (2) and (6) we include Tang and Zhu (2016) measure *TZ* to check whether our measures contain the same information as *TZ*. We find that the significance of *Slope* remains unchanged in the predictive regression and becomes stronger for the contemporaneous regression. The effect of *TZ* is positive as expected, as an increase in the conservative return from CCFDs will boost the demand for collateral thereby the commodity futures risk premium. Interestingly, the effect of *Negative Dummy* is negative and statistically significant at the 1% level for the contemporaneous returns which again suggests that our measures are capturing something different from *TZ*.

Next in columns (3) and (7), we investigate potential interactions between *TZ* and *Slope*. For example, it is interesting to check if the commodity futures risk premiums are more severely affected by the risk in the Chinese shadow banking system when the conservative return from CCFDs is low (when *TZ* is low). On the other hand, we may wonder whether the effect of the risk in the Chinese shadow banking system is alleviated when the conservative return from CCFDs is high. To test this, we add interaction terms for *TZ* and *Slope*. To be specific, we add *Slope* × *Low TZ* and *Slope* × *High TZ*. *Slope* × *Low TZ* equals *Slope* if *TZ* in that particular week is in the bottom quartile of the *TZ* distribution. We define *Slope* × *High TZ* analogously. As before, our measure *Slope* remains strongly significant statistically and economically. This implies both the predictive power and the contemporaneous effect of our measure *Slope* in the periods of normal levels of *TZ*. *TZ* remains significant in the contemporaneous regression, but loses its significance in the predictive regression. As expected, we find that the estimate on *Slope* × *Low TZ* for the predictive regression is negative and statistically significant. This suggests that the short-term interbank liquidity risk in China impacts the commodity futures risk premium more severely when the conservatively estimated gains from trading CCFDs are lower than usual. Looking at the estimate on *Slope* × *High TZ* in the predictive regression, we find it to be positive (0.16) and significant at the

5% level. This supports the alleviating effect of the high CCFD returns over the risk in the Chinese banking systems.

Our results so far suggest that our measures of the short-term interbank liquidity risk seem to explain the commodity futures risk premium. A natural concern to this interpretation is that our measures are simply correlated with fundamental macroeconomic variables that naturally affect commodity futures risk premium. To alleviate this concern, we add a set of control variables as described in Section 4.2.: *MSCI*, *SPX*, *DXY*, *BDI*, *TED spread* and *LIBOR-Repo spread* (see Table I for descriptions). Column (4) shows that the estimates on *Slope* and *Slope* × *Low TZ* are roughly the same as before after controlling for the macroeconomic fundamentals. Surprisingly, *TZ* now has a negative effect, which might indicate that some of the information in *TZ* is captured by the macro variables. For the contemporaneous returns, we find in column (8) that the estimate on *Slope* drops to -0.29 but remains significant. Looking at the estimate of *Slope* × *High TZ* it is equal to 0.26. This implies that when the conservative return from CCFDs is high enough, the interbank liquidity risk in China does not affect the contemporaneous commodity futures excess returns.

In summary, Table II shows that our measure of the short-term interbank liquidity risk in China has an impact on the commodity futures risk premium in developed markets. The interbank liquidity risk has the predictive power as well as the explanatory power on commodity futures excess returns. The impact of our measures remains strong after controlling for Tang and Zhu (2016) measure and fundamental macroeconomic variables. We also find that Tang and Zhu (2016) measure, the conservative estimate of CCFD returns thereby capturing the movement of collateral demand coming from changes in expected returns, has an aggravating effect over the impact of the Chinese interbank liquidity risk when their measure is low as well as an alleviating effect when their measure is high.

We next turn our attention to the effects on commodity futures markets in China. Table III shows our results on the same set of regressions as in the developed markets. All eight estimates on *Slope* are negative and statistically significant at the 1% level. Interestingly, columns (1) to (4) show that *Negative Dummy* is statistically and economically significant when predicting the commodity futures risk premium. For example, column (4) shows that weeks when the spread between 3-month SHIBOR and the overnight SHIBOR is negative, are followed by a decrease in the following week of 0.46 pps futures excess returns. These rare events seem to be very important when predicting commodity futures risk premium in Chinese markets. For contemporaneous commodity futures excess returns, this effect does not hold when macroeconomic conditions are controlled for. This suggests that these 19 weeks of the negative spread between 3-month SHIBOR and the overnight SHIBOR are highly correlated with overall bad economic conditions.

Focusing on columns (4) and (8), the results show the same pattern of estimates for *Slope* $\times$ *Low TZ* and *Slope* $\times$ *High TZ* as in developed markets. However, the magnitude of the impact of *Slope* seems to be smaller for China. For example, column (4) shows that the overall impact of *Slope* on one-week ahead excess returns in China is -0.64 percentage points (-0.32 +(-0.32)). For developed markets, this estimate is -0.90 percentage point (-0.47 + (-0.43)).

We find that an increase in liquidity risk in the Chinese interbank system decreases commodity futures risk premium in both developed markets and in China. In contrast, Tang and Zhu (2016) predict that when the demand for CCFDs decreases, commodity futures risk premium should increase in developed markets and decrease in China. However, in their model, investors only hedge their commodity positions in the Chinese market. In reality, investors might also hedge in developed markets, which might explain why we find that the shor-term interbank liquidity risk has a negative impact in both markets. Moreover, Tang and Zhu (2016) do not find any empirical evidence on the impact of *TZ* in commodity futures risk premium[22], but only in spot prices. Looking at Tables II and III, we find that *TZ* is only relevant when interacted with *Slope*. This is strong evidence that *TZ* cannot solely capture the demand for CCFDs and our measures of risk are an important determinant of such demand.

One may argue that our measures of the short-term interbank liquidity risk capture other factors of the commodity risk premium rather than the demand for CCFDs. For example, the interbank liquidity risk may show a fundamental commodity producer's default risk (Acharya et al. (2013)). If the interbank liquidity risk affects the producer's default risk, the commodity producer's fundamental hedging demand would increase when the risk is high. This would imply an increase in the commodity futures premium – this is opposite to what we find. We can also consider the cases when the interbank liquidity risk captures the risk aversion (Etula (2013) and Adrian et al. (2014)) or the capital risk (He et al. (2017)) of a financial intermediary as a marginal investor. When the interbank liquidity risk goes up, either the risk aversion or the capital risk of a financial intermediary as a marginal investor also goes up. However, the financial intermediary as a marginal investor plays a role of a speculator in commodity futures markets. This implies that the financial intermediary's capacity of taking risk decreases. Thus, according to this story, the commodity futures risk premium should increase when the interbank liquidity risk increases, which, again, is contrary to our findings.

[22]Tang and Zhu (2016) say that it may be due to the joint hypothesis test of the theory of normal backwardation and their theory of commodity as collaterals. They argue that the theory of normal backwardation lacks the empirical evidence on the commodity risk premium.

B. *Commodity futures risk premium – metals vs. nonmetals*

Next, we examine whether the effect of the short-term interbank liquidity risk differs for metal and nonmetal commodities. We expect that the interbank liquidity risk should impact the risk premium of metal commodities more severely than nonmetal commodities because metals are better suited as a medium of CCFDs than nonmetals due to their storability from the lower volume per value. Metals in our data include aluminum, copper, lead, zinc, gold, and silver, while nonmetals include corn, soybeans, soybean meal, soybean oil, wheat, cotton, palm oil, rubber, sugar, and heating/fuel oil. As before, regressions include fixed effects at the individual commodity level and an AR(1) disturbance.

We first look at the impact of our measures *Slope* and *Negative Dummy* on one-week ahead and contemporaneous commodity futures excess returns in developed markets and then repeat the exercise in China. In Table IV, columns (1) to (4) present the predictive regression results for the metals in developed markets. Results for the nonmetals are shown in columns (5) to (8). Lastly, in column (9) we test any difference in the effect of the interbank liquidity risk between metals and nonmetals by having the dummy for metal commodities interacted with our measures *Slope* and *Negative Dummy*.

First, consistent with our results in the previous subsection, for all nine specifications *Slope* is significant at the 1% level. Larger differences between the 3-month SHIBOR and the overnight SHIBOR predict lower commodity futures risk premium. Second, we indeed find evidence that our measure of the interbank liquidity risk impacts more severely metal commodities futures risk premium than nonmetals. Comparing the coefficients of *Slope* in metals and nonmetals, we find that these are more negative for metal commodities. More importantly, in column (9) we see that the coefficient on the interaction term *Metals* × *Slope* is -0.32 and statistically significant at the 5% level. Economically, this is a very significant effect given that the estimate on *Slope* is -0.35. In other words, the impact of the interbank liquidity risk for metal commodities is twice as much as for nonmetal commodities. Third, more evidence that these effects are larger for metals is provided by the interaction terms between *Slope* and *TZ*. When the currency hedged carry trade returns are low (low TZ), a deterioration of the interbank liquidity condition is three times more severe for metal commodities (-0.75 versus -0.25). No difference is observed when the conservative estimate of the CCFD returns is large (high TZ).

Next, we do the same analysis for contemporaneous commodity futures excess returns in developed markets. Table V presents, overall, the same picture as Table IV. Specifically, the estimates on *Slope* are more negative for metal commodities than for nonmetals. Moreover, in column (9) we see again that this difference is statistically significant at the 5% level and economically significant – the estimate on *Metals* × *Slope* is -0.27, compared to the nonmetals baseline estimate of -0.19. The only difference between the results in Table IV and Table V is that now the interaction term, Slope $\times$ Low TZ, is not statistically significant.

Next, we repeat the exercise for Chinese markets. Table VI, which presents the panel regression results for predicting one-week commodity futures excess returns, again provide supporting evidence for our hypothesis. As before, *Slope* estimates in all columns are statistically significant at 1% level, and columns (1) to (4) are larger in absolute value than the ones in columns (5) to (8). However, in column (9) this difference is not statistically significant as shown by the estimate on *Metals* $\times$ *Slope*. We again observe that with *Slope* $\times$ *Low TZ* on one-week ahead metals futures excess returns is statistically significant at 1% level. Moreover, *Slope* $\times$ *Low TZ* in metals futures excess returns is stronger than in nonmetals returns (-0.45 versus -0.26).

Interestingly, *Negative Dummy* plays a role in Chinese markets as shown in Table VI. *Negative Dummy* is statistically significant at 1% level in all specifications of metals but none of the nonmetals. In column (9), the interaction term *Metals* $\times$ *Negative Dummy* is also significant. Overall, Table VI provides evidence that our measures of the interbank liquidity risk in China predict the commodity futures risk premium through CCFDs. The effect of the interbank liquidity risk in China to the commodity risk premium is vividly shown up when the interbank market in China faces the moment of market failure, measured by *Negative Dummy*.

Table VII completes the picture by showing the regression results for contemporaneous commodity futures returns in China. *Slope* estimates in all columns are statistically significant at 1% level. Contrary to the previous results, we do not find that *Slope* or *Negative Dummy* seem to affect contemporaneous commodity futures excess returns differently for metals and nonmetals commodities.

In summary, metals futures risk premium are more affected by Chinese interbank liquidity risk than nonmetals. This is valid for commodities in developed markets, as well as in Chinese markets. Our findings reveal the same pattern as Tang and Zhu (2016) as they find the evidence that the demand for CCFDs measured by *TZ* is more related to metals than nonmetals in both developed markets and China.

C. Robustness tests

In this section, we run two robustness tests. First, we include dummies with our measures to show that the previous results are highlighted where we believe CCFDs are popular. Second, we use an array of variables to proxy for overall funding liquidity risk and show that the array of variables does not subsume the power of our measures, the interbank liquidity risk. Both of results provide more evidence that our measures, *Slope* and *Negative Dummy*, are a proxy for maturity mismatch risk that affects the demand for CCFDs.

Notably, there are several indications that the amount of CCFDs activity has soared since 2009. For example, Copper bonded warehouse inventory and short-term foreign currency lending in China have increased five times since 2009 (Layton et al. (2013)), and the value of gold imports from Hong Kong into China, which considered gold financing deals, has increased more than 10 times since 2009 (Yuan et al. (2014a)). Lastly, China's stimulus program for high economic growth has launched since 2009.[23] Based on the evidence, we test whether our measures, the interbank liquidity risk, have the bigger impact on the commodity futures risk premium since 2009 or not. We choose the reference date as the break point of the US business cycle expansions and contractions by the National Bureau of Economic Research (NBER)[24], which we expect that soaring the amount of CCFDs activity approximately begins after the US financial crisis (July 3rd, 2009). We use a set of *Non-crisis, Variable* dummy which has the value of '*Variable*' since July 3rd, 2009 and otherwise *Non-crisis, Variable* is 0.

Table VIII shows the panel regression results on the same set of regressions as performed in Table II and III with *Non-crisis, Variable* dummies. Column (1) indicates the regression result of the predicting one-week ahead commodity futures excess returns in developed markets. *Slope* before the reference date is no longer significantly different from 0. However *Non-crisis* × *Slope* is -0.65 and statistically significant at 1% level. *Slope* × *Low TZ* and *Slope* × *High TZ* shows the same pattern of the previous estimates, and *Non-crisis* × *Slope* × *Low TZ* and *Non-crisis* × *Slope* × *High TZ* support that the interaction effects are intensified since 2009. This pattern also is shown in *Negative Dummy* and *Non-crisis* × *Negative Dummy*. Even if *Negative Dummy* is positive (-1.16) and statistically significant at 1% level before the reference date, it turns to be double negative (-2.06) and statistically significant at 1% level since 2009. Interestingly, *TZ* also become positive and statistically significant at 1% level since 2009. Columns (2) shows the regression result of the contemporaneous commodity futures excess returns in developed markets. Except for *Non-crisis* × *Slope* × *Low TZ* and *Non-crisis* × *Slope* × *High TZ*, we have the identical patterns. Columns (3) and (4) show the same results in China with respect to our measures, the interbank liquidity risk in China. In short, we conclude that our measure, the interbank liquidity risk should strongly affect the commodity risk premium since 2009, which is additional evidence of CCFDs. Furthermore, our finding in Table VIII alleviate the identification problem related to the comovement or contagion effects of the US financial crisis (Aloui, Aïssa, and Nguyen (2011), Reinhart and

[23]"Wen: China ready to put forward new stimulus package", China Daily, March, 13th, 2009.
[24]http://www.nber.org/cycles.html

Rogoff (2008), and Longstaff (2010)). Table VIII confirms that our findings are not driven by the variation of the US financial crisis.

Next, we confirm that the effect of the interbank liquidity risk in China measured by *Slope* and *Negative Dummy* on the commodity risk premium does not come from overall funding liquidity risk. We follow Asness et al. (2013) to define the overall funding liquidity risk. Since we already use the TED Spread and the LIBOR-Repo spread as controls, which Asness et al. (2013) use for funding liquidity risk measures, we additionally use the spread between interest rate swaps and short-term treasury bill rate (*Swap-Tbill spread*) as the US liquidity risk measures.[25] Next, we test the spread between 3-month SHIBOR and the term repurchase rate in China (*SHIBOR-Repo spread*) for the China funding liquidity risk measure in line with LIBOR-Repo spread.[26] Lastly, we show that the effects of our measures on the commodity risk premium are not explained by the other interbank liquidity risk measures in China such as the spread between the 3-month SHIBOR and the 1-month SHIBOR.

Table IX shows the panel regression results of the robustness tests on the same set of regressions as performed in Table II and III. We have consistent and robust results across adding the array of funding liquidity measures. Whether other funding liquidity risk measures (*Swap-Tbill spread* and *SHIBOR-Repo spread*) are included or not, our previous findings are not changed. *Slope* is negative and statistically significant at 1% level in all columns. *Negative Dummy* is statistically significant at 5% level when it predicts the one-week ahead commodity risk premium in China. (Column (7) to (9)). The interaction terms, *Slope* $\times$ *Low TZ* and *Slope* $\times$ *High TZ* show the same results what we previously have. Remarkably, *SHIBOR spread* does not have explanation power on the commodity futures risk premium in terms of CCFDs. In column (12), *SHIBOR spread* is positive and statistically significant at 5% level, but the result does not match with the theory of normal backwardation and CCFDs. In addition, we conduct a placebo test that the money market condition of other sectors do not exhibit what we found (the result are not shown). We replace the interbank market rates in China (SHIBOR) with Repo rates in China, and construct *Slope* and *Negative Dummy*. We find large discrepancies in predicting the commodity futures risk premium and contemporaneous one. *Slope* and *Negative Dummy* constructed by Repo rates in China are not consistently and statistically significant, and the coefficient of *Slope* and *Negative Dummy* often have conflicting signs. To sum up, our measures, *Slope* and *Negative Dummy*, capture something different from overall funding liquidity risk. The relationship between the

[25] Asness et al. (2013) use the measures as the residuals from an AR(2) model. We use the funding liquidity risk measures as the spread itself to have unity with *Slope* and *Negative Dummy*. We also test with AR(1), AR(2), AR(3) models, and changes in the spread measures. We have the same results.

[26] Due to the lack of reliable data for government rates in China, we only use the *SHIBOR-Repo spread* for the China funding liquidity risk measure.

interbank liquidity risk in China and the commodity futures risk premium is only captured by our measures, which is not explained by the relatively longer-term interbank liquidity risk in China. Based on our findings, we can conclude that the interbank liquidity risk in China measured by *Slope* and *Negative Dummy* mainly capture a maturity mismatch risk of the commercial banks in China. The maturity mismatch risk affects the hedging demands in the commodity futures markets thought CCFDs channel. Therefore our measures show the relationship between the interbank liquidity risk in China and the commodity futures risk premium.

V. Conclusion

In this paper, we find that an increase in the interbank liquidity risk in China, measured by the spread between the 3-month SHIBOR and the overnight SHIBOR, predicts a decrease in the commodity futures risk premium one-week ahead in both developed markets and China. We also find the negative comovement between the interbank liquidity risk in China and the commodity futures risk premium. When tested for different commodities and subperiods, the effect of the interbank liquidity risk in China was more severe for metal commodities than nonmetal commodities, and stronger during the periods when CCFDs are known to be more prevalent than the other periods. In addition, we show that the effect of our measure for the interbank liquidity risk in China remains robust after controlling for Tang and Zhu (2016) proxy for the demand for CCFDs and other funding liquidity risks which are not essentially related to maturity mismatch risk.

We study how the interbank liquidity risk in China may affect the commodity futures risk premium. Investors import commodities and collateralize them to invest in the high-yielding shadow banking products in China. In this investment involving commodities, Chinese commercial banks play a crucial role in providing the shadow banking products as well as issuing letters of credit and lending the CNY loan with the pledged commodities. As commercial banks in China frequently use the interbank market to resolve maturity mismatch risk of the shadow banking products, we expect that an increase in the interbank liquidity risk in China would lead to an increase in the risk of shadow banking system. The heightened shadow banking risk can then reduce the collateral and hedging demand for commodities in the commodity futures markets. According to the theory of normal backwardation, this demand decrease will result in a decrease in the commodity futures risk premium. To sum up, the commodity futures risk premium is expected to go down when the interbank liquidity risk in China goes up due to Chinese commercial banks heavy involvement in commodity financing deals and the shadow banking system.

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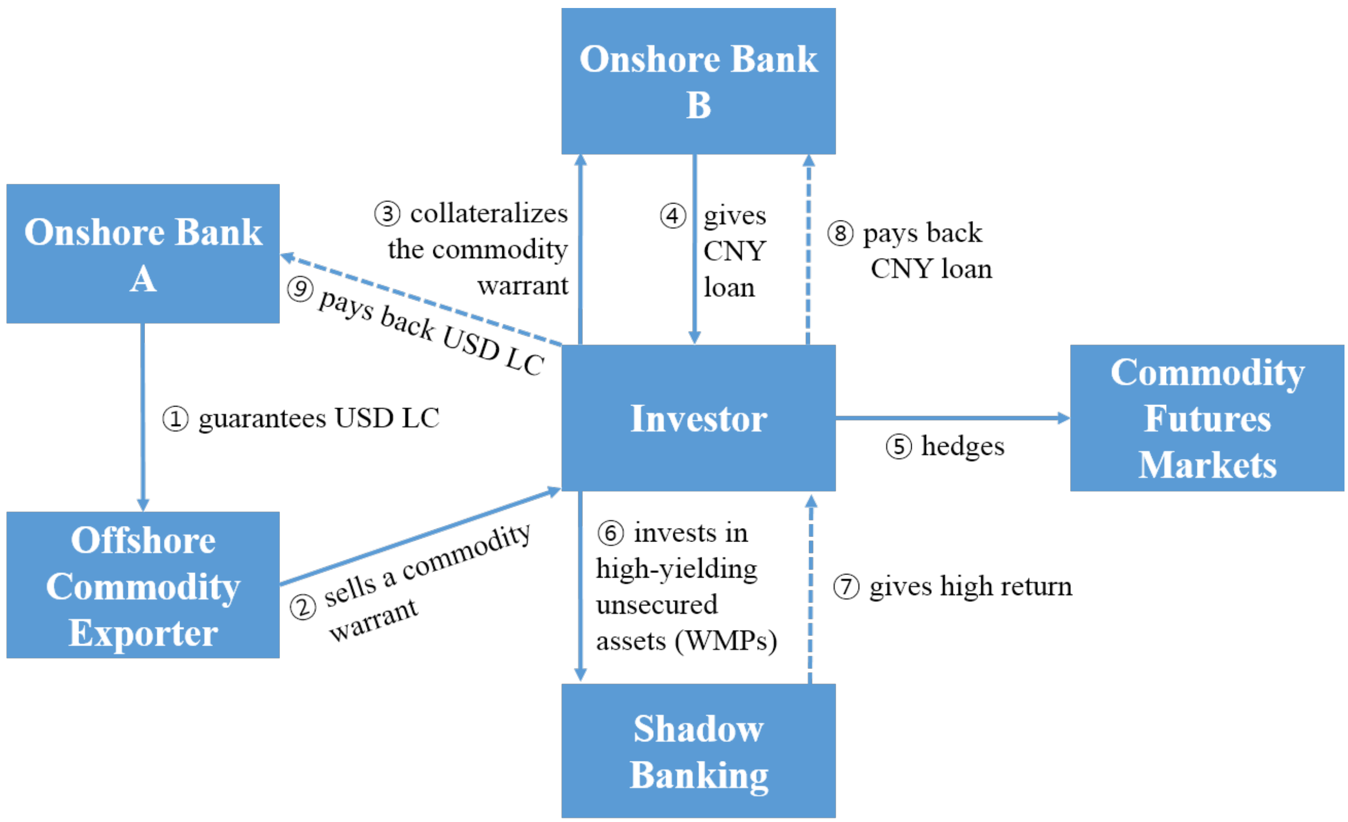

Figure 1. One cycle of the typical Chinese commodity financing deal.
Compare to the blue line, the blue dashed line indicates time passed in 3-6 months.

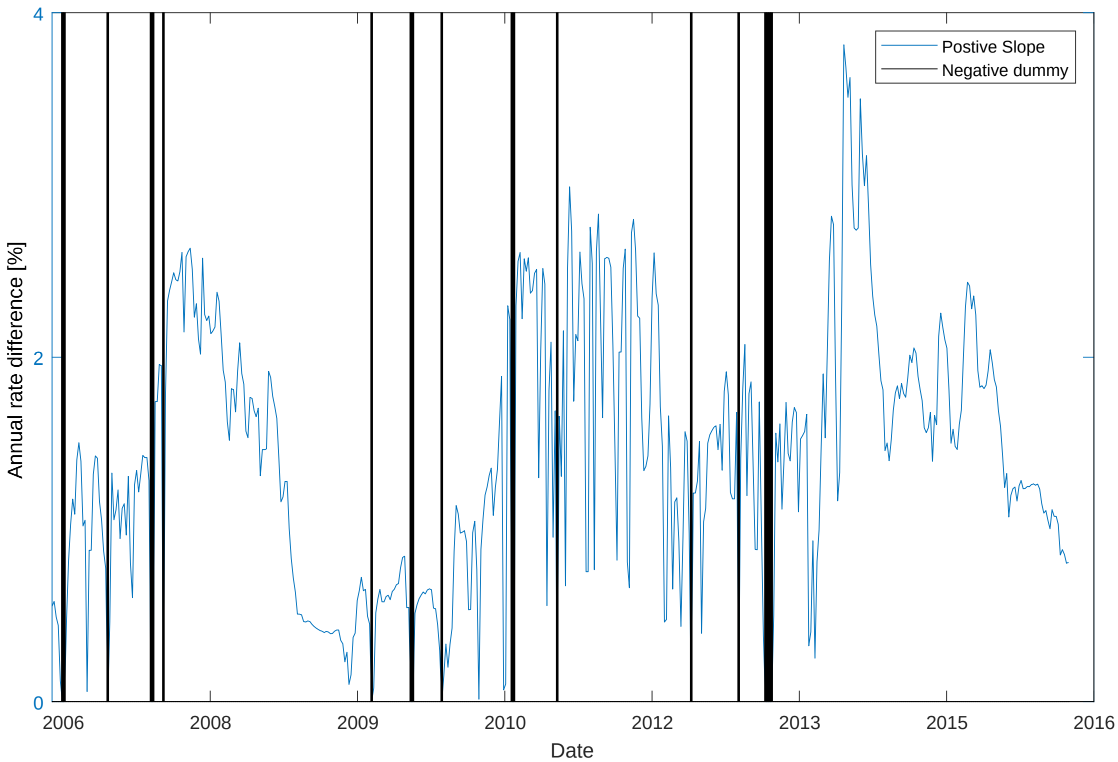

Figure 2. The spread between the 3-month SHIBOR and the overnight SHIBOR. The blue line (*Slope*) indicates the positive spread between the 3-month SHIBOR and the overnight SHIBOR. The black bar (*Negative Dummy*) indicates the negative spread between the 3-month SHIBOR and the overnight SHIBOR.

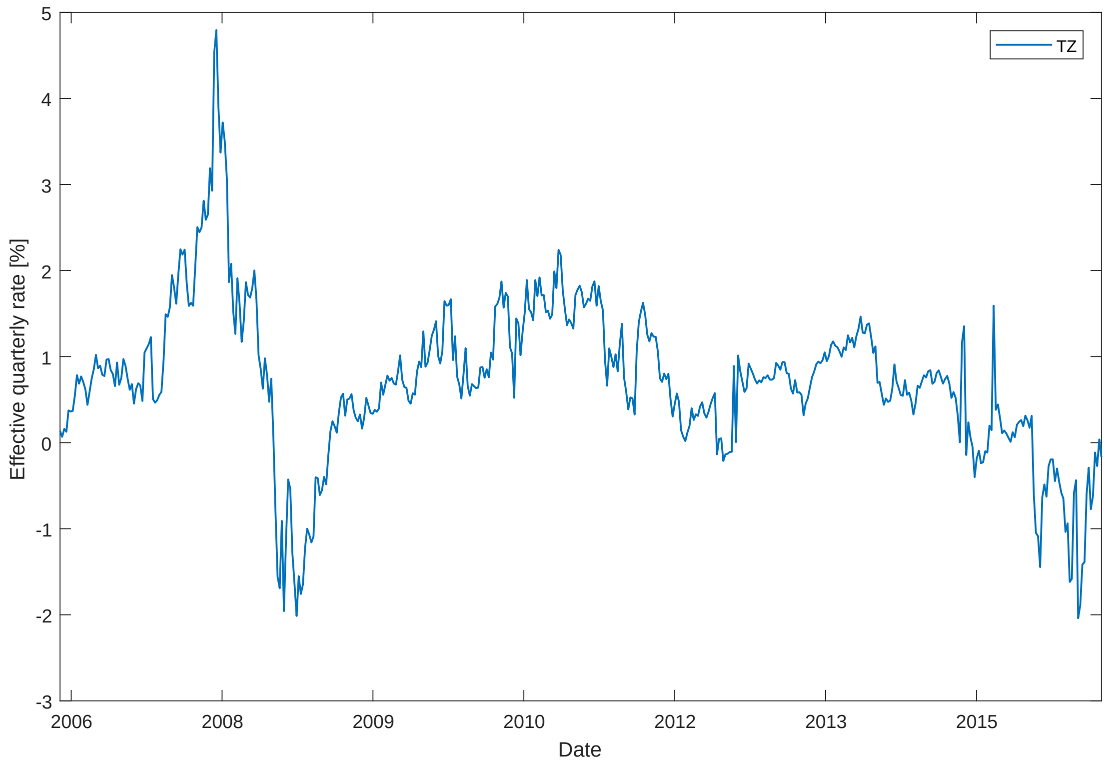

Figure 3. The 3-month currency-hedged carry trade returns (TZ) by Tang and Zhu (2016). The currency-hedged carry trade returns are calculated as the sum of the interest rate difference between the 3-month SHIBOR and 3-month LIBOR and the hedged currency returns from the official USD-CNY spot exchange rate and the USD-CNY 3-month nondeliverable forward (NDF) exchange rate.

Variable	Description	Mean	Std. dev	Max	Min
Excess Returns	Weekly excess returns of all commdodities in developed markets [%]	0.10*	4.22	25.69	-28.49
	Weekly excess returns of all commdodities in China [%]	0.01	2.97	17.76	-24.78
	Weekly excess returns of metals in developed markets [%]	0.07	4.20	25.69	-27.39
	Weekly excess returns of metals in China [%]	-0.07	2.91	15.34	-17.73
	Weekly excess returns of nonmetals in developed markets [%]	0.12*	4.22	24.20	-28.49
	Weekly excess returns of nonmetals in China [%]	0.04	3.00	17.76	-24.78
Basis	Annual Basis of all commdodities in developed markets [%]	-1.61**	14.78	272.77	-39.45
	Annual basis of all commdodities in China [%]	-2.32**	23.27	469.82	-499.26
	Annual basis of metals in developed markets [%]	-1.95**	7.40	89.43	-35.04
	Annual basis of metals in China [%]	-1.46**	7.08	47.01	-62.51
	Annual basis of nonmetals in developed markets [%]	-1.38**	18.49	272.77	-39.45
	Annual basis of nonmetals in China [%]	-2.73**	27.88	469.82	-499.26
Slope	Positive value of the spread between the 3-month and the overnight SHIBOR (CNY) [%]	1.40**	0.78	3.81	0.00
Negative Dummy	Negative dummy variable of the spread between the 3-month and the overnight SHIBOR (CNY)	0.04**	0.19	1.00	0.00
$i_t^* - i_t$	3-month SHIBOR (CNY) - 3-month LIBOR ($) at date t [%]	0.60	0.56	1.50	-0.66
s_t	$s_t = log($ Spot (CNY/$)$_t)$ - $log($3-month NDF (CNY/$)$_t)$ [%]	0.12*	1.02	4.37	-2.64
TZ	$TZ = i_t^* - i_t + s_t$; 3-month currency-hedged carry trade returns [%]	0.72**	0.90	4.79	-2.04
MSCI	Weekly excess returns of the MSCI emerging markets Asia index [%] over one week LIBOR ($)	0.02	3.26	13.90	-18.87
SPX	Weekly excess returns of the S&P 500 index [%] over one week LIBOR ($)	0.06	2.66	11.34	-20.16
DXY	Weekly log changes in the dollar index [%]	0.02	1.17	4.77	-4.14
BDI	Weekly log changes in the Baltic dry index [%]	-0.47	9.25	42.83	-43.47
TED spread	The spread between 3-month Eurodollars ($) and 3-month Treasury Bill ($) [%]	0.47**	0.41	2.61	0.02
LIBOR-Repo spread	The spread between 3-month LIBOR ($) and 3-month Repo ($) [%]	0.37**	0.45	4.07	-0.05

* $p < 0.05$, ** $p < 0.01$.

Table I. Summary statistics. All variables are calculated from Oct. 13th, 2006 to Mar. 25th, 2016. The table shows the average (mean), standard deviations (SD), maximum (Max), minimum (Min) of the variables and sample mean test of the null hypothesis that each variable is zero.

Variables	A. Predictive				B. Contemporaneous			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Slope	-0.40**	-0.47**	-0.44**	-0.47**	-0.43**	-0.61**	-0.62**	-0.29**
	(0.07)	(0.07)	(0.08)	(0.08)	(0.07)	(0.07)	(0.08)	(0.07)
Negative Dummy	0.08	-0.06	-0.03	-0.08	-0.38	-0.74**	-0.73**	-0.35
	(0.26)	(0.27)	(0.27)	(0.27)	(0.27)	(0.27)	(0.27)	(0.25)
Basis	-0.02**	-0.02**	-0.02**	-0.02**	0.01**	0.01**	0.01**	0.01**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
TZ		0.18**	-0.12	-0.25**		0.47**	0.42**	-0.01
		(0.06)	(0.09)	(0.09)		(0.06)	(0.09)	(0.08)
Slope × *Low TZ*			-0.47**	-0.43**			-0.04	-0.09
			(0.10)	(0.11)			(0.10)	(0.10)
Slope × *High TZ*			0.16*	0.33**			0.06	0.26**
			(0.08)	(0.08)			(0.08)	(0.08)
MSCI				-0.05*				0.23**
				(0.02)				(0.02)
SPX				0.06**				0.14**
				(0.02)				(0.02)
DXY				-0.00				-0.74**
				(0.04)				(0.04)
BDI				0.01				0.01
				(0.01)				(0.00)
TED spread				-0.88**				-0.18
				(0.27)				(0.26)
LIBOR-Repo spread				0.13				-0.18
				(0.25)				(0.23)
Constant	0.62**	0.60**	0.84**	1.22**	0.74**	0.66**	0.71**	0.59**
	(0.11)	(0.11)	(0.12)	(0.14)	(0.11)	(0.11)	(0.12)	(0.13)
Observations	7888	7888	7888	7872	7872	7872	7872	7872
Adjusted R^2	0.008	0.010	0.012	0.017	0.005	0.014	0.014	0.150

Standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$.

Table II. Commodity futures risk premium in developed markets. This table presents the panel regression results in developed markets (aluminum, copper, lead, zinc, gold, silver, corn, soybeans, soybean meal, soybean oil, wheat, cotton, palm oil, rubber, sugar, and heating oil) with including fixed effects at the individual commodity level and an AR(1) disturbance. Panel A including columns (1) to (4) reports results for predicting commodity futures excess returns ($Excess\ Returns_{i,t+1} = \beta_0 + \beta_1 Slope_t + \beta_2 Negative\ Dummy_t + \beta_3 Basis_{i,t} + \gamma X_t + \epsilon_{i,t+1}$). Panel B reports results for contemporaneous commodity futures excess returns ($Excess\ Returns_{i,t} = \beta_0 + \beta_1 Slope_t + \beta_2 Negative\ Dummy_t + \beta_3 Basis_{i,t} + \gamma X_t + \epsilon_{i,t}$).

Variables	A. Predictive				B. Contemporaneous			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Slope	-0.34**	-0.36**	-0.34**	-0.32**	-0.30**	-0.39**	-0.44**	-0.25**
	(0.05)	(0.05)	(0.06)	(0.06)	(0.05)	(0.05)	(0.06)	(0.06)
Negative Dummy	-0.47*	-0.50*	-0.49*	-0.46*	-0.32	-0.51*	-0.50*	-0.21
	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.19)
Basis	-0.03**	-0.03**	-0.03**	-0.02**	0.01**	0.01**	0.01**	0.01**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
TZ		0.04	-0.15*	-0.29**		0.25**	0.09	-0.15*
		(0.04)	(0.06)	(0.07)		(0.04)	(0.07)	(0.06)
Slope × *Low TZ*			-0.31**	-0.32**			-0.14	-0.14
			(0.08)	(0.07)			(0.08)	(0.07)
Slope × *High TZ*			0.10	0.22**			0.18**	0.34**
			(0.06)	(0.06)			(0.06)	(0.06)
MSCI				-0.01				0.22**
				(0.01)				(0.01)
SPX				0.07**				-0.03
				(0.02)				(0.02)
DXY				-0.12**				-0.22**
				(0.03)				(0.03)
BDI				0.00				0.01**
				(0.00)				(0.00)
TED spread				-0.10				0.04
				(0.20)				(0.20)
LIBOR-Repo spread				-0.36				-0.50**
				(0.19)				(0.19)
Constant	0.45**	0.44**	0.61**	0.81**	0.46**	0.43**	0.57**	0.57**
	(0.08)	(0.08)	(0.09)	(0.10)	(0.08)	(0.08)	(0.09)	(0.10)
Observations	7221	7221	7221	7210	7205	7205	7205	7205
Adjusted R^2	0.040	0.040	0.042	0.053	0.007	0.012	0.013	0.092

Standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$.

Table III. Commodity futures risk premium in China. This table presents the panel regression results in Chinese commodity futures markets (aluminum, copper, lead, zinc, gold, silver, corn, soybeans, soybean meal, soybean oil, wheat, cotton, palm oil, rubber, sugar, and fuel oil) with including fixed effects at the individual commodity level and an AR(1) disturbance. Panel A including columns (1) to (4) reports results for predicting commodity futures excess returns ($Excess\ Returns_{i,t+1} = \beta_0 + \beta_1 Slope_t + \beta_2 Negative\ Dummy_t + \beta_3 Basis_{i,t} + \gamma X_t + \epsilon_{i,t+1}$). Panel B including columns (5) to (8) reports results for contemporaneous commodity futures excess returns ($Excess\ Returns_{i,t} = \beta_0 + \beta_1 Slope_t + \beta_2 Negative\ Dummy_t + \beta_3 Basis_{i,t} + \gamma X_t + \epsilon_{i,t}$).

Variables	*Metals*				*Nonmetals*				*All Commodities*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*
Slope	-0.61**	-0.65**	-0.56**	-0.63**	-0.27**	-0.36**	-0.36**	-0.38**	-0.35**
	(0.11)	(0.12)	(0.13)	(0.13)	(0.08)	(0.09)	(0.10)	(0.10)	(0.09)
Negative Dummy	-0.29	-0.36	-0.33	-0.36	0.29	0.13	0.15	0.07	0.13
	(0.44)	(0.44)	(0.44)	(0.44)	(0.34)	(0.34)	(0.34)	(0.34)	(0.34)
Basis	0.01	0.01	0.02	-0.01	-0.02**	-0.02**	-0.02**	-0.02**	-0.02**
	(0.03)	(0.03)	(0.03)	(0.03)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
TZ		0.10	-0.33*	-0.43**		0.21**	-0.02	-0.15	-0.25**
		(0.09)	(0.15)	(0.15)		(0.07)	(0.11)	(0.12)	(0.09)
Slope × *Low TZ*			-0.76**	-0.75**			-0.31*	-0.25	-0.43**
			(0.17)	(0.18)			(0.13)	(0.13)	(0.11)
Slope × *High TZ*			0.15	0.32*			0.16	0.32**	0.33**
			(0.13)	(0.14)			(0.10)	(0.11)	(0.08)
MSCI				-0.09**				-0.03	-0.05*
				(0.03)				(0.03)	(0.02)
SPX				0.03				0.08*	0.06**
				(0.04)				(0.03)	(0.02)
DXY				0.00				0.03	-0.00
				(0.07)				(0.06)	(0.04)
BDI				-0.01				0.02**	0.01
				(0.01)				(0.01)	(0.01)
TED spread				-0.43				-1.14**	-0.88**
				(0.46)				(0.35)	(0.27)
LIBOR-Repo spread				-0.59				0.56	0.13
				(0.42)				(0.32)	(0.25)
Metals × *Slope*									-0.32*
									(0.14)
Metals × *Negative Dummy*									-0.54
									(0.54)
Constant	0.89**	0.87**	1.19**	1.56**	0.46**	0.43**	0.62**	0.98**	1.21**
	(0.18)	(0.18)	(0.21)	(0.23)	(0.13)	(0.14)	(0.15)	(0.17)	(0.14)
Observations	2958	2958	2958	2952	4930	4930	4930	4920	7872
Adjusted R^2	0.008	0.008	0.014	0.023	0.009	0.011	0.012	0.018	0.018

Standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$.

Table IV. Metals vs. nonmetals for predictive futures risk premiums in developed markets. This table presents the panel regression results of predictive futures returns ($Excess\ Returns_{i,t+1} = \beta_0 + \beta_1 Slope_t + \beta_2 Negative\ Dummy_t + \beta_3 Basis_{i,t} + \gamma X_t + \epsilon_{i,t+1}$) on metals V.S. nonmetals in developed countries with including fixed effects at the individual commodity level and an AR(1) disturbance. Panel Metals including columns (1) to (4) reports results for aluminum, copper, lead, zinc, gold, and silver. Panel Nonmetals including columns (5) to (8) reports results for corn, soybeans, soybean meal, soybean oil, wheat, cotton, palm oil, rubber, sugar, and heating oil. Panel All Commodities reports results for both metals and nonmetals with metals dummy variables.

Variables	*Metals*				*Nonmetals*				*All Commodities*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*
Slope	-0.63**	-0.82**	-0.89**	-0.43**	-0.33**	-0.51**	-0.49**	-0.21*	-0.19*
	(0.11)	(0.11)	(0.13)	(0.12)	(0.09)	(0.09)	(0.10)	(0.10)	(0.09)
Negative Dummy	-0.15	-0.49	-0.50	0.06	-0.56	-0.90**	-0.90**	-0.58	-0.51
	(0.43)	(0.44)	(0.44)	(0.39)	(0.34)	(0.34)	(0.34)	(0.32)	(0.31)
Basis	0.13**	0.13**	0.13**	0.10**	0.01**	0.01**	0.01**	0.01**	0.01**
	(0.03)	(0.03)	(0.03)	(0.02)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
TZ		0.47**	0.46**	-0.02		0.48**	0.42**	-0.00	-0.01
		(0.09)	(0.15)	(0.14)		(0.07)	(0.11)	(0.11)	(0.08)
Slope × Low TZ			0.12	0.10			-0.13	-0.19	-0.09
			(0.17)	(0.16)			(0.13)	(0.13)	(0.10)
Slope × High TZ			0.12	0.32**			0.01	0.21*	0.26**
			(0.13)	(0.13)			(0.10)	(0.10)	(0.08)
MSCI				0.37**				0.15**	0.23**
				(0.03)				(0.02)	(0.02)
SPX				0.06				0.18**	0.14**
				(0.04)				(0.03)	(0.02)
DXY				-0.83**				-0.68**	-0.74**
				(0.06)				(0.05)	(0.04)
BDI				0.00				0.01	0.01
				(0.01)				(0.01)	(0.00)
TED spread				-0.56				0.03	-0.18
				(0.41)				(0.33)	(0.26)
LIBOR-Repo spread				0.17				-0.30	-0.17
				(0.38)				(0.30)	(0.23)
Metals × Slope									-0.27*
									(0.13)
Metals × Negative Dummy									0.41
									(0.51)
Constant	1.15**	1.07**	1.08**	0.82**	0.62**	0.54**	0.59**	0.52**	0.59**
	(0.18)	(0.18)	(0.21)	(0.20)	(0.14)	(0.14)	(0.15)	(0.17)	(0.13)
Observations	2952	2952	2952	2952	4920	4920	4920	4920	7872
Adjusted R^2	0.017	0.025	0.025	0.221	0.003	0.012	0.012	0.117	0.151

Standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$.

Table V. Metals vs. nonmetals for contemporaneous futures risk premium in developed markets. This table presents the panel regression results of contemporaneous futures returns ($Excess\ Returns_{i,t} = \beta_0 + \beta_1 Slope_t + \beta_2 Negative\ Dummy_t + \beta_3 Basis_{i,t} + \gamma X_t + \epsilon_{i,t}$) on metals V.S. nonmetals in developed countries with including fixed effects at the individual commodity level and an AR(1) disturbance. Panel Metals including columns (1) to (4) reports results for aluminum, copper, lead, zinc, gold, and silver. Panel Nonmetals including columns (5) to (8) reports results for corn, soybeans, soybean meal, soybean oil, wheat, cotton, palm oil, rubber, sugar, and fuel oil. Panel All Commodities reports results for both metals and nonmetals with metals dummy variables.

Variables	*Metals*				*Nonmetals*				*All Commodities*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*
Slope	-0.46**	-0.47**	-0.41**	-0.40**	-0.28**	-0.30**	-0.30**	-0.30**	-0.27**
	(0.08)	(0.09)	(0.10)	(0.10)	(0.06)	(0.06)	(0.07)	(0.07)	(0.07)
Negative Dummy	-1.06**	-1.09**	-1.08**	-1.00**	-0.21	-0.25	-0.23	-0.24	-0.20
	(0.35)	(0.36)	(0.36)	(0.36)	(0.24)	(0.24)	(0.24)	(0.24)	(0.24)
Basis	-0.01	-0.01	-0.01	-0.01	-0.03**	-0.03**	-0.03**	-0.03**	-0.02**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
TZ		0.03	-0.17	-0.31**		0.06	-0.13	-0.25**	-0.29**
		(0.07)	(0.11)	(0.12)		(0.05)	(0.08)	(0.08)	(0.07)
Slope × *Low TZ*			-0.38**	-0.45**			-0.27**	-0.26**	-0.32**
			(0.12)	(0.13)			(0.09)	(0.09)	(0.07)
Slope × *High TZ*			0.03	0.15			0.13	0.24**	0.22**
			(0.10)	(0.11)			(0.07)	(0.07)	(0.06)
MSCI				-0.03				-0.02	-0.01
				(0.03)				(0.02)	(0.01)
SPX				0.05				0.07**	0.07**
				(0.03)				(0.02)	(0.02)
DXY				-0.15**				-0.10*	-0.12**
				(0.05)				(0.04)	(0.03)
BDI				-0.01				0.01	0.00
				(0.01)				(0.00)	(0.00)
TED spread				0.62				-0.43	-0.11
				(0.40)				(0.25)	(0.20)
LIBOR-Repo spread				-1.41**				0.07	-0.36
				(0.36)				(0.23)	(0.19)
Metals × *Slope*									-0.18
									(0.10)
Metals × *Negative Dummy*									-0.87*
									(0.42)
Constant	0.62**	0.61**	0.79**	0.93**	0.37**	0.36**	0.52**	0.73**	0.81**
	(0.14)	(0.14)	(0.16)	(0.18)	(0.09)	(0.09)	(0.11)	(0.12)	(0.10)
Observations	2346	2346	2346	2344	4875	4875	4875	4866	7210
Adjusted R^2	0.011	0.010	0.014	0.031	0.055	0.055	0.056	0.064	0.053

Standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$.

Table VI. Metals vs. nonmetals for predictive futures risk premium in China. This table presents the panel regression results of predictive futures returns ($Excess\ Returns_{i,t+1} = \beta_0 + \beta_1 Slope_t + \beta_2 Negative\ Dummy_t + \beta_3 Basis_{i,t} + \gamma X_t + \epsilon_{i,t+1}$) on metals V.S. nonmetals in China with including fixed effects at the individual commodity level and an AR(1) disturbance. Panel Metals including columns (1) to (4) reports results for aluminum, copper, lead, zinc, gold, and silver. Panel Nonmetals including columns (5) to (8) reports results for corn, soybeans, soybean meal, soybean oil, wheat, cotton, palm oil, rubber, sugar, and fuel oil. Panel All Commodities reports results for both metals and nonmetals with metals dummy variables.

Variables	*Metals*				*Nonmetals*				*All Commodities*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*
Slope	-0.34**	-0.41**	-0.43**	-0.18*	-0.28**	-0.38**	-0.43**	-0.28**	-0.23**
	(0.08)	(0.09)	(0.10)	(0.09)	(0.06)	(0.06)	(0.07)	(0.07)	(0.07)
Negative Dummy	-0.49	-0.64	-0.63	-0.14	-0.26	-0.46	-0.45	-0.23	-0.17
	(0.35)	(0.36)	(0.36)	(0.33)	(0.24)	(0.25)	(0.25)	(0.24)	(0.23)
Basis	-0.01	-0.00	-0.00	-0.00	0.01**	0.01**	0.01**	0.01**	0.01**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
TZ		0.18*	0.08	-0.24*		0.27**	0.07	-0.13	-0.15*
		(0.07)	(0.11)	(0.11)		(0.05)	(0.08)	(0.08)	(0.06)
Slope × *Low TZ*			-0.09	-0.09			-0.18	-0.17	-0.14
			(0.12)	(0.12)			(0.10)	(0.09)	(0.07)
Slope × *High TZ*			0.11	0.31**			0.22**	0.35**	0.34**
			(0.10)	(0.10)			(0.07)	(0.08)	(0.06)
MSCI				0.33**				0.18**	0.22**
				(0.02)				(0.02)	(0.01)
SPX				-0.06				-0.02	-0.03
				(0.03)				(0.02)	(0.02)
DXY				-0.36**				-0.16**	-0.22**
				(0.05)				(0.04)	(0.03)
BDI				0.01				0.01*	0.01**
				(0.01)				(0.00)	(0.00)
TED spread				-0.08				0.12	0.03
				(0.36)				(0.25)	(0.20)
LIBOR-Repo spread				-0.58				-0.50*	-0.50**
				(0.32)				(0.23)	(0.19)
Metals × *Slope*									-0.07
									(0.10)
Metals × *Negative Dummy*									-0.14
									(0.42)
Constant	0.43**	0.42**	0.51**	0.50**	0.47**	0.43**	0.60**	0.60**	0.57**
	(0.14)	(0.14)	(0.16)	(0.17)	(0.10)	(0.10)	(0.11)	(0.12)	(0.10)
Observations	2340	2340	2340	2340	4865	4865	4865	4865	7205
Adjusted R^2	0.004	0.006	0.006	0.165	0.010	0.015	0.017	0.069	0.092

Standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$.

Table VII. Metals vs. nonmetals for contemporaneous futures risk premium in China. This table presents the panel regression results of contemporaneous futures returns ($Excess\ Returns_{i,t} = \beta_0 + \beta_1 Slope_t + \beta_2 Negative\ Dummy_t + \beta_3 Basis_{i,t} + \gamma X_t + \epsilon_{i,t}$) on metals V.S. nonmetals in China with including fixed effects at the individual commodity level and an AR(1) disturbance. Panel Metals including columns (1) to (4) reports results for aluminum, copper, lead, zinc, gold, and silver. Panel Nonmetals including columns (5) to (8) reports results for corn, soybeans, soybean meal, soybean oil, wheat, cotton, palm oil, rubber, sugar, and fuel oil. Panel All Commodities reports results for both metals and nonmetals with metals dummy variables.

Varibles	*Developed Markets*		*China*	
	Predictive (1)	*Contemporaneous* (2)	*Predictive* (3)	*Contemporaneous* (4)
Slope	0.14	0.51**	-0.04	0.26
	(0.19)	(0.17)	(0.14)	(0.14)
Negative Dummy	1.16**	1.04**	0.43	0.60*
	(0.37)	(0.35)	(0.29)	(0.28)
Basis	-0.02**	0.01**	-0.02**	0.01**
	(0.00)	(0.00)	(0.00)	(0.00)
TZ	-0.94**	-0.39**	-0.61**	-0.38**
	(0.15)	(0.14)	(0.11)	(0.11)
Slope × *Low TZ*	-1.63**	0.14	-0.02	0.06
	(0.37)	(0.35)	(0.28)	(0.28)
Slope × *High TZ*	0.91**	0.45**	0.77**	0.51**
	(0.17)	(0.16)	(0.13)	(0.13)
Non-crisis × *Slope*	-0.65**	-0.79**	-0.27*	-0.48**
	(0.18)	(0.17)	(0.13)	(0.13)
Non-crisis × *Negative Dummy*	-2.06**	-2.16**	-1.37**	-1.10**
	(0.52)	(0.48)	(0.38)	(0.38)
Non-crisis × *TZ*	0.50**	0.34*	0.20	0.10
	(0.19)	(0.18)	(0.14)	(0.13)
Non-crisis × *Slope* × *Low TZ*	-0.72**	-0.19	-0.66**	-0.22
	(0.19)	(0.36)	(0.14)	(0.29)
Non-crisis × *Slope* × *High TZ*	1.24**	-0.25	-0.37	-0.21
	(0.39)	(0.17)	(0.29)	(0.14)
MSCI	-0.05*	0.23**	-0.01	0.22**
	(0.02)	(0.02)	(0.01)	(0.01)
SPX	0.06**	0.14**	0.07**	-0.03
	(0.02)	(0.02)	(0.02)	(0.02)
DXY	0.00	-0.73**	-0.12**	-0.21**
	(0.04)	(0.04)	(0.03)	(0.03)
BDI	0.01	0.00	-0.00	0.01*
	(0.01)	(0.00)	(0.00)	(0.00)
TED spread	-1.78**	-0.87**	-0.71**	-0.51*
	(0.30)	(0.28)	(0.22)	(0.22)
LIBOR-Repo spread	0.48	-0.55	-0.60**	-0.71**
	(0.31)	(0.28)	(0.23)	(0.23)
Constant	1.53**	0.76**	1.11**	0.73**
	(0.15)	(0.14)	(0.11)	(0.11)
Observations	7872	7872	7210	7205
Adjusted R^2	0.027	0.156	0.061	0.097

Standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$.

Table VIII. Commodity futures risk premium for prevalent CCFDs period. This table presents the panel regression results ($Excess\ Returns_{i,t+1} = \beta_0 + \beta_1 Slope_t + \beta_2 Negative\ Dummy_t + \beta_3 Basis_{i,t} + \gamma X_t + \epsilon_{i,t+1}$) for prevalent CCFDs period (aluminum, copper, lead, zinc, gold, silver, corn, soybeans, soybean meal, soybean oil, wheat, cotton, palm oil, rubber, sugar, and heating oil) with including fixed effects at the individual commodity level and an AR(1) disturbance. Column (1) reports results for predicting commodity futures excess returns in developed markets. Column (2) reports results for contemporaneous commodity futures excess returns in developed markets. Column (3) reports results for predicting commodity futures ecess returns in China. Column (4) reports results for comtemporaneous commodity futures excess returns in China. Non-crisis period starts July 3rd, 2009.

Varibles	Developed Markets						China					
	Predictive			*Contemporaneous*			*Predictive*			*Contemporaneous*		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Slope	-0.46**	-0.53**	-0.48**	-0.34**	-0.28**	-0.31**	-0.33**	-0.34**	-0.34**	-0.31**	-0.27**	-0.30**
	(0.09)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Negative Dummy	-0.08	-0.16	-0.05	-0.22	-0.35	-0.31	-0.46*	-0.49*	-0.43*	-0.07	-0.24	-0.11
	(0.28)	(0.27)	(0.27)	(0.26)	(0.25)	(0.25)	(0.21)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
Basis	-0.02**	-0.02**	-0.02**	0.01**	0.01**	0.01**	-0.02**	-0.02**	-0.02**	0.01**	0.01**	0.01**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
TZ	-0.25**	-0.27**	-0.25**	-0.01	-0.01	-0.01	-0.29**	-0.29**	-0.28**	-0.15*	-0.16*	-0.14*
	(0.09)	(0.09)	(0.09)	(0.08)	(0.08)	(0.08)	(0.07)	(0.07)	(0.07)	(0.06)	(0.06)	(0.06)
Slope × *Low TZ*	-0.43**	-0.39**	-0.43**	-0.08	-0.09	-0.08	-0.32**	-0.30**	-0.32**	-0.13	-0.13	-0.14
	(0.11)	(0.11)	(0.11)	(0.10)	(0.10)	(0.10)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
Slope × *High TZ*	0.33**	0.33**	0.33**	0.28**	0.26**	0.27**	0.22**	0.22**	0.23**	0.36**	0.34**	0.36**
	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
MSCI	-0.05*	-0.05*	-0.05*	0.23**	0.23**	0.23**	-0.01	-0.01	-0.01	0.22**	0.22**	0.22**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
SPX	0.06**	0.07**	0.06**	0.13**	0.13**	0.14**	0.07**	0.07**	0.07**	-0.03	-0.03	-0.03
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
DXY	-0.00	0.01	-0.00	-0.74**	-0.74**	-0.74**	-0.12**	-0.12**	-0.12**	-0.22**	-0.22**	-0.22**
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
BDI	0.01	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.01**	0.01**	0.01**
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
TED spread	-0.88**	0.22	-0.87**	-0.18	-0.26	-0.16	-0.10	0.24	-0.09	0.03	0.38	0.07
	(0.27)	(0.44)	(0.27)	(0.26)	(0.41)	(0.26)	(0.20)	(0.33)	(0.20)	(0.20)	(0.33)	(0.20)
LIBOR-Repo spread	0.13	0.28	0.12	-0.22	-0.19	-0.19	-0.36	-0.32	-0.37*	-0.55**	-0.45*	-0.53**
	(0.25)	(0.26)	(0.25)	(0.24)	(0.24)	(0.23)	(0.19)	(0.19)	(0.19)	(0.19)	(0.19)	(0.19)
Swap-Tbill spread	-1.35**			0.10			-0.41			-0.42		
	(0.42)			(0.39)			(0.31)			(0.31)		
SHIBOR-Repo spread		0.05			0.09			0.07 *			0.20**	
		(0.10)			(0.09)			(0.07)			(0.07)	
SHIBOR spread			-0.00			0.12			0.00			0.14*
			(0.09)			(0.08)			(0.06)			(0.06)
Constant	1.21**	1.47**	1.23**	0.65**	0.58**	0.62**	0.81**	0.89**	0.83**	0.65**	0.65**	0.64**
	(0.14)	(0.16)	(0.14)	(0.13)	(0.15)	(0.13)	(0.11)	(0.12)	(0.10)	(0.10)	(0.11)	(0.10)
Observations	7872	7872	7872	7872	7872	7872	7210	7210	7210	7205	7205	7205
Adjusted R^2	0.017	0.019	0.017	0.150	0.150	0.150	0.052	0.053	0.053	0.093	0.092	0.093

Standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$.

Table IX. Robustness tests. This table presents the panel regression results (aluminum, copper, lead, zinc, gold, silver, corn, soybeans, soybean meal, soybean oil, wheat, cotton, palm oil, rubber, sugar, and heating oil) with including fixed effects at the individual commodity level and an AR(1) disturbance. Panel Developed Countries reports results for commodity futures excess returns in developed markets. Panel China reports results for commodity futures excess returns in China. Panel Predictive reports results for predicting commodity futures excess returns ($Excess\ Returns_{i,t+1} = \beta_0+\beta_1 Slope_t+\beta_2 Negative\ Dummy_t+\beta_3 Basis_{i,t}+\gamma X_t+\epsilon_{i,t+1}$). Panel Contemporaneous reports results for contemporaneous commodity futures excess returns ($Excess\ Returns_{i,t} = \beta_0 + \beta_1 Slope_t + \beta_2 Negative\ Dummy_t + \beta_3 Basis_{i,t} + \gamma X_t + \epsilon_{i,t}$). The column (1), (4), (7), and (10) are for adding Swap-Tbill spread (USD). The column (2), (5), (8), and (11) are for adding SHIBOR 3M-1M spread (CNY), The column (3), (7), (9), and (12) are for adding 3M SHIBOR - 3M Repo spread (CNY).

Appendix A. Data description

Sector	Commodity	Exchange (Code)	N	Excess Return Mean	Excess Return SD	*Basis* Mean	*Basis* SD
Panel A: Developed Market							
Industrial Metals	Aluminum	LME (AH)	494	-0.06	3.20	-5.35**	4.25
	Copper	LME (CA)	494	-0.01	3.97	0.55**	2.21
	Lead	LME (PB)	494	0.17	5.38	-0.93**	3.79
	Zinc	LME (ZS)	494	-0.04	4.51	-3.15**	3.50
Precious Metals	Gold	NYMEX (GC)	494	0.18	2.70	-1.44**	1.71
	Silver	NYMEX (SI)	494	0.17	4.83	-1.73**	1.53
Grains	Corn	eCBOT (C)	494	0.13	4.60	-4.78**	18.74
	Soybeans	eCBOT (S)	494	0.15	3.59	4.53**	19.73
	Soybean Meal	eCBOT (SM)	494	0.17	4.17	12.32**	24.77
	Soybean Oil	eCBOT (BO)	494	0.12	3.40	-4.84**	3.37
	Wheat	eCBOT (W)	494	0.09	4.73	-10.26**	10.38
Softs	Cotton	ICE US (CT)	494	0.12	4.05	-1.58**	17.56
	Palm Oil	KLCE (FCOP)	494	0.19	3.99	1.29	17.03
	Rubber	TOCOM (N/A)	494	0.07	4.94	-4.48**	21.50
	Sugar	ICE US (SB)	494	0.16	4.50	-0.44	20.84
Energies	Heating Oil	NYMEX (HO)	494	-0.01	4.04	-5.54**	9.92
Panel B: China							
Industrial Metals	Aluminum	SHFE (AL)	494	-0.09	2.03	-2.38**	7.31
	Copper	SHFE (CU)	494	-0.06	3.57	2.83**	7.01
	Lead	SHFE (PB)	262	-0.12	1.99	-1.53**	6.98
	Zinc	SHFE (ZN)	470	-0.09	3.48	-3.80**	5.62
Precious Metals	Gold	SHFE (AU)	429	0.07	2.63	-1.53**	6.79
	Silver	SHFE (AG)	203	-0.23	3.11	-4.01**	5.68
Grains	Corn	DCE (C)	494	0.04	1.77	-4.25**	16.39
	Soybeans	DCE (B)	494	0.08	2.70	-4.81**	25.92
	Soybean Meal	DCE (M)	494	0.06	3.03	11.13**	23.90
	Soybean Oil	DCE (Y)	494	0.07	3.04	-3.33**	16.39
	Wheat	DCE (WS)	494	0.11	1.90	-11.42**	19.07
Softs	Cotton	ZCE (CF)	494	-0.02	2.33	-0.00	17.24
	Palm Oil	DCE (P)	439	-0.03	3.66	-9.95**	54.80
	Rubber	SHFE (RU)	494	-0.02	4.23	-2.24**	19.78
	Sugar	ZCE (SR)	494	0.13	2.74	-3.75**	16.73
Energies	Fuel Oil	SHFE (FU)	494	0.00	3.73	-9.13**	38.72

Table A1. Summary of individual commodity futures excess returns and basis. This table presents the summary statistics for individual weekly commodity futures excess returns and basis. Futures excess returns and basis are calculated from Oct. 13th, 2006 to Mar. 25th, 2016. The abbreviation of the exchanges is following: LME (London Metal Exchange), NYMEX (New York Mercantile Exchange), eCBOT (Electronic Chicago Board of Trade), ICE US (ICE Futures US), CME (Chicago Mercantile Exchange), KLCE (Kuala Lumpur Commodities Exchange), TOCOM (Tokyo Commodity Exchange), SHFE (Shanghai Futures Exchange), DCE (DaLian Commodity Exchange), and ZCE (Zhengzhou Commodity Exchange). The code in parenthesis indicates the ticker symbol code of commodity in the exchange. The fourth column indicates the number of the observations. The table shows average weekly excess returns (mean), the standard deviations of weekly excess returns (SD), average annual basis (mean), the standard deviations of annual basis (SD), and sample mean tests of the null hypothesis that excess return and basis are zero, respectively. The estimates marked with two (one) asterisks are significantly different from zero at the 1% (5%) level, respectively.