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WAREHOUSE MONITORING FOR EFFICIENT METALS MARKETS

HELYETTE GEMAN AND MATTHIAS SCHEIBER

The goal of the paper is twofold: i) Exhibit the challenges posed to regulators by the monitoring of warehouses, after two major frauds took place in the metal markets in 2014 and 2017, and at a time when metals increasingly act as collateral in the activities of trade finance worldwide; ii) Demonstrate, using data of the Shanghai Futures Exchange copper inventories and forward curves, that a) both Exchange inventories and forward curves exhibited extremely abnormal moves at the time of the Qingdao fraud in June 2014 and b) the Theory of Storage of Working (1949) and Brennan (1958) remarkably discriminates between the Exchange inventories available for consumption at a given date of analysis, and the undocumented metals piled in 'bonded warehouses' coming to legal existence at some random future date. This finding may provide policy makers with a first avenue in the surveillance of metals markets.

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1. INTRODUCTION

The world metal markets have been marked in the last few years by two categories of events, partly correlated:

a) The move East of the center of gravity of the trading activity, both of the raw materials – with China continuing to increase its share of the world consumption of copper and other metals – and of financial instruments, as reflected by the acquisition for $1.3 billion of the 136-year old London Metal Exchange by the Hong Kong Exchange, and the growing importance of the Shanghai Futures Exchange. This one, built in 1999, went from being ranked in 2011 the 14th largest derivatives Exchange by volume to the sixth largest one in 2016 (source, Futures Industry Association), with more than 1.6 billion contracts traded per year, *all settled by physical delivery.*

b) Large problems involved with warehouses around the world: in the US and Europe, queues in the delivery process at maturity of those who had taken long positions in metal Futures on the London Metal Exchange reached the extraordinary number of more than 800 days (versus a few days a decade before) in LME- registered warehousing companies acquired by financial institutions such as Goldman Sachs for the Detroit- based warehouse Metro and JP Morgan for the English Henry Bath company; we refer to the paper by Stevens and Zhang (2016) for a thorough analysis of these unprecedented events.

Far away in the East, the so-called 'Qingdao scandal' that erupted in June 2014 in a state-owned bonded warehouse in Eastern China, was followed by another major case of fraud related to the Asian warehousing company Access World in March 2017; both combined led to many hundreds of millions of dollars of losses for major banks involved in trade finance, namely the US bank Citi, the UK-headquartered Standard Chartered, the Australia- New Zealand bank and the French bank Natixis. Warehouse receipts were issued multiple times .against the same collateral in Qingdao, no collateral at all in the case of the Asian warehouse of the private company Access World.

Lending against commodities stored in in a warehouse- the modern version of the Monte di Pieta founded in Perugia, Italy, in the 15th century - has become increasingly popular for banks involved in trade finance, a $1.4 trillion industry that includes traditional export finance and spans the whole supply chain of commodities, including logistics and shipping, hence central to the world economy. In the early days of the use of commodities as collateral, this one was anything from precious metals and stones to grain and rubber. Copper, the world's oldest mined commodity, has the merit of not degrading with time and being storable at a reasonable cost.

Our goal in the paper is to investigate the Chinese copper markets during the period 2008 to 2015 when the activity of Commodity Collateral Financial Deals (CCFDs) exploded - with copper being the main collateral – together with the use of 'bonded warehouses, state owned or not. We show that interestingly, the Theory of Storage applied to the Shanghai Exchange forward curves recognizes at a given date of analysis the Exchange inventories immediately available for consumption from the stockpiles stored in bonded warehouses that will come out with duties paid at some random time in the future (or may be returned to the export country).

On a subject close to ours, Tang and Zhu (2016) analyze inventory financing in China through copper, aluminum and six other commodities. Aggregating the official SHFE inventories and the bonded warehouses, they introduce a new 'Theory of Inventory' that leads to prices that increase with inventory, in contrast to the 'Theory of Storage' of Working (1945) and Brennan (1958) (and in contrast to the daily moves upward of oil prices, both Brent and WTI, with the news of decreasing inventories.) Our analysis of the slopes of the SHFE forward curves against Exchange inventories confirms a fair robustness of the Theory of Storage in the Chinese copper market in the period 2008 to 2015; the addition of 'bonded warehouses ' weakens this relationship.

The remaining of the paper is as follows. Section 2 provides a description of copper markets in the recent period and the use of commodities as collateral. Section 3 discusses the Shanghai Exchange inventories and forward curves, as well as the bonded warehouses' data. Section 4 recalls

in details the Theory of Storage and how it performs on Chinese data during the period 2008-2015. Section 5 describes the recent actuality of world metal markets and Section 6 concludes the paper.

2. World Copper Markets

Copper mines were identified in ancient India; copper production then extended to various parts of the world, from Chile to Africa, because of the importance of this metal, in particular in electricity conduction. The world copper market, both spot and derivatives, has been very large for a long time. The London Metal Exchange came to existence in 1877, less than 30 years after the Chicago Board of Trade, and has always been the reference place where mining companies and metal consumers would hedge their risks. The COMEX (Commodity Exchange) was founded in New York in 1933 and became in 1974 the leading exchange for gold Futures. The LME kept its leading position for the six base metals and developed a network of licensed warehouses over the world (China still does not have any LME/HKEX warehouse on its soil as of today); these places are the place of delivery of the metal for the long positions in Futures held until maturity by large consumers such as car and aircraft manufacturers or producers of aluminum- canned drinks and have to be located in various countries in order to attract to the LME trading orders from all over the world.

By 1985, the copper market was already very large, as reflected by the size of the trading activities made by the Japanese metal trading firm Sumitomo - both in spot and physical trading – that ended in a loss of two billion dollars or more, a large amount of money at the time and today. Krugman (1994) explains that the regulators in charge were difficult to identify between Japan, where the company was based; Britain, where the London Metal Exchange was located and the United States, where much of the copper Sumitomo owned through LME Futures was delivered. All three groups of regulators should have wondered at the time why a Japanese corporation requested delivery of very large amounts of Futures - related copper in Long Beach, California; arguably not to help Toyota and Honda produce their cars,

since their manufacturing plants were essentially all based in Japan at the time.

Returning to our primary focus, China emerged as a voracious consumer of copper over the years 2000 to 2015. Construction, electricity grids and infrastructure pushed the country's demand for copper rise from 1.8 million tons in 2000 to over 10 million tons in 2015 and account in 2015 for 44% of the world global demand, up from 12% in 2000, according to the World Bureau of Metal Statistics. Construction and infrastructure combined represented in 2015 54% of the copper consumption. The boom of the Chinese construction sector at the beginning of the decade 2010 was illustrated by the famous statement made by Bill Gates in his blog in 2014, that China had consumed more cement over the three years 2011 to 2013 than the US had over the entire 20th century. An illustration, non-less interesting, pictured two cubes of cement, one small and one very large standing against the Chicago skyscraper outlines and was produced by Rhett Allain in *Science*, in June 2014.

The financial activity in Chinese metal markets exploded in a parallel manner, through the Futures contracts traded on the Shanghai Futures Exchange, as well as the growth of so-called 'Commodity Collateral Financial Deals (CCFDs) where Chinese investors would borrow at better rates, to generally invest in the real estate market, against a metal used as collateral and often stored in bonded warehouses after having been imported from Australia for example. As in the case for Bourbon and other alcohols stored in bonded warehouses in Kentucky (USA), the payment of duties and taxes does not take place until the moment when the metal comes into the market (or re-expedited to the producing country as it happened sometimes).

Copper Spot Prices and Spot Volatility

We display in Figure 1 the price trajectory of the copper spot price in China over the period 2003 to 2015. After the sharp decline that follows the financial crisis of 2009, prices rebounded in 2010 and 2011 to levels as high as those of May 2008, with gigantic imports of copper for the Chinese construction and electrification. As of 2012, prices declined continuously (see Figure 1), probably because of the reduced pace of growth of the world economy.

Volatility - classically computed as the standard deviation of price returns and plotted in Figure 1 - was quite high over the period 2007 to 2015 (with a spike in 2008 like in all commodity markets); this may have contributed to the increase need of hedging by consumers, hence higher liquidity in the Futures contracts traded on the Shanghai Exchange.

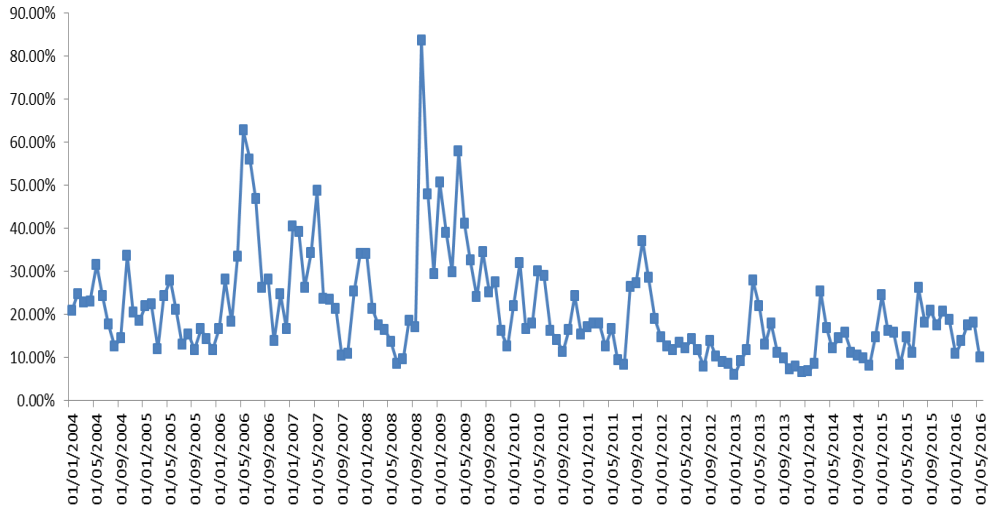

FIGURE 2: ONE- MONTH VOLATILITY BASED ON DAILY SHANGHAI COPPER SPOT PRICES (ANNUALIZED)

Source: Shanghai Futures Exchange, Authors' calculations

3. Chinese Copper Inventories and Shanghai Exchange Forward Curves

3.1. The SHFE Inventories

The Shanghai Exchange started trading copper Futures as of 1999; according to the rule followed by any Exchange, the warehouse volumes got published daily. As a representation of the growing importance of the SHFE compared to the LME in London/ Hong Kong and the COMEX in Chicago, the SHFE inventories went from representing 4.22% of the world exchange inventories in January 2009 to 33.17% in April 2015 (sources LME, COMEX, Bloomberg). Figure 2 shows the official Exchange copper inventories, which fluctuated between 100,000 tons and 250,000 tons during the period 2009 to 2015. We

can observe a large collapse in the first part of 2014 when the inventory volume was divided by more than one half.

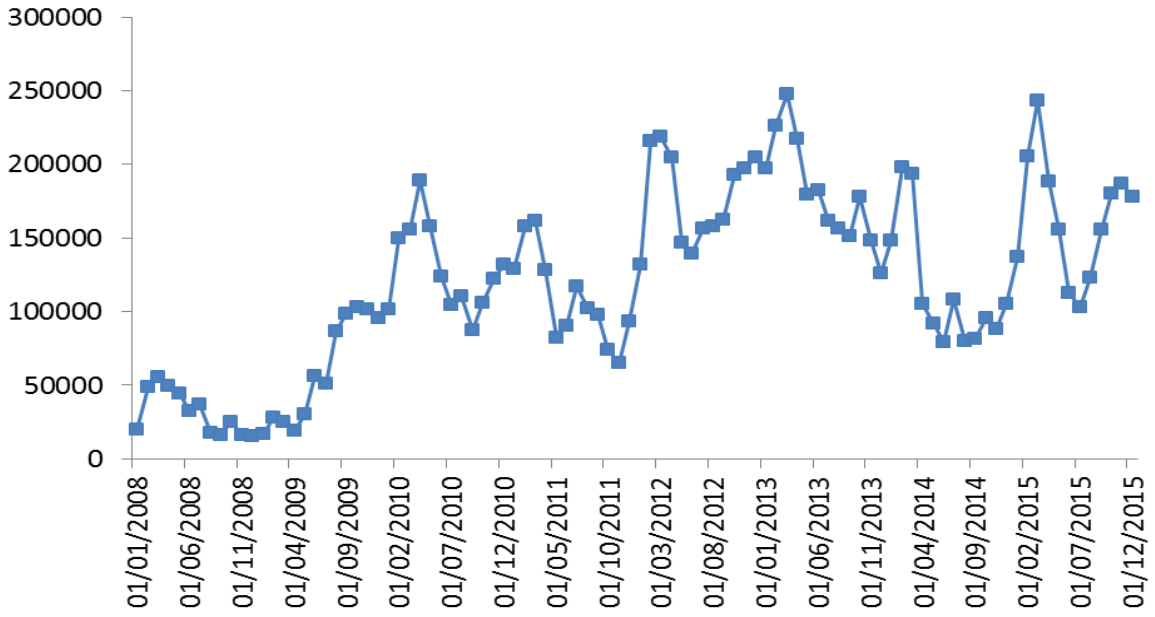

FIGURE 2: SHANGHAI COPPER INVENTORY 2008 TO 2015 (IN TONS)

Source: Shanghai Futures Exchange

3.2. Bonded Warehouses in China

Bonded warehouses have been famous in the US history for old whisky and other alcohols. The terminology irrupted in the actuality of metal markets in June 2014 at the time of the so-called 'Qingdao scandal', when it emerged that warehouse receipts had been issued multiple times against the same copper and aluminum collateral in a state-owned bonded warehouse of a port in Eastern China. Essentially no official data were produced by China on the stockpiles in bonded warehouses. These played a central role in the CCFDs where the metal was used as collateral by Chinese investors to borrow at a better rate than the SHIBOR (Shanghai Inter Bank Offered Rate). Some authors infer the bonded warehouses' volumes from CCFDs and currencies' considerations (Zhang and Balding, 2015); or CCFDs and interest rates

(Tang and Zhu, 2016). We find these approaches too much model-based, hence possibly hazardous since the model needs to be validated later on using the same data, and prefer to multiply the sources to identify reasonable estimates. We display below a dataset for China bonded warehouses provided by Bloomberg.

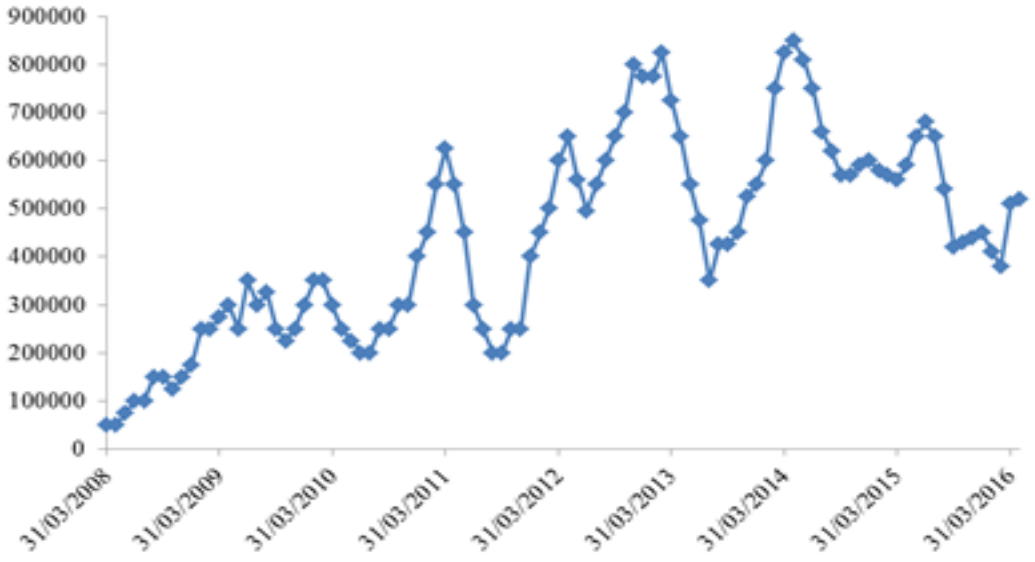

FIGURE 3: BONDED WAREHOUSES (IN METRIC TONS)

Sources: Bloomberg

Each month, ten to fifteen bonded warehouses, copper traders and other industry participants are surveyed; the results are aggregated to an overall bonded warehouse number that has been published by Bloomberg since 2014, including the data prior to 2014. The graph in Figure 3 represents the bonded warehouses' volumes over time. Figure 4 plots below the data provided for the period 2009 to 2016 by CRU, an independent company which produces specialized information on metals markets. The two series of numbers are very close. Both sources indicate in particular an all-time peak of roughly 870,000 tons of copper in China bonded warehouses at the end of April 2014, just before the Qingdao fraud got revealed.

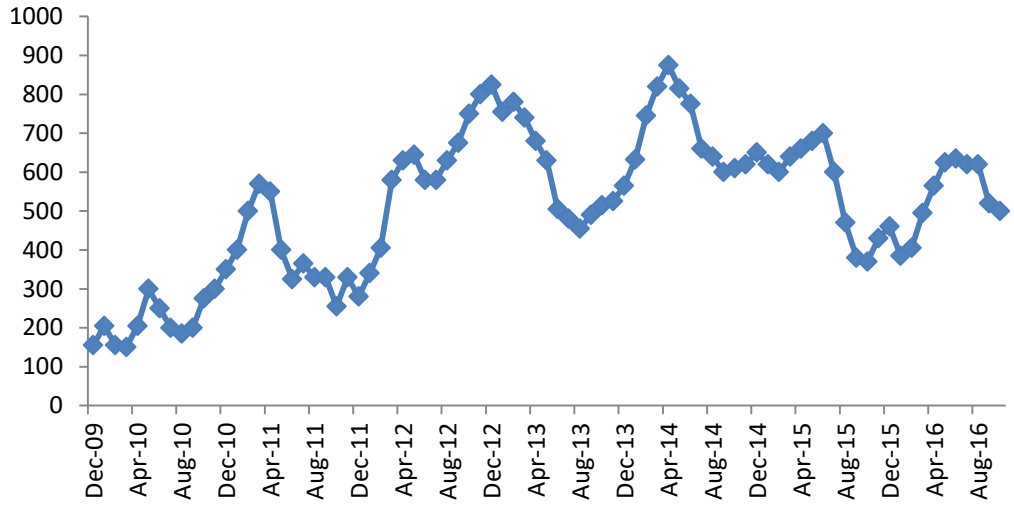

FIGURE 4: BONDED WAREHOUSES (IN 1000 METRIC TONS)

Source: CRU

D. Shanghai Exchange Forward Curves

We plot below some forward curves observed on the Shanghai Exchange and compare them to those of the London Metal Exchange at the end of 2013 and 2015. Note that the shapes of forward curves are central in capturing a commodity market beyond the simple spot price; they depict at which prices market participants are willing to trade for future dates and also uncover possibly profitable strategies. Figure 5 and Figure 6 highlight a difference in the term structure of copper on the Shanghai and LME copper Futures in 2013 versus 2015; and SHFE versus LME.

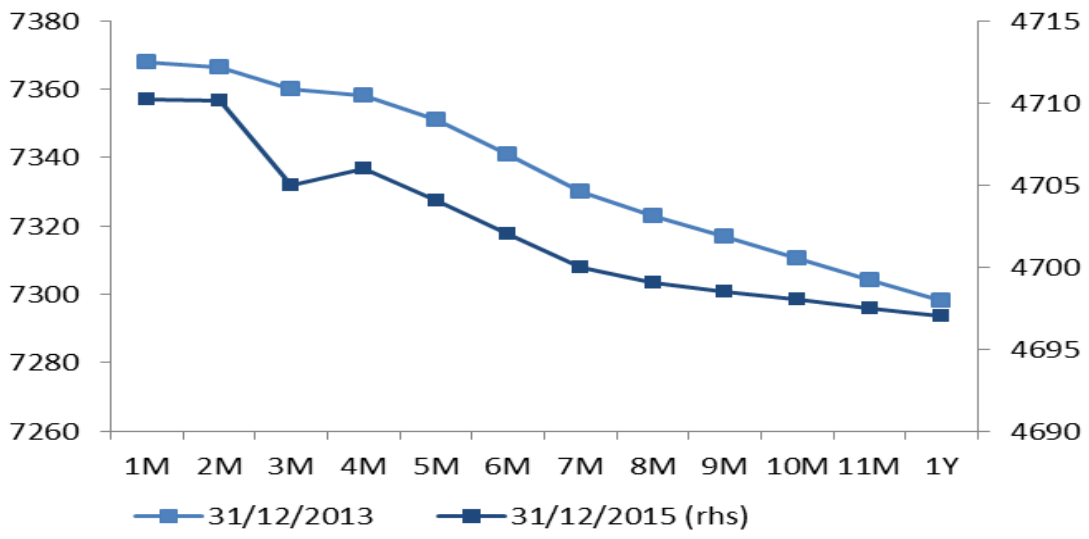

FIGURE 5: LME COPPER FORWARD CURVES AS OF 31/12/2013 AND 31/12/2015 (USD PER TONNE)

Source: LME

On the LME, both forward curves have the decreasing shape of 'normal backwardation'. On the SHFE, the increasing/ contango shape that prevailed at the end of 2013 may be explained by an abnormal activity related to the CCFDs. Note that after 2010, the liquidity on the Shanghai Futures Exchange became quite satisfactory. As of that moment, the single big difference for any market participant in taking a Future position on the London Metal Exchange versus the SHFE was related to the differences in physical delivery since at the time (and today), the LME/HK did not own any warehouse in China.

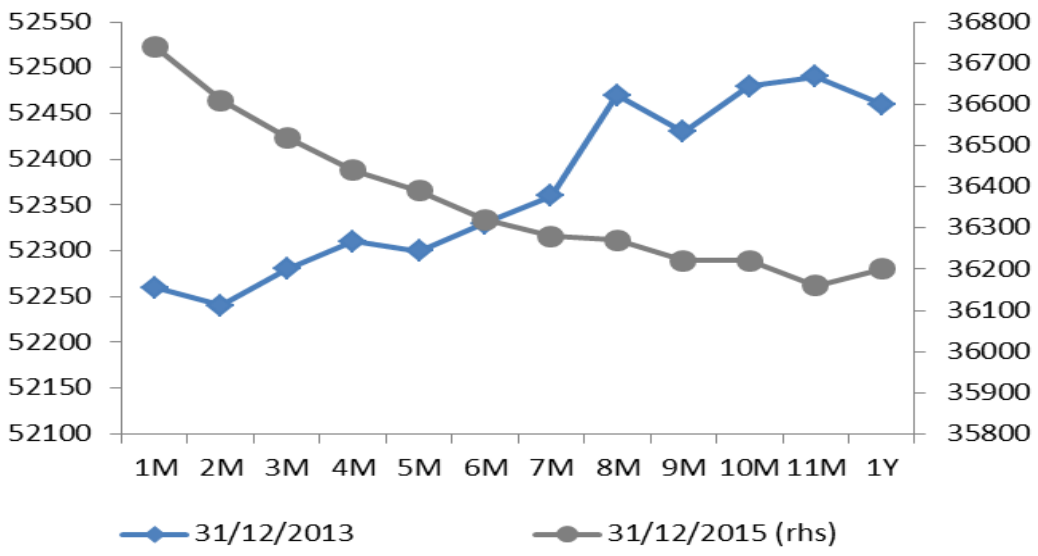

FIGURE 6: SHANGHAI COPPER FORWARD CURVES AS OF 31/12/2013 AND 31/12/2015 (10 YUAN PER TON)

Source: Shanghai Futures Exchange

Figure 7 shows the interesting similarity between the curves on the two Exchanges in December 2015, after the activity in CCFDs had greatly receded.

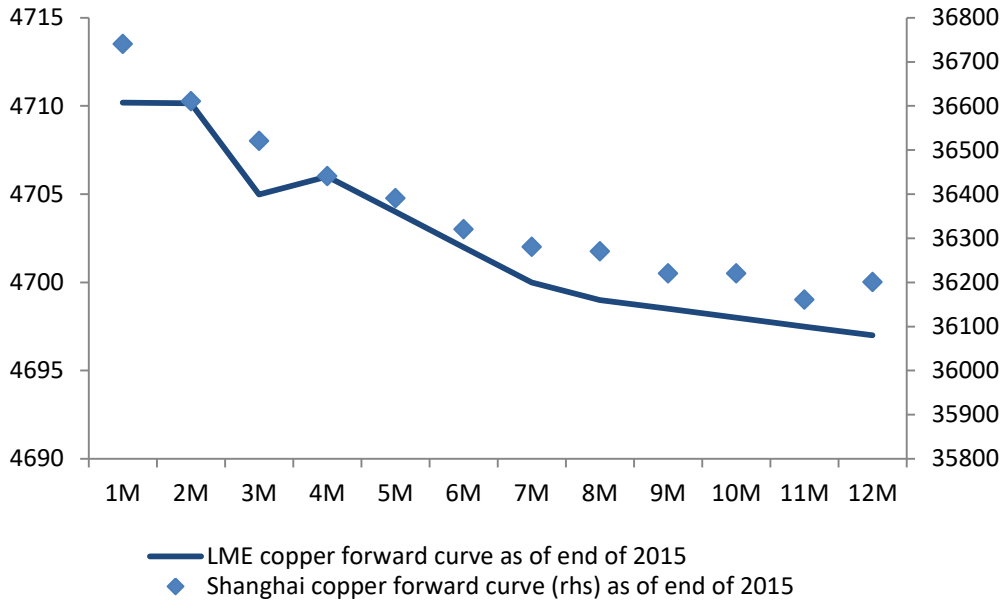

FIGURE 8: SHANGHAI AND LME COPPER FORWARD CURVES AS OF 31/12/2015

Sources: LME, Shanghai Futures Exchange

Figure 8 illustrates that the monthly volume of the 6-month Shanghai copper Future contract sharply increased from 2011 onwards, and one may recognize there the large number of CCFDs traded at the time, mostly with 6-month duration, and the corresponding positions put in place by the traders to hedge the price risk of the metal in storage.

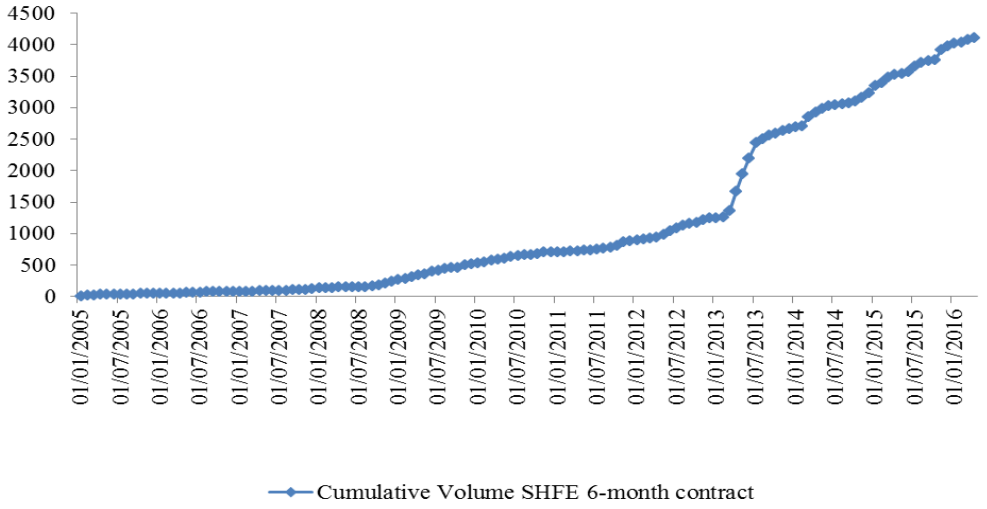

FIGURE 9: 6-MONTH SHANGHAI COPPER FUTURE CONTRACT VOLUMES (CUMULATIVE, IN THOUSAND CONTRACTS)

Source: Shanghai Futures Exchange, Bloomberg

For comparison, we represent in Figure 9 below the volumes traded on the London Metal Exchange over the same period 2005-2016, namely a gradual increase in the cumulative volume. Instead, the Shanghai Exchange had very low traded volumes until 2008, then a rapid take off as of 2008 followed by a regular activity. The amount of trading activity is known to be a key indicator in the analysis of the microstructure of any market.

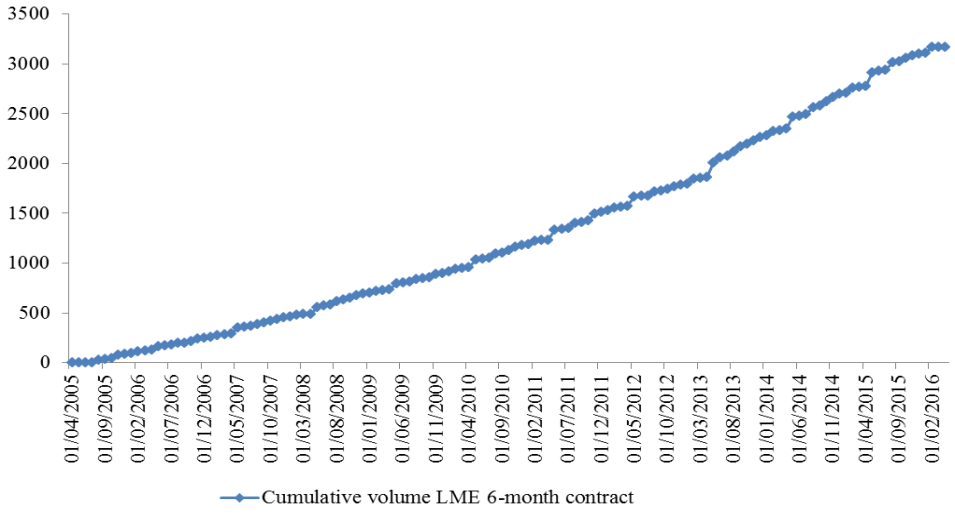

FIGURE 9: 6-MONTH LME COPPER FUTURE CONTRACT VOLUMES (CUMULATIVE, IN THOUSAND CONTRACTS)

Source: London Metal Exchange, Bloomberg

4. Theory of Storage, Shanghai Exchange Inventories and Bonded Warehouses

4.1. Normal Backwardation, Inventory and Theory of Storage

We recall below the major elements of the Theory of Storage as it has existed for the last 85 years, as well as the property of 'normal backwardation', which is also relevant in our discussion.

4.1.1. "Theory" of Normal Backwardation

In his Treatise of Money (1930), Keynes argues that, in commodity markets, the forward curve is in 'normal backwardation', like the LME curves in Figure 6, since producers of commodities are more prone to hedge their price risk - by selling Futures contracts - than consumers, and accept lower prices for distant maturities, hence the decreasing/ backwardated shape.

The 'theory' was empirically validated in the oil market by Gabillon (1991) and Geman (2005), and observed most of the time in forward curves of all commodity markets until 2008 (except for gold, which plays a particular role among commodities, as demonstrated by history). We can observe in Figure 6 that the forward curve of the Shanghai Exchange was *not* in 'normal backwardation' in December 2013, at the

peak of the CCFD activity and a few months before the revelation of the Qingdao fraud. The shape of the forward curve is a key feature that is too little discussed to our view in the large recent academic literature on the so-called 'financialization' of commodity markets.

4.1.2. Theory of Storage

The role of inventory in explaining the shape of the forward curve and spot price volatility is central in the Theory of Storage developed by Holbrook Working while he was a researcher as of 1927 at the Food Research Institute of the University of Stanford. The institute had decided to focus on wheat, a crucial agricultural commodity, and large amounts of data were collected. Working carefully plotted the spread between the 3-month Future and the spot price against the existing inventory and developed his findings in a little quoted paper published in 1933. Brennan (1958) confirmed for a number of agricultural markets the results exhibited introduced by Working in his remarkable 'Theory of the Price of Storage' in 1949.

The founding results are centered on inventories and can be simply described as follows:

i. If inventories are high (like in the oil markets of 2015 and 2016, after the price collapse of 2014), the convenience yield (net of storage costs) is negative and the forward curve tends to be in contango like the December 2013 one in Figure 6.

ii. When inventories are tight, the convenience yield (net of storage costs) is positive and the forward curve tends to be in backwardation like in Figure 7.

4.1.3. Inventory and Spread of the Forward Curve

In the same way, the shape of the yield curve of interest rates at date t is a key piece of information about the monetary and bond market at that date, the forward curve and its slope at date t summarize a number of crucial properties of a given commodity market and represent a major tool for practitioners –

whether they are engaged in trading activities or in the management of commodity indexes - and academics alike.

Continuing on his research of 1933, Working (1949) introduced in a founding paper the 'relative spread' of the forward curve that he defined as

$$\text{Spread} = \{F(t, T) - S(t)\}.\ 1/\ S(t) \qquad (1)$$

where F(t,T) is the price at date t of a Future contract maturing at date T (chosen at the time to be three months) . Working showed that the spread is positively correlated to inventory, a low inventory being characterized by a negative spread, in agreement with the points i) and ii) above. The important paper of Brennan (1958) confirmed this result. In their reference paper, Fama and French (1987) directly adopted the relative spread of the forward curve as a proxy for inventory to study the relationship between inventory and spot price volatility in 31 metals and agriculture markets. Geman and Smith (2013) add all inventories licensed by the London metal Exchange and display, in the case of the six base metals over a 24-year period (1988 to 2011) a strong relationship between the adjusted spread and inventory. In their parallel analysis of Chinese bonded warehouses' volumes, Tang and Zhu (2016) do not consider any forward curve and instead, introduce a 'theory of inventory' which leads to metal prices (and convenience yields) increasing with inventories, in contrast to economic intuition and all existing literature.

4.2. Testing the Theory of Storage on SHFE Inventories, with and without adding bonded warehouses' volumes

We argue in this section that the theory of storage does prevail during the years 2008 to 2015 in the setting of the Shanghai Exchange forward curves and SHFE inventories, after some years of existence of the SHFE in December 1999. We also show that adding the bonded warehouses prevailing at a given date of analysis to the Exchange inventories greatly weakens the relationship, illustrating the fact that bonded copper does not qualify as inventory available for consumption until it is released from the warehouse and taxes are paid. We find the result interesting and in line with our expectations. To draw a comparison with

the remarkably liquid oil market, be it WTI or Brent, spot prices immediately adjust to the arrival of news on inventories - which also trigger also today many 'High Frequency Trading' activities by oil traders – and with a change opposite to the inventory adjustment. These inventories never include the *reserves* of oil companies, even though these reserves (very well documented in the documents produced by oil companies) may become inventory at a later *random* time, exactly like the metals stored in bonded warehouses. It is interesting to note that, in the case of Bourbon and whisky stored in bonded warehouses in the US, evaporation creates what is called in the industry 'shrinkage' and the precious liquor derived from corn is unknown until it comes out of the bonded warehouse.

Returning to the test of the Theory of Storage, we choose to define the 'relative spread' of the forward curve with a maturity of six months for the Future - as it is standard in the academic literature - and make our case in several parallel ways:

i. Compute the correlations between the forward spread, defined as (6-month Future minus spot) divided by spot, and changes in SHFE inventories.

ii. Repeat the exercise with the addition of changes in bonded warehouses to the SHFE inventories, quantities we qualify as 'aggregate' inventories.

We also compute rank (Spearman) correlations as well since they are more robust to the existence of outliers, which may happen with non-fully transparent quantities, and find the following correlations over the period.

Correlation Results

The correlation results over the period of analysis are the following:

Pearson correlations: In the case of the forward spread versus SHFE Inventories, the estimated correlation coefficient is 0.30 with a confidence interval of (0.35;0.25). For the forward spread versus the aggregation of SHFE inventories and bonded warehouses, the estimated correlation coefficient is lower at 0.22 with a confidence interval of (0.30;0.15).

Spearman (rank) correlations: In the case of the forward spread versus SHFE Inventories, the estimated correlation coefficient is 0.32. For the forward spread versus the aggregation of SHFE inventories and bonded warehouses, the estimated correlation coefficient is lower at 0.27.

We see that the addition of bonded warehouses clearly weakens the Working (1949) relationship.

4.3. Testing the Theory of Storage with Inventories expressed in days of copper consumption

We represent in Figure 10 the Inventory-to-Demand ratio expressed in days of Chinese consumption for the SHFE inventories and their addition to bonded warehouses' volumes.

Geman and Smith (2013) who tested the Theory of Storage in the case of the six base metals on LME data over the period 1998 to 2012 also measured the inventories in terms of days of consumption. We repeat their approach here by dividing the numbers by Chinese annual consumption and express the results into days for both types of inventories. It is valuable to observe that the volume of copper in bonded warehouses is of the order of 10% on average of the annual Chinese consumption. SHFE inventories fluctuate around seven days of consumption; the number exhibited by Geman and Smith (2013) as a threshold of 'scarcity' for the six base metals on the LME was a six-day inventory.

The new correlation numbers are as follows:

i. Rank correlation between the forward spread and SHFE inventories measured in days of consumption = 0.30.

ii. Rank correlation between the forward spread and aggregate inventories measured in days of consumption = 0.21.

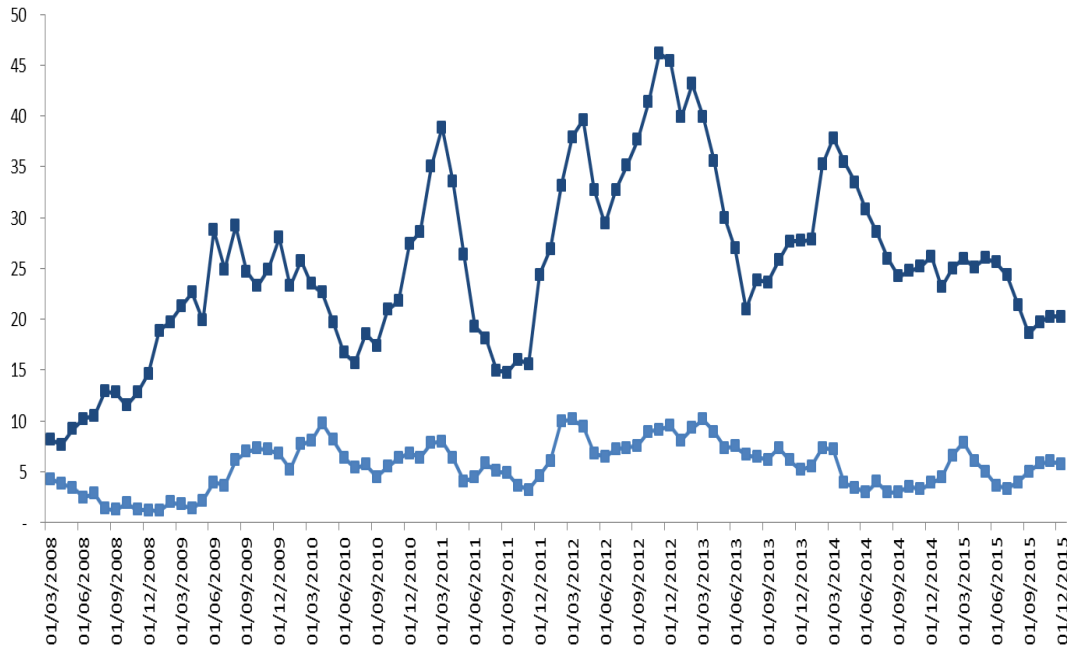

FIGURE 10: CHINESE INVENTORIES EXPRESSED IN DAYS OF COPPER DEMAND (EXCLUDING – DARK BLUE AND INCLUDING – LIGHT BLUE - BONDED WAREHOUSE DATA) ,IN DAYS OF CONSUMPTION

Source: Shanghai Futures Exchange, Authors' calculations

4.4. The extraordinary moves of the SHFE forward curves and SHFE inventories in the second quarter of 2014

We wish here to make the case, from yet another angle, for the remarkable information on inventories reflected at all times in the forward curve.

We plot below the copper forward curves observed on the Shanghai Exchange at the end of each quarter of the eventful year 2014. The graph below shows a very rare move of the forward curve between March and June 2014, with the first two nearby Future prices jumping by 10%. During that quarter, all sources (LME, Bloomberg, and CRU) converge on exhibiting all times- high values of 820, 000 to 880,000 tons for the bonded warehouses volumes over the months of March, April and May 2014. For Tang and Zhu (2016), the price jump is the proof of the 'new result' that commodity prices can increase with high inventories. We argue instead that the sole Exchange inventories were reflected in the forward curve and the steep rise of prices was in agreement with their steep decline.

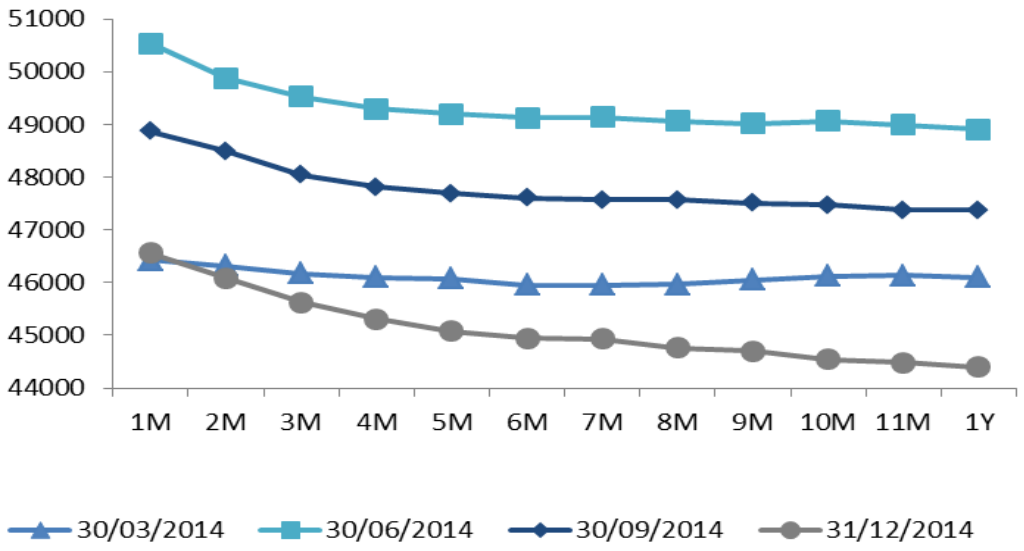

FIGURE 11: THE UNUSUAL DYNAMICS OF THE SHFE FORWARD CURVE DURING THE YEAR 2014 (SCALE OF 10 YUAN PER TON)

Source: Shanghai Futures Exchange, Authors' calculations

Figure 11 shows that the forward curves observed in September and December 2014 are located *between* the March and June ones, a situation rarely observed in changes of forward curves - including during crises that created large changes in oil markets. In the case of the Qingdao conundrum, it was later established that, during the investigation for corruption of a powerful official in the Qinghai province, the controller of the private company Dezheng Resources that owned the copper metal stored in the state-

owned bonded warehouse had been arrested in April 2014. It seems that the forward curves 'knew' before the press and Twitter…

5. Recent Developments

The story of Qingdao was never fully clarified, except for the fact that the same collateral copper was pledged multiple times. No conclusions on the Qingdao case have been published yet by the Chinese Central Commission. As of July 2017, China had not yet allowed the LME/HK Exchange to have licensed warehouses in China, and metal destined to China continues to be shipped from Singapore or South Korea. However, the Chinese president reaffirmed in May 2017 the central positioning of the country in global trade by launching in Beijing the Belt and Road Forum for International Cooperation, a modern version of the famous Silk Road.

Faked warehouse receipts were used again three years later in 2017 in a case of fraud seemingly related to the Asian company Access World. Remarkably, warehouse receipts - a key instrument in the world trade together with Bills of Lading - continue at this moment in time to be mostly made out of paper, hence fairly easy to fake. Litigation at the London High Court took place in June 2015 between the Swiss commodity trading house Mercuria and the bank Citi in relation to the missing inventory in Qingdao that Mercuria had pledged as collateral in a loan it had obtained from Citi. The ruling left Citi with a loss of $270 million.

After probably large profits in storage fees generated by the extraordinary queues in Detroit LME-licensed warehouses (see Stevens and Zhang, 2016), Goldman sold in December 2014 to the Swiss aluminum trading firm Reuben, for an undisclosed amount of money, the warehousing company Metro it had bought in 2010. JP Morgan sold in October 2014 its physical commodities business to the Swiss commodity trading house Mercuria (mentioned above) for $3.5 billion; in particular its shares of the British warehousing company Henry Bath. The Vlissingen warehouse owned by the latter near Rotterdam had also been the theatre of unprecedented queues in metal delivery (Business News, Reuters, Feb 2012).

6. Conclusion

We have extensively discussed in this paper the central role in metals markets of the proper monitoring of warehouses, a subject which has received little attention in the literature. We also tried to shed some light on the notion of 'bonded warehouses', which played/play a significant role in the Chinese copper and aluminum markets during the years 2008 to 2014. Extending the results of Geman and Smith (2013) on the LME base metals, we find that the Theory of Storage of Working (1949) extends in a fairly robust manner to the SHFE copper market during the years 2008 to 2015, a period during which the country's consumption of copper continued to grow, while financial activity involving the use of the metal as collateral exploded, together with stockpiles of metals in bonded warehouses. Confronting many sources of data on these opaque stocks and using a variety of statistical tools, we showed that the result of Working linking the spread of the forward curve to inventory was best validated when using the visible Exchange inventories than the addition of bonded warehouses to SHFE stocks. Policy makers and regulators should be interested in metals because of their role as collateral in trade finance. We suggest they bring their attention to the remarkable message of Hieronymus (1977) - both an economist and a trader- on the key role of independent warehousing companies, and also to the information carried at all times in forward curves.

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