Chapter 6

From Chicago to Shanghai and Dalian: Apprehending the Future of Chinese Commodity Derivative Markets

1. Introduction

From the turn of the 21st century, the emergence of China as the powerhouse of world economic growth has been astounding. China is now the world's second largest economy, behind the United States and has achieved this in less than two decades. Innumerable pages of academic research, economic analysis and political commentary have been produced to evaluate this phenomenon. No matter what the context, there is one word that is always associated with it – *commodities*.

Whether agriculture, metal or energy commodities, China plays a key role either as a producer, consumer, importer or exporter; occasionally it plays several of these roles simultaneously.

Take iron ore as an example, the world's largest dry bulk commodity in terms of volume: in 2016 an estimated 2.23 billion metric tons were produced (USGS, 2017), of which 1.49 billion MT were traded internationally, with China accounting for 1 billion MT of global imports. There is no major commodity from any of the main groups – metals and minerals, agriculture and energy – where China does not have some presence, usually a substantial one. Table 1 shows sample commodities and China's share of world production by volume, and exports and imports by value.

Table 1: Chinese share of production and imports of major commodities

Commodity (SITC code)	Production[1] (thousand MT)	Export value[2] ($ million)	Import value ($ million)
Iron ore (2601)[3]	825,000 (37%)	<0.5%	57,088 (68%)
Aluminium ores & concentrates (bauxite & alumina - 2606)	123,500 (86%)	<0.5%	2,526 (64%)
Copper ores & concentrates (2603)	1,740 (9%)	<0.5%	20,569 (48%)
Soybeans (1201)[4]	12,900 (4%)	<0.5%	33,958 (61%)
Wheat (1001)	128,850 (17%)	<0.5%	801 (2%)
Corn (1005)	219,554 (21%)	<0.5%	637 (2%)
Fertilizers (31)[5]	67,722 (32%)	6,551 (13%)	2, 412 (5%)
Crude oil (2709)[6]	214,600 (5%)	<0.5%	116,171 (17%)
Petroleum products (2710)	530,868 (13%)	19,368 (4%)	11,130 (2%)
Coal (2701)	3,747,000 (48%)	<0.5%	11,486 (13%)

Note: Percentage numbers in brackets indicate share of world production, exports or imports

Although Table 1 does not provide an exhaustive list of commodities, it offers a glimpse of how important China is, at least on the physical side, for many commodities. It is little wonder then that the country has a keen interest in increasing its participation in the pricing mechanism of at least some of the commodities which are significant for its economy.

The rest of this chapter attempts to shed some light on the development of China's commodity exchanges, from their birth in the 1990s to their ascendancy to being in the top echelons of commodity derivatives markets globally. We start by casting our eye on the establishment of the main three commodity exchanges and follow with an overview of the key commodity contracts each one lists. We then turn our attention to scholarly research on their performance, especially since the 2000s and we conclude our review with some reflection and discussion on what may lie ahead both for China's commodity exchanges and the commodities traded in them.

2. A brief history of commodity exchanges in China

In 1978, the Chinese Communist party and its leader Deng Xiaoping launched a series of economic reforms, starting with the "household-responsibility system" in the countryside, which gave some farmers ownership of their product for the first time. Two years later, the southern city of Shenzen became the first "special economic zone", to experiment with more liberal economic policies.

Public unrest in 1986 was followed by economic turbulence and high inflation in 1988, further anti-government protests in 1989 and culminated in the well-documented events in Beijing's Tiananmen Square in June of the same year. In 1990, the first ever stock market in Communist China, the Shanghai Stock Exchange, opened. Shortly afterwards and throughout the 1990s several more exchanges, including commodity ones, opened in several Chinese cities, heralding an era of renewed economic growth and focus on market-driven growth. The country greeted the new millennium with accession to the World Trade Organization and the meteoric ascent of the Chinese economy which has incessantly dominated global economic development since then.

In the years following WTO accession, China: sent its first man in space orbit; built the Three Gorges Dam, overtaking Brazil's Itaipú as the world's largest hydroelectric dam; hosted the hugely successful summer Olympic Games in Beijing; became the largest automobile producer in the world; became the world's largest energy consumer and largest electricity producer; and rose past several OECD members to become the world's second largest economy. This enumeration by no means covers all the milestones achieved by China in the last 15-20 years, nor does it mention the low points and difficulties faced in this path of economic growth. It is an indication, however, of how rapid this growth has been and how important institutional reform must have been to achieve these milestones.

Closer to home with commodity markets was the establishment of the China Securities Regulatory Commission (CSRC) in 1998. The CSRC is a ministerial-level public institution under the State Council which exercises regulatory control over all securities and futures markets in

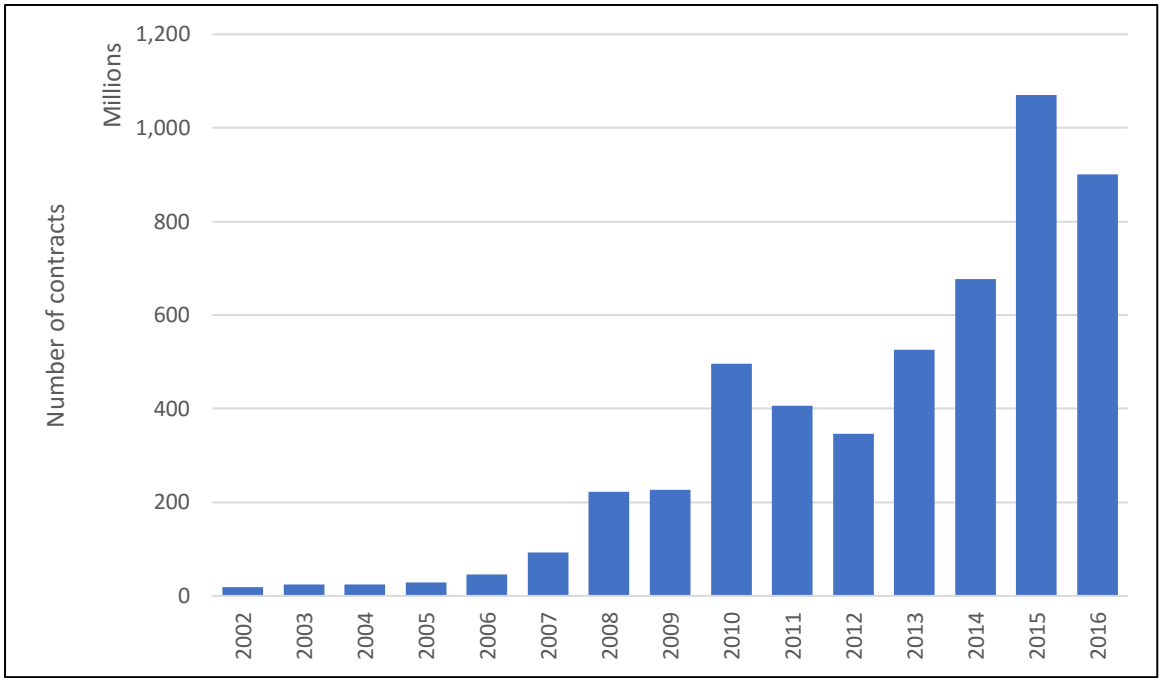
China. It is responsible for: formulating policies and developing plans for these markets; performing supervisory control of the markets and its officials; supervising the listing, trading and settlement of stocks, bonds and domestic futures contracts; monitoring the overseas futures-related activities of its domestic institutions; and supervising the communication of information and management of statistics pertaining to securities and futures markets. It is as crucial for Chinese commodity derivatives markets, as the CFTC is for the US ones. But what about the commodity exchanges themselves?

2.1. Zhengzhou Commodity Exchange (CZCE)

Established in 1990 on a pilot scheme and trading only a forward contract, the Zhengzhou Commodity Exchange listed its first futures contracts in wheat, corn, soybean, green beans and sesame in 1993. Over the years more agricultural commodity contracts were launched and in 2006 the first non-food contract was launched – pure terephthalic acid (PTA - a commodity chemical used for the manufacturing of polyester fibre and PET plastics). This was followed by glass, thermal coal, methanol and ferroalloy; PTA and methanol are currently (early 2017) leading all other contracts by volume, closely followed by rapeseed meal.

Despite being the first commodity exchange to be founded, the CZCE has lagged the other two and in 2016 it was in third place in China and 11th in the world.

Figure 1: Volume of Futures Contracts Traded Annually on the CZCE



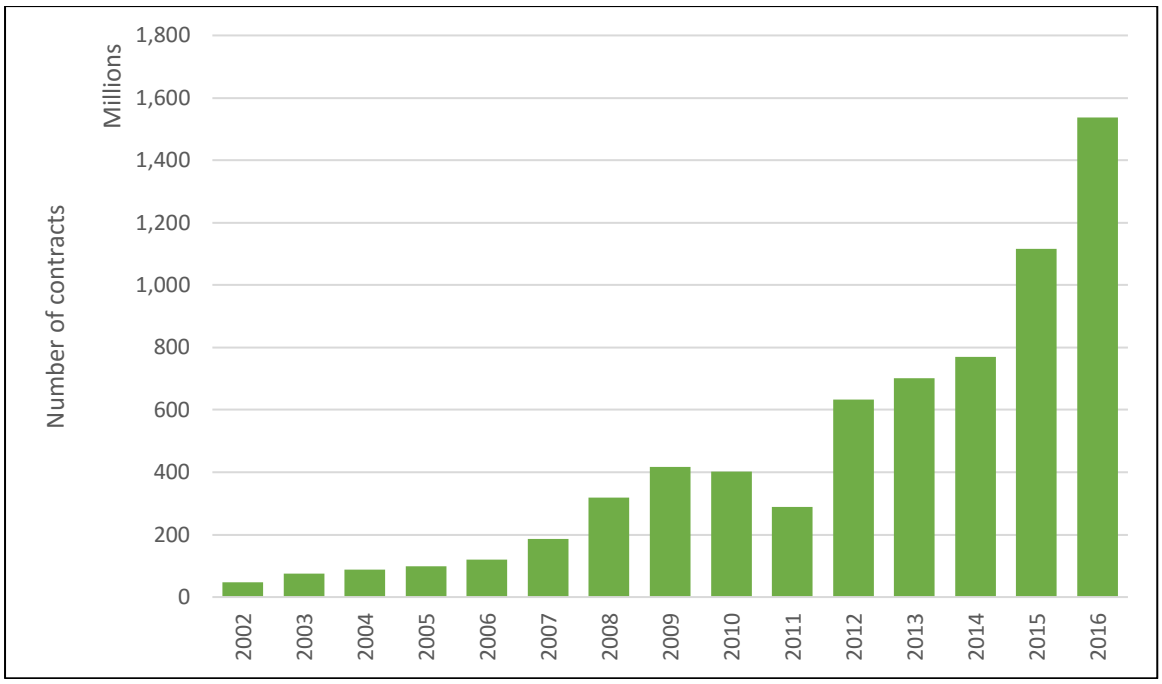
Source: (FIA, 2017a)

2.2. Dalian Commodity Exchange (DCE)

Established in 1993, the DCE initially focused on listing agricultural commodities, including soybeans, soybean meal and corn. In the following year, the DCE was one of the fifteen commodity exchanges which emerged after the consolidation of over fifty smaller exchanges around the country. In 1995, the first long-distance trading system was established in multiple

cities throughout China. In 1998, a further round of consolidation resulted in only three major national exchanges – Dalian, Shanghai and Zhengzhou.

Figure 2: Volume of Futures Contracts Traded Annually on the DCE



Source: (FIA, 2017a)

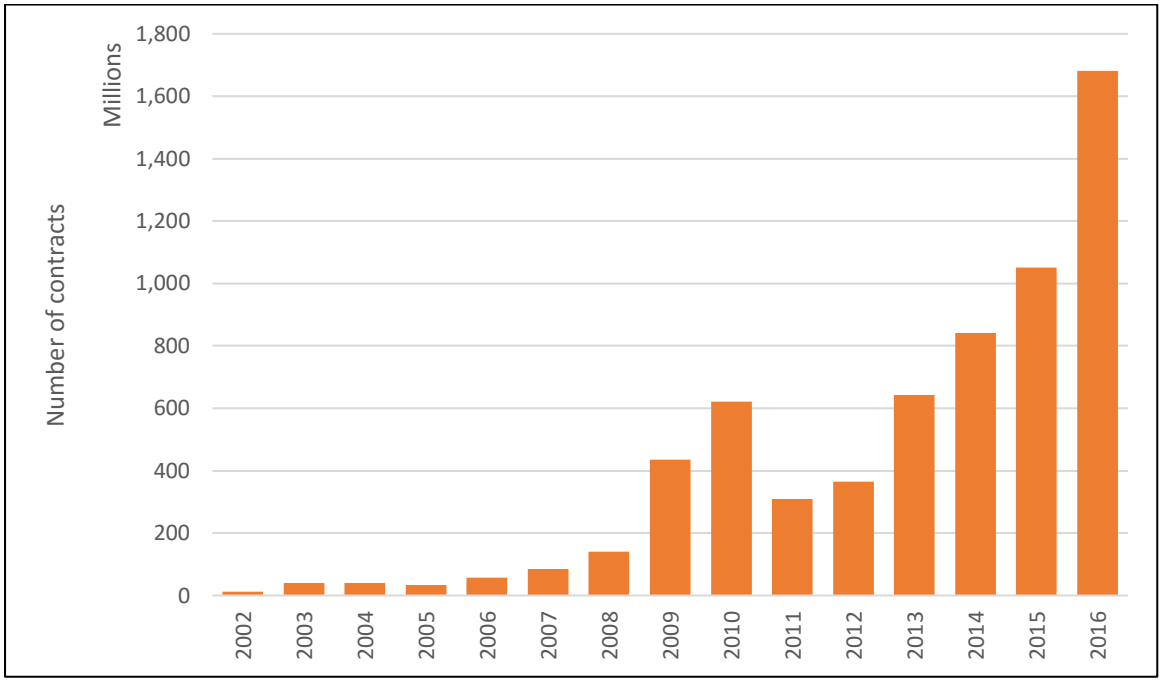
Despite the addition of further agricultural commodity contracts, trading volumes remained modest, until the addition of the first few industrial commodities, such as LLDPE (linear low density polyethylene), PVC and RBD Palm Olein. By the end of 2008, the trading volume had surpassed 1 million contracts per day and by the end of 2012 it was just over 2.5 million contracts per day. The major boost in activity, however, came with the launch of the iron contract at the end of 2013, the world's first iron ore futures contract for physical delivery. Figure 2 shows the development of trading volume in the DCE since 2001, with notable increase in activity from 2006 onwards and the spectacular rise from 2014 until recently. In 2016, the iron ore and the soybean meal contracts each accounted for nearly a quarter of the total trading volume on the exchange, while the DCE fell to second place in China behind SHFE and to 8th place on a global basis, with over 1.5 billion contracts traded across all its futures products.

2.3. Shanghai Futures Exchange (SHFE)

The SHFE emerged in 1998 after the second round of consolidation of smaller regional exchanges. It was formed from the merger of the Shanghai Metal Exchange, the Shanghai Cereals and Oil Exchange and the Shanghai Commodity Exchange. Trading started with copper, aluminium and rubber. From the outset, metals remain the focus, with zinc, lead, nickel, tin, gold, silver, steel rebar, steel wire rod and steel hot-rolled coil now listed. Rubber remains one of the most actively traded contracts, while fuel oil and bitumen contracts started trading in 2004.

The development path of the SHFE is very similar to that of its other two domestic competitors. Trading volumes started increasing from around 2006 and after an interruption in 2011, they expanded exponentially. In 2016, the SHFE overtook once again the DCE to become the top commodity exchange in China and the 6th in the world. In doing so, it has long overtaken the London Metal Exchange in terms of trading volume. In the next section, we will see how Chinese exchanges have increased their influence in the main commodity groups and how they compare to other international exchanges.

Figure 3: Volume of Futures Contracts Traded Annually on the SHFE



Source: (FIA, 2017a)

With the help of legislative reforms and institutional changes, under the watchful eye of the CSRC and the immense boost provided by the Chinese economic take-off, the three commodity exchanges thrived and recorded unparalleled growth over the last decade. All three are regular fixtures in the list of the top 30 financial and commodity exchanges. In fact, in 2016 SHFE, DCE and CZCE were 6th, 8th and 11th respectively (see Table 2); this is quite a feat considering that all of them trade in commodity derivatives alone, whereas many of their competitors are driven primarily by their trading in financial products.

There are of course flaws in using a one type of metric versus another. The number of contracts is a consistent measure for comparing trading activity across exchanges, but it does not account for notional quantities of underlying physical assets (which can be important for commodities), nor for their value. In the next section, we look at the three main commodity groups – agriculture, metals and energy – and continue our discussion of the emerging role of China's commodity exchanges.

Table 2: Top Commodity Exchanges by Volume of Contracts

Rank	Exchange	Volume 2016	Volume 2015
1	**CME Group**	3,942,202,299	3,531,776,304
2	**National Stock Exchange of India**	2,119,462,820	3,031,892,784
3	**Intercontinental Exchange**	2,037,932,884	1,998,960,757
4	**Moscow Exchange**	1,950,145,418	1,659,441,584
5	**Eurex**	1,727,766,695	1,672,648,483
6	**Shanghai Futures Exchange**	1,680,711,841	1,050,494,146
7	**Nasdaq**	1,575,700,250	1,648,958,123
8	**Dalian Commodity Exchange**	1,537,479,768	1,116,323,375
9	**BM&FBovespa**	1,487,305,788	1,358,592,857
10	**CBOE Holdings**	1,184,553,418	1,173,934,104
11	**Zhengzhou Commodity Exchange**	901,297,047	1,070,335,606
12	**Korea Exchange**	692,990,540	794,935,326

Source: (FIA, 2017b)

3. Overview of commodity contracts traded

The ascent of Chinese futures derivatives markets is clearly attributable to the country's economic growth since the beginning of the millennium. However, it is also worth emphasizing the increased role of commodity contracts in achieving this. In the last 10 years, between 2007 and 2016, the number of contracts in agricultural, metal and energy commodities increased from 1.16 billion to 5.77 billion (FIA, 2017b, p. 20). This growth in commodity derivatives trading occurred in parallel to a fall in equity index futures; this had the dual effect of maintaining the growth momentum in derivatives trading on a global basis and increasing the share of commodities in the overall volume.

Exchanges such the CME Group and ICE remained in a strong position overall, but Chinese commodity exchanges not only rose in terms of overall trading numbers, but also took the lead in several contracts in the agriculture and metal categories. We look at some of these developments below.

3.1. Agriculture

The Chicago Board of Trade[7] was established in 1848 and is the oldest derivatives market for agricultural commodities which still survives today. It is renown especially for its grains and oilseeds contracts and the de facto benchmark setter for reference prices on a global scale. Yet, Table 3 belies this assertion, as the top seven contracts by volume are traded in the DCE, CZCE and SHFE.

There is a straightforward explanation for this – contract size. Take corn for example. The DCE corn contract is for 10 metric tons (MT), whereas the CBOT one is for 5,000 bushels (equivalent to approx. 127 MT). A simple calculation shows that the notional amount of corn

traded on the CME in 2016 was 10.87 billion MT, while on the DCE it was 1.22 billion MT. Even when comparing the soybean meal futures contracts of the DCE (ranked 1st) and the CME (ranked 17th), the difference is not as enormous as it seems. The DCE contract is for 10 MT whereas the CME one is for 100 short tons (90.7 MT). The same simple calculation tells us that the notional quantity traded on the DCE was 3.89 billion MT, while on the CME it was 2.35 billion MT; the DCE contract volume is still the leader but only by about 1.5 times.

Table 3: Top Agriculture Futures Contracts

Rank	Contract, Exchange	Volume 2016
1	Soybean Meal Futures, Dalian Commodity Exchange	388,949,970
2	Rapeseed Meal (RM) Futures, Zhengzhou Commodity Exchange	246,267,758
3	RBD Palm Olein Futures, Dalian Commodity Exchange	139,157,899
4	Corn Futures, Dalian Commodity Exchange	122,362,964
5	White Sugar (SR) Futures, Zhengzhou Commodity Exchange	117,293,884
6	Rubber Futures, Shanghai Futures Exchange	97,371,256
7	Soybean Oil Futures, Dalian Commodity Exchange	94,761,814
8	Corn Futures, Chicago Board of Trade	85,625,219
9	Cotton No. 1 (CF) Futures, Zhengzhou Commodity Exchange	80,530,129
10	Corn Starch Futures, Dalian Commodity Exchange	67,445,264
11	Soybean Futures, Chicago Board of Trade	61,730,753
12	Sugar #11 Futures, ICE Futures U.S.	33,115,334
13	No. 1 Soybean Futures, Dalian Commodity Exchange	32,570,158
14	Chicago Soft Red Winter Wheat Futures, Chicago Board of Trade	31,059,726
15	Soybean Oil Futures, Chicago Board of Trade	29,429,298
16	Rapeseed Oil (OI) Futures, Zhengzhou Commodity Exchange	27,312,246
17	Soybean Meal Futures, Chicago Board of Trade	25,953,938
18	Corn Options, Chicago Board of Trade	22,794,484
19	Egg Futures, Dalian Commodity Exchange	22,474,739
20	Soybean Options, Chicago Board of Trade	20,109,648

Source: (FIA, 2017b)

The interesting story which emerges from the contract data and their development over the last decade is that all three Chinese exchanges are increasingly active at pricing the various commodities within China, whether the contracts are traded for hedging or speculative purposes. Although one may argue that this price discovery is limited to the Chinese domestic market, it would also be fair to say that domestic prices for commodities where China has a substantial market presence may also provide information signals to other established derivatives markets, such as in the US. We revisit this notion in section 4.

3.2. Metals and minerals

Historically, international prices for key base metals are set at the London Metal Exchange (LME), which was founded in 1877, not long after the establishment of the Chicago Board of Trade. Its two flagship contracts are for copper and aluminium, both of which are among the top 20 traded metal contracts globally.

In China, while the first contracts to be listed on its commodity exchanges were primarily from the agricultural group, the new millennium brought with it a renewed focus on industrial commodities, especially metals and minerals. As China embarked on its development path, it placed great emphasis on growing its heavy industry. Right at the centre of this strategy are commodities such as steel (and iron ore), aluminium, copper, zinc, nickel, lead, gold and silver.

Although China produces many of these metals and minerals, it also relies on substantial imports to satisfy its demand for construction and manufacturing. As a result, interest in price discovery and hedging increased as the economy took off. It is no wonder that trading in metal futures took off in a major way from the mid-2000s and the main beneficiary of this growth has been the SHFE. As Table 4 shows, five of the six most traded metal contracts were listed on the SHFE, with steel rebar taking the top spot.

Table 4: Top Metals Futures Contracts

Rank	Contract, Exchange	Volume 2016
1	Steel Rebar Futures, Shanghai Futures Exchange	934,148,409
2	Iron Ore Futures, Dalian Commodity Exchange	342,265,309
3	Nickel Futures, Shanghai Futures Exchange	100,249,941
4	Silver Futures, Shanghai Futures Exchange	86,501,561
5	Zinc Futures, Shanghai Futures Exchange	73,065,922
6	Copper Futures, Shanghai Futures Exchange	72,394,915
7	Gold (GC) Futures, Commodity Exchange (COMEX)	57,564,840
8	Aluminium Futures, London Metal Exchange	53,073,441
9	SPDR Gold Shares ETF Options	52,017,471
10	Aluminum Futures, Shanghai Futures Exchange	44,391,785
11	Hot Rolled Coil Futures, Shanghai Futures Exchange	43,281,751
12	Copper - Grade A Futures, London Metal Exchange	36,947,881
13	Gold Futures, Shanghai Futures Exchange	34,759,523
14	Special High Grade Zinc Futures, London Metal Exchange	26,942,407
15	Gold Futures, Moscow Exchange	22,656,213
16	Copper (HG) Futures, Commodity Exchange (COMEX)	21,524,547
17	Primary Nickel Futures, London Metal Exchange	19,947,714
18	iShares Silver Trust ETF Options	19,338,469
19	Silver (SI) Futures, Commodity Exchange (COMEX)	18,218,740
20	Silver MIC Futures, Multi Commodity Exchange of India	14,882,798

Source: (FIA, 2017b)

As with agricultural commodities earlier on, looking only at the number of contracts traded does not tell the whole story, because of the size of the various contracts. For example, the SHFE copper contract is for 5 MT, whereas the LME one is for 25 MT; hence in 2016 the notional quantity of copper traded on SHFE was approx. 362 million MT, while on the LME the respective amount was 923 million MT, i.e. 2.5 times more.

This, however, does not diminish the fact that a substantial amount of price discovery now takes place in China. As with agricultural commodities, although these prices may be reflective of the domestic Chinese market, they provide strong signals to international prices

set in other exchanges, considering the major role China plays in the physical trade of these metals and minerals.

3.3. Energy

Energy has been at the heart of China's rapid economic growth. The country is the world's largest producer of coal and electricity and the largest importer of coal and crude oil. While most of its energy is still derived from coal, China is diversifying its energy mix by expanding its capacity in hydroelectricity, nuclear energy, natural gas generation and renewables, such as wind and solar.

Table 5: Top Energy Futures Contracts

Rank	Contract, Exchange	Volume 2016
1	Brent Oil Futures, Moscow Exchange	435,468,923
2	WTI Light Sweet Crude Oil (CL) Futures, New York Mercantile Exchange	276,768,438
3	Brent Crude Oil Futures, ICE Futures Europe	210,561,053
4	Bitumen Futures, Shanghai Futures Exchange	186,814,247
5	Henry Hub Natural Gas (NG) Futures, New York Mercantile Exchange	97,480,591
6	Crude Oil Mini Futures, Multi Commodity Exchange of India	67,401,974
7	Gas Oil Futures, ICE Futures Europe	66,158,348
8	Crude Oil Futures, Multi Commodity Exchange of India	53,256,420
9	Coke Futures, Dalian Commodity Exchange	50,461,050
10	Thermal Coal (ZC) Futures, Zhengzhou Commodity Exchange	50,299,868
11	WTI Light Sweet Crude Oil Futures, ICE Futures Europe	47,289,665
12	U.S. Oil Fund ETF Options	46,948,980
13	Crude Oil (LO) Options, New York Mercantile Exchange	45,879,991
14	RBOB Gasoline Physical (RB) Futures, New York Mercantile Exchange	45,428,663
15	Hard Coking Coal Futures, Dalian Commodity Exchange	41,077,427
16	NY Harbor ULSD (HO) Futures, New York Mercantile Exchange	39,389,349
17	Brent Crude Oil Last Day Financial (BZ) Futures, New York Mercantile Exchange	23,713,109
18	Natural Gas (European) (LN) Options, New York Mercantile Exchange	23,520,044
19	Brent Crude Oil Options, ICE Futures Europe	16,152,414
20	Natural Gas Futures, Multi Commodity Exchange of India	15,355,328

Source: (FIA, 2017b)

So far, Chinese exchanges have not featured as prominently in trading energy derivatives. In 2016, the largest energy contract trading in China was for bitumen (a relatively small residual product of the refining industry) on the SHFE. Coke on the DCE and thermal coal on the CZCE were in 9th and 10th place respectively, a reminder that China is the world's largest consumer of both types of coal. The list was topped by the "usual suspects" – WTI light sweet crude on NYMEX (part of the CME group) and Brent crude on ICE[8].

However, China has demonstrated an increasing appetite for oil products, as it is gradually moving to a more consumption-led (rather than export-led) economy, which is typically associated with higher consumption of refined oil products, such as gasoline and diesel oil. In anticipation of this development, the country increased its refining capacity by more than double in the last fifteen years and is now the second largest refining capacity holder after the United States. As oil and gas are likely to increase in importance in the country's energy mix (the former in transportation and petrochemicals, the latter in power generation and industry), it is only natural to expect an increased desire for a more substantive role in price discovery and risk hedging, at least in the Asia Pacific region.

4. The performance of Chinese commodity exchanges

The emergence and increasing importance of Chinese commodity derivatives attracted the attention of both the business and academic communities, since the early years of the institutional restructuring which led to the creation of the three commodity exchanges. We look at some of the research questions which were posed over the past two decades and some of the results from various investigators.

One of the earlier attempts to document the initial performance of Chinese futures markets is the work of Williams *et al* in their paper on the mungbean contract listed on the CZCE (Williams *et al.*, 1998). The authors track the strategy followed by the exchange in its initial steps in 1993. They note that CZCE, after establishing a wholesale market in several agricultural commodities, listed only five contracts initially and trading in mungbeans was the one that took off first. The authors then turn their attention to pricing efficiency and the existence of arbitrage opportunities. They cannot draw any conclusion on the relationship between spot and futures prices, mainly due to lack of a full set of data for all wholesale prices. They do, however, observe inter-temporal arbitrage opportunities in 1993-94, which become scarcer or disappear from 1995 onwards. The authors conclude that the evolution of the mungbean contract on CZCE is a good example on how futures market can evolve quite rapidly, in conjunction with a wholesale spot market, without the need for a long and slow process of developing a forward market which can then be formalised into a futures exchange.

Ten years after the establishment of the Chinese commodity exchanges, Chan *et al* take a closer look at the volatility during this period (Chan, Fung and Leung, 2004). They examine four futures contracts on the three exchanges, over a period of six years: copper (SHFE); soybean (DCE); and mungbeans and wheat (CZCE). Their results indicate that positive and negative returns increase futures volatility, and negative returns appear to have a greater impact on volatility than positive returns. The authors also note that higher volume amplifies volatility, whereas higher open interest mitigates volatility. This is especially the case when looking at data from 1998-2001, when the CSRC imposed more regulations intended to control illegal trading and promote standardized market operations.

A natural progression of research interest in new futures markets is price movement patterns, relationship between futures and spot prices and market efficiency. Wang tackles the issues

in two successive papers (Du and Wang, 2004; Wang and Ke, 2005). Wheat prices go through a battery of standard statistical tests in the 2004 paper, to identify non-stationarity and time-varying volatility. This is followed by fitting AR(1), ARCH(2) and GARCH(1,1) models to the data and comparing results. The authors conclude that the GARCH(1,1) specification is the best overall model, both in terms of goodness of fit and forecasting performance, while also accounting for time-varying volatility and excess kurtosis which is present in the data. The 2005 paper goes on to investigate the efficiency of the wheat and soybean futures contracts on the CZCE and DCE by examining the relationship of futures prices with spot prices from the Zhengzhou and Tianjin wholesale grain markets. Cointegration tests are run between cash and futures prices for six different time horizons from one week to four months. For soybean futures prices, the authors conclude that there is a long-run equilibrium between DCE futures prices and spot prices in Tianjin and Zhengzhou, although the DCE is short-run efficient only with Tianjin spot prices. In contrast, results for the wheat contracts point to a market which was still inefficient at the time, as there was no cointegration between futures and spot prices.

On a similar thread Wang *et al* look at the efficiency of the SHFE fuel oil contract between 2004 and 2006 (Wang, Liu and Chen, 2007). They perform cointegration tests between the price of the SHFE contract with Huangpu fuel oil prices and check the Granger causality between the two series using a vector error correction model (VECM). The authors conclude that fuel oil futures contract exhibited a highly efficient price discovery function.

Shortly afterwards, Lien and Yang evaluate hedging strategies for the copper and aluminium contracts traded on the SHFE (Lien and Yang, 2008). They start from the basic premise of a stable hedge ratio, which assumes stationary variances for spot and futures returns and a stationary correlation coefficient (naïve hedge). They then move onto a bivariate fractionally integrated generalized autoregressive conditional heteroscedasticity (BFIGARCH) model incorporating a dynamic conditional correlation (DCC) element, which accommodates the time series properties of the data, particularly the long-run relationship between spot and futures returns, long memory volatility, and time-varying variance and correlation of spot and futures returns. Finally, their model equations incorporate asymmetric basis effects, i.e. adjustment speeds to restore the long-run equilibrium relationship when the futures market is in contango differ to those when the market is in backwardation. The authors compare the performance of the various models when constructing hedge portfolios for both aluminium and copper and conclude that the asymmetric BFIGARCH model outperforms all other models in the case of aluminium, but there is no clear winner in the case of copper.

So far, we can observe that the study of Chinese commodity exchanges has followed a well-trodden path: initially it is about how well the market is established, how it functions and how well it communicates with the spot market; the focus then moves on examining price behaviour, both in terms of returns and volatility; finally, the long-run relationship between spot and futures prices is tested alongside the hedging effectiveness of the latter.

As the Chinese futures markets became more established, grew in popularity and size and offered a robust platform for domestic price discovery and hedging, the research discourse moved on to the linkages with international commodity exchanges and the flow of price information (on returns as well as volatility) for specific commodities across futures markets.

Among the first to tackle this topic are Hua and Chen who investigate market linkages for four commodities from the metal and agriculture group (Hua and Chen, 2007). They use an array of standard tools, including cointegration tests, error correction models, Granger causality tests and impulse response analysis. They apply these to futures contracts for copper and aluminium (SHFE and LME), soybeans (DCE and CBOT) and wheat (CZCE and CBOT). They find long-run relationships for the copper, aluminium and soybean contracts, but not for the wheat contract. In the case of the three cointegrating contracts, they find that overseas exchanges (LME and CBOT) have a greater influence on their Chinese counterparts (SHFE and DCE, respectively), but there is also flow of information in the opposite direction.

Metal futures are again the focus of Fung *et al* who study copper and aluminium contracts listed on the SHFE and NYMEX between May 1999 and May 2009 (Fung, Liu and Tse, 2010). They identify structural breaks for both metals (as expected) and confirm that futures prices for each metal are cointegrated across the two markets. The authors then proceed to run a VECM which indicates that there is a bi-directional error correction process between Shanghai and New York, with the US market being more informationally efficient than the Chinese market.

Using a VECM-GARCH framework, Liu and An study information transmission, price discovery, lead-lag relationships and volatility spillover effects for copper and soybeans, using Chinese spot prices and SHFE, NYMEX and CME Globex futures prices, for a sample period between January 2004 and December 2009 (Liu and An, 2011). The authors conclude that: Chinese futures, spots, and US futures are cointegrated with one common stochastic factor; there exist bi-directional, but asymmetric, lead–lag relationships between Chinese futures and spot markets, as well as between Chinese and US futures markets in terms of information transmission; and US futures markets lead Chinese futures markets, which in turn lead Chinese spot markets in the short-run.

The cross-market linkage between the DCE and CBOT is revisited by Han *et al* who use SVAR and VECM to investigate soybean futures prices during trading and non-trading hours (Han, Liang and Tang, 2013). The authors use data between March 2002 to September 2011 to construct continuous price series for the two contracts and they calculate returns both for trading hours (open-to-close) and non-trading hours (close-to-open), given that the trading session of the two exchanges do not overlap. Their results reconfirm that there is a long-run cointegration relationship between DCE and CBOT futures prices and that CBOT prices significantly affect DCE ones. However, they also find evidence that the DCE also has a significant impact on CBOT and the magnitude of both impacts is similar, leading to the conclusion that the DCE is playing an important role in the global price discovery of soybean futures.

Building on earlier work by Li and Zhang who identified a long-run relationship between the copper futures contracts trading on the SHFE and LME (Li and Zhang, 2009), Kang and Yoon examine the relationship between the SHFE and LME futures contracts for aluminium, copper and zinc (Kang and Yoon, 2016). They use a generalised VAR methodology, variance decomposition and the Diebold & Yilmaz spillover index model (Diebold and Yilmaz, 2012) on a data sample from August 2007 to April 2016. The authors find that LME has a greater impact

on SHFE futures returns and volatilities and that the dynamic spillover trends are more pronounced in the aftermath of the global financial crisis.

Finally, Fung *et al* expand on previous work on international linkages between Chinese and several other commodity exchanges (Fung *et al.*, 2013). The authors use data for 16 contracts of agriculture and metal commodities trading on the SHFE, DCE and CZCE, between December 2003 and October 2011. The contracts range from soybeans, rice and natural rubber, to copper, zinc and palm olein. They then match them with equivalent contracts from several other exchanges including the LME, EURONEXT, CME, TOCOM[9], ICE and MDEX[10]. The analysis concentrates on returns and it distinguishes between close-to-close, open-to-close and close-to-open (non-trading) returns where appropriate. Results on the trading and non-trading returns analysis show that overnight changes in the Chinese futures returns are significantly driven by relevant information released during the daytime trading hours of the corresponding US/UK market. The authors' analysis of results on the open-to-close returns indicates that the Chinese market leads the US market in cotton futures, while the Malaysian market leads the Chinese futures market in daytime returns of palm olein futures contracts. The authors conclude that most futures contracts in the sample do not exhibit a lead-lag relation between markets and the overall results show that the Chinese and foreign markets are information-efficient on a daily level.

5. Looking ahead

The establishment of organised commodity exchanges in China was revolutionary for a country with a long-established, centrally-planned economic system. The recognition that markets and private enterprise, albeit with government supervision and moderation, can be the engine of growth was the starting point in China's modern economic history.

Since 1993, the process has become more evolutionary and the review of scholarly research follows this evolution. Chinese commodity futures markets followed the well-established "playbook" of other commodity derivatives markets, especially those in the US. The process started with the establishment of a strong regulatory authority and robust wholesale markets in key commodities, initially in agriculture. This was followed by listing a small number of futures contracts and gradually increasing the offerings with commodities which assumed greater importance in the Chinese economy. As results from academic research indicates, futures contracts are efficient in price discovery and hedging and exhibit long-run cointegration with respective spot prices. As Chinese commodity exchanges increased in stature and ranked highly in the lists of top global futures markets, they attracted more interest in terms of their contribution to the global price discovery of certain commodities and their relationship with mature futures markets which have traditionally produced price benchmarking. Existing research suggests that there is a bi-directional influence between contracts listed on the SHFE, DCE and CZCE and their counterparties on other international exchanges and that this influence may be of similar magnitude, i.e. Chinese commodity exchanges could be equally important in setting global prices for some commodities.

So what next? Ahead lie opportunities, as well as challenges. As China continues to embrace open market economics and the risks associated with this, it will need to consolidate and

expand the derivative markets which provide the tool to mitigate these risks. In the words of the Chairman of the DCE "We [in China] are behind international markets because we have too few tools, too few products" (Hornby, 2017). To do this, there is a need to extend the range of available instruments, both in terms of commodities covered (e.g. crude oil, natural gas, fertilizers, etc.), as well as the types offered (e.g. options, swaps and so on).

Now that Chinese exchanges have a closer informational linkage with other international exchanges and China has such an important role as a consumer of many raw materials, there is a stronger desire to play a larger role in setting global commodity prices. For this to happen, the Chinese market needs to be more than a large, but isolated, domestic market. In a recent interview, the vice-chairman of the CSRC said that "China's commodities market should be opened to offshore investors". He added that "the country would look to start doing so in products such as crude oil, iron ore and rubber" and "the regulator is also examining allowing banks and other financial institutions to enter the market" (Lian and Goh, 2016).

As welcome as this may be, there must be an element of apprehension by potential overseas market participants, especially in view of the apparent rush of Chinese speculators who inflated prices in 2016, before the CSRC stepped in to increase fees and margins and limit the number of new positions allowed on a daily basis (Ritchie and Zhu, 2016; Sanderson, 2016; Cang, 2017). The regulator intervention may of course be necessary, but it may also bring unease to existing and potential new market participants, such as western banks and trading houses, who are more comfortable dealing with exchanges where the rules are more constant (Russell, 2016).

China has come a long way from an isolated, closed and largely agrarian economy, to a modern economic powerhouse, driven by manufacturing and exports and moving towards a more 'western-style', consumption-led economy. Commodities remain central to its economic growth in the future, whether agriculture, metal or energy goods. As China continues to play a dominant role in the production, consumption and international trade of many of these commodities, its involvement in pricing and risk management is unlikely to diminish. Challenges do exist and will require careful planning and mitigation. In doing so, Chinese authorities will benefit from giving access to commodity derivatives markets to overseas participants and strengthen their role in global price setting.

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[1] Data estimates for 2016, except fertilizers (2014), crude oil (2015, petroleum products (2015) and coal (2015).

[2] Data exports and imports are for 2016 and taken from the International Trade Centre (ITC, 2017).

[3] Iron ore, aluminium ores and copper ores production data from United States Geological Survey (USGS, 2017)

[4] Soybeans, wheat and corn production data from United States Department of Agriculture (USDA, 2017)

[5] Fertilizer production data (measured as N, P and K nutrients) from the Food and Agriculture Organization (FAO, 2017)

[6] Crude oil, petroleum products and coal production data from British Petroleum (BP, 2016)

[7] The Chicago Board of Trade is now part of the CME group, which also includes the New York Mercantile Exchange (NYMEX). Including its COMEX division which lists metal contracts.

[8] The appearance of Brent crude traded on the Moscow exchange is down to contract size once more. The size of the Moscow contract is just 10 barrels, compared to 1,000 barrels for both the NYMEX and ICE contracts. Hence, the notional quantity of crude traded on the Moscow exchange was 4.35 billion barrels, whereas on NYMEX it was 276.8 billion barrels – approximately 8.5 times the global oil production.

[9] Tokyo Commodity Exchange.

[10] Malaysia Derivatives Exchange.