

For CO₂ Emission Trading in China, Can the Market Become a National One, Four Years after Creating Seven Local Markets?

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Abstract

In this paper, we assess the existing seven local pilot carbon emission trading schemes in China and analyse the factors determining whether China's carbon market is successful in terms of handling substantial amounts of CO₂ emissions rights, regulating the market and trading them at a reasonable price. The emission trading system is developing slowly in most of the participating provinces and cities. Prices tend to decline, while volumes trading slowly increase. The volatility is partially the result of regulation (the rights need to be renewed before a certain date) and partially due to government interventions in the market. Based on the assessment, recommendations are provided for China implementing a national carbon market, based on the experiences and lessons learnt from the seven local carbon emission trading schemes. Conditions for China to roll out the system and later improve the national emission trading scheme to replace the existing local emission trading schemes are formulated.

Keywords

CO₂ Emission Trading, Carbon Market, Carbon Finance, China ETS, Carbon Policy

1. Introduction

CO₂ emissions are a hot topic, given their contribution to climate change. At the United Nations (UN) conference in Paris at the end of 2015, all countries of the world promised they will try to reduce their CO₂ emissions. During the UN Cli-

mate change conference in Copenhagen in 2009, no such agreement could be reached, since China promised only to reduce CO₂ emissions per unit of output. Now it has promised to reduce total emissions by 2030. China President Xi also promised in Paris that China would extend the current system of CO₂ emission rights trading to the whole country.

Carbon trading or emissions trading is a market-based tool which should help to limit the production of CO₂ emissions at lower cost than when each company would invest itself in cleaner technology [1]. If buying rights is cheaper than investing in CO₂ reduction, they will buy, while other firms will invest if they consider this a cheaper option. Through the emission trading system (ETS) emission has a price, which needs to be paid. The system originated with the Kyoto protocol of the United Nations, which was accepted in December 1997 and officially finished in 2012.¹ The same protocol is also at the basis of the clean development mechanism (CDM), which concerns the trading of CO₂ emission rights between countries.

The Clean Development Mechanism is one of the Flexible Mechanisms defined in the Kyoto Protocol that provides for emissions reduction projects in other countries. It generates Certified Emission Reduction (CER) units which may be traded in emissions trading schemes and help industries in developed countries.² They contribute to their own emission reduction targets. The projects and the issue of CERs are subject to approval to ensure that these emission reductions are real and “additional”.³ The CDM allows industrialized countries to buy CERs and to invest in emission reductions where it is cheapest globally.⁴

China decided to start its own ETS, after learning from international ETS experiences. In 2012, seven local pilot ETS were selected and these seven pilot ETS have been functioning since the end of 2013. Based on data for China’s seven pilot ETS, this paper addresses the following issues:

1) To what extent are the existing seven local pilot ETS an effective and efficient market for CO₂ emission rights?

2) Which recommendations can be formulated for China, based on the experiences with other ETS so far, for improving the national ETS, which was

¹Emission trading originated much earlier and was first put to practice in the US for SO₂ and NO_x pollution control.

²The CDM is defined in Article 12 of the Protocol, and is intended to meet two objectives: 1) to assist parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the United Nations Framework Convention on Climate Change (UNFCCC), which is to prevent dangerous climate change; and 2) to assist parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments (greenhouse gas (GHG) emission caps). “Annex I” parties are those countries that are listed in Annex I of the treaty, and are the industrialized countries. Non-Annex I parties are developing countries (Wikipedia).

³The CDM is supervised by the CDM Executive Board (CDM EB) and is under the guidance of the Conference of the Parties (COP/MOP) of the United Nations Framework Convention on Climate Change (UNFCCC).

⁴Developing countries hold the largest share of CDM quotas and hence developed countries are buying them from them, which can be considered as supporting their environmental policies. China has for example developed a series of policies to support pilot work in reducing its carbon emissions and financed them through CDM (Beijing, 2014, issue 10: 8).

launched at the end of 2017?

2. The Initial Development of the CO₂ Emission Rights Trading System in China

Carbon emission trading aims to promote the control of one type of greenhouse gas emission, namely CO₂. There are three mechanisms to curb carbon emissions [2]. A system of production permits which specify a maximum quantity of CO₂, which can be emitted. Secondly, a carbon tax could be charged proportionally to the amount of CO₂ produced and would act as an incentive to lower CO₂ production. Finally, Carbon emission trading is considered the most effective way of reducing CO₂ emissions. The system is based on the price of CO₂, which may stimulate operators to invest in pollution abatement, rather than buying CO₂ emission rights. Because industries in many developed countries have already invested substantially in CO₂ reduction, a dollar invested in a developing country may have more effect than in a developed country. The Kyoto had basic mechanisms for emission reductions, such as the Clean Development Mechanism (CDM) and Emission trading mechanisms.⁵ On February 12, 2014, 3739 registered CDM projects were counted in China [3].

China's carbon market is developing since the National Development and Reform Commission (NDRC) issued its Notice on carrying out pilots of carbon emissions trading in 2011 [4]. At such a market, you buy a carbon credit. A carbon credit is a generic term for any tradable certificate or permit representing the right to emit one tonne of carbon dioxide or the mass of another greenhouse gas with a carbon dioxide (CO₂) equivalent to one tonne of carbon dioxide.⁶ NDRC listed Beijing, Tianjin, Shanghai, Chongqing, Guangdong, Hubei and Shenzhen and in June 2013 Shenzhen opened the first carbon emissions trading market. Beijing and Shanghai launched their markets in the same year. Some 500 companies generating each at least 10,000 tons of CO₂ emissions are subject to quota management and hence are incorporated in the trading system in Beijing. The expectation is that the threshold will eventually be lowered to include also firms emitting between 5 and 10 thousand tons of carbon dioxide per year. Companies producing over 2000 tons per year can also volunteer to participate, which would help them to eventually enter the system [5].

Pilot work has now started in seven provinces and municipalities (Beijing, 2014, issue 10: 17). In June 2013, China started seven pilot emission trading schemes (ETS) in Hubei Province, Guangdong province, Beijing, Tianjin, Shanghai, Shenzhen and Chongqing. March 7 2014 the Beijing Carbon emissions market was operating in the China Beijing environment exchange in the Beijing financial street area for 100 days. It is an online market. However, every day trading transactions had taken place and in this period of 100 days in 2014

⁵The third mechanism (joint implementation) will not be discussed.

⁶The goal is to allow market mechanisms to drive industrial and commercial processes in the direction of low emissions or less carbon intensive approaches than those used when there is no cost to emitting carbon dioxide and other GHGs into the atmosphere.

for 3 million yuan (US\$484,000) transactions were taking place involving 64,217 tons of carbon emissions (Beijing, 2014, issue 10: 8).

These data raises all kinds of questions, such as who are the parties involved, do the prices and quantities trade vary a lot and how important is the “secondary” market for CO₂ emissions (a financial market where you could buy options related to the price of tradable CO₂ emission rights) and how is the system regulated? Trading on the CO₂ emission rights exchange has become more active, with major Chinese and international companies and local and international investors participating [6] [7].

2.1. The Trend in the CO₂ Emissions in China

CO₂ emissions are rapidly increasing in China. The China Daily (10-9-2014: 11) notes that Greenhouse gas levels in China hit new high [8]. **Figure 1** gives the emission of CO₂ in China from 2001 to 2013.

China’s total CO₂ emissions are more than the sum of the US and the EU. China’s per capita CO₂ emissions have surpassed those of Europe (China Daily, 24-9-2014: 1). Although in 2009, during the Copenhagen Climate change conference, China was not yet willing to fix a limit. However, already in December 2014 China has pledged to address total CO₂ emissions (China Daily, 25-9-2014: 1). The Financial Times (28-4-2014: 5) calls this ‘shift in the wind’ the result of pressure from within the country, whereas China had refused to listen to foreign calls to cut carbon emissions.

Table 1 shows the threshold that a company should obligatorily be involved in the pilot emission trading scheme. Total emission of CO₂ of all installations that are being involved in the seven pilot emission trading schemes covers 35% - 60% of the total emission of CO₂ in the seven pilot areas.

Table 1. Threshold that an installation should compulsorily be involved in the pilot ETS⁷.

7 Pilot areas	Threshold (annual emission in 10,000 tons)	Number of installations involved in ETS	Estimated share in total CO ₂ emission in the pilot areas
Beijing	1	415 (2013) 543 (2014)	40%
Tianjin	2	114	60%
Shanghai	Industrial: 1 non-industrial: 2	191 138	50%
Hubei province	6	184 (2013)	35%
Guangdong province	2	190 (2014) 242	55%
Chongqing	2	Industrial 635	40%
Shenzhen	Industrial: 0.5 Buildings 20,000 m ² Government buildings 10,000 m ²	Buildings 197 Total 832	40%

Source: [9].

⁷An “installation” because it could be an individual facility of a company: one factory or a power generation plant of a firm having several installations.

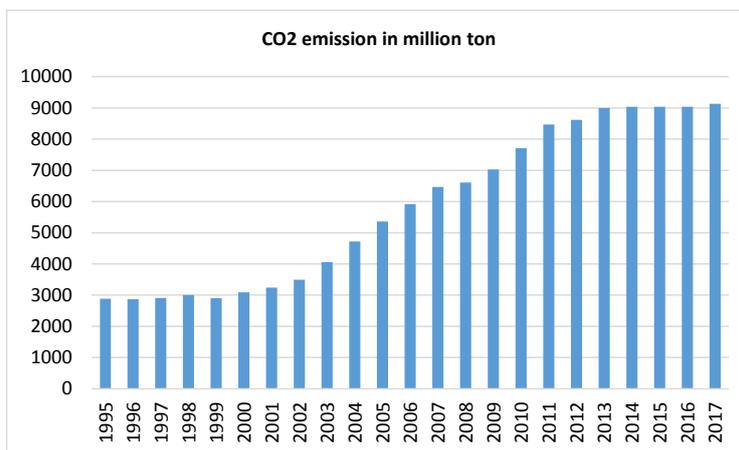


Figure 1. Emission of CO₂ in China: 1995-2017. Source: IEA, CO₂ emission from fuel combustion, OECD/IEA, Paris, 2017.

Although it may sound like a market where physical goods are traded, the CO₂ market in China also makes use of financial instruments to improve its functioning. Not only big polluting companies are buying (and selling if they have managed to reduce their emissions) CO₂ emission rights, also individuals and financial service companies can do so. Their motive is to make money. They hope the price will increase and hence they can sell the rights at a later stage with a profit. This adds liquidity to the market and improves its functioning [10] [11].

2.2. Characteristics of the CO₂ Market in China

Most transactions on the Beijing CO₂ emission rights trading market are made via floor trading, carried out by using the electronic platform of the Beijing Environment Exchange (CBEEEX; Beijing, 2014, issue 10: 19-21). Related party transactions and block transactions can also be made via the over the counter (OTC) trading mode.⁸ It is noted that no daily price limit applies, while there are also pricing and auction transactions. **Table 2** gives the development of the CO₂ market of Beijing between 2013-2015 in terms of volume, average prices paid and turnover.

We note in **Table 2** a gradual but significant development of the CO₂ emissions market between 2013-2015 in terms of volume and turnover. The price is stabilised between 40 - 50 yuan a ton, but with a slightly lower average prices paid and a very limited turnover.

2.3. Further Development of CO₂ Market in China

According to **Table 1**, there are more installations involved in the emission trading schemes in Beijing and Shenzhen than in the other locations. However, the total quota of Shenzhen is only 33 million ton in the first performance year

⁸Over-the-counter (OTC) or off-exchange trading is done directly between two parties, without any supervision of an exchange. It is contrasted with emission trading schemes taking place via an organized exchange.

Table 2. The development of the CO₂ market in Beijing 2013-2015.

Year	Volume	Average price (one dollar is 6.197 yuan)	Turnover
Nov. 28, 2013 in Beijing (trading kick-off day)	3 online deals involving 800 tons	51.25 yuan (US\$ 8.27) a ton	122,050 yuan (US\$ 19,685.48)
2014 March 7, 100 days in business	Transactions were taking place involving 64,217 tons of carbon emissions	484,000 \$/64,217 t (US\$ 0.13268) or 3,000,000 RMB/64,217 t (46.72 RMB/ton)	3 million yuan (US\$ 484,000)
2014	2,106,667 tons	49.83 yuan a ton	105 million yuan
2015	3,160,000 tons	41.46 yuan a ton	131 million yuan

Source: Beijing Environment Exchange,
<http://www.cbeex.com.cn/article/zxdt/bsdt/201601/20160100057721.shtml>.

2013 and the total quota of Beijing is only 50 million ton in the first performance year 2013. Both Hubei and Guangdong have fewer installations involved in the emission trading schemes. However, the total quota of Hubei is 324 million ton and total quota of Guangdong is 388 million ton in the first performance year 2013. The main reason is that both Hubei and Guangdong have more heavy industries (e.g. big chemical industries that are energy intensive), while both Shenzhen and Beijing have limited heavy industries and their economy is focusing on financial and other services. Therefore, the average size of installations in Shenzhen and Beijing is much smaller than that in Hubei and Guangdong.

The Chinese certified emission reduction strategy (CCER; [12]) could reduce CO₂ emissions to a certain degree and the CCER can be involved in emission trading schemes. All seven pilot emission trading schemes allow CCER reducing CO₂ emission to a certain degree. However, for controlling the significant impacts of CCER on the emission trading schemes, all seven pilot emission trading schemes set up a maximum percentage of CCER that could be used for counteracting CO₂ emissions. Hubei, Shenzhen, Guangdong and Tianjin set up the limit of 10%, Chongqing 8%. Shanghai and Beijing: 5%. The following **Table 3** shows the rule of counteracting CO₂ emissions in the seven pilot emission trading schemes.

2.4. The Prices Resulting from Trading and Their Fluctuation

Is this ETS a stable or mature market? Economics would suggest the following criteria for an effective and efficient market [13]: a substantial amount of trade (and traders) dealing at relatively stable prices, covering a big part of the demand and supply, without volatile. There are huge differences between the prices of trading at earlier emission trading schemes stage in the seven pilot emission trading schemes. Among them, prices in Shenzhen were the highest and the prices in Hubei are the lowest. After the initial stage of emission trading schemes, differences in prices among seven pilot emission trading schemes is

Table 3. The rule of counteracting CO₂ emission in the seven pilot emissions trading schemes.

Pilot ETS	CCER percentage	CCER project requirements	Types of CCER projects
Hubei	10% of initial annual quota can be counteracted by CCER However, the max. CCER counteracting amount should be less than 50,000 tons of CO ₂	All CCER projects should be located in Hubei	1) All CCER projects should be registered 2) Non hydropower projects 3) Priority given to agricultural and forest CCER projects
Shenzhen	10% of annual quota can be counteracted	Except agricultural and forest CCER projects, all CCER projects should be located in Shenzhen	Recyclable energy and new energy CCER project Cleaner transportation CCER project Ocean carbon storage CCER project Agricultural & forest CCER projects
Shanghai	5% of annual quota can be counteracted	No requirements	All
Beijing	5% of annual quota can be counteracted in case CCER projects are Beijing local. 2.5% of annual quota can be counteracted in case CCER projects are outside Beijing	More than 50% of CCER projects should be located in Beijing and nearby provinces of Hebei, Inner Mongolia	1) CCER projects after 2013 2) Non hydropower projects 3) Both CCER and energy saving projects 4) Agricultural and forest CCER projects
Guangdong	10% of annual quota can be counteracted in case CCER projects are local	More than 70% of CCER projects should be located in Guangdong province	1) Forest CCER projects 2) CCER projects of hydropower, heating, heat recovering and recovering of gas are not allowed 3) Pre-CDM is not allowed
Tianjin	10% of annual quota can be counteracted	No	1) CCER project after 2013 2) Non hydropower projects 3) Priority given the CCER projects located in Beijing, Tianjin and Hebei province
Chongqing	8% of annual quota can be counteracted	Encouraging local CCER projects	1) Non hydropower projects 2) Encouraging agricultural and forest CCER projects 3) CCER projects after 2013

Source: Policy documents of seven pilot emission trading schemes.

getting smaller and smaller as demonstrated in **Figure 2**, where they are provided from June 2013 (on the left) to June 2015 (on the right).

The table shows price fluctuations in the period of 2013-2014 in the seven pilot emission trading schemes, but also some convergence towards a price range between 10 to 40 , which is lower than the 51.25 yuan originally paid on November 28, 2013, the day the Beijing market started trading.

Table 4 gives the average prices of the seven pilot emission trading schemes in

the performance period of 2013-2014. Again we note a substantial fluctuation over time (volatility), with the variance expressing it and considerable differences between the different locations, where the highest average price (in Beijing) is almost twice the average highest price paid in Tianjin in 2014.

Table 4 shows the volatility of the market, in particular in Shenzhen in 2013 and in Guangdong in 2014. The reason for high variance in Shenzhen is due to the limited governmental intervention. Shenzhen is too much leaving the price development to the market [14]. High variance in Guangdong in 2014 is because the carbon policies in Guangdong are not sustainable.

Prices in Shanghai and Beijing have stabilized. The main reason is that Shanghai has distributed three-year quota in one time (2013), thus the market has very clear understanding of the carbon trading system and very clear market expectations. Although the quota distribution in Beijing is annually based, the

Table 4. Average prices of seven pilot emission trading schemes in the period 2013-2014.

Pilot ETS (Yuan/ton)	Performance period 2013		Performance period 2014	
	Average price	Variance	Average price	Variance
Hubei	-	-	24.34	1.24
Shenzhen	67.67	365.42	44.96	54.56
Shanghai	36.13	21.68	31.56	37.12
Beijing	53.01	5.58	53.19	45.58
Guangdong	62.32	23.68	29.10	129.75
Tianjin	31.28	36.98	23.75	14.87

Data source: Carbon K-line <http://k.tanjaoyi.com/>; till 28 June 2015. Chongqing is not included, since there are limits to trading in Chongqing in 2013-2014.

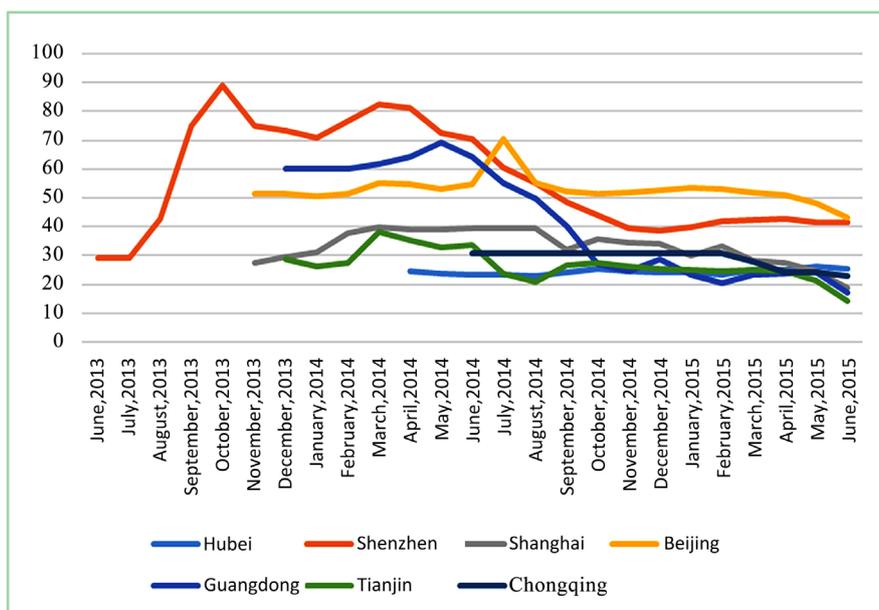


Figure 2. Average prices of seven pilot ETS China during the period of June 2013-June 2015⁹.

⁹Source: Carbon K-Line <http://k.tanjaoyi.com/>, consulted 19-9-2016.

quota for coming three years is already fixed (same as Shanghai) and thus carbon market is also quite stabilized.

2.5. The Quantities Traded

Figure 3 shows the quantities traded in the seven locations in tons and Yuan until mid 2015.

Hubei emission trading scheme has the biggest amount of trading, sharing 48% of total trading amount of the seven pilot emission trading schemes. In the performance period of 2013, most trading happened in the last month of the performance period in Shenzhen, Shanghai, Beijing and Guangdong. The last month trading amount shares 65% of the total trading amount of the performance period (2013). This situation has changed somewhat in the performance year 2014, in which almost 50% of the total trading took place in the last month trading of the performance year. The high share of the last month trading shows that the motivation of most installations involved in the emission trading schemes is still to comply with local emission regulation. It is not related to the price of reducing emission of CO₂. Bringing down the price is an important objective of any emission trading scheme. Therefore, it is still a big challenge for future emission trading schemes how the emission trading schemes could facilitate a reduction of the costs of reducing CO₂ emissions. The conclusion is that the quantities traded are still small, although they are gradually increasing.

2.6. Daily Changes of Trading Amount during the Period June 2013-June 2015

Figure 4 shows the daily changes in trade for six locations.

Among the seven pilot emissions trading schemes, only 12 times real trades happened in Chongqing. Hence the Chongqing emission trading scheme is not successful. The main reason for this failure is that Chongqing has allocated in the beginning too many quota to installations involved in emission trading schemes. Quota were confirmed, based on the highest emission amount in the history of an installation and hence every installation has enough CO₂ emissions rights allocated to it by local government. There is no real carbon market in Chongqing. The issue of the initial allocation of CO₂ emissions allowances is important and discussed by [15]. **Table 5** gives the planned and the real performance for 5 locations currently involved in the system, showing some real business and a high rate of performance.

2.7. The Case of Beijing

The following **Table 6** gives the amount and value of the trade in Beijing. The picture is very much the same: small quantities, big variations in prices and a lack of more recent data.

Below we show the monthly variation in the amounts traded, the value of the trade and the average price (**Figures 5-7**).

The figures depict a clear upward trend for the amount traded and the total value traded, with peaks in June and July when the rights need to be sold. The average price was relatively stable in 2014, but July showed again an outlier.

Table 5. Overall performance among the seven pilot emission trading schemes.

Pilot ETS	Planned performance time	Real performance time	Number of installations involved	Installations performing well	Rate of well performing installations
Shenzhen	30 June	possibility of extension to 30 July	635	631	99.4%
Shanghai	30 June	30 June	191	191	100%
Beijing	15 June	possibility of extension to 27 June	415	403	97.1%
Guangdong	20 June	15 July	184	182	98.9%
Tianjin	31 May	25 July	114	110	96.5%

Source: Beijing Sinocarbon (2014).

Table 6. CO₂ emission rights traded in the Beijing market in 2014.

Month	Amount of trade (ton)	Value of trade (Yuan)	Aver. price (Y/ton)
1	3170	158,995	50.16
2	9800	508,455	51.88
3	21,700	1,248,340	57.53
4	22,600	1,223,070	54.12
5	80,973	4,298,270.9	53.08
6	441,823	24,113,098.3	54.58
7	357,606	25,487,543.8	71.27
8	17,003	876,525	51.55
9	27,600	1,416,025	51.31
10	15,450	785,285	50.83
11	26,000	1,335,700	51.37
12	43,550	2,246,280	51.58

Source: Beijing electronic trading platform for carbon emission trade.

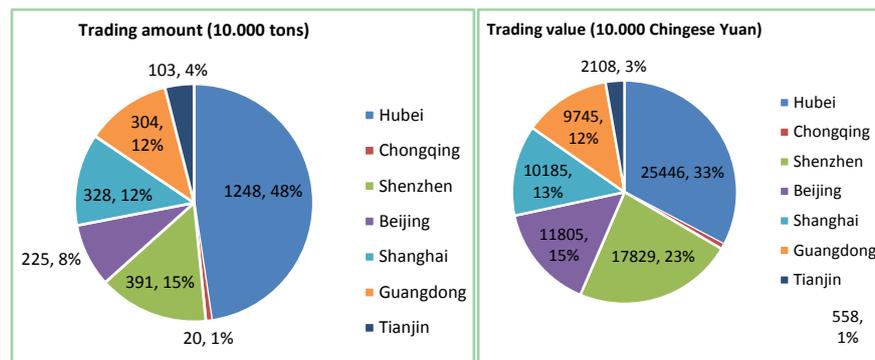


Figure 3. Amount and value of carbon trading in China (till 28 June 2015) Data source: Carbon K-line <http://k.tanjaoyi.com/>.

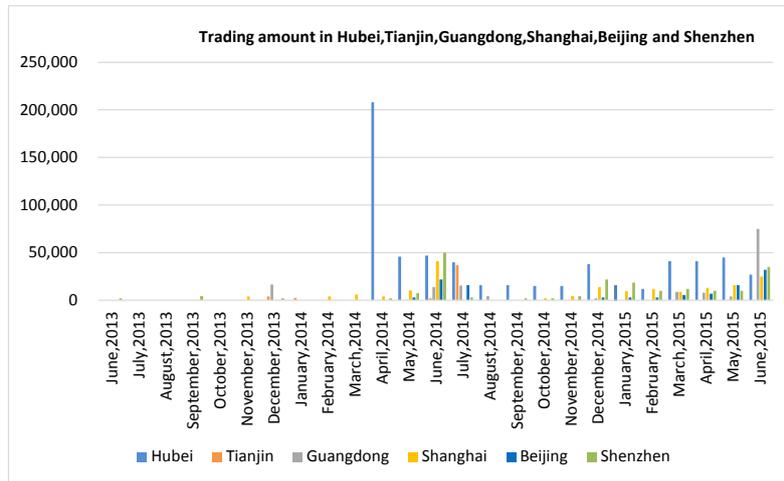


Figure 4. Daily average trading amount in June 2013-June 2015 in pilot emission trading schemes (tons). Source: Carbon K-line <http://k.tanjiayoi.com/>; till 28 June 2015 Note: There were only 12 trades in Chongqing in 19 June 2014, 17 March 2015 and June 2015. Hence Chongqing is not included.

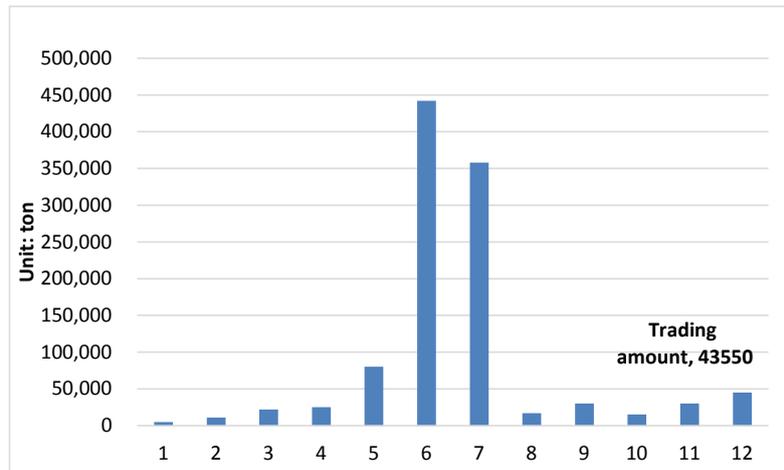


Figure 5. Amount of trading in Beijing in 2014.

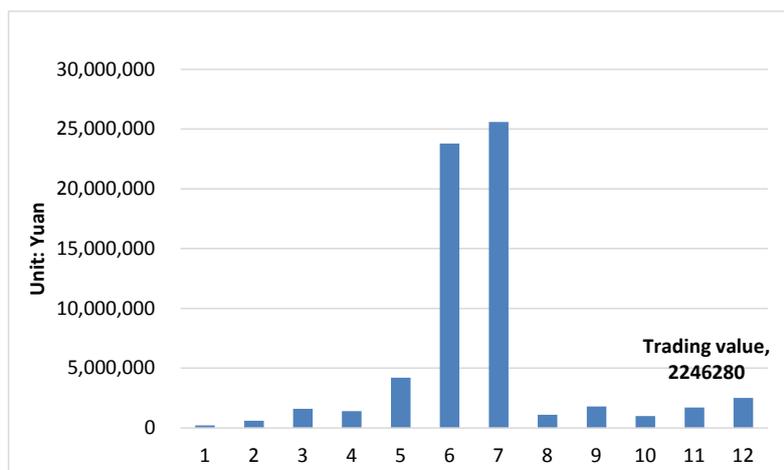


Figure 6. Value of trading in Beijing in 2014.

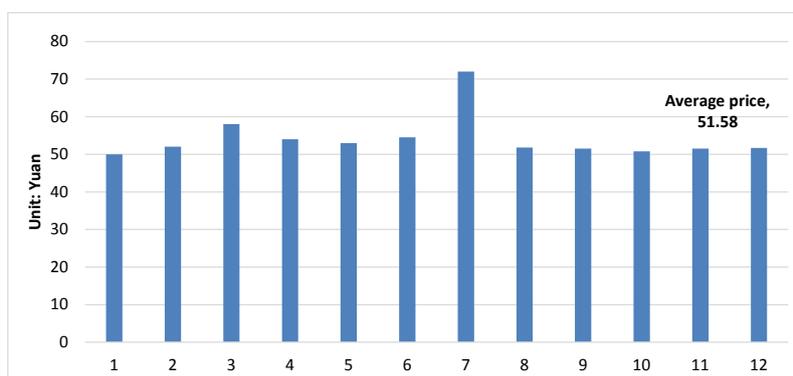


Figure 7. Average price in Beijing in 2014.

2.8. The Case of Shanghai

The following **Table 7** provides a summary of the CO₂ traded in Shanghai in 2014. We also note strong fluctuations in the quantity and (less) in the price per ton.

Figures 8-10 depict a similar trend as in Beijing. An upward trend for the amount traded and the total value traded of CO₂ emission rights, with a peak in June. The average price was relatively stable in 2014, with even in July only a slightly higher price.

3. Factors Determining Whether the Market Will Lead to the Reduction of CO₂ Emissions

Is there a relation between trading emission rights and reduction of emissions? According to the Financial Times (20-8-2015: 2) China's emissions are not as large as expected. This is in line with news that coal mines have reduced production or shut down (International New York Times, 19-9-2015: 1). Declining production of coal contributes to achieving the CO₂ emission reduction objectives [16]. The CDM may also continue to help China to achieve its goals [17] [18]. However, how will China be affected by the collapse in the CO₂ prices in Europe? The European market for CO₂ emissions has faced a number of problems [19]:

- 1) The importance of a number of alternative sources of energy (in particular wind and solar energy) and the resulting reduction in power generation and hence in the demand for CO₂ emissions rights.
- 2) The economic crisis has led to less economic growth and hence less CO₂ emissions.
- 3) Originally the EU and the member countries have issued too many CO₂ emissions rights for free.
- 4) The low price means that the big polluters can continue to pollute because they buy cheap CO₂ emission rights.

From our research the following factors influence whether this national CO₂ emissions rights trading market will be a success and contribute to the reduction of CO₂ emissions:

Table 7. Trading summary Shanghai 2014.

Month	Amount of trade (ton)	Value of trade (Chinese Yuan)	Average price (yuan/ton)
1	6650	208,953	31.42
2	60,002	2,295,012	38.23
3	113,303	4,446,630	39.25
4	69,700	2,735,490	39.25
5	164,758	6,007,070	36.46
6	1,114,777	44,156,118.2	39.61
7	0	0	0
8	0	0	0
9	23,400	765,360	32.71
10	32,600	1,096,110	33.62
11	84,060	2,945,285	35.04
12	314,584	10,748,198.9	34.17

Source: Shanghai environment and energy exchange.

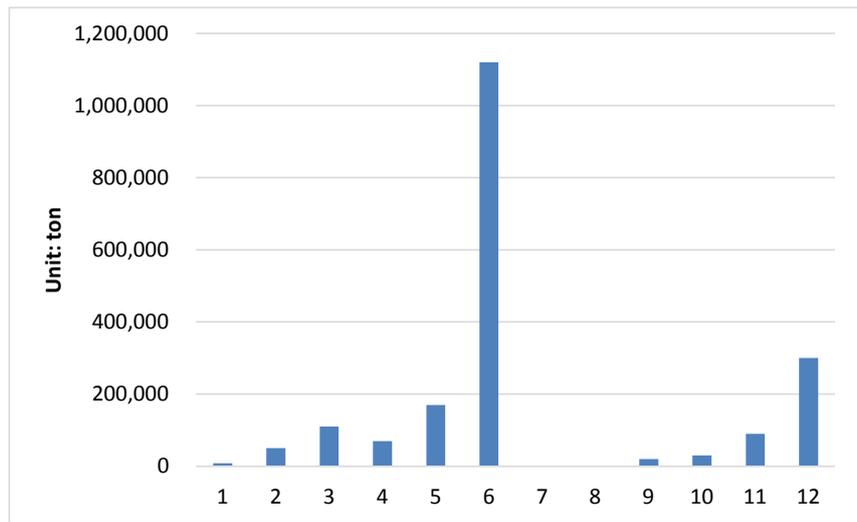


Figure 8. Amount of CO₂ traded in Shanghai in 2014.

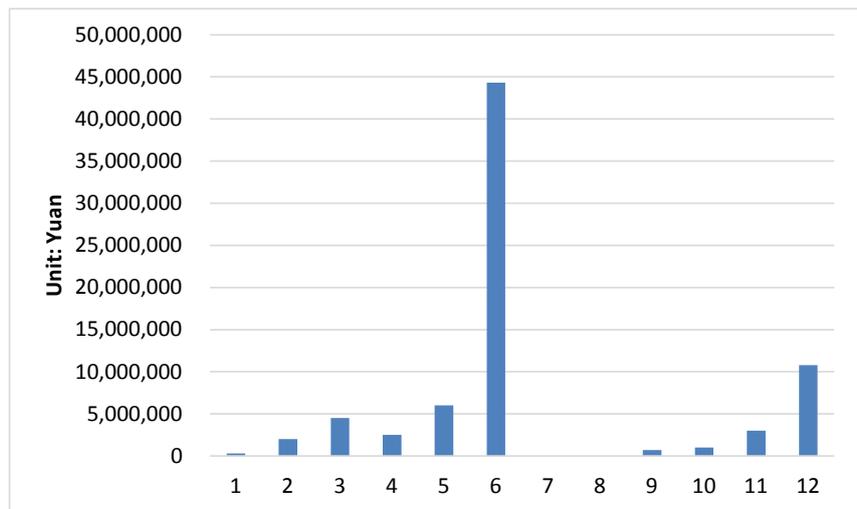


Figure 9. Value of trading in Shanghai in 2014.

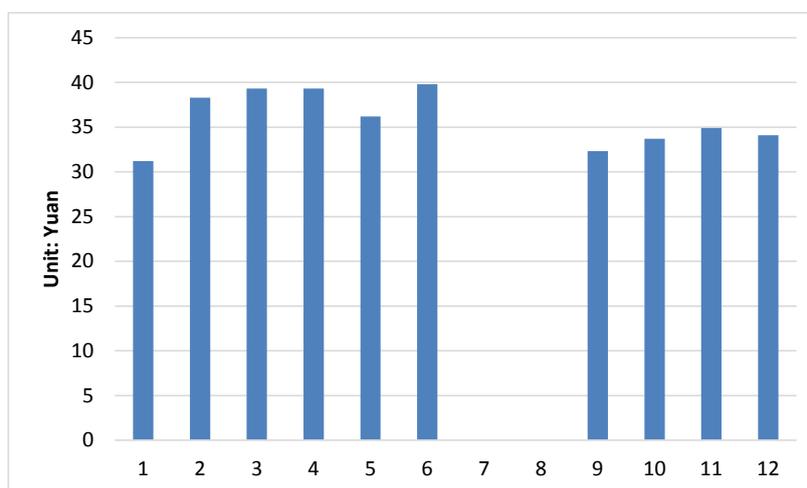


Figure 10. Average price in Shanghai in 2014.

- 1) The capacity of the Chinese government to stabilize the price and to providing the political support to keep the system going;
- 2) Obliging smaller manufacturing units to buy the CO₂ emission rights. It is planned that as of 2017 also companies producing 5000 tonnes of CO₂ emissions must buy the CO₂ emission rights. This will broaden the market, but also make compliance with existing regulation more complicated;
- 3) Enough market parties need to be interested in buying the CO₂ emission rights;
- 4) China must put the right regulation in place and be willing to implement the agreed policies.

4. Going from Local Pilot ETS to a National ETS: Can the Market Become a National One?

Experiences gained from the seven pilot ETS China show that the following key factors are influencing CO₂ prices. From the supply side:

- 1) The total amount of quota that local authorities allocated to the market.
- 2) The amount of remaining emission rights that have not yet been traded in the previous phase. Both the EU and China allow companies/installations to keep a certain amount of emission rights that have not been traded in the previous phase and those can be traded in the next phase.
- 3) The amount of CCER that can be traded.
- 4) The quantity of emission rights retained by local government. In all seven pilot ETS in China, local authorities are storing a certain amount of emission rights for stabilizing the carbon market at a later stage.

From demand side:

- 1) Real requirements of emission rights for companies or installations in their production process. Local governments China have set up CO₂ emission objectives for all big companies, but many are not included yet.
- 2) Companies or installations may buy emission rights for their future devel-

opment (expansion, or upscaling company size).

- 3) Financial service companies or individuals are willing to be involved in the ETS for carbon investment making profits because the prices fluctuate.

Drawn upon experiences and lessons learned from the EU ETS, China's carbon trading pilots have designed some effective features in allowance allocation and distribution, which include an allowance allocation rule based on historical emissions combined with some benchmarking, a free allowance distribution arrangement combined with some level of auction, and pre-determined quotas combined with ex-post allowance adjustments. There are also some particular issues related to China's carbon trading pilots. The issues regarding the design of the allowance mechanism include over-supply of allowances, lack of allowance credits for businesses that take early abatement actions, double-counting of allowances, a heavy reliance on historical emissions, and lack of clarity and transparency of administrative rules governing the allowances allocation and distribution. In order to develop a robust and effective a national level carbon trading scheme in China, it is critical for the country to thoroughly assess the problems that have been revealed in the seven carbon trading pilots and carefully identify ways to address these issues.

5. Conclusions and Policy Implications

Is the CO₂ emission rights trading market sufficiently deep to be expanded? We conclude that it seems like China is better placed to control greenhouse gas emissions and in particular CO₂ emissions in the near future. The CO₂ emission rights trading systems in place imply registering the quantity of CO₂ emissions produced and providing incentives to the polluters to cut down on CO₂ emissions.

Is this a stable or mature market? To assess this, we studied the prices resulting from trading, using criteria such as size of the market (a substantial amount of trade), trading at relatively stable prices, covering a big part of the demand and supply, without volatile variations. The data show that the current system is at an early stage of development and the quantities are limited, while the prices are declining. The fluctuations are big and the question is how the collapse of the European system bodes for China, in particular if we want to go in the direction of a national carbon trading scheme? China must try to make the market more active by including other cities and regions and more companies and other polluters. It should avoid providing CO₂ emission rights for free and harmonize regulation.

It is important to try to harmonize the regulation, in particular if in the long run we want to go to a worldwide CO₂ emission rights trading scheme. It is also necessary to undertake research into the alternatives for a market for CO₂ emission trading rights and how these developments would affect the Chinese system [20]. A world-wide tax on CO₂ should be considered. However, it is clear that no country alone could introduce such a tax, without putting its competitiveness at risk. We consider it unlikely that the National scheme will begin in 2017, despite

the expressed intentions (Financial Times 29-9-2015: 4). The conditions do not seem to be in place yet.

However, China launched national ETS at the end of 2017, based on the experiences and lessons learnt from the seven local pilot ETS [21]. Based on the economic theory about markets, the following four recommendations are crucial for China to create an effective and efficient national ETS:

- 1) A large number of actors involved. The successful pilot ETs of Beijing and Shenzhen show that the number of actors involved in ETS is more important than the total quantity of tons of CO₂ traded. This is also the case of the Hubei ETS. A lack of enough actors is the key factor for the failure of Chongqing ETS in the first trading year.
- 2) Stabilized prices. Both the EU ETS experiences and the Chinese pilot ETS show that relatively stabilized price is one of the key factors for an effective ETS. By learning from international experiences, China has already developed a number of instruments from both supply side and demand side for ensuring the stabilization of prices.
- 3) Fluctuations under control. Fluctuation is possible in a mature market system. However, a mature market system should have certain mechanisms to ensure that the fluctuation remains under control. China is a big country and there are significant differences in terms of economy, culture and social development between eastern China and western China. It is estimated that there is a high possibility of strong price fluctuations when one national ETS will be in place. Therefore, the national authorities of China should set up an effective regulatory and economic mechanism to ensure that the fluctuations remain under control.
- 4) A longer period for trading. In addition, it is also recommended that China fixes a relatively long period for the trading phase (e.g. 3-5 years), instead of a one year trading phase, which is currently the case in the seven pilot ETS. A longer period for a trading phase will ensure that installations and actors involved will have more clear understanding of the market and will motivate installations and actors involved in increasing investment in low-carbon technology, which may lead to a reduction of emissions in the long run.
- 5) There are a number of issues in the design of the carbon allowances in China's 7 pilot ETS due to the limited preparation and lack of reliable production and emissions data. These issues become evident after 1 - 2 years in operation of these pilots. It is important for China to address these issues to meet the country's ambition to create a national carbon trade market.
- 6) In China's 7 pilot ETS, rules published by the program administrators that govern allowances allocation and distribution lack the necessary clarity and transparency. Most of these rules are described merely in very general terms without specific details. Important information such as what and how various factors are used to determine the allowances have not been provided. However, this type of information is important as it helps covered entities understand the efforts they need to make to reduce their emissions and en-

ables researchers to identify potential flaws in the allowance system design. It will be in China's benefit to strengthen transparency in the design of its allowance allocations and distribution. In this respect, the EU ETS set good examples. They not only timely publicize their legislative documents involving the allowance mechanism, but also develop a large number of explanatory documents providing the details of the allowances allocation and distribution.

We finish with listing the challenges for the market of CO₂ emission rights in China, which require more research:

- 1) Are the ETS properly regulated to deal with fluctuations in the future?
- 2) What is the long-run impact for China of the collapse in the CO₂ prices in Europe?
- 3) Is there an empirical relation between CO₂ trading and reduction of CO₂ emissions?
- 4) What will be the role of the clean development mechanism (CDM) in the future, now that Kyoto has finished?

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