The Maturity Analysis of China's Carbon Market—Taking the 7 pilot zones as an example

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Abstract

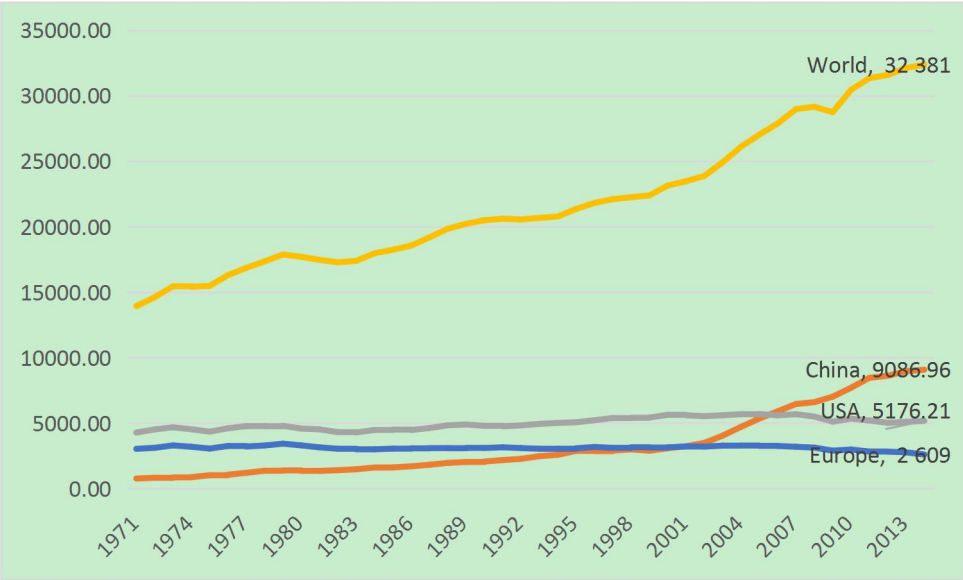
China has co-ratified Paris Agreement with the U.S. in G20, Hangzhou, 2016, which brings a new era of global climate governance. A bottom-up structure of a new global climate regime becomes more likely to be set up. To show China's ambition of climate mitigation, the Chinese government announced to start a national carbon market in 2017, on the basis of the operational experiences of the 7 pilot carbon trade zones in the provinces of Hubei and Guangdong, and municipalities of Beijing, Tianjin, Shanghai, Shenzhen, and Chongqing. A market would experience the development of the emerging stage, the in-transition stage, and the mature stage. The maturity degree of a carbon market will highly influence the efficiency of this national carbon trade policy. This paper will set up a system of indicators in the form of an evaluation model to find a maturity degree of China's existing carbon market in the 7 pilot zones. Meanwhile, the authors intend to figure out the possible measures to enhance the maturity degree of the incoming national carbon market in China.

Key words: Carbon Market, China, Climate Change

1. Introduction

Climate change is one of the biggest challenge to human beings in the 21st century. In the 5th Assessment Report of the Intergovernmental Panel on Climate Change(IPCC-AR5), nearly 2000 climate experts and scientists believe that the human emitted greenhouse gases are extremely likely responsible for more than 50% of the global warming since 1951[1].

Latest IEA data show China's CO_2 emissions reached 9.76 billion tonne in 2014 which takes 27% of the world total CO_2 emissions. The emissions from EU and US together reached 9.7 billion tonne CO_2 in 2014. This is the first time in history that China's CO_2 emission exceeded the biggest developed economies. Furthermore, China's CO_2 emissions from fuel combustion also reached 9.09 billion tonne in 2014. China has been the world biggest CO_2 emitter since 2007. See in Figure 1 for detailed information.



Unit: 1000t CO_2

Figure 1 China's CO_2 Emissions from Fuel Combustion, 1971-2014

Source: IEA, CO_2 Highlights 2016.

China's carbon emissions are still in rise, while in Europe and USA, the total carbon emissions are already on the way for a long term decrease. That means the emission gaps will also keep increase.

In the merits of Common But Differentiated Responsibilities, China and nearly all other Party Members to (UNFCCC) signed the landmark Paris Agreement in 2015. China then co-ratified

[1] IPCC,2014.

Paris Agreement with the U.S. in G20, Hangzhou, 2016, which brings a new era of global climate governance. Paris Agreement comes into force on the 5th of November 2016, and a bottom-up structure of a new global climate regime was established.

China planned to start the pilot carbon market scheme as early as in the October of 2011. China's National Development and Reform Committee(NDRC) launched the Notice of Starting the Work of Carbon Emission Trading Pilot Scheme, in which Beijing, Shanghai, Tianjin, Shenzhen, Chongqing, Guangdong, and Hubei are selected as the pilot cities and provinces. In this working plan, the piloting period was expected to be two years. The real pilot trading scheme began in 2013, and was prolonged till now. Responding to the call from the United Nation Framework Convention on Climate Change(UNFCCC) for Intended National Determined Contribution(INDC) and the National Determined Contribution(NDC) of Paris Agreement, China decided to decrease its CO_2 intensity in GDP for 60-65% in 2030 on the basis of 2005. Limiting to China's development stage, this domestic target is really ambitious.

In order to meet the target and fulfill the implementation of Paris Agreement, China's central government decided to establish a integrated national carbon market in the year of 2017. The industry coverage includes the sectors of iron and steel, power production, chemistry, construction materials, paper making and other key sectors. The number of controlled firms under this national carbon trading scheme is more than 7000. The emissions coverage is expected to reach 40-50% of its total CO_2 emissions and it is expected to grow as the national carbon market grows. It seems that China is expected to establish the largest carbon market in the world. The expected trading volume is 3-4 billion tonne CO_2, and the expected trading amount is around 8 billion Yuan RMB per year. Further more, if consider the market scale of the future market of carbon trade, the trading amount is expected to achieve 400 billion Yuan RMB.

According to the general working plan for a national carbon market in China made by National Development and Reform Committee(NDRC), there are three expected periods for the implementation of the construction of a national carbon market. The first period is from 2014 to 2017, which is the preparatory period, when the 7 pilot carbon markets are established. The second period is from 2017 to 2020, when the first formal national carbon market is kicked off. The third period is expected to start from 2020, when the carbon market could run into a high

development stage[2].

Certain study shows the integration level of seven pilot carbon markets is not high enough for a unified national market. Some of the reasons lie on the lack of linkage among pilot markets from the designing steps, differentiated MRV systems, and uneven legislation systems,etc.. Among the 7 pilot markets, Hubei and Guangdong, because of their market scale and advanced market structure, are probably becoming the future centres of an expected national carbon market.[3] At this turning point to start a national carbon market in 2017, it is crucial important to examine the current situation of the 7 pilot carbon markets. Once the current situation is clear and agreed, the future implementation could be imagined and explored.

2. Methodology

This paper use a method of Maturity Model to analyze and investigate the current situation. Carnegie Mellon University's Software Engineering Institute proposed the Capability Maturity Model (CMM) [4] which became the prototype model, on which all other maturity models were evolved. CMM helps to evaluate the capabilities and "maturity" of an organization in regards to its software development processes. The Model has then been varied and extended to be used in many industries and areas to measure the current maturity level of a certain aspect of an organization, or a market, in a meaningful way, enabling stakeholders to clearly identify strengths and improvement points, and accordingly prioritize what to do in order to reach higher maturity levels[5].

Maturity levels are defined as a series of sequential levels, which together form an anticipated or desired logical path from an initial state to a final state of maturity[6]. Maturity models are defined as tools used to evaluate the maturity capabilities of certain elements and select the appropriate actions to bring the elements to a higher level of maturity[7]. Most of the maturity models are used in the quite diverse domains, from software engineering to asset management and information governance[8]. In China, most of the maturity assessment and research

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[2] Gu Yang, 2015.
[3] Xie Xiaowen, et. al.,2017.
[4] M. Paulk, et. al., 1993.
[5] Diogo Proença, et. al., 2016.
[6] M. Röglinger, 2011.
[7] M. Kohlegger, 2009.
[8] M. Koshgoftar, 2009.

are focusing on the areas of market maturity evaluation, such like stock market[9], land market[11],labor market[12] and logistic market[13], etc.. Normally, there is a two dimension matrix representing the level of market maturity and the evaluating aspects. Choosing indicators for each every evaluating aspects differs among different cases. In that sense, this paper follows the principle logic of the Maturity Model and develops a specific evaluating structure for China's case.

Based on the Maturity Model, this paper sets up an indicator system. The first level indicators include 3 factors, which are Market Scale, Market Structure, Market Efficiency.

Market Scale reflects the capability of a market to provide enough competition. The second level indicators of this factor include: 1) the number of firms under controlled, 2) the proportion of total carbon emissions covered, 3) the volume of trading deals, 4) and the duration of the market.

Market Structure reflects the stability and abundance of a market. The second level indicators of this factor include: 1)the number of third party entities, 2) whether the market is under well established legislation system , using 1 to show yes and 0 to show no, 3) Industry coverage, and 4) size of the controlled firms.

Market Efficiency reflects the activity and efficiency of a market. An efficient market can have its information clear, which means it could find a price, and the price should be stable to go up and down around the true value of the products. To some extent, the price could send good signals in the market and to the substitute and complement markets. The second level indicators of this factor include: 1) the level of participation of the firms under controlled, 2) whether the fluctuation of the prices is sharp, using 1 to show yes and 0 to show no, 3)whether the price could influence relative price of the coal market in terms of the current price and future price, and 4)whether the price is around the true value of carbon property.

The structure of this indicator system could be better seen as in the table below:

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[9] Bao, 2015.
[11] Yu, 2008.
[12] Tian, 2016.
[13] Feng, 2011.

Table 1 The Indicator System of the Maturity Model

Order and Abbreviation of Indicators	First Level Indicators	Allocated Evaluating Score	Second Level Indicators	Allocated Evaluating Score
1 MSc	Market Scale	100/3	1.1 the number of firms under controlled	100/12
			1.2 the proportion of total carbon emissions covered	100/12
			1.3 the volume of trading deals	100/12
			1.4 and the duration of the market	100/12
2 MSt	Market Structure	100/3	2.1the number of third party entities	100/12
			2.2 whether the market is under well established legislation system	100/12
			2.3 Industry coverage	100/12
			2.4 size of the controlled firms	100/12
3 ME	Market Efficiency	100/3	3.1 the prices of the trading deals	100/12
			3.2 whether the fluctuation of the prices is sharp	100/12
			3.3 whether the price could influence relative price of the coal market in terms of the current price and future price	100/12
			3.4 whether the price is around the true value of carbon property	100/12

The table above shows the scores that attributed to every each indicators. As this is a first try to evaluate the maturity of a carbon market, all 100 of the scores are equally attributed to 3 first order indicators, and then also equally attributed to 12 second order indicators. Using the data available and necessary subjective judgment of the author, with the experiences in literature, the paper is to score the current maturity level of the 7 pilot carbon markets in China.

The paper will then move to do more investigation on the maturity degree of China's 7 pilot carbon markets. After collecting data of the second order indicators, we need to normalize the data matrix. Here we use a maths trick, called 0-1 normalization, to make the data matrix normalized for evaluation. The function for data normalization is shown as below:

$$x^* = \frac{x - \min}{\max - \min}$$

In the function, x* is the normalized data, which lies in [0,1], x is the observed data, max is the maximum observed data, and min is the minimum observed data. Take note that the virtual variables, such like 2.2, 3.2, 3.3, and 3.4 do not need normalization. Once the evaluating data

matrix is normalized, we times the attributing score, 100/12, to the sum value of all 12 second level indicators of every market, and get the final evaluating score of the pilot markets. Generally, if the final score is above 60 out of 100, that market is graduating from the Pilot Stage and move to the Standardizing Stage. With the general image of a pilot market, the evaluating work will be done on the basis of the following standard, as in Table 2.

Table 2 Standard of the Maturity Model

Maturity Degree	**1 MSc**	**2 MSt**	**3ME**
Pilot Stage	small	establishing	low
Standardizing Stage	increasing	improving	medium
Mature Stage	more	mature	high

The level of maturity of the market could then be defined as below:

Level 1: A Pilot Market. In this stage, a carbon market could merely find a carbon price, not really reveal the true value of carbon property. The trading are not voluntarily dealt by traders. The participatory proportion of the controlled firms is not high. Statistically, the trading scale is relatively small, market structure is just establishing, the market efficiency is low, and the market function is not fully developed and the quality of the participating firms is not good enough for a free trade.

Level 2: A Standardizing Market. In this period. The maturity level of the market scheme is growing with the former experiences. More and more firms become realizing the function of such a carbon market and begin to learn and adapt to this forming market scheme. From the data, we can see the participation rate of the controlled firms into the carbon market is growing, the market scale is increasing, the legislation system of the market is strengthening, the price is becoming independent and stable, and the firms are more capable for a free trade in the market.

Level 3: A Mature Market. A mature market could reveal the real value of carbon property, and what's more, it could influence the relative market and behavior of the controlled firms. Especially, it will help to enhance the awareness of low carbon development and improve the technology application and research for a low carbon transformation of the whole industry.

It is not easy to figure out the exact line between the three levels. This paper could only do

some primary analysis based on the statistical appearances of the 7 pilot markets. In that way, the results of the analysis only show the comparison among the 7 pilot markets.

3. Data and Result

3.1 Data Structure and Sources

The data within this paper includes only open sourced information from each relevant data platform.

（1）Market Scale

Under the great expectation of China's national carbon market, it is quite important and necessary to figure out the situation in the pilot carbon markets. Data shows that the accumulated trading volume of the current carbon emission quotas in pilot markets achieved 120 million tonne CO_2 till 2016, the accumulated trading amount of which reached more than 3.2 billion RMB[14]. The market scale could be simply seen from a single aspect in Figure 1 below.

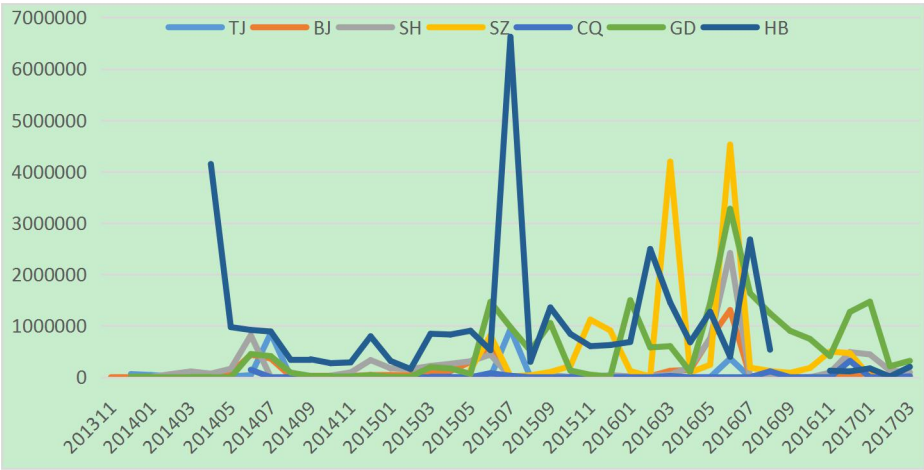

Figure 2 Trend of Carbon Trading Volume of the Pilot Areas

Data Sources: Open trading platforms for pilot markets.

The volume of carbon trading are almost periodically fluctuated according to Figure 1. To some extent, this periodically peak and valley of trading volume is in line with the arrangement of each pilot market. The carbon emission quota submission time differs among the 7 pilots. Normally the volume of trading peaked before the deadline of quota submission day, and went plain for all the implementation year. It is more clear when we compare the price and volume for a

[14] Energy and Environment, 2017.

certain pilot market alone.

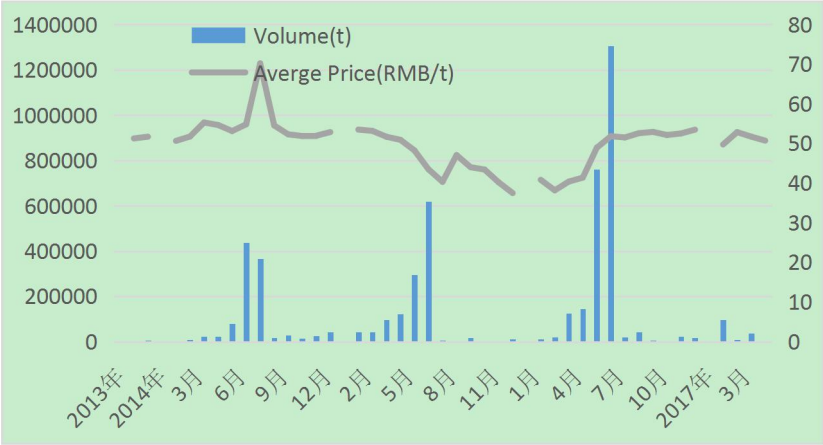

Figure 3 Trading volumes and prices of Beijing Carbon Market, 2013-2017

Data Sources: Beijing Carbon Exchange Platform, 2017.

Figure 3 shows the trading volume in Beijing pilot carbon market, increase sharply in every June and July, and the trading volumes in these two months generally increase steadily from year to year. While in other months of the year, the trading volumes stay in a very low level, and do not show clear fluctuation from year to year.

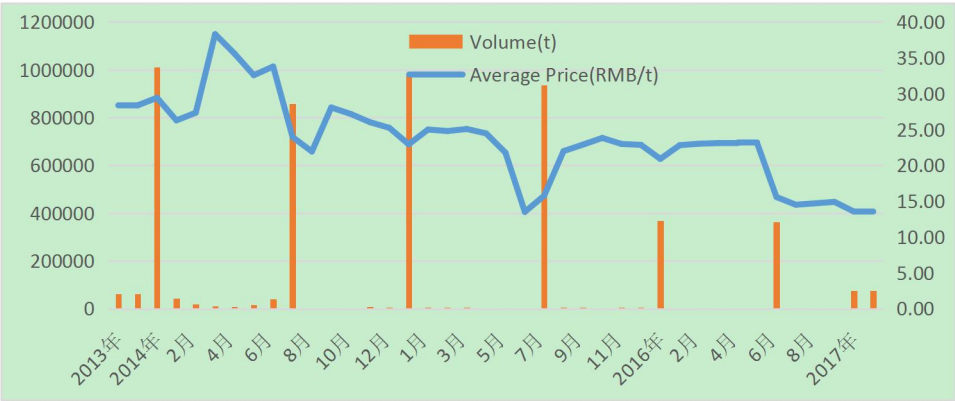

Figure 4 Trading volumes and prices of Tianjin Carbon Market, 2013-2017

Data Sources: Tianjin Carbon Exchange Platform, 2017.

The fluctuation in trading volume also peaked from time to time in a lone term, while the peaking month is not as stable as that in Beijing pilot. See Figure 4 above. It seems that there are two peaking months in January and July. And the trading peak volume does not grow from year to year, but shows a somewhat decrease. The rest of months in the trading year, the trading volume shows a similar low flat line as in Beijing market.

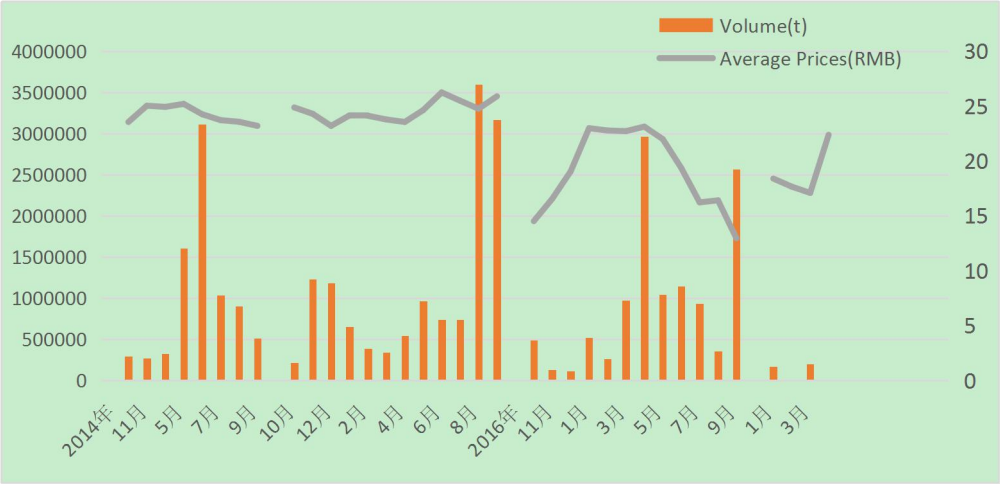

Figure 5 Trading volumes and prices of Shanghai Carbon Market, 2013-2017

Data Sources: Shanghai Carbon Exchange Platform, 2017.

The trading volume of Shanghai pilot peak from time to time, too. The peaking months concentrated in the middle of the year, from April to September. This situation is different from that in Beijing and Tianjin. The differences and gaps in trading volumes between the peaking months and the rest months of the trading years seems smaller than the other two pilots above.

Above three figures show the typical trading volume fluctuations of the pilot carbon markets in China. Generally, the trading volumes are greatly influenced by the design of the trading scheme. That means the markets are not totally self-operation and the trading deals are not quite in a free and random way.

（2）Market Structure

All pilot carbon markets were rapidly established according to the call from the central government, while the market structures of which differs a little from each other, but not much. Industry coverage and size of the controlled firms differ the most among pilot markets.

Table 3 Industry coverage of the 7 pilot markets

Pilot Markets	Industry Coverage
Beijing	Electricity, Heat, Cement, Petrol Chemistry, Mobile Cars, other industry and Service Sector.
Tianjin	Electricity, Heat, Iron and Steel, Chemistry, Petrol Chemistry, Oil and Gas Exploration.
Shanghai	Iron and Steel, Petrol Chemistry, Chemistry, Non Ferrous Metal, Electricity, Construction Material, Textile.
Chongqing	Electrolytic Aluminum, Alloy Aluminum, Flint, Soda, Cement, Iron and Steel.
Shenzhen	Industry Firms and Large Public Buildings.

Guangdong	Electricity, Cement, Iron and Steel, Petrol Chemistry, Paper Making, Civil Aviation.
Hubei	Construction Material, Chemistry, Electricity, Metallurgical Industries, Food and Drink, Oil, Mobile Car, Chemical Fiber, Medicine, Paper Making.

Source: Open files from China's National Development and Reform Committee(NDRC) and local DRCs.

Besides, the allocation methods differ among pilots. Most of the pilot markets use historical emission method and benchmark method to allocate the emission quotas, and a small part of the markets use partially auctioning method to allocate the emission quotas. That is because in the primary period of the piloting scheme, using historical emission method is the easiest way to operate, and could get the best respond from the trading firms.

（3）Market Efficiency

An efficient market could find a price, the price then could reveal the real value of the products. Further more, the price could influence relevant other market prices, and send signals to the market and society to establish a long term confidence on the targeting products. In that way, the behavior of the firms could be changed accordingly, and R&D investment could be increased for the target products. Ultimately, the mitigation cost could be decreased down to a favorable level, and the mitigation technology could be improve from time to time. The welfare of the whole society could also be improved.

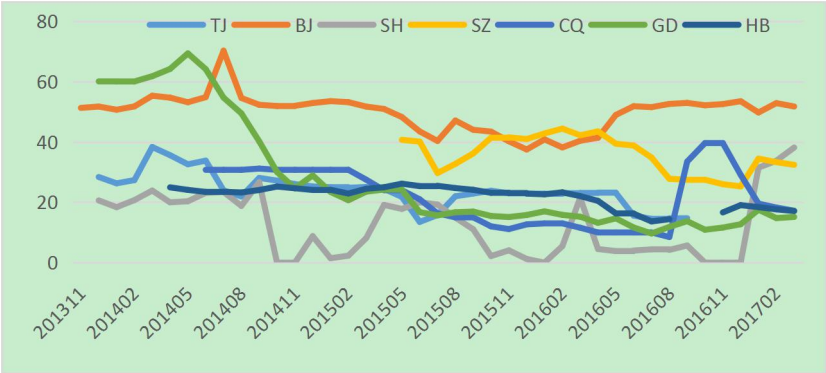

Figure 6 Trend of Carbon Trading Price of the Pilot Areas

Data Sources: Open trading platforms for pilot markets.

Figure 6 shows that the pilot carbon markets do find some carbon prices in the duration of the pilot scheme. In some cases, the prices fluctuated sharply in line with the market demand and supply changes, and in some other cases, the price curves seem to be quite plain. For example, in

Shanghai, Chongqing, and Guangdong the peak and valley of the price curves are quite sharp. To some extent, this situation could be attributed to the trading volume fluctuations.

Figure 7 Average Carbon Prices of the 7 Pilot Markets in 2016

Source: Open data on the market platforms.

Figure 7 shows that the differences in carbon prices among the 7 pilot markets are large. That reveals a fact that the pilot markets are operated in isolated boundaries. The current integration degree among the pilot markets is quite low. Besides, according to previous study on the shadow price of carbon[15], the climate mitigation cost could reach as high as 21695.32 Yuan RMB per tonne CO_2 in early 21st century in China. Study also show that the average CO_2 shadow price of China's iron and steel industry from 2006 to 2012 increased from 1981.76 to 4227.89 Yuan RMB per ton[16]. Under unfavorable expectation of the implementation of Paris Agreement, Figure 8 shows that, the prices of EUA futures decrease since 2016. EU carbon prices keep on the low platform around 5 euros, which is on the high end of China's carbon prices range in this paper. Even if we consider the technology improvement and medium high GDP growth rate, the decrease of mitigation cost could not reach the level of the presenting carbon prices. In that sense, this paper believe the carbon prices are far below the real carbon value. However, from the perspective of lowering the mitigation cost, we should say, this price is really good for firms to fulfill their climate obligations.

[15] Dong, 2003.
[16] Linan Che,2017.

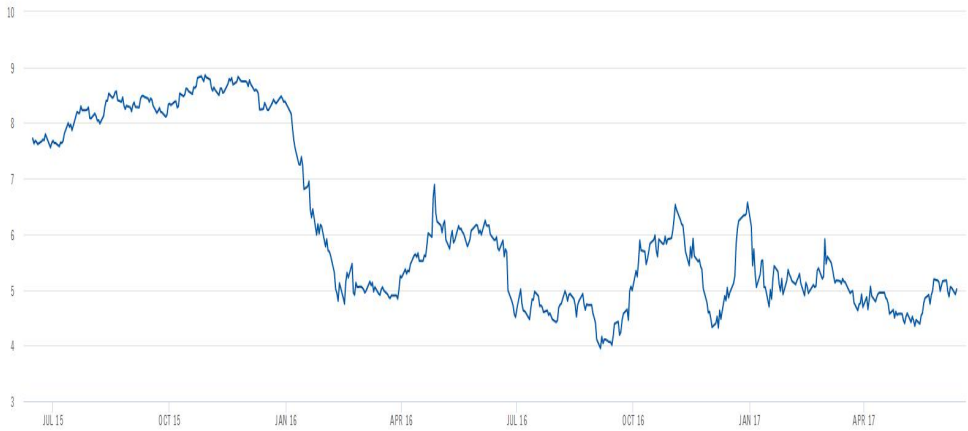

Figure 8 EUA Futures Prices, 2015-2017

Source: ICE,https://www.theice.com/products/197/EUA-Futures/data

(4) Short Summary of the Available Data

Table 4 Maturity Evaluating Data of China's Carbon Trading Pilot Areas

Second Level Indicators	BJ	TJ	SHH	SHZ	CHQ	GD	HB
1.1 the number of firms under controlled	947	114	190	636	242	189	29
1.2 the proportion of total carbon emissions covered(%)	50	60	50	40	40	60	45
1.3 the volume of trading deals(10000t)	1260	236	1697	1508	73	3063	3707
1.4 and the duration of the market(months,up to 2017 JUNE)	43	42	42	25	36	42	38
2.1the number of third party entities	26	4	10	28	11	29	8
2.2 whether the market is under well established legislation system	1	1	1	1	1	1	1
2.3 Industry coverage(number)	7	6	7	2	6	6	10
2.4 size of the controlled firms(10000 tCO_2)	1	2	2	0.3	NA	2	6
3.1the average price of trading deals	37.3	16.1	11.7	32.5	21.5	15.1	13.7
3.2 whether the fluctuation of the prices is sharp	0	0	1	0	1	1	0
3.3whether the price could influence relative price of the coal market in terms of the current price and future price	1*	NA	NA	NA	NA	NA	NA
3.4 whether the price is around the true value of carbon property	0	0	0	0	0	0	0

Note:1)BJ is Beijing, TJ is Tianjin, SHH is Shanghai, SHZ is Shenzhen, CHQ is Chongqing, GD is Guangdong, and HB is Hubei. 2)* Study shows, carbon price has negative impact on coal price fluctuation to some extent, both in coal stock market and coal future market; while in some cases, this kind of influence could be random[Huajiao Li, 2017.].

Sources: Tianjin Carbon Exchanges, http://www.chinatcx.com.cn/tcxweb/pages/trading/trading_hq.jsp; Beijing Carbon Exchange

Platform, http://www.bjets.com.cn/article/jyxx/; Shenzhen Emission Trading Institute, http://www.cerx.cn/dailynews/index.htm; Hubei Carbon Exchange Centre, http://www.hbets.cn/jbXwzx/index.htm; Carbon K Line, http://k.tanjiaoyi.com/.

Table 4 gathered all available data from above and established a data matrix for further analysis in below.

Hence, the normalized data matrix for maturity analysis is shown as in Table 5:

Table 5 Normalized Maturity Evaluating Data of China's Carbon Trading Pilot Areas

Second Level Indicators	BJ	TJ	SHH	SHZ	CHQ	GD	HB
1.1 the number of firms under controlled	1.00	0.09	0.18	0.66	0.23	0.17	0.00
1.2 the proportion of total carbon emissions covered(%)	0.50	1.00	0.50	0.00	0.00	1.00	0.25
1.3 the volume of trading deals(10000t)	0.33	0.04	0.45	0.39	0.00	0.82	1.00
1.4 and the duration of the market(months,up to 2017 JUNE)	1.00	0.94	0.94	0.00	0.61	0.94	0.72
2.1the number of third party entities	0.88	0.00	0.24	0.96	0.28	1.00	0.16
2.2 whether the market is under well established legislation system	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2.3 Industry coverage(number)	0.63	0.50	0.63	0.00	0.50	0.50	1.00
2.4 size of the controlled firms(10000 tCO2)	0.12	0.30	0.30	0.00	NA	0.30	1.00
3.1the average price of trading deals	1.00	0.17	0.00	0.81	0.38	0.13	0.08
3.2 whether the fluctuation of the prices is sharp	0.00	0.00	1.00	0.00	1.00	1.00	0.00
3.3whether the price could influence relative price of the coal market in terms of the current price and future price	1.00	NA	NA	NA	NA	NA	NA
3.4 whether the price is around the true value of carbon property	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: NA is for not applicable.

3.2 Results

We sum up the normalized evaluating data of each pilot market, then times the results to its allocated evaluating score, which is 100/12, and we get the general result as below.

Table 6 Result of the Evaluating Scores for Maturity Analysis

Pilot Markets	BJ	TJ	SHH	SHZ	CHQ	GD	HB
Scores	62.12	33.77	43.58	31.91	33.38	57.27	43.42

As the full score is 100, we can see from Table 6 that, only Beijing has just pass the Pilot Stage. Guangdong gets a score very close to that place. Shenzhen and Hubei are in the middle

among the 7 pilot markets. Tianjin, Chongqing and Shenzhen get the lowest scores among the pilots.

We use radar charts to show the maturity level of every 7 pilot carbon markets in China.

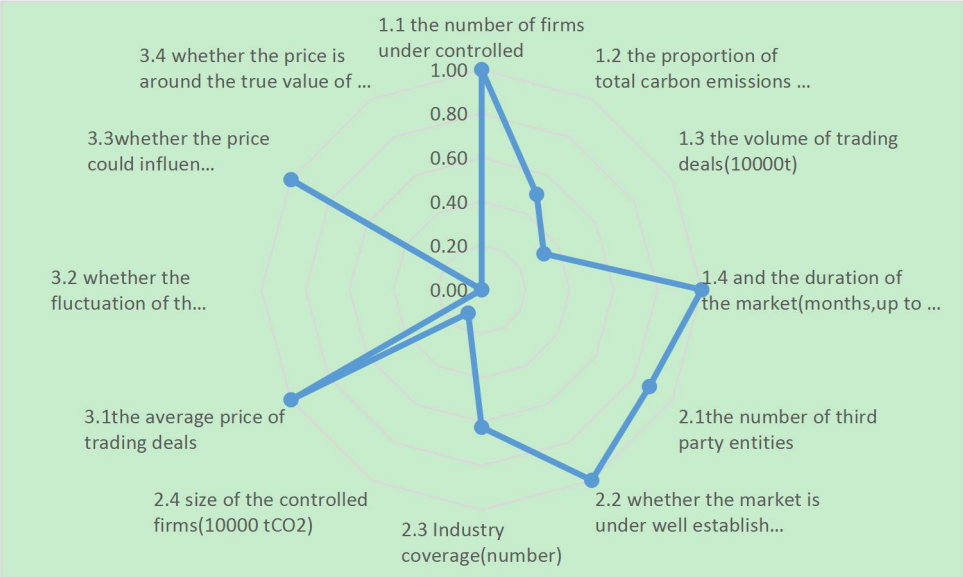

Figure 9 Maturity Level of Beijing Carbon Market

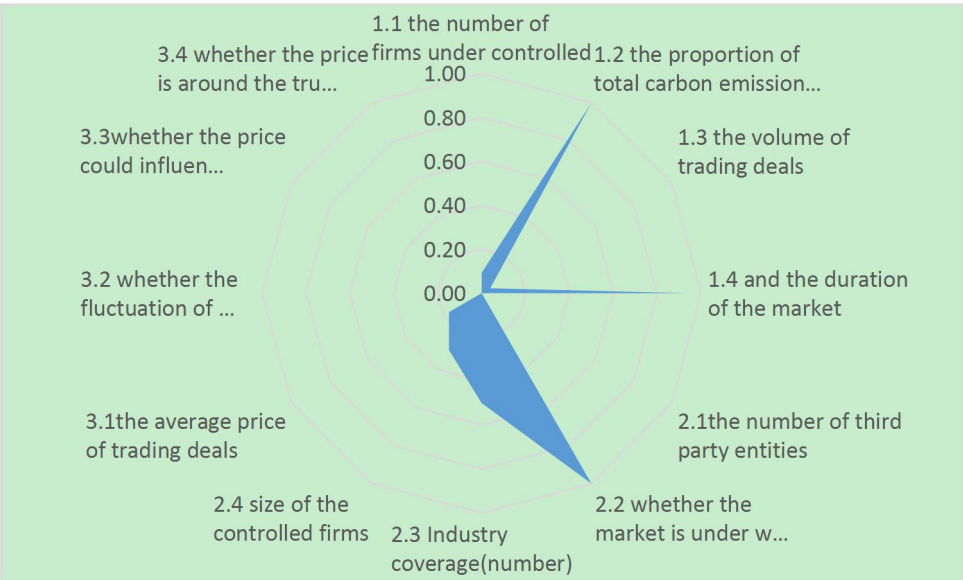

Figure 10 Maturity Level of Tianjin Carbon Market

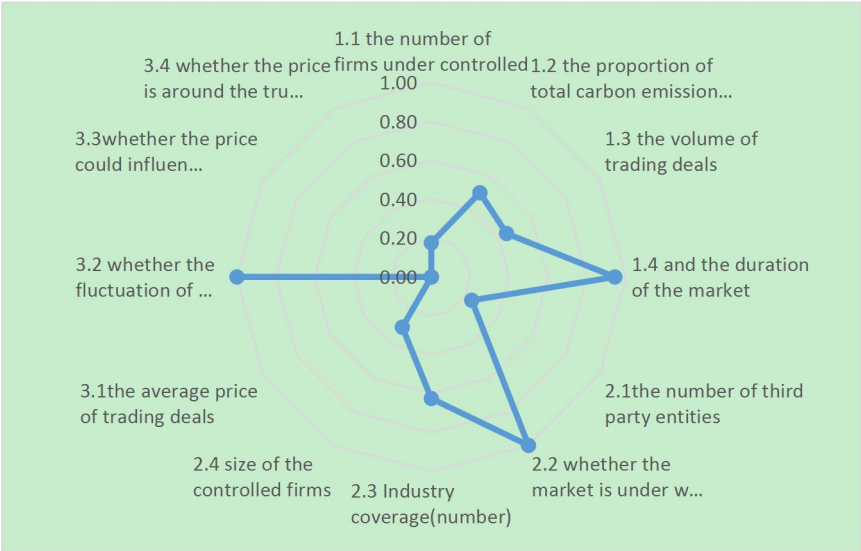

Figure 11 Maturity Level of Shanghai Carbon Market

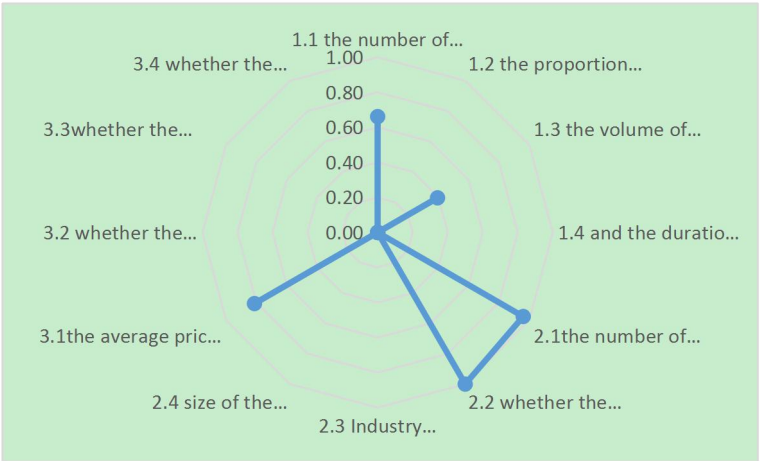

Figure 12 Maturity Level of Shenzhen Carbon Market

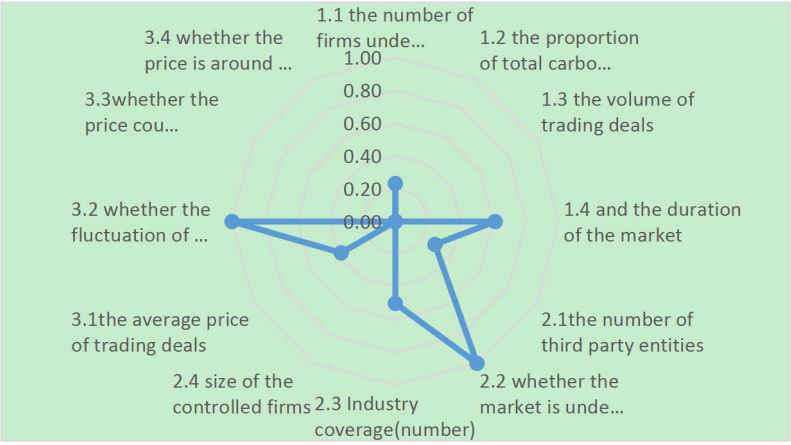

Figure 13 Maturity Level of Chongqing Carbon Market

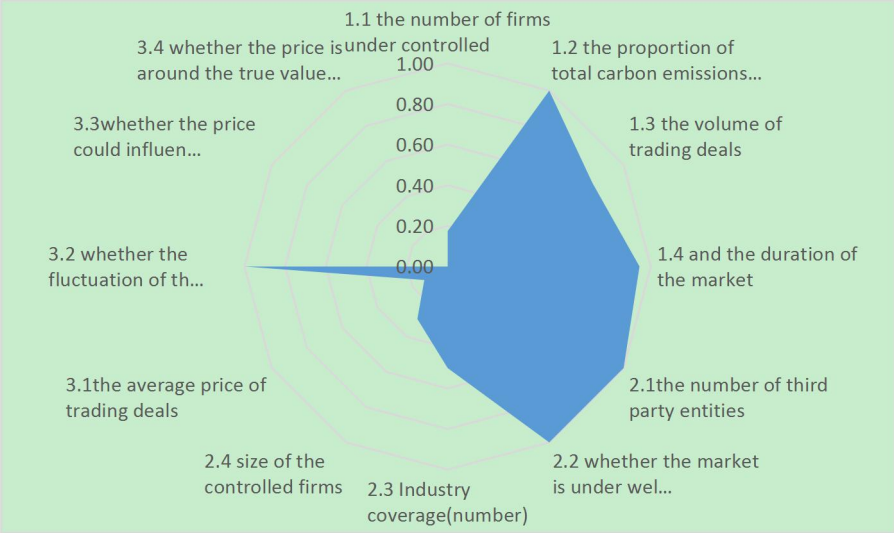

Figure 14 Maturity Level of Guangdong Carbon Market

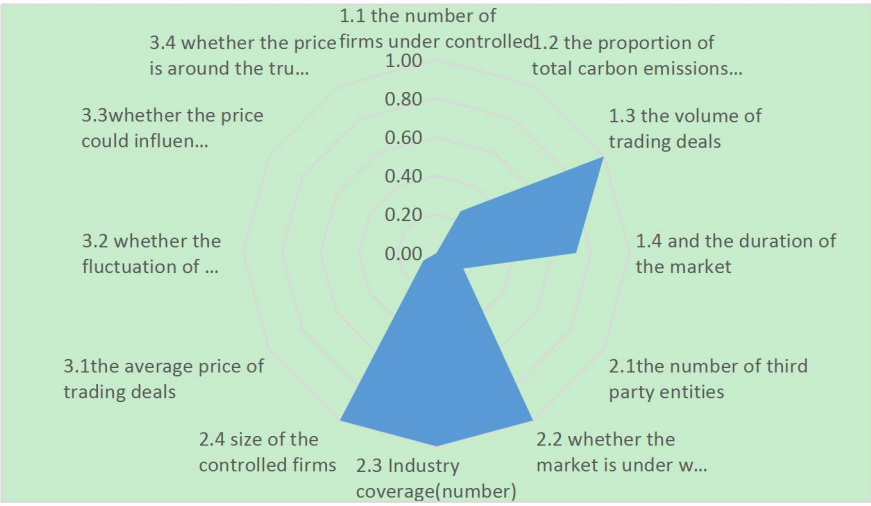

Figure 15 Maturity Level of Hubei Carbon Market

Let's compare the results in detail.

(1) Market Scale

Beijing and Guangdong both have a highest score in the indicators presenting of market scale. To achieve certain level of market scale is a very important aspect for a maturity market. With a larger scale, the market could attract more firms to participate into the carbon trading deals. It could also provide more opportunities for potential benefits.

(2) Market Structure

Beijing, Guangdong and Shanghai are well structured, and this will allow the third party entities to establish independent credits in the market and help the market to grow out of the hand of the government.

(3) Market Efficiency

At the Pilot Stage, all pilot markets show low efficiency. That is quite reasonable. The price is not totally decided by the market itself, but is influenced by many other abundant signals from the government. If the markets have good structures, when the market scale grow the certain point, the market efficiency could then be improved.

4. Conclusion

The maturity degree of China's pilot carbon market is like in between of the primary and the middle stages.

Generally speaking, Beijing and Guangdong are moving across the line from the Pilot Stage to the Standardizing Stage. The rest of the pilot markets are still in the primary period. Good experiences and best practices should be explored more in Beijing and Guangdong. And lessons in the rest pilots should be learned and avoided in the future.

In order to establish and mobilize a national carbon market, there are two most important steps to be done according to the experience from the pilot markets.

First, more stringent and well structured legislation system is the fundamental step for a national integrated carbon market. This could give a clear signal to the market that the carbon property is being priced and low carbon development is the right way to go. Furthermore, a good legislation system including relative laws, regulations,standards, could draw a clear line between the government and the market, which could give the market enough space to grow. A good legislation system is the right and only right thing a government should do in constructing a new market.

Second, a well structure transparency system is crucial important for establishing the credit of a market and a price, especially for a virtual market, which is aiming to price a virtual carbon emitting space. An equivalent number and a good credibility of the third party entities in this market could make a newly established market steady and alive, and achieve its full length of potentiality.

Third, Beijing's carbon market got the highest score in the maturity analysis. In the construction of the national integrated carbon market, Beijing's best practices and experiences should be sincerely considered by the policy designers and decision makers.

5. Discussion

There are some limitations of this paper subject to the time schedule and data availability. For further investigation, the following aspects could be adjusted according to more friendly researching conditions.

First, the maturity level could be more specific and be divided into 5-6 stages, which could reflect the differentiated development trajectory of the pilot markets and the incoming national integrated carbon market.

Second, the indicator system could be adjusted so that it can more efficiently reflect the maturity aspects of the maturity level of the market. For example, this paper could look more into some aspects which could reveal the market function, such as 1)whether a market could find a carbon price, 2) whether a pilot market could guarantee the future price of a carbon property, 3) whether new mitigation technology is promoted,4)whether the mitigation cost is decreased. And the Trading Firms' Quality is empowered by the market and could evolve with the market. In future studies, people could use 1) whether the firm is a listed company, 2) whether the firm disclosure its environmental information, 3) whether the firm has a position for carbon property management, and 4) whether the firm is volunteered to participate in carbon trading as the second level indicators.

Third, the evaluating standard could be improved using more rational and applicable methods, such like Delphi Method, using experts' objective expertise, and Benchmark Method, using comparable data of EU ETS or US Carbon Trading Scheme. That would make a more clear map to show where it was being and where it would go of the incoming integrated national carbon market.

In the end, the analysis based on statistical methods should be further justified by field research and expert interviews.

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