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# China's Carbon Market:
## Accelerating a Green Economy in China and Reducing Global Emissions

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# China's Carbon Market:
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**Abstract**

The National Carbon Emission Rights Trading Market (ETS) Construction Plan (Power Generation Industry) was released in Beijing on December 19th, 2017 by China's government. As promised during COP23 held in Bonn, Germany in November 2017, this is a key step to fulfilling China's commitment to the Paris Agreement.

The performance of ETS pilot projects in seven provinces of China have been evaluated since October 2011. The supporting policies were also thoroughly analyzed at both local and central government levels. Analysis of the pilot projects shows that the national ETS just initiated in China will not only strengthen supply-side structural reform and carbon-saving patterns of economic growth, but it will also contribute to poverty alleviation by introducing ecosystem valuation into the market. This is a practical application of the "Two Mountain Theory" suggesting that the economic and ecological systems can work in harmony, as proposed by President Xi and emphasized in the 19th National Congress of the Communist Party of China (CPC) on development, poverty alleviation and environmental protection in October 2017.

Policy suggestions in terms of economic characteristics, industrial development and regional differences were developed to improve the effects of ETS in China. Taking advantage of differences in the costs of reducing emissions and expanding the size of the trading market are key to success.

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The views expressed in this paper are those of the authors. They do not necessarily represent the views of the institutions with which the authors are associated.

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## Introduction

After the United States declared its intention to withdraw from the Paris Agreement, China was pushed to the frontier of international cooperation on climate change. At the 23rd Conference of the Parties of the U.N. Framework Convention on Climate Change held in Bonn, Germany in November 2017, China presented a summary of accomplishments regarding its pilot carbon trading markets in seven regions since 2011, and announced the launch of a comprehensive carbon trading market in 2017, which helped to boost confidence among participating countries in tackling climate change.

At the COP23 China Pavilion on November 14th, the Governor of California announced that California's carbon trading market, which was scheduled to expire in 2020, would be extended to 2023 and developed jointly with Quebec, Canada. Canada, Chile, United Kingdom, Singapore, and Japan also announced new developments in carbon trading initiatives at the Japan Pavilion.

On December 19th, 2017, China's National Development and Reform Commission (NDRC) released the National Carbon Emission Rights Trading Market Construction Plan (Power Generation Industry) in Beijing, marking the start of China's nationwide carbon market. It indicates that China will fulfill its own commitment to the Paris Agreement and advances the progress of COP23-Fiji Momentum for Implementation. The NDRC's Plan reinforces the determination of the 19th Party Congress of China in October 2017, promoting supply-side reform that ecological factors should be included in markets. Overall, the Plan represents an important milestone in developing a "green economy" in China.

## 1.1 The Progress and Performance of the Carbon Emission Trading System Pilot

In October 2011, The National Development and Reform Commission (NDRC) issued the *Notice on Pilot Work on Carbon Emissions Trading*[4], indicating that pilot projects for carbon Emission Trading Systems (ETS) were approved in seven provinces, including Beijing, Shanghai, Tianjin, Chongqing, Hubei, Guangdong and Shenzhen. Markets in Beijing, Shanghai, Guangdong, Shenzhen and Tianjin opened in 2013. All seven carbon trading markets were open by 2014. At the end of September 2017, the seven pilot trading programs covered a total of 197 million tons of carbon dioxide, equivalent with a total value of 4.5 billion yuan[5]. NDRC has also approved greenhouse gas voluntary emission reduction trading institutions based in the Fujian Haixia Equity Exchange, and added Fujian as a new carbon trading market on July 31, 2016.

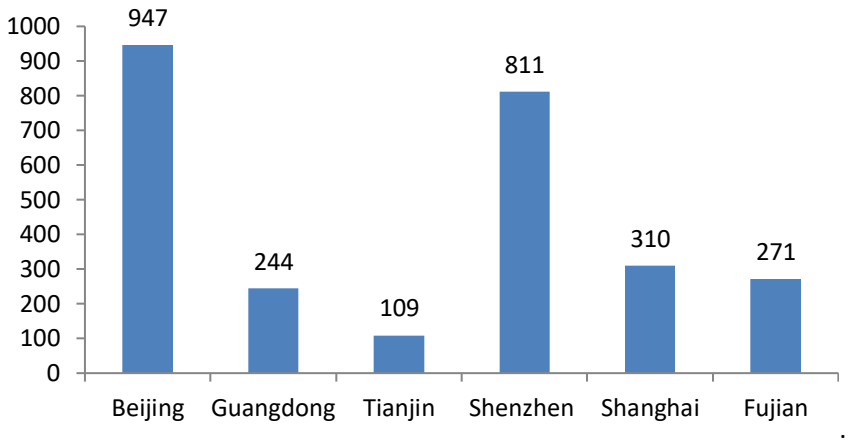
Although the pilot markets have only been established for a short time, the implementation of the policy has been relatively efficient and has made rapid progress. From the data provided by local Development and Reform Commission (DRC), the number of enterprises that are included in carbon emission control is growing year by year. According to the UNDP's "China Carbon

[4] The document was released by. the National Development and Reform Commission (NDRC) on 29th， October 2011 http://www.ndrc.gov.cn/zcfb/zcfbtz/201201/t20120113_456506.html

[5] China Carbon Market Research Report 2017. UNDP .2017.2.17

Market Research Report 2017" released on February 17, 2017, a total of 2,391 emission enterprises and units are included. By the implementation period of June/July 2017, 947 firms were participating in the carbon market in Beijing according to the website of China Carbon Dioxide Emission.[6] The number of enterprises included in carbon emission control for six provinces is shown in the Figure 1 below. (Numbers were not available for Hubei and Chongqing).

**Figure 1:** Number of emission control enterprises




Source: Carbon trading website
http://www.tanpaifang.com/tanjiaoyi/2017/0712/60007.html

The allocation of carbon quotas is essential in a carbon market system. With eight carbon trading pilot markets moving forward, the scope of carbon markets has expanded to include industries such as electric power, thermal power, air and water transportation, steels, petrochemical, and cement industries. Due to social-economic differences among provincial regions, the measures adopted in the allocation of quotas for different industries vary.

According to the latest *carbon allowance allocation policy* issued by the various provinces and cities, there are three primary methods used to allocate: industry benchmark, historical intensity method, and historical emission method. Currently, most carbon emission quotas in China are allocated for free using the historical emission method, which is based on the enterprises' historical emission data over the past few years. However, there are some problems with this approach. For example, some enterprises that have already implemented emissions reduction actions and some enterprises with outstanding emissions reduction abilities have been given lower quotas, which reduces the incentive for emissions reductions. For this reason, it is usually preferable for the pilot areas to select different assessment schemes based on the specific industries in the respective markets. For example, in Shanghai's 2017 quota allocation policy, electricity

[6] http://www.tanpaifang.com/tanjiaoyi/2017/0712/60007.html

generation, power grid, heat supply, and other electric heating industries are evaluated using the benchmark method; airlines, ports, water transport, water utilities, and other enterprises are evaluated using the historical intensity method. Difficulties in applying either the industry benchmark method or the historical intensity method for shopping malls, hotels, business offices, airports, and other complex industries have led to adoption of the historical emissions method. For example, the municipal DRC determined the amount of carbon emissions allocated in 2017 based on 2016's carbon emissions as a proportion of total emissions, and distributed these allocations for free through the quota registration system after completion of the assessment (see Table 1).

**Table 1:** Allocation of quotas in various industries in the pilot areas

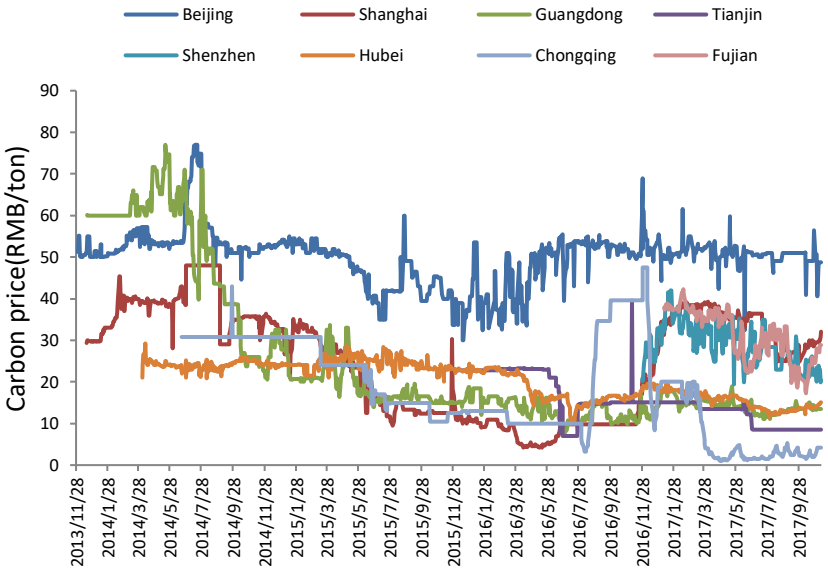
| **Method** | **Shanghai** | **Guangdong** | **Hubei** | **Fujian** |
|---|---|---|---|---|
| **Industry Benchmark** | electricity generation, power grid and heat supply and other electric heating industries | cement, electricity, steel | cement, electrical power, thermal power, the thermoelectric coupling | power generation, cement, electrolytic aluminum, flat glass |
| **Historical Intensity Method** | aviation, port, water transportation, tap water production and other industries | comprehensive utilization of power industry resources generating units and heating boilers | Others | power grid, copper smelting, steel, chemicals, crude oil processing |
| **Historical Emission Method** | product complex enterprises | Comprehensive utilization of resources in the power industry with generating units and mining industry, | glass, building materials, ceramics | ceramics for daily use |

Source: *Carbon Allowance Allocation Policy* issued by the pilot areas[7]

Since the supply curve of carbon quotas is predetermined, the demand curve dominates carbon price fluctuations. As a result, carbon prices in the eight pilot areas are significantly different. For example, in late 2017, the price of carbon in Beijing was about 53 (RMB)/ton of carbon dioxide, while Shanghai's carbon price was around 32 RMB/ton of carbon dioxide, Guangdong's carbon price was 13 RMB/ton of carbon dioxide and Tianjin's carbon price was around 8.5 RMB/ton of carbon dioxide. The price in the Shenzhen market fluctuated greatly, in the range of 18-35 RMB/ton of carbon dioxide. In Hubei, the carbon price range was 13-16 RMB/ton of carbon dioxide. Fujian's carbon price was in a range of 24-30 RMB/ton of carbon dioxide. Chongqing had the lowest carbon price, with a range of 2-5 RMB/ton of carbon dioxide (see Figure 2).

[7] For additional information on the carbon allowance allocation policy, see the following websites for the respective pilot areas: Shanghai (http://www.shanghai.gov.cn/nw2/nw2314/nw2319/nw12344/u26aw54538.html), Hubei (http://fgw.hubei.gov.cn/xw/tzgg_3465/gg/tpwj/201701/t20170103_109021.shtml), Guangdong (http://www.gddrc.gov.cn/zwgk/zcwj/zcjd/201712/t20171229_458119.shtml), and Fujian (http://www.fujian.gov.cn/zc/zxwj/bmwj/201612/t20161216_1286884.htm)

**Figure 2:** Carbon prices in emission trading market pilot

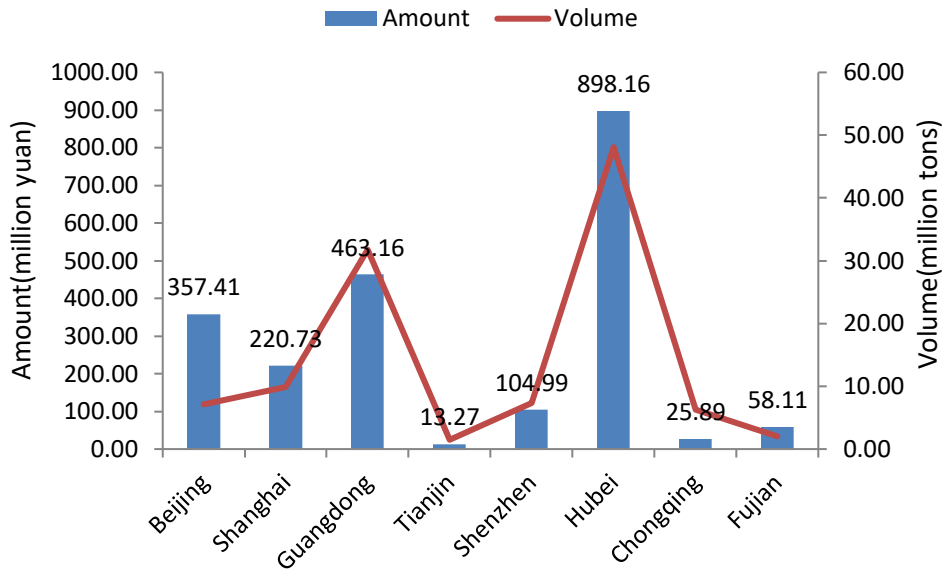



Source: http://k.tanjiaoyi.com/

From June 2013[8] to November 2017, the total carbon volume was about 110 million tons and the transaction value was about RMB 2100 million. Judging from the volume of transactions, Hubei and Guangdong were the most active markets, with a turnover of RMB 898 million and RMB 463 million respectively. Beijing, Shanghai and Shenzhen, followed with RMB 357 million, RMB 221 million and RMB 105 million, respectively. Although the Fujian market was developed later, it developed rapidly and its volume reached RMB 58 million, while the Tianjin and Chongqing markets were not very active (See Figure 3).

[8] Daily data is available from June 2013 at the website http://k.tanjiaoyi.com/

**Figure 3:** Volume of carbon trading (RMB)




Source: http://k.tanjiaoyi.com/

## 1.2 Policy Description of the Carbon Trading Pilot

In October 2010, carbon dioxide emissions per unit of GDP were included as a constraint in China's 12th Five-Year Plan. During the development of the 12th Five-Year Plan, the government approved the establishment of seven pilot provinces and cities. After the 18th Party Congress of China in 2012, the development of carbon markets began to accelerate Several departments, including NDRC, launched a series of policies to support the implementation of low-carbon and emission reduction activities. Such policies included the *Interim Measures on the Management of Voluntary Emission Reduction of Greenhouse Gases*, and *The Review and Certification Guidelines for Greenhouse Gas Voluntary Emission Reduction Projects*. These policies systematically standardized the Chinese Certified Emission Reduction (CCER) project and achieved substantial results.

In September 2016, the design for the national carbon market was prepared, with a focus on the market prices of electricity. In March 2017, the quota setting and allocation plan was approved, and the market was widely expected to start in July. On December 19, 2017, NDRC issued *National Carbon Emission Rights Trading Market Construction Scheme (Power Generation Industry),* which indicated that the power industry would be the first industry included in carbon trading. Thus, the national carbon market system officially started trading by the end of 2017.

Various regions have formulated carbon trading policies that are adapted to local development with the support of the NDRC. Specifically, Shenzhen released *Interim Measures on Trading Management of Carbon Emission Rights in Shenzhen* through People's Congress legislation. It establishes a fine of up to RMB 50,000 for failing to meet the required quota or filing a false report, and requires remediation. On June 16, 2017, the Shenzhen DRC also issued a notice warning that funding would be stopped for enterprises that failed to complete the 2016 emission

obligations on time. Therefore, many small businesses that cannot meet the goal of reduction will be at risk of bankruptcy.

On August 28, 2017, Guangdong province issued the *2017 Carbon Emission Quota Allocation Measures*. On December 20, 2017, Shanghai issued *2017 Carbon Emission Quota Allocation Measures* to determine the total quota and trading scope of the carbon emission trading system. These two regions have stronger policy timeliness and better policy execution than the other areas. Shanghai has led the way in introducing a carbon accounting guide, using the 'historical emission method' and the 'industry benchmark'.

In November 2013, Beijing issued the *Implementation Rules for OTC trading of Beijing Carbon Emission Quota (Trial)*, which regulates association transactions. Any transaction of more than 10,000 tons is required to use the OTC approach.

With only 109 enterprises being included in carbon emission control, the size of Tianjing's carbon trading market is not large., However, as the only municipality that participates in the low-carbon pilot project with provinces and cities, greenhouse gas emission inventories, and regional carbon emission rights trading,, it has a good foundation for the establishment of a carbon trading market. In *Measures for the Control of Carbon Emission Trading Risk Control in Tianjin Emission Rights Exchange (Trial)* and some other policy documents, strict market regulation and risk management rules are established, implementing a system of reporting on the largest holdings and on double risk reserves[9].

*Interim Measures on Trading Management of Carbon Emission Rights* has been issued in Chongqing. Compared with other pilot areas, Chongqing's total quota control is relatively loose, but it established a quota adjustment mechanism to ensure the normal operation and good development of enterprises. The Thirteenth Five-Year Plan in Hubei Province included the strategic goal of building a national carbon trading center and a carbon finance center in Wuhan, Hubei province. The revised *Interim Measures on the Management and Trading of Carbon Emission Rights in Hubei Province* was officially implemented in November 2016. The threshold for the control of enterprises' carbon emissions in Hubei province will be reduced from 60,000 metric tons of coal to 10,000 metric tons of coal, which means the province's emission controls will be expanded from 50 percent to about 80 percent, and the size of Hubei's carbon market will expand further.

Although carbon trading market in Fujian started late, it is distinctive. *The Fujian Carbon Emission Trading Rules* was issued in December 2016 and stipulates the varieties that can be traded including FJEA (Fujian Emission Allowance), CCER (Chinese Certified Emission Reduction), and FFCER (Fujian Forestry Certified Emission Reduction).

On December 17, 2017 the National Energy Conference (NEC) was held in Beijing. Based on energy work since the 18th Party Congress of China, the conference stressed a focus on green development and vigorous promotion of the development of clean energy. In 2018, the seven carbon pilot markets will continue to operate to complete the connection with the national carbon market. Seven other high energy-consuming industries, petrochemical, chemical, steel, nonferrous metals, paper, and aviation industries, will participate in the carbon market in the near future.

[9] Double risk reserve includes company reserve and exchange agency reserve

**Table 2:** Carbon trading policy in pilot area

| Region | Date | Sources | Policy | Content |
|---|---|---|---|---|
| Shenzhen | 2014-4 | *http://www.sz.gov.cn/zfgb/2014/gb876/201404/t20140402_2335498.htm* | Shenzhen Emissions Trading Interim Measures | Companies should submit quotas equal to their actual 2016 carbon emission through the register system before June 30, 2017 |
| Shanghai | 2017-12 | *http://www.shanghai.gov.cn/nw2/nw2314/nw2319/nw12344/u26aw54538.html* | Carbon Allowance Allocation Policy of Shanghai in 2017 | Determine a total quota of 156 million tons for the city's carbon trading system in 2017 |
| | 2017-12 | *http://www.shdrc.gov.cn/xxgk/cxxxgk/32913.htm* | Notice on Carrying out Filing of 2018 Carbon Emission Monitoring Plan | Standardize the preparation of 2018 annual monitoring plan |
| Guangdong | 2017-8 | *http://www.gddrc.gov.cn/zwgk/zcwj/zcjd/201712/t20171229_458119.shtml* | Carbon Allowance Allocation Policy of Guangdong in 2017 | Power, cement, steel, petrochemical, papermaking and civil aviation industries are included in the scope of carbon emissions management and trading in 2017. |
| Beijing | 2013-12 | *http://qhs.ndrc.gov.cn/zcfg/201312/t20131231_574013.html* | Notice on Conducting Pilot Emissions Trading of Carbon Emissions | Allows participants to offset a percentage of their quotas by acquiring CCERs from project transactions. |
| Tianjin | 2013-12 | *http://www.chinatcx.com.cn/tcxweb/pages/news/news_info.jsp?article_id=2120* | Tianjin Emissions Exchange Emissions Trading Risk Control Measures (Trial) | *Tianjin Emissions Exchange Emissions Trading Risk Control Measures (Trial)* |
| Chongqing | 2014-3 | *http://www.cq.gov.cn/publicinfo/web/views/Show!detail.action?sid=3874934* | Interim Measures for the Management of Chongqing Emissions Trading | Quota management will be implemented for emission units that reach the prescribed scale of carbon emissions each year. At the same time, other emission units are encouraged to participate voluntarily in quota management. |
| Hubei | 2017-2 | *http://www.hubei.gov.cn/zwgk/zcsd/zcsd/snzc/201702/t20170213_950319.shtml* | Hubei environmental protection in "the 13th Five-year" | Strategic goal of building Wuhan into a national carbon trading center and a carbon financial center in Hubei Province |
| | 2016-11 | *http://www.hubei.gov.cn/govfile/ezl/201610/t20161020_1031955.shtml* | Interim Measures for Management and Trading of Carbon Emission Rights in Hubei Province | Control of enterprises in Hubei Province threshold will be 60,000 tons of standard coal dropped to 1 million tons of standard coal |
| Fujian | 2017-8 | *http://www.fujian.gov.cn/zc/zxwj/szfwj/201708/t20170808_1586852.htm* | Energy-saving emission reduction comprehensive work program of Fujian Province in "the 13th Five-year" | By 2020, energy consumption per 10,000 yuan of GDP in the whole province will drop by 16% compared to2015 and the emission reductions of sulfur dioxide and nitrogen oxides in major projects will reach 35,000 tons and 46,000 tons, respectively. |
| | 2016-12 | *http://www.npfgw.gov.cn/cms/html/fgw/2016-12-26/2140432817.html* | Fujian Province Emissions Trading Rules (Trial) | Varieties that can be traded are: 1. FJEA (Fujian Emission Allowance) 2. CCER (Chinese Certified Emission Reduction) 3. FFCER (Fujian Forestry Certified Emission Reduction) 4.Other Innovative carbon-related emissions trading products. |

## 1.3 Carbon Trading Pilot Assessment

After more than six years since the establishment of the carbon trading pilot project, it is now possible to make an initial assessment of the results of the project in terms of carbon emission reductions by region.

Since Beijing ETS officially launched its pilot program in November 2011, the research and establishment of the trading mechanism, the issuance of quotas, and trading performance have been smooth and orderly. Jingjing Zhu (2014) made use of two tools developed by the World Resources Institute, *Greenhouse Gas Accounting System: Policies and Action Standards* and *Climate Policy Implementation Tracking Framework,* to assess the impact of greenhouse gas emission reductions on pilot projects in Beijing's carbon emissions trading system. The results show that in the years from 2013 to 2015, Beijing ETS achieved respectively 0.41 million tons, 1.55 million tons and 2.9 million tons of $CO_2$ emission reductions, accounting for 0.60%, 2.25% and 4.19% of the baseline $CO_2$ emissions respectively. The total reduction was 4.87 million tons in three years.

The Tianjin pilot relies more on carbon emissions in the industrial sector. Yu Liu (2016) evaluated the carbon trading pilot project in Tianjin and found that the pilot carbon trading project in Tianjin would reduce carbon emissions by 0.62% (1.03 million tons) in 2014. While this indicates measurable results, there appears to be several problems in the operation of the Tianjin carbon market. Firstly, the initial pricing is too high. Compared to the other pilot area, its price at the end of 2017 was the highest. Second, incomplete quota policy creates a large trading risk. This leaves buyers uncertain about the allocation of shares available in the future and whether carbon quotas for the enterprises are sufficient. Third, most companies currently participating in carbon trading are state-owned enterprises, which have limited incentive to participate in carbon trading. Fourth, marginal reduction costs are lower than the high carbon prices. Therefore, there is little incentive for most businesses to buy and sell carbon quotas.

Results in several other pilot areas have also been evaluated by researchers. Songyan Ren (2015) constructed a two-region dynamic model for Guangdong Province. The results show that by 2015, Guangdong will achieve the goal of 19.5% reduction in carbon intensity. Shenglv Zhou (2015) selected Shanghai as a sample and designed different scenarios for industry and distribution based on a CGE model. The results show that implementing carbon trading can significantly provide environmental benefits and contribute to the realization of $SO_2$ and $NO_X$ emission reduction targets. Xiujie Tan (2016) also used a CGE model to simulate the impact on Hubei province's economy. The results show the emission reduction effect in the Hubei carbon trading pilot. Luyun Wang (2016) pointed out that since 2011, the growth rate of total carbon emissions in Chongqing area has decreased year by year.

In terms of overall operating efficiency, Yongwei Cheng (2017) used the DEA model[10] to evaluate the operating efficiency of China's pilot carbon market. The results show that the carbon markets in Shenzhen, Hubei and Tianjin are DEA-efficient with the market efficiency of Shanghai, Beijing, Guangdong and Chongqing following in descending order. The carbon price level in

[10] DEA model: data envelopment analysis model

Shenzhen is the highest and the most stable, while Guangdong and Hubei have the fastest growth in trading activity. Based on a counterfactual framework study, Shengbing He (2015) used the method of matching estimators to estimate the parameters. The results show that there are obvious industry differences in the impact of carbon trading on firm performance. For example, CDM[11] project significantly improves the operating performance of thermal power and cement enterprises. However, the implementation of CDM projects has a negative impact on the performance of steel enterprises.

The establishment of carbon trading generally has a positive impact on emission reductions goals. In the past, energy conservation and emission reductions goals depended on central government regulation. Emission reductions has now become a matter of self-governing behavior. Enterprises have realized that carbon emission management can be linked to profitability, cash flow, and business investment. They can also experience reputational benefits from establishing a green corporate image. Many enterprises included in the pilot carbon markets have increased R&D investment to control pollution emissions, thereby helping to achieve the regional emission reduction targets.

# 2. The Impact of Carbon Trading in China

## 2.1 China's Contribution to Global Carbon Emission Reduction

The Kyoto Protocol, which was adopted by the third conference of the parties to the United Nations Framework Convention on Climate Change (1997), initiated the concept of Emission Trading Scheme (ETS). The European Union formally implemented an ETS in 2005. The scheme has had mixed results due to the free distribution of permits, insufficient scale, and other uncertainties that have led to a volatile carbon price. California, Quebec, Switzerland, New Zealand and South Korea have also initiated carbon-trading schemes. These schemes play an important role in reducing global greenhouse gas emissions. In the past decade, the amount of emissions covered by the trading schemes has tripled worldwide. This still only covers 15% of global carbon emissions. Although the initial stage of China's carbon market only entails the power generation industry, its expected trading volume will still be larger than the existing carbon market in the EU. This will significantly increase the size of carbon markets globally and contribute to improving carbon market performance, thus reducing the global cost of responding to climate change.

The homogeneity of carbon dioxide emissions makes large-scale market transactions possible. After nearly 20 years of practice in the European Union, Switzerland, California, as well as China's pilot projects in seven provinces and municipalities after 2011, there is also a large amount of carbon market experience.

[11] CDM: clean development mechanism

## 2.2 Carbon Trading: Deepening China's Supply-side Structural Reform

At the 2017 Bonn Climate Change Conference, China's initiatives for carbon market, green finance and South-South Cooperation were widely supported by the participating countries. Minimizing the cost of emission reduction is a key issue. China stands to play a major role here both in realizing its own commitment to reducing emissions and in helping to promote international cooperation on climate change.

China has been working on energy conservation and emission reduction since the 'Tenth Five-Year Plan'[12]. Most of the measures adopted are 'responsibility commitment'[13], limiting emissions, strengthening the responsibility of polluters, and establishing punishments for violations. Such direct regulation methods, while significant in the short term, result in higher administrative costs due to the lack of economic incentives for emitting firms. This not only aggravates the operating burden for the existing enterprises, but also discourages innovative enterprises from entering the market.

Compared to the direct regulation method, ETS gives enterprises greater autonomy to choose between reducing their emissions or purchasing permits from participants involved in emissions reduction. Market trading enables companies with low marginal abatement costs to have competitive advantages, thus stimulating technological and management innovation. With the 'invisible hand' of the market, trading policy can effectively make up for the deficiency of traditional administrative command tools. By combining carbon trading with other administrative measures, policy makers can gradually reduce the total carbon emission quota and achieve low cost emission reduction in the regional, national, and international areas.

Carbon trading schemes can be expanded from the initially covered enterprises to other firms, non-governmental organizations, and financial institutions. This will introduce carbon pricing more widely within the economic system, stimulate low-carbon investment, and encourage low-carbon production methods, and green consumer lifestyles. In turn, this will effectively intensify supply-side structural reform in China and comprehensively stimulate the transformation of economic growth towards low-carbon emissions.

## 2.3 Carbon Market: Extending the Process of Market Allocation of Ecological Factors

The low or even zero price of ecological functions and services in the economic system are the fundamental cause of the imbalance between ecological conservation and economic development. In the early 1980s, China carried out theoretical research and practical application on environmental economics policy tools. For example, the Dongyang-Yiwu Water Rights Exchange was initiated in 2000. Pollution Rights Trading had been carried out in Shanghai,

[12] http://www.ndrc.gov.cn/fzgggz/fzgh/ghwb/gjjh/200709/P020070912638583847233.pdf

[13] Officials sign the commitment in terms of energy conservation and emission reduction, always including the detailed task.

Zhejiang, Jiangsu, and other areas in the 1990s. Guangzhou and Zhejiang provinces have actively explored volatile organic compounds emission rights (VOCs) in recent years. Jiangsu province has also promoted green insurance in recent years. All of these policies extend the use of market mechanisms in the application of ecological environment governance. However, the public goods nature and the heterogeneity of environmental factors have led to low transaction prices, small transaction volume, and insufficient market incentives. This results in a stagnant secondary market, with the primary market being driven by the government through high costs. Related academic research also shows that emission trading system is efficient in limited regions (Zhang, et al. 2017).

The Paris Agreement reached a global consensus to reduce emissions in 2016, and the Climate Summit in Poland (COP24) will require countries to assess the progress of their emissions reductions in 2018. In accordance with these requirements, a national carbon market has been fully launched in China after the 19th Party Congress of China and the Bonn Climate Summit (COP23). This marks the creation of the first national market for ecological factors. The operation of the carbon market will not only help China fulfill its commitments, but it will also gradually improve the 'water rights exchange', 'pollution rights trading', 'power consumption rights trading' and ecological compensation mechanisms related to resources, environment and ecosystem services. It will provide a market-based mechanism to attract social capital into ecological and environmental protection and deepen ecological reform.

In summary, China's launch of the carbon trading market is not only a significant economic policy tool for China to fulfill its responsibilities in responding to climate change, but it is also an important step towards China fully implementing market mechanisms in ecological environmental management.

## 2.4 Promoting Targeted Poverty Alleviation and Balanced Development

The 19th session of the national congress of the Communist Party of China (CPC) stressed 'winning the fight against poverty' as an important goal to improve livelihoods. It put forward the goal of 'rural poor people achieving poverty alleviation and solving regional poverty...'[14] These poor rural regions tend to be areas of forest, vegetation, and biodiversity, Agriculture is the main industry in these areas. Different farming methods in agriculture play a significant role in the release and absorption of $CO_2$ (Xiaobin Yang 2011). Eco-agriculture was entered into the COP23 agenda for the first time because it can help to reduce carbon emissions compared with mechanized agriculture.

As a major carbon sink, forests have crucial capacity to absorb $CO_2$. In the past 20 years, China has implemented ecological compensation measures, such as returning farmland to forestry, which has been primarily compensated by direct cash payments. It is possible, however, to incorporate payments for reforestation or carbon-absorbing agriculture into a carbon trading scheme, potentially creating a stream of revenue for low-income and rural areas. Thus, the

[14] http://www.gov.cn/zhuanti/2017-10/27/content_5234876.htm

comprehensive implementation of a carbon trading market can introduce the previously underestimated value of forest, vegetation, and soils that absorb $CO_2$ into the market. It also complements an increased global focus on the importance of forests, soils, and wetlands in carbon management.

As the carbon market expands from the power industry to other high-emission industries and sectors like chemical, steel, tourism, agriculture, financial institutions, national parks, non-profit organizations, and individual farmers, low-income regions can take advantage of the trading system to develop low-carbon and green agriculture farming patterns that can fully reflect the value of forests, vegetation, and soils as carbon sinks. This is consistent with the "two mountain theory,"[15] that the environment should not be sacrificed for money.

## 3. Suggestions on Improving the Performance of China's Carbon Market

As the world's largest carbon trading market, China's emissions reduction performance will depend on a series of social and economic preconditions and the implementation of specific policies. Based on the experiences of mature markets such as the European Union, California, and Quebec, China needs to design the carbon trading market in terms of its economic characteristics, industrial development and regional differences. To have successful carbon trading markets, China must account for the heterogeneity of marginal abatement costs and the market size.

The seven pilot projects contributed to carbon emissions in China, but the trading volume is still small compared with the total potential carbon market in China. The reasons are that the pilot areas are divided, and the possibilities for reducing emissions in a single industry are limited. After many small generators exited the market, differences in emission reduction costs and the amount of tradable carbon have decreased. Implementation in pilot areas has led to insufficient liquidity of carbon markets. Thus, carbon trading in the pilot areas is often regarded as a prerogative of the local government, rather than profit-seeking behavior by the relevant enterprises. This leads to insufficient overall reduction performance and relatively high administrative costs.

Heterogeneities in the marginal abatement costs of carbon trading are based on five factors. The first is the production heterogeneity of similar power generation enterprises. For instance, the emission costs of thermal power plants differ due to the different size of generator sets, power generation technologies, management systems, and emission reduction technologies. The second factor is the heterogeneity of various enterprises' energy structures. For example, the emission variances among hydropower, thermal power, wind power, biomass power, nuclear power and other different generating bodies are a major source of cost heterogeneities in the industry. The third factor is that marginal abatement costs differ in different industries, especially in high-pollution, high-emission and resource-based industries, such as chemical, steel and electric power

[15] The "two mountain theory" suggests that the economic and ecological systems can work in harmony. It was proposed by President Xi in Zhejiang Province in 2005 and emphasized in the 19th Party Congress on poverty alleviation and environmental protection.

industries. The fourth is that there are differences in the environmental costs of industrial emissions. As China's per capita income has increased significantly, demand for housing, appliances and automobiles has grown rapidly, and energy consumption among residents has become a major source of carbon emissions. Meanwhile, various farming patterns in agriculture also lead to increased emissions. Carbon emission differences among agriculture and service industries are a major reason for differences in transaction costs. The fifth factor is the cost variability in reducing emissions between regions. For example, regional and urban-rural differences lead to variances in emission reductions between eastern and western areas and between urban and rural areas in China. The implementation of a nationwide carbon market can effectively address the problem of weak performance of the pilot regions due to geographical segmentation and the lack of liquidity of carbon rights, thus improving national emission reduction performance.

The current carbon market in China is based on differing regional emission costs in the electric power industry. There is a need to further develop carbon markets as follows: first, the trading market should be promoted further within the electric power industry, and once the market operation of the power industry is mature, it should be expanded to industries such as the chemical and steel industries, which are high-emission, high-pollution and resource-based. Next, carbon markets should be developed in other industrial, agricultural, and service industries. The overall domestic carbon market should also be integrated. Another important step will be to align China's carbon market with the EU and other mature international carbon markets. Finally, regional markets from countries in the area of "The Belt and Road Initiative"[16] and other cooperation areas should be established.

[16] The Silk Road Economic Belt and the 21st-century Maritime Silk Road. http://zt.ccln.gov.cn/xxxjp/jzjd/jj3/9613.shtml

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