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The Inspiration of the International Carbon Market for the Development of Green Finance in China

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Abstract: After introducing the Clean Development Mechanism in 2004, China combined foreign carbon market experience and actively carried out pilot carbon market construction in selected provinces and cities. In September 2020, President Xi Jinping announced China's "dual carbon" goal for the first time at the 75th United Nations General Assembly general debate. The goal is to strive to peak carbon dioxide emissions by 2030 and achieve carbon neutrality by 2060. Although seven regional carbon market pilots have been launched in the past three years and experience has been accumulated, China's experience in using market-based climate policies is still limited. Establishing a unified domestic carbon market and making it a major tool for China's emission reduction and response to climate change requires continuous learning and drawing on the successful experience of international carbon markets, especially lessons from failures. The international carbon market provides important inspiration for the development of green finance in China. By establishing a carbon market, China can achieve carbon pricing, promote the growth of green funding, strengthen financing uphold for low-carbon projects, and contribute to addressing climate change challenges and achieving sustainable development goals.

Keywords: clean development mechanism, carbon neutrality, green finance, carbon market

1. Introduction

As the trend of global warming continues to intensify, it has attracted widespread attention from the international community. Human actions have resulted in a global temperature increase of approximately 1 degree above pre-industrial levels. According to this trend, the temperature rise will reach 1.5 degrees between 2030 and 2052 [1], and natural and human systems will face higher climate risks. In 2015, 195 countries reached the Paris Agreement, establishing the overall goal of the global response to the threat of climate change: to limit the global temperature rise to below 2 degrees and strive to limit it to within 1.5 degrees [2]. To restrict global warming to 1.5°C, worldwide carbon emissions must be reduced by 50% by 2030 and achieve "net zero".(i.e., carbon neutrality) by the mid-21st century. Climate change has also risen from a purely scientific issue to an economic and political issue. The emission space of atmospheric greenhouse gases is a global public resource, which means that the issue of climate change must be resolved through international cooperation. Although countries have agreed to cooperate in mitigating the serious issue of greenhouse gas (GHG) emissions, one of the primary obstacles is to provide funding for mitigation and adaptation actions for

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climate change and sustainability, which requires a large amount of investment. Maintaining the 2-degree threshold requires an energy-related investment of $53 trillion by 2035, which has driven the continuous development of international financial markets and helped improve the international climate governance system [3].

According to the International Finance Corporation (IFC) in 2017, green finance refers to "financing for investments that provide environmental benefits." Since its emergence, The significance of eco-friendly financing has been emphasized through widespread dialogues between global institutions and state administrations. This has also stimulated an increasing curiosity among scholarly investigators. Green finance, whether as an institutional arrangement or market mechanism design, not only helps achieve social energy-saving goals but also contributes to sustainable economic development [4]. Due to the inherent delay in the development of green finance, investors and financial institutions may lack the incentive to enter the green sector. This can result in a limited scale of green finance, which mainly relies on market mechanisms and difficulty in realizing its potential. The need to maintain and improve social ecosystems [5].

At present, There are still numerous issues that need to be addressed in China's carbon finance market. In today's increasingly complex international economic situation, they need to learn from the development status of international carbon finance markets and explore effective strategies conducive to the development of China's financial market. This review attempts to deeply analyze capacity building and connectivity issues based on a review of the development status of international carbon markets, analyze the impact and inspiration of international carbon market experience on China's future establishment of carbon markets, propose building a sound MRV system, strengthen cooperation with foreign carbon markets, and promote the steady development of green finance. To enable a national carbon market to play an effective role under policies that conform to national conditions and trading mechanisms, achieve China's emission reduction goals, promote China's economic transition to carbon, move towards green sustainable development, and reach our greenhouse gas reduction objectives at the most affordable expense.

2. Status of the International Carbon Market

The expansion of the global carbon trade has gone through several different stages. From 1992 to 2005, the development of the carbon market was very slow and was basically in the exploratory stage. The main issue under discussion was whether to implement a carbon market or a carbon tax policy. During the initial implementation of the Kyoto Protocol under the UNFCCC framework, the main focus was on the Clean Development Mechanism, carbon markets, and the introduction of carbon taxes. According to a report by the International Carbon Action Partnership [6], as of the end of January 2021, there were 24 operating carbon trading markets (carbon markets) in countries around the world, covering 16% of global carbon emissions. At the same time, the financial value of carbon markets is becoming increasingly prominent. A report by Lufthansa shows that in 2021, the global carbon trading volume of major carbon markets was about 7.6×11 euros, with a year-on-year growth rate exceeding 160% [7].

Carbon markets are conducted with greenhouse gas emission permits or offsets to reduce greenhouse gas emissions and can be used as underlying assets. In layman's terms, it means treating the right to emit carbon dioxide as a commodity for buying and selling. Enterprises that need to reduce emissions will receive a certain amount of carbon emission quotas. Successful emission reduction can sell excess quotas, while excess emissions must purchase quotas on the carbon market.

Green finance motivates economic actors to concentrate on environmental conservation, fosters sustainable growth and the building of an ecological. Green finance encompasses financial services such as the investment, and financing of green industry projects, project operation, and risk management. It not only effectively supports green technological innovation and fosters green

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entrepreneurship but also transforms the mode of economic development and optimizes the economic structure to achieve China's green transformation of its economy. This will facilitate the high-quality development of China's economy and create a more favorable external environment for the growth of the domestic financial industry.

According to data released by the International Energy Agency on March 2, global energy-related carbon dioxide emissions in 2022 exceeded 36.8 billion tons, an increase of 321 million tons or 0.9% compared to the prior year. The data indicates that extreme weather events such as droughts and heatwaves, as well as shutdowns at many nuclear power plants, contributed to the increase in carbon dioxide emissions. However, the implementation of more green energy solutions prevented 550 million tons of emissions. The International Energy Agency's statistics show that US emissions expanded by 0.8% in 2022, while EU emissions decreased by 2.5%. [8].

Table 1: Trading system and characteristics of the Chinese carbon market.

ETS	Industries covered					Trading gas	quota allocation	Invocation and recovery phase	Market Connection	Counteract / credit
	Industrial	energy	architecture	traffic	aviation					
Beijing	√	√				CO_2	Free	From 2013 to 2015, it was the pilot phase of carbon trading, preparing for the national carbon market	In 2017, it will be incorporated into the national carbon trading market	Domestic offsets
Tianjin	√	√				CO_2	Free			
Shanghai	√	√		√	√	CO_2	Free/Auction			
Shenzhen	√	√	√			CO_2	Free/Auction			
Chongqing	√	√	√	√		Six GHG	Free			
Guangdong	√	√	√	√		CO_2	Free/Auction			
Hubei	√	√				CO_2	Free/Auction			

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ETS	Industries covered					Trading gas	quota allocation	Invocation and recovery phase	Market Connection	Counteract/ credit
	Industrial	energy	architecture	traffic	aviation					
European Union	√	√			√	CO/N,O/ PFC	Free/Auction	I:2005-2007; Ⅱ:2008-2012; Ⅲ:2013-2020;IV:2021-2030	Currently negotiating with Switzerland	Limiting international CDM offsets
RGGI	√	√				CO_2	Auction	I:2009-2011; Ⅱ:2012-204 Ⅲ:2015-2017	Nothing	Domestic offsets
NewZealand	√	√		√		Six GHG	Free/Auction	Launched in 2008, most industries have a one-year contract period	Nothing	Cancel international credits, only domestic offsets
Korea	√	√		√		Six GHG	Free/Auction	I:2015-2017; Ⅱ:2018-2020 Ⅲ:2021-2025	Nothing	Domestic offsets
California	√	√	√	√		Lots of GHG	Free/Auction	I:2013-2014; Ⅱ:2015-2017 Ⅲ:2018-2020	2014 and Quebec connection	Domestic offsets

Source of information: Clean Energy Blue Book: Greenhouse Gas Reduction and Carbon Market Development Report (2016)

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Table 1 summarizes the elements and basic characteristics of current international and domestic carbon market policy design. With the changes in the international and domestic emission reduction situation and climate policy, the pattern of the international carbon market is also evolving [9].

2.1. Development of the European Union Emissions Trading System (EUETS)

The European Union Emissions Trading System (EUETS) is the first multi-national enterprise participation quota emission trading system. The EUETS is characterized by being the greatest trade organization worldwide, far exceeding other carbon markets in terms of scale and market value.

The implementation of the EUETS is divided into four stages, and each stage has adjustments to the Educational testing service (ETS) system itself, showing the dynamic characteristics of system design. The first stage (2005-2007) of the European Union (EU) emission reduction market was a learning-by-doing stage. In the second stage (2008-2012), the scope of the trading system was expanded to include the aviation industry, and Iceland, Luxembourg, and Norway joined the EU emission system in 2012. In the third stage (2013-2020), the scope was expanded to 17 industrial activities, with N2O and Particle Flow Code (PFC) added, and Croatia joined the EU emission system. Currently, the European Commission is negotiating to link the EUETS with Switzerland's ETS. The rules and regulations for the fourth stage (2021-2028) are still under discussion [10].

The dynamism of the EUETS is also reflected in the continuous updating of quota allocation methods. In the first and second stages, EU member states determined the total number of quotas, i.e., emission limits, which were approved by the European Commission and then distributed among objects included in the trading system among member states. The third stage made substantial adjustments to quotas, establishing a unified emission limit for EU member states and distributing free quotas according to unified principles. In 2016, EUETS allowed participants to use international carbon reduction credits to offset their emission limits.

2.2. The Regional Greenhouse Gas Initiative (RGGI) in the Midwestern United States

The Regional Greenhouse Gas Initiative (RGGI) is unique in that it primarily uses auctions to allocate quotas, rather than giving most quotas to covered businesses for free, as is the case with other cap-and-trade systems. RGGI only covers emissions from the public electricity sector. It is a provincial-level CO_2 emission trading system composed of individuals, and the proceeds from auctioning quotas in the carbon trading market are invested in energy efficiency and renewable energy. RGGI is composed of independent state-level CO_2 trading systems, allowing quotas to be traded among member states. The United States ranks second in global carbon emissions, with California's carbon trading system being the most typical. The state's carbon market is also the world's first trading market to allocate all quotas by auction. California ranks second in carbon emissions among all states in the United States, with industrial sector carbon emissions accounting for nearly 1/4 and transportation sector carbon emissions accounting for nearly 1/2. In 2013, California's carbon trading system covered about 85% of the state's carbon emissions and most economic sectors, with traded gases covering almost all types of greenhouse gases defined by the Kyoto Protocol. California's carbon market includes emission sources in two stages. In the first stage (2013-2014), large industrial facilities were included, including 12 industries such as cement production, power generation, glass production, steel production, hydrogen production, and oil refining, as well as power generation facilities and power importers, covering 35%. In the second stage (after 2015), emission reduction sources were extended from upstream to downstream, including natural gas suppliers, liquefied petroleum gas suppliers, mixed fuel suppliers, etc., and the coverage increased to 85% [11].

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2.3. Development and Dynamics of Carbon Markets in Other Countries

National carbon market individuals differ greatly and are also changing recently. From 2015, New Zealand's carbon market no longer accepts emission reduction quotas such as CDM under the Kyoto Protocol, but the original quotas allocated by New Zealand can participate in compliance obligations. This decision takes into account changes in the international carbon reduction system and the excess emission reduction quotas generated by the Kyoto Protocol market. New Zealand will reassess this decision, which will set a long-term direction for New Zealand's emission reduction market and help achieve its 2020 emission reduction target.

Singapore introduced a carbon pricing mechanism, namely a carbon tax, in 2019. Under this system, companies need to pay taxes for every ton of carbon dioxide emitted. This measure aims to encourage companies to decrease carbon emissions and advance sustainable growth. Singapore's carbon tax policy covers multiple industries, including energy, petrochemicals, manufacturing, and transportation. Although Singapore does not currently have a complete carbon market, the government has been actively exploring the possibility of a carbon market and plans to gradually introduce more carbon market mechanisms in the future. These efforts aim to strengthen Singapore's leadership in addressing global warming and advancing a carbon-reduced economy.

The Korean carbon market was launched in 2015 and is Asia's first national-level total trading system. The total quota of the Korean carbon market is 5.73×108t of carbon dioxide, making it the second largest carbon market after the European Union, covering about 2/3 of Korea's carbon emissions. However, there are some flaws in the design of the Korean carbon market system, mainly throw back to the following two aspects: (1) high emission monitoring costs. The Korean carbon market covers all gases specified by the Kyoto Protocol. Due to the very complex procedures, some gases are difficult to directly and accurately monitor, resulting in high social emission monitoring costs. (2) High emission reduction intensity and increased burden on enterprises. The Korean government's emission reduction target is ambitious, and the emission reduction intensity of the Korean carbon market is greater than that of other carbon markets, pushing up the carbon price and bringing excessive emission reduction costs to controlled enterprises.

2.4. The Current State of China's Carbon Market

The Chinese government places a high priority on the development of a national carbon market. Utilizing market mechanisms to control and reduce greenhouse gas emissions is a significant institutional innovation that fosters sustainable and low-emission progress. It is as well an essential policy tool for achieving carbon peaking, carbon neutrality, and national independent contribution goals. On July 16, 2021, the national carbon emission trading system was formally introduced for internet trading. The seven provincial-level carbon trading pilots will be merged into the national-level emission trading system, implementing unified ETS rules and management. The operation of China's regional pilot carbon finance has the following characteristics: (1) Excessive concentration of trading volume distribution. The trading volume of the pilot carbon market is limited at ordinary times, and concentrated trading occurs about one month before compliance. In some pilot carbon markets, it even exceeds 65% of the monthly trading volume, indicating that the trading strategy of most controlled entities is only passive compliance. (2) Significant fluctuations in trading prices. Most pilot carbon markets have experienced sharp drops in carbon prices, and excess quotas are the main factor causing fluctuations in carbon prices. (3) Diversification of market investors. Hubei and Shenzhen pilot markets are the most open to participating entities. In addition to institutional and individual investors, overseas investors can also enter the market for trading, while other carbon markets have not yet allowed overseas investment. The diversification of market investors can enrich the investment levels of the greenhouse gas market and improve the

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augment the market's fluidity. (4) The rapid growth of carbon finance products. Each pilot carbon market has opened unique carbon financial products, such as Beijing's carbon quota pledge financing, Guangdong's swap-type carbon trading, Hubei's carbon insurance, etc. These financial products further reduce the emission reduction costs of enterprises, spread out the risks of emission reduction markets, broaden emission reduction financing channels, and enhance the activity of carbon markets. After 10 years of development, China's carbon market has gradually formed a multi-level emissions trading scheme with national and regional, primary and secondary, spot, and options. In comparison to mature international carbon markets, China's carbon market construction still has a long way to go.

Table 3: Cumulative online quota transaction situation of seven pilot carbon markets.

Pilot	Start Date	Total transaction volume (10,000 tons)	Total transaction amount (100 million yuan)	Average transaction price (yuan/ton)
Beijing	2013.11.28	1815.31	12.29	87.57
Tianjin	2013.12.26	2380.79	5.88	32.40
Shanghai	2013.11.26	1943.39	6.39	56.58
Shenzhen	2013.06.18	5429.89	14.11	34.67
Guangdong	2013,12,19	19063.20	46.52	76.39
Hubei	2014.04.02	8211.21	20.25	47.37
Chongqing	2014.06.19	1047.19	0.96	39.29

Source: CEEP-BIT (2023) Review of China's carbon market and prospects for the optimal order of industry inclusion (2023)

3. Problems in China's Carbon Marketing

3.1. Capacity Building Issues in the Carbon Market

First of all, as of now, the National Development and Reform Commission has approved the establishment of seven national carbon market capacity building centers including Shenzhen, Hubei, Chongqing, Beijing, Guangdong, Shanghai, and Chengdu. Relying on some pilot provinces and cities, a national carbon trading capacity-building training center has been established. It should be noted that these training centers undertake the function of providing personnel support for the operation of the carbon market in terms of capacity building. The key objects of capacity building include government departments in charge of work related to the construction and operation of the carbon market, key emitting enterprises, third-party verification agencies, and departments and personnel providing consulting services for enterprises. At the same time, through the platform of the capacity center, the competent department of the carbon market and other institutions can continuously communicate and exchange effectively with multiple stakeholders and continuously learn from the experience of other regional carbon markets to continuously improve the management and operation level of the carbon market and accumulate experience. From Table 3, it can be seen that in terms of online transaction volume and total transaction amount, The Guangdong carbon market leads in terms of both carbon emission right trading volume and transaction amount, with the Hubei carbon market following closely behind. Chongqing carbon market has the lowest carbon emission right trading volume and transaction amount. Beijing's carbon market has a higher carbon emission trading volume than the Chongqing carbon market, but its total transaction amount is much higher than that of the Chongqing carbon market. This is mainly due to the high trading

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price of carbon emission rights in the Beijing carbon market. In terms of the average transaction price, the Beijing carbon market has the highest trading price for carbon emission rights, while the Tianjin carbon market has the lowest trading price for carbon emission rights. In addition, the average transaction prices of all pilot carbon markets have increased compared to 2021, with the Shenzhen carbon market having the largest increase (179.07%) and the Tianjin carbon market having the smallest increase (16.51%). First, China's carbon market has a large room for improvement in terms of market activity. In 2022, the turnover rate of the national carbon market fluctuated within 2%-3%, below the average turnover rate of about 5% for seven pilot carbon markets and far lower than the turnover rate of about 500% for EU carbon markets. This shows that China's national carbon exchange is still in its infancy of development and has huge room for improvement in activity in the future. Second, daily average transaction prices are relatively stable: generally fluctuating around 58 yuan/tonne, compared to 47 yuan/tonne in 2021.

3.2. Connection Issues in China's Carbon Market

The inauguration of a unified carbon market in China means that seven regional pilots will be incorporated into consistent rules and management systems, which is essentially a process of linking different carbon markets. Of course, it is relatively easy for China's seven pilots to merge into a national-level carbon market because the design and policies of pilot area carbon markets are carried out under unified guidance, unlike links from different countries and systems. The possibility and existing problems of linkage need to be considered. At least based on studying the experience and lessons of international carbon markets, conditions should be created or preparations should be made for future linkage of carbon markets. In addition, China's emissions trading design needs to have flexible characteristics that can continuously adjust and optimize mechanisms as national conditions change and international emission reduction dynamics change to become a mainstream emission reduction market [12].

4. Suggestions and Prospects for China's Carbon Market

The development of the international carbon market in the past decade, China's experience in participating in the CDM market, and the accumulation of three years of operation of seven carbon market pilots have provided important references for the future policy design, market management and operation, and supporting policy support of China's carbon market. Combining the experience of international carbon markets and China's national conditions, the establishment of China's carbon market still needs to be strengthened in the following aspects.

4.1. China's Carbon Market Needs a Strong MRV System

Although China's seven pilots have established a stable MRV system, the huge scale of the national ETS far exceeds that of the seven pilots. The count of participating enterprises in the ETS and the complexity of different industries will pose challenges to the expansion of MRV nationwide. In addition, if the future development trend is to transition from free quota allocation to auctioning, it may take several years for the existing MRV system to reach a reliable and stable system required for auctioning, which may delay discussions on linking with other ETSs and advancing policies. In addition, MRV of all current regional emission data is a necessary prerequisite for incorporating it into the national carbon market, allocating quotas among regions, and conducting transactions. Only in this way can the operation of the national-level carbon market be guaranteed and it is also a necessary condition for linking with other international carbon markets. Therefore, the national carbon trading policy needs to provide unified guidelines and methods for market design as well as mandatory MRV norms for market operation [13].

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4.2. China's Carbon Market Needs a Mutually Supportive Climate Policy System

Governments face the challenge of selecting effective policy tools to guarantee the implementation of the Paris Agreement and their national independent contribution goals. Manufacturing and usage trends, along with encouraging advancement in technological exploration and innovation, infrastructure development, and funding systems. To achieve low-carbon transformation in the power industry. Governments must also ensure that these changes generate fresh economic expansion prospects, augmented job opportunities, and elevated standards of living. Carbon valuation is one potential strategy that can steer investment towards eco-friendly sectors, amplify energy conservation, heighten project competitiveness, inspire companies to improve low-carbon products, and motivate consumers to choose low-carbon options, thereby providing a pathway for realizing green ecological value. China's climate policy is a set of different types of policies. The forthcoming national carbon trading system is only part of these policies, not a specific policy to reduce greenhouse gas emissions. Therefore, overlapping policies are worrying. The risk of overlapping China's carbon trading market policy and other policies is that ETS may weaken the effectiveness of other policies and may suppress the effectiveness of the national carbon trading ETS market. China's energy policy, low-carbon policy, environmental policy, and climate policy are all important contents of the climate policy system. Therefore, in designing carbon market policies, we should fully study the characteristics of these policies and coordinate with other policies to form good complementary effects.

4.3. Strengthening Cooperation in Carbon Markets and Green Low-Carbon Fields

Mechanisms such as the Paris Agreement, the "Belt and Road" initiative, the Shanghai Cooperation Organization, and the Asian Infrastructure Investment Bank can be used to foster green investment in relevant nations and advance international cooperation in green finance. The two-way opening of green securities markets can be encouraged, allowing for the issuance of green bonds by Chinese financial institutions and enterprises overseas, as well as by international financial organizations and multinational companies in China, establishing collaborative green development funds, and carrying out green investment [14]. The EU carbon market is widely acknowledged as the most all-encompassing and representative of its kind on a global scale. By promoting carbon trading with Europe, China can benefit from the EU carbon market's sophisticated methods, the introduction of innovative carbon financial products, and the establishment of efficient carbon pricing, and enhance its domestic carbon market, fully playing an important role in reducing emissions during this process [15]. It is imperative to speed up the establishment of a unified standard carbon market and establish an accounting system for carbon emission statistics to improve management and release systems for emission data in carbon markets.

5. Conclusion

Governments of various countries have played a key role in guiding the development of the carbon finance market by formulating carbon finance policies, establishing carbon trading mechanisms, and implementing carbon tax systems, which have promoted the healthy development of the carbon finance market. Financial institutions are also constantly innovating carbon finance products to provide enterprises with more carbon asset management tools. Although our country's carbon finance market has achieved certain results, there are still some problems. In the future, our country should learn from international experience, strengthen the guiding role of the government, promote the innovation of carbon finance products by financial institutions, and help enterprises strengthen carbon asset management. The ongoing development and enhancement of the national carbon market will certainly play a crucial role in propelling this process forward.

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