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Discussion On The Development Of China's Regional Carbon Market Under The Background Of Double Carbon

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Abstract

Accelerating China's carbon trading market is one of the important means to deal with climate change and achieve the dual carbon goal. Due to the huge differences in China's regional economic development and carbon resource endowment, the impact of the establishment of the national unified carbon trading market on regional economic development is unstable and uncertain. For local governments to make full use of this empty window period, this paper combs the recent development of the carbon market, and discusses the development prospect of China's regional carbon market under the background of carbon trading. The results show that: ①in the current development of the national carbon emission trading market, we can not achieve the carbon unification of the market and abandon the local carbon trading market; ②In the process of regional carbon trading, it can promote the low-carbon development of local economy; ③In the process of regional carbon trading, it can increase the share of clean energy and improve the efficiency of regional ecological and environmental protection. Then, some suggestions are put forward for the development of local carbon trading: ①appropriately expand the pilot scale of local carbon trading, go up and down, and realize the double cycle development of carbon market; ②Strengthen the training of professionals and create an innovative and entrepreneurial business environment; ③build a carbon platform with big data technology and improve the Regional Internet plus carbon enterprise database; ④Actively promote the development of PPP model, explore the carbon sink transaction of cooperation between the government and social capital, continuously improve the regional green and low-carbon development, and jointly promote the realization of the "double carbon goal".

Keywords

Double carbon; carbon trading market; carbon finance; government finances.

1. Introduction

As global climate continues to deteriorate, it has become a problem and challenge that all of humanity must face together. To address the climate crisis, the Paris Climate Agreement was adopted at the 21st United Nations Climate Change Conference, which aims to achieve net-zero emissions by around 2050. In support of this goal and to contribute to China's "dual carbon" targets, the country aims to reach peak carbon emissions by 2030 and achieve carbon neutrality by 2060. Regional carbon trading is a critical part of achieving these zero-carbon targets. China has already established seven carbon trading market pilots, and the first compliance period has been initiated [1].In 2021, the Ministry of Ecology and Environment issued the "Interim Regulations on the Management of Carbon Emission Rights Trading," which marked the standardization of national carbon emission and trading-related activities Establishing and improving the national carbon emissions trading market mechanism to regulate carbon emissions and promote green, low-carbon development is not only an important part of

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institutional framework building but also a core policy for implementing the national dual carbon targets [2].

There are significant differences in regional economic development and carbon resource endowments across China. The establishment of a unified national carbon trading market has uncertain and unstable effects on regional economic development, especially in economically underdeveloped areas that rely on agriculture and animal husbandry. The mechanism by which carbon trading affects various industries in these regions is relatively complex, and the financial flows triggered by carbon trading may not cover all sectors. Depending on the characteristics of these regions, the investment patterns of some sectors or industries may change. From a macroeconomic perspective, during regional carbon trading, local governments can make reasonable use of carbon sinks and carbon emission rights, while continuously improving carbon emission trading systems and mechanisms. This process involves converting carbon emissions from primary energy sources, increasing the consumption ratio of clean new energy, and improving regional climate change. Suggestions have been made on how local governments can utilize various regional resources to increase local finances through carbon trading. This can further drive low-carbon development across various industries in the region, attract investment, and enhance the use of clean energy, thereby helping to reduce carbon emissions.

2. Overview of the Carbon Trading Market

2.1. Carbon Trading

Carbon trading involves trading carbon dioxide emission rights as a commodity. The basic idea is to establish varying proportions of permissible costs through policy constraints and market adjustments, encouraging emission entities to incorporate carbon emissions into production costs during their activities, thereby achieving the goal of reducing and controlling carbon emissions early in the production process. This mechanism encourages carbon-emitting entities to actively promote the use of clean energy, reduce carbon emissions, and gradually decrease the use of non-renewable energy sources. Currently, China's carbon emission quotas are mainly managed in two stages. Initially, free allocation is predominant, and after a certain period, there is a coordinated shift towards paid allocation, with a gradual increase in the proportion of paid allocation for carbon emission quotas. The ultimate goal is to achieve a dual-track system of paid allocation revenue and expenditure, incorporated into government fiscal management. Moreover, the competent authorities may reserve a certain portion of the carbon emission quotas for significant construction projects and for regulating the carbon trading market. The "Interim Regulations on the Management of Carbon Emission Rights Trading" specify two types of emitting units: the first type includes key emitting units with annual greenhouse gas emissions of 26,000 tons or more, which are incorporated into the national carbon emission trading market and are not allowed to participate in provincial (city) carbon markets or related activities such as carbon quota trading and clearing. The second type includes non-key emitting units with annual greenhouse gas emissions of less than 26,000 tons, which are managed within the provincial (city) carbon markets. Large key emitting units participate in the national carbon emission trading market, while non-key emitting units remain under the jurisdiction of provincial ecological and environmental authorities for quota allocation [3].

From the practice of carbon trading at home and abroad, it is evident that carbon trading can bring tangible benefits to companies, especially those that have made significant progress in reducing carbon emissions. For example, Tesla disclosed in its 2020 financial report that without the revenue from carbon trading, the company would have reported a loss of $859 million. However, carbon trading brought Tesla $1.58 billion in revenue by selling carbon credits to traditional energy vehicle companies. For instance, Fiat Chrysler Automobiles in

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Europe spent $362 million in 2020 alone to purchase carbon credits from Tesla to offset its own greenhouse gas emissions.

2.2. Carbon Pricing

Carbon pricing involves assigning a specific price per ton of carbon dioxide emissions by the carbon emission rights holders, following the principle that the polluter pays. This internalizes part of the carbon emission cost within society, further driving companies towards low-carbon transitions, innovation in new energy technologies, and industrial upgrades, thereby helping to achieve the dual carbon targets.

Currently, there are two common carbon pricing mechanisms: one is the government pricing mechanism, where the government levies a carbon tax on relevant companies. The carbon tax, being one of the government's tax types, is relatively fixed for companies, making it easier for them to plan emission reductions. For the government, it increases revenue that can be invested in developing new emission reduction technologies. The second mechanism is market-based, involving the creation of a carbon emission trading system. Here, carbon trading is carried out through market mechanisms, with emission limits set for carbon emitters, and any emissions exceeding these limits being subject to market-based carbon trading. In this mechanism, emission standards are set by the state, while carbon prices are determined by the market. Therefore, the level of carbon prices is uncertain. Moreover, since carbon emission rights are marketable commodities, they naturally possess financing attributes, attracting more banks, funds, and companies to participate, thereby enhancing the efficiency of carbon emission rights allocation. However, because carbon trading is a designed and regulated market, it incurs high supervision costs and carries significant moral hazard. Due to the volatility of carbon prices, financialization of carbon trading requires higher financial risk management capabilities, making it more suitable for countries and regions with relatively mature financial markets.

2.3. Carbon Finance

Carbon finance refers to investment and financing activities in the context of the Kyoto Protocol, also known as "carbon finance" or "carbon commodity" trading. It involves direct investment and financing, carbon rights trading, bank loans, and other financing activities that support technologies and projects aimed at limiting greenhouse gas emissions. Carbon finance is a higher level of financial trading based on carbon trading. It leverages its ability to allocate resources across regions and time to identify and assist carbon trading demanders and suppliers within China or other countries, helping them determine carbon trading prices and creating a dynamic channel for ongoing negotiation, which helps establish equilibrium prices. Essentially, the carbon trading market functions as a financial market responsible for the conversion of funds upon maturity and risk management. Compared to traditional commodity markets, the carbon market not only fulfills the basic functions of conventional markets but also features investment orientation and risk management across cycles, based on carbon pricing, with distinct financial functions. The key is how to better utilize "carbon pricing" for risk management, investment guidance, and expectation stabilization, guiding the entire society toward an orderly low-carbon transition.

3. Overview of China's Carbon Trading Market

3.1. Pilot Stage

Since the National Development and Reform Commission officially approved the launch of carbon trading pilots in 2011, China’s carbon market has achieved certain stage-wise results after nearly a decade of development. However, in the initial construction phase, both national and local carbon trading pilots progressed relatively slowly due to insufficient organization, mechanism, and policy support, as well as a lack of promotion experience. Local carbon market

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transactions mainly involved spot trading and China Certified Emission Reductions (CCER), with slow market liquidity and limited market efficiency. Although some local carbon markets, such as those in Shanghai and Hubei, actively promoted product iterations like futures contracts, the overall effect has been insignificant, with trading remaining light and financial attributes insufficiently mature. With the proposal of the "30-60" targets, the national carbon emission trading regulatory system and trading system have gradually improved, accelerating relevant work, and the launch of the national carbon market is expected to significantly impact the development of local carbon markets.

Currently, in China, there are two types of carbon trading: one is the emission quota, which is the carbon emission limit allocated by the government to key emitting units within a certain period, serving as a certificate and carrier of carbon emission rights. The other type is the national certified voluntary emission reductions, which are voluntary emission reductions recorded in the national greenhouse gas voluntary emission reduction trading registry system, in line with the Ministry of Ecology and Environment's voluntary emission reduction management regulations, abbreviated as CCER. In practice, China adopts a 1:1 ratio to replace carbon emission quotas with CCER, meaning one carbon market unit quota is equivalent to one ton of CO2 equivalent. The development stages of China's carbon trading market are shown in Table 1.

Table 1: Development Stages and Achievements of China's Carbon Trading Market

Time	Achievements
2009	China made its first commitment at the Copenhagen World Climate Conference, pledging to reduce national carbon intensity by 40%-45% compared to 2005 levels by 2020.
2010	The National Development and Reform Commission selected seven provinces and cities, including Beijing, Tianjin, Shanghai, Chongqing, Hubei, Guangdong, and Shenzhen, to pilot the construction of carbon emissions trading markets.
2011	The National Development and Reform Commission selected seven provinces and cities, including Beijing, Tianjin, Shanghai, Chongqing, Hubei, Guangdong, and Shenzhen, to pilot the construction of carbon emissions trading markets.
2013	Shenzhen took the lead in launching its pilot carbon market, followed by the launch of pilot carbon markets in Shanghai, Beijing, Guangdong, Hubei, and Chongqing.
2015	China submitted its Nationally Determined Contribution (NDC) document to the United Nations Framework Convention on Climate Change (UNFCCC), committing to reduce carbon dioxide emissions per unit of GDP by 60%-65% compared to 2005 levels by 2030, and incorporating climate change actions into the 13th Five-Year Plan.
2020	China announced its ambition to peak carbon emissions by 2030 and strive to achieve carbon neutrality by 2060.
Late 2020	The number of existing pilot carbon trading markets increased to nine, with the addition of Sichuan and Fujian markets to the original seven pilot markets.
2021	In seven provinces and cities, China's pilot carbon emissions trading achieved optimized allocation of carbon resources, established a comprehensive carbon trading framework, and formed a complete carbon emissions trading market system with total volume control, verification, and trading mechanisms.

By the end of 2020, the nine pilot carbon trading markets covered more than 3,000 key emitting units across 20 industries, including electricity, steel, and cement, with a cumulative quota transaction volume of 480 million tons of carbon dioxide equivalent and a transaction value of approximately 11.4 billion yuan.

In 2020, the total trading volume across the nine national carbon markets in China reached 141 million tons, with the majority of transactions involving quotas and CCER (China Certified

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Emission Reduction) projects. The total quota trading volume was 77.07 million tons, accounting for 55.05% of the total carbon trading volume for the year.

The top three markets by trading volume were:

1. Guangdong Carbon Market: Total trading volume of 45.7377 million tons, accounting for 32.43%, ranking first.
2. Tianjin Carbon Market: Total trading volume of 29.0852 million tons, accounting for 20.62%, ranking second.
3. Shanghai Carbon Market: Total trading volume of 26.9268 million tons, accounting for 19.09%, ranking third.

Sichuan ranked last, with a total trading volume of only 1.8763 million tons, accounting for 1.33% [4].

Due to the impact of the pandemic, the allocation of carbon quotas for 2019 was delayed, resulting in a later distribution of carbon credits to enterprises in various provinces and cities. The trading period was significantly shortened compared to the same period in previous years. Trading activity was sluggish from January to July, with the majority of transactions concentrated between August and October, accounting for over 90% of the total trading volume.

In 2020, spot trading of CCERs continued to grow, with a total trading volume of 63.3807 million tons, representing 44.95% of the total carbon trading volume for the year. The Shanghai Carbon Market stood out in CCER project trading, with a volume of 21.0223 million tons, a year-on-year increase of 38.99%, accounting for 33% of the national annual CCER trading volume, continuing to lead other regional carbon markets.

Based on the K-line chart of the national carbon market from 2013 to 2021, the overall trend of carbon trading in China has been upward, although some pilot carbon trading markets have experienced significant fluctuations. The half-year K-line chart shows that Shanghai stands out the most, with the highest transaction price reaching 102.96 yuan and the lowest at 24.00 yuan, indicating a large fluctuation with an extreme price difference of 78.96 yuan. As the national carbon trading center, the Shanghai Carbon Market's trading prices have been relatively stable, generally fluctuating around 41 yuan, with minimal overall volatility. However, the Shenzhen Carbon Market, despite being a special economic zone, has not performed well, showing a downward trend overall. The lowest transaction price over the six-month period dropped to 7.41 yuan, significantly lower than the national average of 40 yuan per ton. This disparity warrants special attention, and relevant authorities should consider implementing some adjustment measures.

3.2. Market Unification

On July 16, 2021, the national carbon emissions trading market was officially launched. Power companies, as the primary participants in the first batch, accounted for 40% of the total carbon emissions in the power sector, making this the largest carbon emissions trading market in the world by coverage. On the first day of trading, 4.1 million tons were traded. However, the trading volume subsequently declined over the next few cycles, fluctuating between 100,000 to 200,000 tons in late July and dropping to just a few tens of thousands of tons in August. On August 12, the trading volume even fell to 6,001 tons.

The main reasons for this phenomenon are that the national carbon emissions trading market is still in its early stages, with limited participating enterprises, a single trading industry, and a limited total trading volume. The market also lacks a sound framework for carbon market construction and reasonable limits on total trading volumes. However, as the policies, regulations, and other conditions of the national carbon emissions trading market gradually improve, local carbon trading market industries and enterprises will be progressively integrated into the national carbon emissions trading system. With the increase in trading

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entities, the involvement of institutional investors, and the continuous enrichment of carbon trading products, China's carbon trading market is expected to experience sustained and positive growth.

4. Carbon Trading Promotes Local Government Development in Multiple Directions

Currently, since the national carbon emissions trading market's functions are still being perfected, there will be a "window period" for local carbon trading markets for some time. Particularly, the "Interim Regulations on the Administration of Carbon Emission Trading" issued by the Ministry of Ecology and Environment on January 5, 2021, stipulates that carbon emission rights are equivalent to emission allowances. The appendix further clarifies that carbon emission rights for a specified period are allocated by the government to key emission entities. This makes it clear that emission allowances, or carbon emission rights, are allocated by administrative authorities. Local governments need to expedite the construction of their regional carbon emission trading markets [5], continuously improve the relevant mechanisms and systems for local carbon trading and carbon allowances, and actively explore the establishment of carbon trading systems for the primary, secondary, and tertiary industries. They must fully leverage the dual functions of constraint and incentive provided by the carbon trading market [6]. Local governments should seize the opportunity, fully utilize and exert their dominant position in regional carbon emissions trading, and effectively manage the significant leverage that regional carbon emission rights represent for local development.

In the current carbon emissions trading market, carbon emissions can be traded as a commodity. In practice, the higher the carbon emissions of a particular industry, the higher the associated costs, making carbon trading a critical need for enterprises aiming to achieve carbon neutrality. As the main entity in regional carbon emission trading markets, local governments must reasonably allocate carbon allowances, indirectly promote the transformation and upgrading of regional enterprises and the adjustment of industries, increase local fiscal revenue, continuously improve local governance capabilities, promote the development of low-carbon economies, and enhance the sense of well-being and happiness among local residents.

4.1. Carbon Trading Drives Local Government Investment Promotion

In 2015, the State Council issued the "Made in China 2025" plan, marking the beginning of the "Fourth Industrial Revolution." This revolution has broken the traditional technology and processes of enterprises, ushering in a new era of digitization, intelligence, and networking [7]. Particularly, China's manufacturing industry, the backbone of the national economy, has since the reform and opening up established the world's largest, most comprehensive, and most independent industrial system. Under the backdrop of a new round of industrial transformation and technological revolution, the pattern of industrial division between different regions in China is being reshaped.

Due to the impact of the global COVID-19 pandemic in 2019, the economies of various countries were in a state of stagnation. In Eastern China, labor-intensive manufacturing enterprises, especially those affected by the pandemic, faced challenges such as disrupted labor flow and a significant labor shortage in recent stages. This has made the technological transformation and upgrading of enterprises an urgent task. With the advent of the "post-pandemic era," China has been promoting strategies such as "manufacturing return" and "re-industrialization," leading to increasingly fierce competition in the high-end manufacturing sector across regions [8]. Against this backdrop, the Chinese government has proposed a new development strategy driven by innovation, and local governments are intensifying efforts to transform enterprises and attract key regional economic pillar enterprises. For instance, labor-intensive enterprises

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with carbon emission limits in Eastern China can shift industries to the central and western regions. Local governments should actively attract enterprises with carbon emission needs to relocate industries and provide carbon allowance support. Particularly for industrial manufacturing enterprises, local governments can prioritize ensuring labor needs for these enterprises, while also playing a leading role in carbon trading. Additionally, they can provide support through tax incentives and local financial policies, coordinate low-carbon development and utilization systems for industrial transfer projects, and vigorously support the settlement and development of related low-carbon industrial transfer enterprises. Local governments should ensure the rights and obligations of the enterprises they attract through policy and institutional guarantees, strengthen communication between the government and enterprises to understand their reasonable needs, and actively combine local government carbon trading rights with existing regional investment promotion policies to drive regional economic development and the transformation and upgrading of local enterprises.

4.2. Carbon Trading Promotes Low-Carbon Regional Development

President Xi Jinping's statement, "Clear waters and green mountains are as valuable as mountains of gold and silver," provides new energy and mission to the historic ecological transformation towards low-carbon development. While promoting low-carbon economies in different regions, it is also essential to focus on formulating low-carbon strategies. These strategies serve as a macro framework that uses low carbon as the development model, product standard, and endless goal. Large enterprises with the necessary resources can undertake the overall planning and implementation of low-carbon strategies. The continuous development and improvement of regional carbon trading markets can strengthen low-carbon economic development and the low-carbon transformation and upgrading of regional enterprises. Through carbon trading, industrial production’s carbon emissions can be indirectly reduced, and industrial upgrading can be promoted, thereby fostering the development of new low-carbon urban clusters. This is also a critical issue in urban governance by local governments. By forming a closely cooperative vertical division of labor between industrial clusters and urban centers [9], local governments can establish a circular system of urban clusters characterized by clean production, thereby promoting low-carbon regional development.

In China's current labor market, particularly under the premise that the profits from carbon trading exceed the investment costs in technological or industrial innovation, a significant amount of capital will flow into critical new energy sectors such as wind power and hydropower. This capital flow will drive the optimization of industrial structures and economic adjustments, and it will also influence local governments' regional policies and spatial arrangements. As China's energy supply-side reform continues to advance, the country’s long-distance natural gas pipelines have expanded to 83,000 km, forming an initial network of "four major (import) corridors" and a "three vertical and three horizontal" network system. Additionally, LNG reception capacity has significantly increased to 90 million tons, and underground gas storage has grown to 14.7 billion cubic meters, though this still only accounts for 4.5% of China’s natural gas consumption [10]. Local governments, through the exercise of carbon trading rights, can indirectly or directly drive regional natural gas storage and consumption. For example, ongoing urban construction projects such as "coal-to-gas" conversions, low-carbon infrastructure, and new energy applications will enter deeper levels of implementation under carbon trading. This will also increase the application of LNG and the corresponding construction of natural gas pipeline facilities, thereby expanding the use of clean natural gas from top to bottom, reducing carbon emissions, and promoting low-carbon regional development.

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4.3. Carbon Trading Promotes Low-Carbon Development in Rural Revitalization

The 19th National Congress of the Communist Party of China proposed the rural revitalization strategy, clearly indicating that low-carbon development is a necessary path for rural revitalization [11]. In 2016, the State Council proposed the vigorous development of low-carbon agriculture, focusing on reducing agricultural carbon emissions, scientifically and effectively controlling methane emissions from farmland, and establishing low-carbon agriculture pilot and demonstration projects in various regions. The goal is to continuously increase forest carbon sinks and grassland carbon sinks, thereby enhancing ecosystem carbon sequestration [12]. In 2018, the Central Committee of the Communist Party of China and the State Council issued the "Rural Revitalization Strategic Plan (2018-2022)," which emphasized the need to promote ecological restoration and improve the carbon emission trading system, integrating ecological restoration with carbon sink trading [13].

China is gradually incorporating agricultural carbon sinks into the carbon market, including forestry carbon sinks, livestock and poultry breeding, and livestock and poultry manure treatment as voluntary carbon sequestration projects in the carbon market [14]. Since farmers do not have enough carbon emission reductions to sell externally through market mechanisms, local governments must take the lead in constructing a "corporate-carbon trading market-farmer cooperative-farm household" carbon sink trading mechanism [15]. Local governments should actively leverage their leading role in regional carbon sink trading markets to promote the development of regional low-carbon agricultural industry branding mechanisms. Through the carbon trading market, they can drive low-carbon agricultural development, strengthen rural governance and rural civilization construction, and promote the creation of "ecologically livable" low-carbon rural areas. Additionally, they should establish pilot projects for carbon sink subsidies and farmer welfare tailored to regional specificities, promote green production and living practices in rural areas, advance "coal-to-gas" projects in rural areas to increase the use of clean natural gas, gradually establish a green industrial environment policy system, and pursue a green, low-carbon, and circular development path to achieve low-carbon rural revitalization.

4.4. Carbon Trading Promotes the Development of Regional Forestry Carbon Sink Trading

Forestry carbon sinks are not only a critical pathway to achieving carbon neutrality but also a natural solution to climate change, and they serve as an indispensable trading method in carbon sink trading. Currently, China's forestry carbon sink market operates both online and offline, with trading projects such as forestry carbon sink projects traded in pilot carbon trading markets based on the voluntary greenhouse gas emission reduction trading mechanism (CCER) and forestry carbon sink projects traded in local carbon markets.

The development of forestry carbon sink trading by regional governments is conducive to promoting regional forestry ecological development. Through the scientific and rational development and utilization of forestry resources and carbon sink trading, regional fixed ecological assets can be transformed into regional economic advantages. This approach also strengthens regional ecological governance and enhances residents' "green happiness." By using carbon allowances, carbon credits, or carbon sinks generated by new forestry projects to offset large greenhouse gas emissions from specific regional enterprises, and by maintaining a positive consumption environment through fiscal subsidy policies, guiding policies, and supporting policies for relevant energy-consuming enterprises, regional carbon neutrality can be achieved. Establishing regional forestry carbon sink projects to practice carbon neutrality will further consolidate the position of forestry carbon sinks in the carbon trading market.

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5. Related Suggestions

5.1. Coordinated Development of Carbon Markets

To actively achieve the "dual carbon goals," particularly on the basis of the existing seven carbon trading pilots, it is essential to establish a national carbon trading market and appropriately expand local carbon trading market pilots. Higher-level administrative departments should make full use of the preliminary experience accumulated by lower-level pilot carbon markets, continuously improve the development of the national carbon trading market, learn from mature foreign carbon market mechanisms [16], and integrate these into China's carbon market system to develop a market mechanism that suits China's national conditions. In practice, it is important to explore a model where the national carbon market plays a leading role in managing carbon market participants and trading industries, while reasonably delegating authority to regional carbon markets for areas with carbon trading needs below standard limits. This approach involves a hierarchical management system, with a focus on the main carbon market and local market needs, ensuring flexibility and avoiding neglect of smaller aspects. Based on regional carbon markets, perfect trading mechanisms, explore development characteristics, protect regional carbon market development, leverage local government administrative capabilities, and promote regional dual carbon goal achievement. Use the national carbon trading market as a platform to promote the development results of regional carbon markets, consolidate and improve the national carbon trading system, and achieve coordinated development of carbon markets.

5.2. Talent Development and Innovation Business Environment

In the post-pandemic era, regional economic development has slowed, and regional GDP growth rates have decelerated. Seizing the opportunity of national industrial transfers [17], regional governments should intensify efforts to attract talent by introducing relevant supportive measures to lower the barriers for skilled technical talent in terms of employment, entrepreneurship, and settlement. Encourage enterprises to enter development and technology parks to further attract talent and foster technological innovation. Additionally, enhance continuing education programs to upgrade the knowledge and skills of the workforce and support their continuous development. Regional governments should actively promote cooperation between schools and enterprises, and between local governments and businesses, to cultivate local talent in the carbon sector [18]. Strengthen deep cooperation with research institutions, continuously improve regional carbon trading market systems, provide "carbon enterprise pilot cooperation," and rely on multi-party collaboration between research institutions, universities, and enterprises to explore and perfect carbon trading innovations and translate research into practical market capabilities.

5.3. Platform Construction and Improvement of Regional Internet+ Carbon Enterprise Database

Regional carbon cycling is a crucial component of the dual-cycle strategy. Within regions, efforts should be made to reduce data barriers, seek integrated development of regional carbon market data transactions, and enhance data exchange platforms between cities. Develop comprehensive regional carbon trading databases that are updated dynamically, ensure smooth information flow, and utilize an integrated data platform incorporating 5G, industrial big data, and the Internet+ [19]. This approach can: 1) strengthen regional government oversight and manage carbon trading market risks, 2) enhance transparency in the carbon supplement enterprise value chain, rationally adjust carbon trading quotas, and prevent resource waste due to information asymmetry, and 3) improve communication and interaction between enterprises, and between government and enterprises, showcasing information resources and promoting positive interactions.

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5.4. Promoting PPP Development and Exploring Government-Social Capital Cooperation in Carbon Trading

With the introduction of the "dual carbon goals," the use of clean energy has increased annually, and ecological protection has become a key mission for regional governments. However, due to historical development and regional economic factors, local government fiscal resources are limited and cannot focus solely on ecological restoration. Therefore, in the Public-Private Partnership (PPP) model [20,21], ecological PPP projects have emerged, where local government forestry departments cooperate with social capital to attract stakeholders and jointly complete ecological projects. The use of the ecological PPP model in environmental protection projects will improve the efficiency of regional ecological governance, enhance green development capabilities, and utilize carbon market mechanisms to trade forestry carbon credits, converting long-term ecological benefits into real economic benefits. Particularly, regional governments should strengthen carbon accounting in afforestation projects, determine transaction amounts based on net carbon credits and carbon prices, and play a leading role in project site selection, design decisions, and project coordination. This includes mitigating project risks, enhancing project management, and strategically supplementing regional carbon trading volumes. While utilizing forestry carbon credits, reasonable local industrial layout should be considered to drive sustainable and healthy low-carbon economic development.

References

[1] Song Xu, Bin Hui. From Local Carbon Pilot to National Carbon Trading Center. China Environmental Management, Vol. 13 (2021) No. 01, p. 175-176.

[2] Measures for the Administration of National Carbon Emission Trading (Trial). [Online] Available at: http://www.gov.cn/xinwen/2020-11/05/content_5557519.htm

[3] Gui Zhiguo. The Current Situation of China's Carbon Trading Market and Countermeasures for Commercial Banks. Engineering Economy, Vol. 31 (2021) No. 08, p. 50-53.

[4] 2020 Shanghai Carbon Market Report. [Online] Available at: https:// www.cneeex. com/ tpfjy/xx/yjybg/tscbg/

[5] Zhang Hui, Feng Zihang. Administrative Control of Carbon Emission Rights in Carbon Trading Systems. Environmental Protection, Vol. 49 (2021) No. 16, p. 39-43.

[6] Song Xiaoling, Kong Chuiming. Empirical Analysis of the Impact of China's Carbon Trading Market on Regional Economic Structure. Macroeconomic Research, (2018) No. 09, p. 98-108.

[7] Zhang Qizai, He Jun. Connotation and Economic Effect of the Fourth Industrial Revolution. People's Forum, (2021) No. 13, p. 74-77.

[8] Wang Hua, Zhan Shaokang. Intelligent Manufacturing, Labor Substitution, and Collective Exclusion—A Sociological Study of the Impact of "Machine Substitution" on Worker Employment. Journal of Anhui Normal University (Humanities and Social Sciences Edition), Vol. 49 (2021) No. 04, p. 85-94.

[9] Wang Liwei, Ma Yaotian, Ouyang Hui. Basic Characteristics and Influencing Factors of Low-Carbon Layouts in China's Urban Agglomerations. Macroeconomic Research, (2017) No. 05, p. 125-133.

[10] Zou Caineng, Xue Huaqing, Xiong Bo, Zhang Guosheng, Pan Songqi, Jia Chengye, Wang Ying, Ma Feng, Sun Qian, Guan Chunxiao, Lin Minjie. The Connotation, Innovation, and Vision of "Carbon Neutrality". Natural Gas Industry, Vol. 41 (2021) No. 08, p. 46-57.

[11] Wang Zhen, Kong Yinghao, Li Wei. Review of the Development of China's Natural Gas Industry under the Background of "Carbon Neutrality". Natural Gas Industry, Vol. 41 (2021) No. 08, p. 194-202.

[12] State Council. "13th Five-Year Plan" Work Plan for Controlling Greenhouse Gas Emissions. Central People's Government of the People's Republic of China, November 4, 2016.

ISSN: 2710-0170

[13] Central Committee of the Communist Party of China, State Council. Rural Revitalization Strategy Plan (2018-2022). Ministry of Agriculture and Rural Affairs of the People's Republic of China, September 26, 2018.

[14] Yang Changjin. Practice and Path Exploration of Carbon Trading Market in Promoting Low-Carbon Development of Rural Revitalization. Price Theory and Practice, (2020) No. 02, p. 18-24.

[15] Li Xiaoyan, He Xiaoling. Basic Ideas for the Development of Low-Carbon Agriculture in Sichuan—Based on Domestic and International Experience and Insights. Rural Economy, (2012) No. 11, p. 48-52.

[16] Yu Xiaozhong, Luo Xia. "Belt and Road" Energy Symbiosis Cooperation: Framework Analysis and Advancement Path. Gansu Social Sciences, (2021) No. 02, p. 198-206.

[17] Zhu Mengshi. Countermeasures for Investment Promotion in Development Zones in the Post-Pandemic Era—A Case Study of Jiangsu National Economic and Technological Development Zones. Jiangsu Business Review, (2021) No. 10, p. 44-47.

[18] Yu Xiaozhong, Liu Mengwei, Bai Long. Innovation Research on the "Belt and Road" International Energy Cooperation Model Based on High-Quality Development. Scientific Management Research, Vol. 39 (2021) No. 02, p. 166-170.

[19] Li Shouguo, Song Baodong. The Impact of Internet Development on Carbon Emissions—An Empirical Study Based on Panel Threshold Model. Ecological Economy, Vol. 35 (2019) No. 11, p. 33-36+70.

[20] Li Haoran, Zhang Zhiguang. Research on the Risk Mechanism of Forestry Carbon Sink Government and Social Capital Cooperation Projects. Forestry Economy, Vol. 42 (2020) No. 10, p. 74-84.

[21] Yu Xiaozhong, Luo Xia. Research on the Interactive Mechanism of Multiple Subjects in Innovation of "Belt and Road" International Energy Cooperation Model. Qinghai Social Sciences (2019) No. 05, p. 43-50+67.