

The Synergistic Effects and Mechanisms of China's Carbon Tax and Carbon Trading Market

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Abstract: As global climate change accelerates, countries worldwide are adopting measures to curb carbon emissions and promote sustainable development. China, a major emitter, has actively implemented carbon reduction policies, with carbon tax and carbon trading markets as key mechanisms. The carbon tax raises the cost of emissions, encouraging enterprises to reduce their emissions, while the carbon trading market enhances the allocation of emission resources through market-driven pricing mechanisms, thereby improving overall reduction efficiency. This study aims to explore the synergistic effect between China's carbon tax and carbon trading market, analyzing their interaction in promoting carbon emission reduction and assessing their influence across different industries and regions. Based on a review of relevant literature and data from government carbon emissions statistics, the study examines the synergy between carbon tax and the carbon trading market. The results indicate that the implementation of the carbon tax increases the cost of carbon emissions for enterprises, thus prompting them to adopt more proactive reduction measures while providing stable demand for the carbon trading market. Besides, the carbon trading market improves overall emission reduction efficiency by optimizing the market-driven allocation of carbon allowances. After the carbon tax was implemented, corporate emissions dropped, market activity increased, and price fluctuations signaled emission reduction. In addition, it reveals that the synergistic effect of carbon tax and carbon trading market varies across different industries and regions, suggesting that policy adjustments should be tailored to specific circumstances.

Keywords: Carbon Tax, Carbon Trading Market, Collaborative Mechanism, China

1. Introduction

Climate change is a major global challenge in the 21st century, with extreme weather events like heatwaves, heavy rainfall, and hurricanes influencing the economy and environment. The World Meteorological Organization reports that global temperatures have increased by 1.55 °C compared to pre-industrial levels, and reducing greenhouse gas emissions is a key strategy to address this. As such, China has pledged to peak carbon emissions by 2030 and achieve carbon neutrality by 2060 [1]. To achieve these goals, China has implemented various policy tools, including carbon tax and carbon trading markets. The carbon tax encourages emission reductions by increasing the cost of carbon dioxide emissions, while the carbon trading market promotes reductions by optimizing the allocation of carbon emission rights through market mechanisms [2]. Due to issues like insufficient liquidity and imperfect pricing in the carbon trading system, the carbon tax will be introduced to complement the carbon market and support the “dual carbon” goals [3]. The study investigates the synergistic

mechanism between China's carbon tax and carbon trading market, analyzing their combined influence on carbon emission reduction and their role in achieving the carbon peak and carbon neutrality goals. In particular, it focuses on how emission reductions are driven and policy effectiveness is enhanced through the complementarity of the carbon tax and carbon trading market. The synergistic effect of the two mechanisms is assessed via China's carbon emission data, carbon trading market data, and related literature, exploring their performance across sectors and regions. The research can support optimizing China's carbon policies, aiding in achieving the "dual carbon" goals.

2. The necessity of introducing a carbon tax in China

2.1. The selection of carbon pricing policies

As a critical tool in addressing climate change, carbon pricing encourages emission reductions by putting a price on carbon. Carbon markets achieve this through a carbon credit system, where each credit allows the emission of one metric ton of CO₂ [4]. At present, China has chosen carbon trading over carbon taxes to balance the emissions reduction burden across various industries. And carbon trading, through a "cap and trade" system, sets emission caps for high-emission sectors such as steel and chemicals, enabling emissions reductions through market transactions. In comparison to carbon taxes, carbon trading is better suited for large-scale, high-emission enterprises and, when the market mechanism is mature, can more effectively achieve emission reduction targets [5].

Carbon taxes and carbon markets are the two main approaches to carbon pricing globally. Based on Pigouvian tax theory, carbon taxes incentivize companies to reduce emissions by imposing taxes, with the revenue used for technological research and emission reduction projects. Moreover, carbon markets optimize resources by setting emission caps, allocating allowances, and enabling trading. Despite their greater flexibility and wider applicability, carbon taxes are harder to predict in terms of their reduction outcomes. In contrast, carbon markets adjust emissions through price mechanisms and better facilitate regional coordination for reductions, although their prices are more volatile [5].

China's adoption of carbon trading policies is driven by the need for industrial restructuring. As China transitions from traditional, energy-intensive growth to high-quality growth, carbon trading helps improve resource efficiency and promotes industrial upgrading. Particularly in high-emission sectors such as steel, power, and building materials, carbon trading enables centralized management and allowance allocation, facilitating emission reductions. Despite their broad applicability, carbon taxes are less effective in the early stages compared to carbon trading [6]. Globally, many countries and regions, including the European Union Emissions Trading System (EU ETS), have established carbon markets with considerable progress [7]. As a key source of global greenhouse gas emissions, China's carbon trading market is of significant international importance. By developing its carbon market, China enhances its influence in global climate governance and carbon markets, promoting international cooperation [8,9].

2.2. The significance of timing the introduction of a carbon tax

By fully internalizing environmental costs, carbon taxes overcome the limitations of carbon trading schemes. While carbon trading markets incentivize emissions reductions through price mechanisms, they may not always fully reflect environmental costs, leading to insufficient reductions. In such cases, carbon taxes provide additional economic incentives, encouraging more proactive emission reductions. Evidence from countries, such as Denmark and Sweden, early adopters of carbon taxes, shows that appropriate tax rates can effectively reduce reliance on fossil fuels and promote the adoption of cleaner energy. The experiences of these countries offer valuable insights for refining China's carbon tax system and provide important references for the formulation of policy [10].

Even with a stable carbon trading market in place, carbon taxes remain essential. While carbon trading dominates key sectors, it fails to cover all emission sources, leaving small enterprises and the agricultural sector out of scope. Furthermore, carbon prices in trading markets fluctuate with economic cycles, which can undermine long-term emissions reduction goals. In contrast, such taxes offer price stability and enable businesses to plan emissions reductions more effectively by ensuring consistent carbon costs regardless of market fluctuations. The universal application of carbon taxes eliminates disparities in carbon costs across industries, promotes fair competition, and drives the widespread adoption of green, low-carbon practices [11].

3. The current status of China's carbon trading market

3.1. The evolution of China's carbon trading market

Since 2013, China has introduced carbon trading markets in eight provinces and cities, culminating in the formal launch of the national carbon market in 2021, which marked a key milestone in the development of China's carbon emissions pricing system. In 2011, the National Development and Reform Commission (NDRC) approved pilot carbon trading programs in Beijing, Tianjin, Shanghai, Chongqing, Guangdong, Hubei, and Shenzhen. These pilot programs began in 2013, covering over 20 industries, including power, steel, and cement, involving nearly 3,000 key emission-intensive entities. And Fujian launched the eighth pilot market in 2018. By July 2023, the cumulative trading volume in China's regional carbon markets reached 449.0518 million tons, peaking at 70.9025 million tons in 2019 and gradually declining since. However, trading volumes in Fujian, Shanghai, and Hubei have consistently increased. For instance, Guangdong's carbon market accounts for over 40% of the total trading volume and transaction value in the national carbon market. The average transaction price in 2022 was 51.85 yuan per ton, a 54.69% year-on-year increase. Beijing's pilot carbon market recorded the highest average transaction price at 66.88 yuan per ton [12].

The evolution of China's carbon trading market has undergone several key milestones, as shown in Table 1. The initiation of pilot programs in 2011 and the formal launch of the national carbon market in 2021. Despite fluctuations in trading volumes, markets in regions like Guangdong have maintained steady growth. By July 2023, the total transaction value of the national carbon market reached 11.077 billion yuan, with an average transaction price of 46.02 yuan per ton [13,14].

Table 1: Current status of China's carbon trading market

Date	Event/Data	Details
2011	NDRC approves pilot carbon trading programs in seven provinces and cities	Beijing, Tianjin, Shanghai, Chongqing, Guangdong, Hubei, Shenzhen initiate pilot programs, covering over 20 industries and nearly 3,000 emission-intensive entities
2013	The Third Plenary Session of the 18th CPC Central Committee proposes a nationwide carbon trading system	Further promotion of the construction of the national carbon market
2013-2014	Seven pilot regions initiate carbon emissions trading	Development of respective carbon trading systems
End of 2014	NDRC releases "Interim Measures for the Management of Carbon Emission Rights Trading"	Provides a basic framework for carbon trading market development

Table 1: (continued).

December 2016	New pilot carbon markets in Sichuan and Fujian	Sichuan focuses on CCERs, Fujian implements forestry carbon sink trading
December 2017	NDRC releases “National Carbon Emission Rights Trading Market Construction Plan (Power Generation Industry)”	Launch of national carbon trading system, first batch of power industry enterprises included
2018	Fujian carbon trading pilot market established	The eighth pilot market in China
December 2020	Ministry of Ecology and Environment (MEE) releases “Trial Measures for the Management of National Carbon Emission Rights Trading”	Further standardization of national carbon market management
May 2021	MEE releases “Carbon Trading Rules”	Standardizes registration, trading, and settlement of national carbon emission rights
July 16, 2021	National carbon market officially launches, with over 2,000 power generation enterprises participating	Shanghai Environment and Energy Exchange becomes the trading platform
2021	First compliance cycle of national carbon market begins	Marks the beginning of a new phase for the national carbon market
2022	The average transaction price in the national carbon market was 51.85 yuan per ton, a 54.69% year-on-year increase	Beijing’s carbon market recorded the highest transaction price, 66.88 yuan per ton
By July 2023	Cumulative trading volume of regional carbon markets reached 44.905 million tons, total transaction volume of national carbon allowances reached 241 million tons, with a transaction value of 11.077 billion yuan	Guangdong accounts for over 40% of total trading volume and transaction value

3.2. The effectiveness of carbon trading policies

Carbon trading systems offer significant advantages in controlling carbon emissions from specific industries, particularly for major emission sources such as the power sector. The power industry accounts for a large share of China’s carbon emissions, and carbon trading allows precise control of emissions by setting industry-specific emission benchmarks and allocating allowances based on enterprise output.

In addition, carbon trading incentivizes voluntary emission reductions by firms. Through carbon markets, companies can reduce emissions more cost-effectively while driving investment in cleaner technologies [15]. Under the carbon trading system, a firm’s allowances are determined by its actual output and government-established emission benchmarks. If a company reduces emissions through technological upgrades, it can profit by selling its surplus allowances. Conversely, if a company’s emissions exceed its allocation, it must buy additional allowances from the market. This mechanism encourages companies to actively adopt energy-saving and emission-reduction strategies, thereby improving resource efficiency. For example, it is noted that carbon emission indicators are driving industry reforms and enhancing efficiency, with carbon trading playing a critical role in reducing excess capacity. Moreover, leveraging carbon trading mechanisms to foster low-carbon industrial

development enhances efficiency and generates “double dividend” benefits. The carbon trading system serves two purposes: it mandates energy conservation and emission reduction via a quota system, while allocating auction revenues to support low-carbon technologies. Compared to direct government subsidies, quota auctions not only reduce the economic burden on energy-intensive, high-emission industries but also direct funds towards the development of renewable energy and energy-efficient industries, thus achieving a “double dividend.”

3.3. Challenges and future outlook for China’s carbon trading system

The Chinese carbon trading system faces a series of challenges that must be addressed and adjusted to ensure its successful future development. Firstly, linking carbon tax to carbon market prices is a complex issue. To mitigate potential price fluctuations in the carbon trading market, the carbon tax rate should be set slightly above the market average, ensuring stability during market challenges. However, the tax rate should not only depend on market fluctuations but also consider the actual emission reduction costs across industries. Flexible adjustment of the tax rate, without burdening enterprises, will promote both environmental protection and sustainable economic development. The tax should be practical and targeted, enabling businesses to reduce emissions while remaining competitive, encouraging active participation in emission reduction. Besides, while China’s carbon trading market currently concentrates on large enterprises and key emission sectors, the emissions from small and micro-enterprises (SMEs) cannot be overlooked. Due to their smaller scale, SMEs face higher costs for carbon emission monitoring and management, which limits their influence and participation in the carbon trading market. As such, the carbon tax can drive emission reductions in SMEs by improving energy efficiency, optimizing processes, and increasing clean energy use. At the same time, such policy can guide the behavior of these enterprises through economic regulation, encouraging them to accelerate technological transformation and production upgrades, contributing to the overall societal goal of a low-carbon transition. Moreover, increased tax revenue will help the government support low-carbon economy development and fund emission reduction efforts.

The policy sends clear carbon cost signals to businesses, especially SMEs, urging them to focus on energy efficiency, emissions reduction, and the use of green technologies. By implementing the carbon tax, companies are incentivized to reduce emissions, while contributing to the fulfillment of national carbon reduction goals. In coordinating carbon tax and carbon trading, it is important to follow the principle of tax neutrality to prevent undermining business competitiveness. By drawing on the experiences of developed countries in Europe and the U.S., such policies can be gradually implemented, reducing the burden on businesses and ensuring their competitiveness. In addition, the carbon tax should be integrated into the existing resource and environmental tax systems, with a dynamic adjustment mechanism based on actual emission reductions. This policy will drive carbon reduction, ensure fair competition, and support sustainable development, laying a strong foundation for the carbon market’s future maturity.

4. The synergistic mechanism of carbon tax and carbon trading

4.1. Setting a reasonable scope for regulation

As a market mechanism, carbon trading internalizes the external costs of carbon emissions and the benefits of emission reductions, thereby boosting enterprises’ incentives to pursue green innovation [16]. To enhance the synergy between carbon taxes and carbon trading, it is crucial to establish more detailed and specific implementation guidelines. In the agricultural sector, carbon tax policies can be established by linking carbon emissions to processes such as fertilizer application, pesticide spraying, and agricultural waste disposal. Also, low-carbon technologies like green cultivation and precision agriculture should be encouraged, with tax incentives to promote emission reductions. For

commercial entities, carbon tax standards can be formulated based on a company's carbon footprint, energy consumption, and environmental protection measures. Additionally, this project will create a carbon trading platform, enabling companies to trade carbon allowances, thus encouraging active participation in emission reduction efforts. Entry barriers will be set in the carbon trading market to ensure only environmentally compliant companies participate, preventing market disorder.

Furthermore, the government should strengthen the implementation of carbon tax and carbon trading mechanisms to ensure policy effectiveness. Besides, the government should enhance public outreach to raise awareness of low-carbon initiatives and create a supportive environment for broad societal participation. Table 2 presents the current status and regulatory scope of China's carbon trading market.

Table 2: Current status and regulatory scope of China's carbon trading market

Analysis Dimension	Current Status and Regulatory Scope	Data/Policy Basis
Covered Industries	By 2025, mandatory inclusion will extend to the power, steel, cement, and electrolytic aluminum sectors, involving around 8,000 enterprises.	Initially covering the power sector (with an allowance of 5.1 billion tons), by 2025, steel, cement, and electrolytic aluminum will be included, increasing the total allowance to over 8 billion tons.
Total Allowance	The total allowance of the national carbon market will increase from 5.1 billion tons to over 8 billion tons, making it the largest carbon market in the world.	The allocation of allowances to newly included sectors will diversify by 2025, with the overall increase in allowances driving market expansion.
Trading Volume	As of February 13, 2025, the cumulative trading volume was 63.24 million tons, with a transaction value of 432.298 billion yuan, showing a steady rise in daily trading volume.	From January 1 to February 13, 2025, the trading volume was 2.15 million tons, with a transaction value of 1.97 billion yuan, reflecting increased market activity.
Price Trends	Carbon prices exhibited a fluctuating upward trajectory in 2025, with the closing price on February 13th recorded at 92.34 yuan per ton, showing a slight increase of 0.13% from the previous day.	Price fluctuations are influenced by macroeconomic conditions, policy adjustments, and shifts in supply and demand. The long-term upward trend is linked to emission reduction pressures and related policy refinement.
Regulatory Measures	1. Allowance Allocation: Implement diversified allocation methods, including auction mechanisms. 2. Sector Expansion: Mandate the inclusion of high-emission industries. 3. Financial Instruments: Support innovation in carbon financial derivatives.	Emphasizes the role of market mechanisms in emissions reduction, promoting market standardization through detailed regulations (e.g., the "Management Measures for Carbon Emission Trading") and international cooperation.
Challenges and Optimization Directions	1. Insufficient market liquidity; 2. Significant disparities in corporate carbon management capabilities; 3. Need for improved integration with international carbon markets.	To address these challenges, it is essential to refine the regulatory framework, enhance corporate training, diversify carbon financial instruments, and actively participate in global carbon trading regulations, such as those outlined in Article 6.4 of the Paris Agreement.

It is crucial to define the jurisdictional boundaries of carbon emission taxes and carbon trading schemes. Carbon trading should target high-emission sectors with easy-to-monitor emissions and proven reduction technologies, like electricity, steel, and construction. This will effectively manage overall emissions and help achieve key reduction targets. At the same time, carbon taxes should be applied to commercial, agricultural, and residential sectors, which have lower and more dispersed emissions. For example, taxes should be levied on coal used for winter heating in rural areas and on the energy consumption of small businesses. Implementing carbon taxes can refine the carbon emission management system, preventing issues like double taxation and regional regulatory gaps. By integrating carbon trading and carbon taxes, their combined strengths can ensure comprehensive emissions coverage. Thus, linking carbon markets can drive price convergence, boost liquidity, and enable companies in high-cost regions to purchase allowances from low-cost regions, encouraging more ambitious climate goals [17].

4.2. Establishing a carbon price floor

When establishing a carbon price floor, it is crucial to evaluate national carbon reduction targets, along with the abatement potential and costs in various sectors. Economic and environmental impacts under different emission reduction scenarios can be modeled to inform the determination of a price floor that encourages corporate emission reductions without disrupting economic stability. And this price floor should be regularly assessed and adjusted based on technological advancements, market conditions, and policy changes. An independent expert committee can be set up to analyze relevant data and recommend adjustments. Also, a transparent information disclosure mechanism should be put in place to ensure public awareness and oversight of the carbon price floor's creation and adjustments.

The “carbon tax backstop mechanism” is designed to automatically trigger the imposition of a carbon tax when the carbon trading market price falls below the predetermined carbon price floor. This mechanism prevents the carbon trading market from falling into a low-price state caused by extreme supply and demand imbalances, which could weaken the incentive for emission reductions. The carbon price floor should be set based on long-term emission reduction targets and the average abatement costs of companies. A stable carbon price floor can encourage investment in renewable energy technologies [18]. Under the Paris Agreement, countries may cooperate directly or involve other entities, including the private sector, in the financing and transfer of mitigation outcomes [19]. This mechanism imposes a carbon tax on companies with excess emissions, keeping the carbon price within a reasonable range and ensuring returns on emission reduction investments, supporting the sustainable development of green technologies. China launched its national ETS in December 2017, thus making it the key policy to meet the country's domestic decarbonization goals and global climate commitments [20].

4.3. Adhering to the principle of tax neutrality

The principle of tax neutrality in carbon taxation suggests that the carbon tax should not increase the overall economic burden, but instead redistribute it across sectors or between consumers and producers. However, applying this principle in a way that avoids disparities across industries and demographic groups is a challenging and sensitive task. Policymakers must carefully consider the differential impacts of carbon taxation across various sectors to strike a balance between corporate interests and societal equity. For carbon-intensive industries, such as energy and manufacturing, an increase in carbon taxes can significantly elevate production costs, affecting their competitiveness. Consequently, policymakers may need to provide transitional support to these sectors, such as tax reductions and subsidies, to facilitate their adaptation to the new carbon tax regime.

To ensure social equity, it is essential for policymakers to consider how carbon taxes affect low-income households, as they are more susceptible to energy price fluctuations. The increased cost of living resulting from carbon taxes can place a disproportionate burden on these households. Therefore, governments should implement social safety nets and subsidy programs to mitigate the economic strain on low-income families. Besides, in the execution of tax neutrality, policymakers must closely monitor the allocation of carbon tax revenues. Investing these revenues in the research and development of clean energy technologies and environmental protection measures can foster the growth of a green economy and, to some extent, offset the negative economic impacts of the carbon tax, thereby achieving both economic and environmental benefits. Carbon tax revenues can effectively promote the development of green technologies, thereby reducing carbon emissions [21]. The widespread use of renewable energy contributes to economic growth, highlighting the crucial role of clean energy in achieving sustainable development [22].

4.4. Implementing a paid allocation mechanism

To ensure transparency and fairness in the implementation of a revenue allocation system, a public auction mechanism can be adopted. Building upon this, this paper proposes a multi-round bidding approach. Following each round of bidding, quotas are assigned based on the bid prices, thereby incentivizing active and rational participation from both corporations and individuals. The revenue generated from the auction can be allocated in several ways. Firstly, it can be channeled into carbon tax regulation, either through adjusting carbon tax rates or offering tax reductions, to mitigate the economic impacts of the carbon tax and ensure a smooth economic transition. Secondly, it can be invested in research, development, and application of new energy technologies, which will not only foster the growth of China's green economy but also enhance energy efficiency and reduce carbon emissions. Thirdly, it can support the establishment and refinement of the carbon trading market, including the formulation of relevant regulations, strengthening regulatory mechanisms, and improving trading platforms, to enhance market transparency and liquidity, thereby attracting more participants. Only through these measures can a rational revenue allocation system be established, enabling the efficient allocation of resources and promoting the harmonious development of the economy and the environment.

In carbon trading schemes, the paid utilization of carbon emission allowances should be further strengthened. Renewable energy has a positive influence on the environment and socio-economic welfare, and effective allocation mechanisms are crucial to support sustainable development [23]. This demonstrates that, in addition to the initial allocation of allowances necessary for the basic operation of enterprises, the remaining allowances should be distributed through periodic auctions or other paid transfer methods. Such an approach would encourage companies to value allowances more highly, incentivizing them to reduce carbon emissions and increasing their urgency to meet emission reduction targets. Meanwhile, the revenue generated from auctions should be directed into a carbon tax regulation fund, supporting the implementation of preferential carbon tax policies and the development and operation of the carbon trading market. This can facilitate the deep integration of carbon emission taxes with investments in research and development, creating synergies at the financial and policy levels, and enhancing the overall effectiveness of emission reduction efforts.

5. Conclusion

The synergistic mechanism between carbon emissions and carbon trading is crucial for achieving the “dual carbon” goals in China and constitutes the core of the carbon trading system. As policy tools for emission reduction, carbon taxes and carbon trading each have their advantages and limitations. The synergistic mechanism effectively integrates both tools, hence enhancing emission reduction

efficiency and expanding the scope of carbon reduction. However, limitations exist in the current study, such as sample selection, data acquisition, and analytical methods, which need to be improved to enhance the rigor and reliability of the research. Future research will delve deeper into evaluating the impacts of different policy combinations on carbon emissions trading, exploring regional carbon trading implementation strategies, and assessing the influence of new technologies on carbon trading, providing valuable insights for future studies. Currently, carbon trading markets primarily focus on large enterprises and key emission sources, while carbon taxes can cover small and medium-sized enterprises, preventing carbon leakage. The synergistic mechanism can support carbon trading prices, addressing the issue of undervalued carbon prices. Carbon taxes can serve as a price floor, incentivizing emission reductions when the carbon trading market is ineffective. The dual pressure of carbon taxes and carbon trading will push high-energy, high-emission enterprises to reduce emissions, while providing greater development opportunities for low-carbon enterprises, promoting the low-carbon transition and advancing the overall low-carbon development of the socio-economic system.

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