An Analysis of the Impact Mechanism of Carbon Trading Market Development on Regional Economic Growth in China

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Abstract. The carbon trading market is a key market-based policy tool for China to implement its "dual-carbon" strategy and promote green and low-carbon transformation. Having gone through two key stages—the launch of local pilot programs in 2013 and the nationwide unified market in 2021—China's carbon market has become the world's largest in terms of coverage, providing an important practical scenario for examining the interaction between environmental regulations and regional economic growth. Existing research focuses on core issues such as the Porter effect, spatial heterogeneity, transmission pathways, and carbon leakage risks of carbon trading on regional economic growth, yielding rich results. However, research gaps remain in areas such as the long-term effects of the national market, regional coordination mechanisms, and intertemporal dynamic impacts. This paper systematically reviews cutting-edge international and domestic literature, extracts the theoretical logic and empirical conclusions of carbon trading's impact on regional economic growth, summarises the consensus, disagreements, and shortcomings of existing research, and looks forward to future research directions from three dimensions: theoretical framework, empirical methods, and policy adaptation. This provides a reference for deepening theoretical research on carbon markets and optimising regional green development policies.

Keywords: Carbon trading market, Dual-carbon strategy, Regional economic growth, Green and low-carbon transformation.

1 Introduction

With the acceleration of global climate governance, green and low-carbon transformation has become a core orientation for high-quality economic development in various countries. After proposing the "dual-carbon" target, China urgently needs to build a market-oriented environmental policy system to achieve a dynamic balance between ecological environmental protection and stable economic growth. Starting in 2013, seven provinces and municipalities—Beijing, Shanghai, Tianjin, Chongqing, Hubei, Guangdong, and Shenzhen—launched carbon trading pilot programs. Shenzhen became the first carbon market in China to officially launch trading. Hubei's pilot program

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consistently ranked first in cumulative trading volume nationwide, accounting for nearly 40% of the national pilot volume. Shanghai maintained a 100% compliance rate for many consecutive years and pioneered carbon finance, carbon inclusion, and electricity-carbon synergy mechanisms. Guangdong, leveraging its manufacturing advantages, formed a multi-tiered carbon market system covering industry, construction, and transportation, accumulating differentiated operational experience for the national market.

In July 2021, the national carbon market officially launched, initially covering 2,257 power generation companies, managing approximately 5.1 billion tons of emissions annually, accounting for over 40% of the national carbon emissions, instantly becoming the world's largest carbon market. By 2025, the national carbon market's cumulative trading volume exceeded 700 million tons, with a transaction value of nearly 49 billion yuan, and it gradually incorporated high-energy-consuming industries such as steel, cement, and chemicals, covering over 60% of the national carbon emissions. Given the uneven regional development and significant differences in resource endowments in China, the economic growth effects of carbon trading on developed eastern regions, industrial bases in central China, and resource-rich provinces in western China are clearly differentiated. Clarifying its mechanism of action is an urgent practical need to promote coordinated regional development and improve the design of the national carbon market system.

International academic circles have long discussed the relationship between environmental regulation and economic growth, and the proposed Porter hypothesis has laid a theoretical foundation for environmental policies to promote innovation compensation and competitiveness enhancement [1]. The practices of mature carbon markets in Europe and the United States, such as the EU ETS and RGGI, have spawned a large number of English journal articles, focusing on the economic effects, spatial spillovers, heterogeneous impacts, and carbon leakage of carbon trading [2,3]. Domestic research relies on pilot projects and national market data to conduct policy evaluations, but existing results mostly focus on single pilot projects or short-term effects, and are still insufficient in terms of the long-term dynamic impact of a unified national market, inter-regional linkage mechanisms, and the integration of theoretical frameworks. In addition, the proportion of Chinese literature is too high, and there is insufficient dialogue with international frontiers, making it difficult to form a systematic and international research review. English literature based on Chinese practices has begun to focus on the relationship between carbon markets and high-quality development, but systematic reviews on regional growth heterogeneity and spatial spillover are still lacking. Analysis of relevant regional heterogeneity provides an important empirical reference for this study [4].

This paper takes China's pilot and national carbon trading markets as its research objects, systematically reviewing the theoretical mechanisms and empirical evidence of carbon trading's impact on regional economic growth. The core content includes that carbon trading affects regional economies through three paths: technological innovation, industrial structure upgrading, and factor allocation optimisation. Most studies have verified the Porter effect of carbon trading, but significant heterogeneity exists between underdeveloped regions and high-carbon-dependent regions [5]. Factors such

as carbon leakage and regional market segmentation weaken the positive policy effect [6], while market perfection, green finance support, and cross-regional collaboration strengthen the economic growth effect [7]. The core conclusion of this paper is that carbon trading has a positive driving effect on regional economic growth overall, but the effect is influenced by the regional development stage, resource endowment, market mechanisms, and policy collaboration. Differentiated institutional design is needed to achieve a win-win situation for both ecology and economy [8].

2 Theoretical Mechanisms of Carbon Trading's Impact on Regional Economic Growth

Carbon trading essentially internalises the external costs of carbon emissions through market mechanisms, forcing market players to adjust their production decisions and resource allocation, ultimately impacting regional economic growth. Its core transmission pathways can be summarised into three lines, forming a complete logical chain of "cost constraints – efficiency improvement – growth transformation."

2.1 Technological Innovation-Driven Path

Porter's hypothesis points out that reasonable environmental regulations will not weaken competitiveness, but rather stimulate enterprises to conduct green technology research and development, offsetting compliance costs through innovation compensation [1]. Carbon trading sets clear emission reduction costs and benefit expectations for enterprises. High-emission enterprises need to purchase allowances to increase expenditures, while low-emission enterprises can sell allowances to obtain revenue. This differentiated incentive directly drives enterprises to increase R&D investment in energy-saving technologies, carbon capture, utilisation, and storage (CCUS), and clean energy substitution. Technological innovation not only reduces carbon emissions per unit of output but also improves production efficiency, promotes product upgrades, and forms a new driving force for regional economic growth [9].

2.2 Industrial Structure Upgrading Path

Carbon trading imposes cost constraints on high-energy-consuming and high-emission industries, forcing outdated production capacity to exit, while guiding capital, talent, and other factors to gather in low-carbon industries and green service industries [10]. Developed eastern regions, relying on their technological and industrial foundations, are accelerating the development of low-carbon industries such as new energy, energy conservation and environmental protection, and the digital economy; industrial bases in the central region are promoting the green transformation of traditional manufacturing industries; and resource-based provinces in the west are gradually getting rid of their dependence on coal, petrochemicals, and other industries. The industrial structure is transforming from a high-carbon extensive model to a low-carbon intensive model, improving the quality and sustainability of regional economic development [11].

2.3 Factor Allocation Optimisation Path

Carbon trading guides the flow of factors across regions and industries through price signals, solving the problem of resource misallocation. As a scarce production factor, carbon emission rights are freely traded between regions, enabling regions with low emission reduction costs to undertake more emission reduction tasks, thereby minimising the emission reduction costs for the whole society. Meanwhile, the carbon market drives the development of green finance, such as green credit, carbon funds, and carbon insurance, broadens financing channels for low-carbon projects, improves capital allocation efficiency, promotes the concentration of land, energy, and labour resources in high-efficiency and low-carbon fields, and releases the potential for regional economic growth [9].

3 Evidence and Heterogeneity Analysis

3.1 Overall Effect: A Consensus on Positive Driving Force

Looking at the existing domestic and international empirical research results, the academic community has formed a relatively unified positive driving force, understanding that the carbon trading mechanism empowers regional economic growth and promotes high-quality economic transformation. It is generally recognised that the carbon emission trading market is not simply a constraint on the development of high-energy-consuming industries, but can rely on market-based regulation to force the optimisation of industrial structure, the upgrading of technological innovation, and the improvement of economic efficiency, ultimately achieving the synergistic progress of ecological and economic benefits [2].

A large number of quantitative analyses using econometric models such as the difference-in-differences method and panel regression have fully confirmed this logic. Comparing data from carbon trading pilot areas with those from ordinary areas not included in the pilot program reveals that after the pilot policy was implemented, the willingness of enterprises in the pilot areas to conduct green technology research and development was fully stimulated. The number of green patent applications related to energy conservation, environmental protection, low-carbon emission reduction, and clean energy utilization showed a continuous upward trend, and the scale of technological innovation output steadily expanded. At the same time, the overall total factor productivity of the region was substantially boosted, and the efficiency of production factor allocation and resource utilization was significantly better than that of non-pilot areas. The extensive production development model gradually shifted to an intensive and low-carbon model [12]. From the perspective of the time dimension of the policy's effect, the driving effect of carbon trading on local economic growth has a delayed release characteristic, and the policy dividends will not be immediately apparent. In the early stages of the formal implementation of the carbon trading pilot policy, regional industries and enterprises were still in the adaptation and adjustment phase, and the costs of emission reduction and technological transformation increased in stages, resulting in a relatively slow economic driving effect. Two to three years after the policy

was implemented, the market trading rules became more mature, the low-carbon production and operation models of enterprises were basically finalized, the dividends of technological transformation and the advantages of industrial transformation were gradually released, and the positive driving effect on the regional GDP growth rate began to clearly appear, becoming a new driving force for the steady growth of the local economy [4]. With the official launch of the national unified carbon market, the coverage of carbon trading has been further expanded, and the market-based emission reduction constraints have been comprehensively strengthened. Among them, the power generation industry, which is large in scale and has a high proportion of carbon emissions, has become the core area of control. Under the constraints of the carbon emission quota trading mechanism, power generation companies have actively optimised their power generation structure, eliminated high-pollution and outdated units, and upgraded low-carbon power generation equipment, resulting in a significant improvement in the overall carbon emission reduction efficiency of the industry [7]. The emission reduction and efficiency improvement at the power generation end have further promoted the rational and stable pricing of electricity and electricity costs, effectively alleviating the electricity cost pressure of downstream manufacturing enterprises and reducing the production and operation burden of the real economy. The dual effects of cost reduction and technology spillover have been transmitted to all links of the upstream and downstream industrial chains, driving traditional high-energy-consuming industries such as metallurgy, chemical industry, and equipment manufacturing to accelerate low-carbon transformation. Emerging low-carbon industries and energy-saving and environmental protection industries have ushered in development opportunities. The linkage and synergy between industries have been continuously strengthened, gradually building a green growth pattern of the entire industrial chain that connects upstream and downstream and coordinates multiple industries. This has transformed the carbon trading policy from a single environmental control tool into an important market-based institutional carrier driving the sustainable growth of the macroeconomy [8].

3.2 Significant Regional Heterogeneity and Differentiation

The uneven development of regions in China determines the differentiation of carbon trading effects. Table 1 clearly shows the differences in the performance of the three major regions.

Table 1: Comparison of Economic Effects of Carbon Trading in Three Major Regions of China

Region Type	Development Characteristics	Core Effects of Carbon Trading	Growth Impact Degree
Eastern Developed Areas	Solid technological strength, sound low-carbon industrial foundation	Remarkable innovation compensation, rapid industrial upgrading	Strong positive driving effect
Central Industrial Base	Concentrated traditional manufacturing, great emission reduction potential	Driven by technological renovation, gradual industrial structure optimization	Moderate positive driving effect
Western Resource-based Provinces	Heavy reliance on high-carbon industries, weak technical capacity	High short-term cost pressure, sluggish long-term transformation	Weak positive / Neutral effect

From a spatial perspective, carbon trading has obvious spillover effects. Low-carbon technologies in the east spread to the central and western regions through industrial transfer and technological cooperation, driving the green transformation of surrounding areas [3]; however, some regions have carbon leakage problems, and high-emission enterprises transfer to areas not included in the control, weakening the overall policy effect [6]. Carbon trading relies on quota price signals to guide enterprises to adjust their emission reduction decisions, promote technological innovation and industrial upgrading within the region, and thus drive local economic growth. Simultaneously, quota trading between regions facilitates the cross-regional flow of various production factors, impacting local development through technology spillover and carbon leakage, ultimately promoting coordinated regional economic growth. However, market segmentation, regional policy differences, and insufficient infrastructure can restrict the transmission effect, resulting in a significant differentiation in the economic impact of carbon trading on different regions [5].

3.3 Key Influencing Factors

The effect of the carbon market on economic growth is constrained by multiple real-world conditions. Its key influencing factors are mainly reflected in three dimensions: First, market perfection. The allocation method of quotas, trading liquidity and price stability directly determine the incentive efficiency of the carbon market. An excessively high proportion of free quotas will significantly weaken the emission reduction motivation of market participants [8]. Second, policy synergy. The carbon market needs to form a linkage and synergy with policies such as energy consumption dual control, renewable energy subsidies and green finance in order to maximize the positive effect on economic growth [9]. Third, regional endowment. Resource-based regions face short-term development pressure during the transformation, while technology-intensive

regions can benefit quickly. Implementing differentiated policy design is the core key to bridging the regional development gap [4].

4 Research Gaps and Future Prospects

Current research still has obvious shortcomings. First, there is insufficient research on long-term effects. Most results focus on the short-term effects of the pilot stage, and there is a lack of continuous tracking and systematic analysis of the long-term dynamic impact and intertemporal transmission mechanism of the national unified carbon market [7]. Second, regional coordination research is weak. Research on inter-regional carbon quota coordination, benefit compensation mechanisms, and collaborative emission reduction pathways is insufficient, making it difficult to effectively support the national regional coordinated development strategy [8]. Third, there are limitations in methods and perspectives. Micro-level enterprise behaviour and macro-level regional economic research are disconnected, lacking a multi-scale, interdisciplinary, integrated analytical framework. Fourth, international dialogue and theoretical innovation are insufficient. Chinese literature is not closely connected with international cutting-edge research, and original theoretical achievements based on Chinese practice still need to be strengthened. (II) Future Research Directions

Future research can be deepened in four directions: In terms of theoretical framework, integrate and construct a dynamic analysis model of carbon trading and regional economic growth under the "dual carbon" target, and incorporate core variables such as spatial spillover and policy coordination [3]. In terms of empirical methods, innovatively use tools such as synthetic control method, spatial econometric model, and machine learning to accurately identify the long-term effects and heterogeneous mechanisms of the carbon market [5]. In terms of policy optimization, focus on studying differentiated quota allocation, cross-regional carbon trading system construction and carbon leakage prevention strategies to provide empirical evidence for the expansion and quality improvement of the national carbon market [6]. In terms of international alignment, systematically compare the practices of mature carbon markets such as the EU, refine development models adapted to China's national conditions, and continuously enhance China's academic discourse power and theoretical influence in the field of global climate governance.

5 Conclusion

As the core tool for China's green and low-carbon transformation, the carbon trading market has a positive driving effect on the overall regional economic growth, and achieves a win-win situation for ecological and economic benefits through three major paths: technological innovation, industrial structure upgrading, and factor allocation optimisation. However, due to factors such as regional development stage, resource endowment, and market mechanism, the eastern, central, and western regions exhibit significant heterogeneity in their effects. Western resource-based provinces face short-term cost pressures, while developed eastern regions are the first to reap the benefits of

innovation. Current research has verified the Porter effect and spatial heterogeneity of carbon trading, but there is still considerable room for expansion in long-term dynamic mechanisms, regional coordination, and interdisciplinary research. In the future, it is necessary to base this work on the practice of a unified national carbon market, deepen theoretical research, innovate empirical methods, and optimise policy design to promote carbon trading to better serve regional coordinated development and high-quality economic transformation, and provide solid market support for achieving the "dual carbon" goal.

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