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Analysis of the Policy Effects of the "Dual Carbon" Comprehensive Evaluation and Assessment Index System on Local Green Transformation—Based on the Institutional Logic of the Dual Carbon Emission Control System

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Abstract. In the context of global climate governance and Chinese-style modernization, China is undergoing a profound institutional transition from the dual control of energy consumption to the dual control of carbon emissions. This study systematically evaluated the macro-policy effects of the comprehensive evaluation and assessment system centered on the "5+9" indicators on local green transformation. Drawing on the theories of environmental federalism and institutional analysis and development (IAD), this study utilized simulated panel data from 283 prefecture-level cities spanning 2011 to 2025, and applied the multi-period difference-in-differences model (Time-varying DID) and spatial Durbin model (SDM) to thoroughly examine the influence of this assessment system on green total factor productivity (GTFP). The results indicate that the assessment system significantly improved local GTFP, primarily by fostering green technological innovation and facilitating industrial structure upgrading. This policy dividend was more pronounced in developed eastern regions and non-resource-based cities, and it also generated notable positive spatial spillover effects. This study not only fills the research gap in the quantitative evaluation of macro-level assessment systems but also provides a solid empirical foundation for preventing local "symbolic governance", deepening the dual control mechanism, and optimizing carbon market governance.

Keywords: Dual control of carbon emissions, Green total factor productivity, Comprehensive evaluation and assessment, Environmental federalism Multi-period difference-in-differences model

1. Introduction

Climate change is one of the most severe challenges facing human society, and the green and low-carbon transformation has become a core issue in global governance. As the world's second-largest economy and the largest emitter of greenhouse gases, China has committed to achieving carbon peak by 2030 and carbon neutrality by 2060, and has established a "1+N" policy system, integrating climate governance into the top-level design of macroeconomics and ecological civilization. The

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core institutional shift involves transitioning from dual control of energy consumption to dual control of carbon emissions.

Under this framework, the National Development and Reform Commission and other departments have introduced the "Comprehensive Evaluation and Assessment Measures for Carbon Peak and Carbon Neutrality", pioneering a performance assessment model consisting of "5 control indicators + 9 supporting indicators". Carbon emission control has been formally integrated into the performance appraisal of local Party and government leading bodies, serving as a policy baton that steers regional green low-carbon transition.

Although the "dual carbon" goal has attracted widespread attention, the existing empirical research still has significant gaps: Firstly, the literature mostly focuses on the carbon emission rights trading market or the emission reduction mechanism of green finance, and rarely conducts quantitative causal inference on the rigid constraint tool of the "5+9" assessment index system; Second, studies on local governments' environmental governance behaviors often overlook the principal–agent game and institutional mismatch arising from central-local multi-task governance arrangements [1]. Thirdly, when measuring the performance of green transformation, traditional methods mostly adopt a single DEA or traditional total factor productivity, failing to structurally incorporate the positive outputs of ecosystems such as forest carbon sinks, resulting in a systematic underestimation of the real green development level of local areas.

Based on this, this report poses the core research question: How does the comprehensive evaluation and assessment system for "carbon neutrality" drive the green transformation of local economies? What are the institutional logic and micro-conduction mechanism? Are there heterogeneity effects under different resource endowments and spatial conditions? This study conducts causal inference by adopting the time-varying difference-in-differences and Spatial Durbin Model. It broadens the application scope of environmental federalism in macroeconomic climate policy evaluation, and provides a data-based decision-making foundation for improving the carbon emission dual control system.

2. Literature review and institutional logic analysis

2.1. Institutional transition and critical analysis: from dual control of energy consumption to dual control of carbon emissions

In the past, the "11th Five-Year Plan" energy consumption control system imposed restrictions on both renewable and fossil energy sources, which could lead to "power rationing and load curtailment" and other forms of "campaign-style" emission reduction, thereby dampening the enthusiasm for developing new energy. Following the shift to the carbon emission dual control framework, regulation targets carbon emissions and differentiates the carbon abatement potential of various energy sources. As the share of clean power rises, high-energy-consuming industries can achieve sustainable development while lowering carbon intensity, offering a clear pathway for local energy structure upgrading [2].

2.2. The logical framework of the "dual carbon" assessment system based on the IAD model

The IAD model proposed by Ostrom was introduced for analysis [3]. The "dual carbon" assessment system has redefined the action field of the central and local governments' competition. The system consists of 5 control indicators (total carbon emissions, reduction in carbon intensity, total coal consumption, total oil consumption, and proportion of non-fossil energy) and 9 supporting

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indicators, forming a "5 + 9" structure. A rigid "pass/fail" assessment mechanism is implemented: if any one mandatory indicator or three supporting indicators fail to meet the standards, the assessment is deemed "unqualified", and the results are directly linked to the assessment and appointment of Party and government leading bodies.

2.3. The principal-agent dilemma and the prevention of symbolic governance

Carbon emission governance is confronted with a central-local principal-agent problem. Localities tend to prioritize GDP over carbon reduction in the competition of multiple tasks, which may lead to regulatory formalism [1]. Under intense supervision, if the resource endowment is insufficient, it is more likely to trigger "symbolic compliance" [4]. The rigid dual carbon assessment, characterized by the Party and government sharing equal responsibilities, addresses institutional mismatch [1]. It significantly enhances officials' political attention to environmental governance, drives resource allocation toward green technologies and collaborative governance, and facilitates substantive emission reduction [4].

2.4. Research hypotheses

Based on the above logical deduction, this report presents three research hypotheses:

Hypothesis 1 (H1): The comprehensive evaluation and assessment system for dual carbon can significantly improve regional green total factor productivity (GTFP) by tightening environmental accountability and reshaping officials' promotion incentives.

Hypothesis 2 (H2): Under rigid constraints, local governments tend to achieve long-term emission reduction through promoting green technological innovation (technical effect) and promoting the upgrading of the industrial structure (structural effect).

Hypothesis 3 (H3): Due to differences in initial resource endowment and organizational capabilities, this policy is more significant in the developed eastern regions and non-resource-based cities, and can generate positive spatial spillover effects through technology transfer [5].

3. Research methods and experimental design

3.1. Sample selection and data sources

This study selected 283 prefecture-level and above cities in mainland China as the research sample, covering the period from 2011 to 2025. The primary data were compiled from the China City Statistical Yearbook, the China Energy Statistical Yearbook, and provincial and municipal carbon emission inventories. For the most recent years with missing values, interpolation was performed based on reports from the National Greenhouse Gas Observation Network and official provincial/municipal bulletins on carbon neutrality progress.

3.2. Core variable measurement

Dependent Variable: Local Green Transformation Index (GTFP). To mitigate the radial bias inherent in traditional DEA models, this study adopts the non-radial directional distance function (NDDF) combined with the meta-frontier Malmquist-Luenberger (MML) index to conduct dynamic efficiency measurement. Input indicators include labor force, capital stock, and energy consumption; expected outputs include the actual regional GDP and regional forest carbon sink volume (FCS); non-expected outputs cover carbon dioxide, sulfur dioxide, and industrial wastewater emissions.

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Core explanatory variable: Dual Carbon assessment policy shock (DualCarbon). Construct a multi-period difference-in-differences dummy variable $\mathrm{DualCarbon}_{it}$. If city i was officially subject to strict dual control assessment constraints in year t, then it is assigned a value of 1; otherwise, it is assigned a value of 0.

Mechanisms and Control Variables: The mechanism variables include green technological innovation (GTI, logarithm of the number of green invention patents) and industrial structure upgrading (ISU, ratio of the third industry to the second industry). The control variables include level of economic development (LnPGDP), foreign direct investment (FDI), level of financial development (Fin_Dev), and degree of government intervention (Gov_Intervention).

3.3. Econometric model specification

(1) Multi-period Difference-in-Differences Model (Time-varying DID) In order to accurately identify the net impact of the assessment policies on GTFP, a two-way fixed effects model was constructed:

$$\mathrm{GTFP}_{it} = \alpha_0 + \alpha_1 \mathrm{DualCarbon}_{it} + \beta \mathrm{X}_{it} + \mu_i + \delta_t + \epsilon_{it} \quad (1)$$

Here, μ_i represents the fixed effect of individual in the city, and δ_t represents the fixed effect of the year. If α_1 is significantly positive, it indicates that the assessment policy is effective.

(2) Spatial Durbin Model (SDM) Taking into account the strong spatial spillover effect of carbon emissions and green innovation [5], the model is further expanded as:

$$GTFP_{it} = \rho WGTFP_{it} + \alpha_1 DualCarbon_{it} + \theta WDualCarbon_{it} + \beta X_{it} \quad (2)$$

$$+\gamma WX_{it} + \mu_i + \delta_t + \epsilon_{it}$$

Here, W represents the spatial weight matrix, and θ measures the spillover effect of the assessment implemented in neighboring cities on the local area.

4. Empirical results and mechanism analysis

4.1. Baseline regression results

Table 1 presents the baseline regression results. After gradually adding control variables and controlling for two-way fixed effects, the coefficient of the core explanatory variable remains highly robust.

Table 1. Benchmark regression results

Variable	(1) No control variable	(2) Add control variable	(3) Full sample two-way fixed
DualCarbon	0.068*** (0.012)	0.055*** (0.014)	0.052*** (0.015)
Ln(PGDP)	-	0.021** (0.009)	0.018* (0.010)
FDI	-	0.011 (0.008)	0.009 (0.007)
Gov_Intervention	-	-0.012* (0.007)	-0.014** (0.006)
Fin_Dev	-	0.028*** (0.010)	0.033*** (0.011)
City fixed effect	No	Control	Control
Year fixed effect	No	Control	Control

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Table 1. (continued)

Observations	4245	4245	4245

Note: ***, **, * indicate significance at the 1%, 5%, and 10% levels respectively. The numbers in parentheses represent robust standard errors.

Table 1 indicates that the implementation of this assessment system has raised the GTFP of targeted cities by roughly 5.2%, relative to the pre-policy period. This strongly validates Hypothesis 1. The rigid indicators tied to officials' promotions have successfully transformed external macro pressures into the endogenous driving force for local-led reconfiguration of the low-carbon economy.

4.2. Mechanism verification: exploring the micro pathways of green transformation

A mediation effect model was applied to examine the two mediating pathways of green technological innovation (GTI) and industrial structure upgrading (ISU). The results indicated that the policy implementation had a driving coefficient of 0.084*** for GTI and 0.061*** for ISU.

This indicates that, in the face of strict assessments, local governments did not adopt the "one-size-fits-all" shutdown strategy that would undermine the economic foundation. Instead, they substantially increased subsidies for technological research and development and green credit support, compelling enterprises to carry out technological upgrades. At the same time, the precise control indicators effectively cut off the expansion paths of high-energy-consuming and outdated production capacity, prompting capital to accelerate its transfer to modern service industries, thereby verifying Hypothesis 2. Further analysis shows that the synergy between healthy inter-local government competition and green technological innovation serves as the primary driver of low-carbon transformation in regional economies [6].

4.3. Heterogeneity analysis and spatial spillover effects

The heterogeneity analysis reveals that the eastern region and non-resource-based cities exhibit the most significant policy dividends (coefficients of 0.065*** and 0.059*** respectively). This profoundly reflects the issue of organizational capability compatibility in environmental governance: the eastern region has a complete digital infrastructure and abundant green financial capital, which can quickly convert regulatory pressure into technological innovation; while resource-based cities in the west are constrained by an industrial structure lock, and the transformation resistance is huge [4]. Heterogeneity analysis of cities in typical geographic regions including the Yellow River Basin further shows that environmental regulation and high-quality development goals can be effectively coordinated under the dual control policy [7].

Furthermore, the results of the spatial Durbin model confirmed that the indirect spillover effect of the policy was significantly 0.041***. This indicates that the local industrial structure upgrading and carbon emission reduction have a significant spatial spillover effect. It not only promotes local technology diffusion but also drives the low-carbon restructuring of surrounding cities through the green supply chain [5], thereby verifying Hypothesis 3.

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5. Discussion: the game and complementarity of administrative evaluation and carbon market governance

By placing the results of this study within the overall framework of China's macro climate policies, one can deeply understand the unique logic of China's "hybrid governance model".

Some Western studies and market-oriented scholars argue that carbon abatement should rely exclusively on the price discovery mechanism of the national carbon emission trading scheme (ETS). However, a deep analysis based on the framework of principal-agent theory reveals that there are significant institutional challenges in China's current carbon market. As the dominant players in the market are mainly large state-owned enterprises (SOEs), their participation in market transactions is often for fulfilling political compliance obligations rather than for maximizing market profits. Such behavior not only distorts authentic carbon price signals but also limits the market participation of private firms [1]. Moreover, in the absence of strong administrative intervention, local developmentism is prone to collude with enterprises, leading to the marginalization of the carbon pricing mechanism and triggering deep problems such as formalization of compliance and data opacity [1].

In this context, the administrative comprehensive evaluation and assessment system based on the "5+9" indicator framework becomes particularly necessary. As a crucial "infrastructure" within the environmental federalism framework [8], this top-down administrative rigid requirement (linking results directly to officials' promotions) not only plays a role in "guaranteeing the bottom line" and "correcting deviations", but also forcibly breaks the entrenched interests of localities. Studies indicate that only after administrative pressure has eliminated backward production capacity and standardized the underlying data can green finance and market-based carbon trading truly exert the synergistic effect of capital pricing and optimal resource allocation [8].

6. Policy recommendations

First, improve the database to prevent data distortion. Accelerate the construction of emission factor databases for key industries, utilize big data and in-depth auditing to prevent carbon data fraud, and precisely quantify the dynamic evolution of the carbon footprint factors of the power grid [9]. Second, support the just transformation in the central and western regions. Address the pain points and capacity deficiencies of resource-based cities in their transformation, and provide targeted support for coal-fired power transformation and CCUS technologies through the National Green Development Fund. Empirical evidence shows that green finance can significantly reduce the carbon emission intensity of non-resource-based cities [10]. Third, strengthen the collaboration between the government and the market. Clarify the relationship between dual control assessment and the carbon market, promote the bottom-level connection between administrative assessment indicators and carbon quota allocation mechanisms, gradually resolve the price distortion caused by the dominance of state-owned enterprises, and transform administrative pressure into market-driven internal motivation [1].

7. Conclusions

This study systematically examined the impact of the "dual carbon" comprehensive evaluation and assessment index system on local green transformation. First, this rigid dual evaluation system linked to cadre assessment has significantly enhanced the urban green total factor productivity and effectively curbed the symbolic governance of local governments. Second, the assessment system

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did not lead to economic decline; instead, it spurred green technological innovation and accelerated industrial structure upgrading., shaping a long-term green momentum. Third, policy dividends generate positive spatial spillover effects but exhibit regional heterogeneity. Economically developed eastern regions and non-resource-based cities have benefited more significantly. However, this study has certain limitations. The measurement of expected and non-expected outputs primarily relies on macro-statistical data, which may not capture the micro-level firm behaviors fully. Future research could integrate higher-resolution data, such as enterprise-level emission reports or satellite remote sensing datasets, to more accurately map the dynamic implementation mechanisms of the dual carbon policies.

References

[1] Xu, X., Deng, J., & Chen, G. C. (2025). Government Supervision and Control Mechanisms for the Carbon Market in China: A Principal-Agent Perspective. The China Quarterly, 1-19.
[2] Zhang, X. (2025). Dual Control of Energy Consumption in China: Evolution and Optimizations. Korea Europe Review: an interdisciplinary journal of politics, society, and economics, (8).
[3] Zhou, C., Zhang, R., Loginova, J., Sharma, V., Zhang, Z., & Qian, Z. (2022). Institutional logic of carbon neutrality policies in China: what can we learn?. Energies, 15(12), 4391.
[4] Liu, Y., & Cang, Y. (2025). How to promote local governments collaboration? evidence from carbon reduction in the Yangtze River Delta. Frontiers in Environmental Science, 13, 1620195.
[5] Gao, R., Li, W., & Zeng, J. Q. (2025). Synergistic effects of new energy and low-carbon pilot dual policies on pollution and carbon reduction: A causal analysis based on double machine learning. Available at SSRN 5338252.
[6] Xu, Y., Ge, W., Liu, G., Su, X., Zhu, J., Yang, C., ... & Ran, Q. (2023). The impact of local government competition and green technology innovation on economic low-carbon transition: new insights from China. Environmental Science and Pollution Research, 30(9), 23714-23735.
[7] Tian, Z., & Mu, X. (2024). Towards China's dual-carbon target: energy efficiency analysis of cities in the Yellow River Basin based on a "geography and high-quality development" heterogeneity framework. Energy, 306, 132396.
[8] Gao, P., & Qu, C. (2025). Assessing the impact of green transformation on carbon emissions: a dynamic spatial Durbin model. Frontiers in Environmental Economics, 4, 1478861.
[9] Wu, Y., Zhang, Z., Zhu, S., Song, X., Ning, L., Chen, P., ... & Zhang, L. (2025). Decarbonizing China's grid: provincial grid carbon footprint factors and export-embedded electricity emissions from 2020 to 2060. Carbon Footprints, 4(4), N-A.
[10] Zhang, T., Zhang, Y., & Zhang, Y. (2025). Green finance and urban carbon emission dual control: an empirical evidence from China. Frontiers in Environmental Science, 12, 1503735.