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Dual Target Governance and Sustainable Low-Carbon Development: Reassessing the Growth- Environment Nexus in Chinese Cities

By Yancheng Liu[1], Zhiyuan Luo[1*], Xiangjie Li[2], Ran Wang[2] , Xilin Zhang[3*]

ABSTRACT:
Existing research indicates that excessively high economic growth targets are detrimental to environmental protection. This paper further examines the moderating effect of introducing environmental objectives on the relationship between economic growth and carbon emission intensity, exploring the theoretical mechanism that shifts the relationship between economic growth and environmental protection from substitution to complementarity. Empirical analysis utilizes panel data from 278 Chinese cities between 2006 and 2019. Two variables—textual data from local government work reports and the exogenous shock of the new Environmental Protection Law's enactment—serve as proxies for "environmental target introduction." Find- ings reveal: (1) Higher economic growth targets inhibit carbon reduction, while introducing environmental targets mitigates this effect; (2) Government development targets primarily in- fluence carbon intensity through three channels: environmental regulation, green innovation, and industrial structure; (3) The impact of economic growth and environmental targets on car- bon intensity exhibits spatial heterogeneity. In economically developed cities, resource-based cities, provincial capitals, cities with independent planning status, and sub-provincial cities, the dual targets show no significant effect on carbon intensity. This study provides theoretical support for further refining government target management systems.

Keywords: economic growth targets; environmental targets; carbon intensity; Environmental Protection Law (EPL).

1. Introduction

Target-setting is one of the most critical decision-making tools in organizational management. It can influence individual behavior through direction, motivation, and strategic activation (Meier et al., 2015; Boyne and Chen, 2007; Holm, 2017; Zhang and Wu, 2018). In 1994, China officially introduced GDP growth expectations in its Government Work Reports. Since then, this indicator has become a guiding benchmark for macroeconomic policymaking. It permeates the entire political system and plays a crucial role in China's four-decade growth miracle, serving as a major mechanism for motivating local governments and officials (Zhou et al., 2015). Existing studies confirm that growth targets can effectively promote economic development. Xu and Liu (2017), using panel data from 49 countries or regions including China, find that a 1% change in economic growth targets is associated with an average 1% change in actual growth rates.

However, scholars have also noted that overly ambitious economic growth targets may pro- duce unintended negative consequences. Specifically, such targets can exacerbate

[1]School of Sociology and Anthropology, Sun Yat-sen University, Guangzhou, China
[2]School of Finance and Taxation, Inner Mongolia University of Finance and Economics, Hohhot, China
[3]University of Gdańsk, Gdańsk, Poland
*Author to whom correspondence should be addressed.

inequality in urban–rural income distribution (Yang et al., 2023), reduce fiscal transparency (Liu and Zhang, 2023), diminish local fiscal efficiency (Mo et al., 2023), weaken urban economic resilience (Chen et al., 2023a), hinder industrial upgrading (Wang and Wang, 2021), constrain firm-level innovation (Wang et al., 2021), and impair total factor productivity.

The environmental consequences of growth targets have also drawn increasing academic attention. A wide body of literature suggests that economic growth and environmental protection are often in conflict (Gray,1987;Stern et al.,1996;Sun and Lin,2018), and growth targets have been shown to suppress environmental outcomes (Shi, 2022; Li and Zhao, 2024). Under a GDP-centric governance framework, local governments tend to prioritize short-term economic outcomes (Tang et al., 2024). Since polluting enterprises often contribute substantially to local output, tax revenue, and employment, they are favored by local officials (Li and Chen, 2019). Consequently, local governments have strong incentives to lower environmental standards or enforcement to encourage investment and meet economic targets (Oates and Schwab, 1988; Li et al., 2014).

Given the significant effects of local development targets on economic trajectories, a critical question emerges: how can governments design more balanced targets to achieve a "win-win" between growth and environmental protection? Specifically, if environmental targets are integrated alongside economic growth targets in local government plans, can this transform their relationship from one of substitution to complementarity, thereby enabling a low-carbon transition?

To answer this question, we leverage both observational and quasi-experimental methods—two- way fixed effects models, instrumental variables, and a difference-in-differences (DID) design around the 2014 Environmental Protection Law (EPL) reform. In doing so, we aim to contribute to the institutional reform of target-setting mechanisms under China's dual-carbon strategy.

The marginal contribution of this paper lies primarily in the following aspects: First, while existing literature examines the environmental damage effects of economic growth targets, this study further explores the moderating role of environmental targets in this effect. We acknowledge that textual frequency in government reports primarily reflects political intention or attention allocation. However, according to the attention-based view of governance, such attention is a scarce resource that often precedes administrative action. To address the concern that text might be "cheap talk," we complement this measure with the exogenous shock of the 2014 Environmental Protection Law (EPL) reform in Section 5. This dual-validation strategy allows us to assess both the signaling effect of local targets and the binding constraints of central mandates, ensuring our findings capture substantive implementation. The objective is not merely to verify the impact of introducing environmental targets on carbon emissions, but to seek, from a public management perspective, the theoretical mechanisms that drive the shift from a substitution relationship to a complementary relationship between economic growth and low-carbon development. Second, it examines the impact mechanism of local government development goals on carbon emissions through three dimensions: environmental regulation, green innovation, and industrial structure. By considering potential heterogeneity across cities from three angles—economic development level, administrative hierarchy, and resource type—it provides a more nuanced portrayal of the relationship between local development goals and carbon emissions. This offers theoretical grounding for institutional reforms promoting high-quality economic development under the dual carbon goals. Third, we employ both a two-way fixed effects model and a difference-in-differences model. The former utilizes the quantitative indicator of environmental protection term frequency in government work reports, while the latter leverages the exogenous shock of the new Environmental Protection Law. This dual approach combines the strengths of different econometric methods to maximize the alignment of theoretical findings with empirical reality.

2. Theoretical Mechanism and Hypotheses

2.1 Development Targets, Environmental Regulation, and Carbon Emis- sions

Due to better access to local environmental information, subnational governments in China often receive devolved environmental management authority from the central government (Fredriks- son and Wollscheid, 2014; Ma et al., 2023). This decentralization empowers local governments to adjust the stringency of environmental regulations to achieve development objectives.

When economic growth is the sole priority, local officials face strong incentives to weaken en- vironmental enforcement in order to attract external investment. According to the “pollution haven” hypothesis, pollution-intensive industries may relocate to jurisdictions with looser environmental standards when regulations become stricter elsewhere (Becker and Henderson, 2000). Yang et al.(2008) argue that to meet their growth targets, local governments may compete with each other by lowering environmental standards, resulting in a “race to the bottom” in environmental regulation (Yang et al., 2008). This behavior is deeply rooted in China’s "promotion tournament" system. Local officials, driven by political incentives, often set ambitious growth targets to signal competence. However, when these targets exceed the city's actual resource endowment and administrative capacity (a high "target gap"), officials face a trade-off. To bridge this gap, they are politically incentivized to relax environmental regulations and tacitly allow high-polluting projects to proceed, thereby prioritizing short-term economic output over long-term sustainability. This relaxation of regulatory enforcement inevitably leads to higher carbon emissions.

However, if environmental targets are formally integrated into local development goals, gov- ernments must shift toward a low-carbon growth paradigm. This dual-target framework may mitigate the suppressive effect of economic goals on carbon reduction.

2.2 Development Targets, Technological Innovation, and Carbon Emissions

Technological progress is a critical channel for reducing carbon emissions. It enables the phaseout of energy-intensive equipment and increases energy efficiency (Lin and Du, 2013; Zheng et al., 2022). Under exclusive emphasis on economic growth, local governments often distort factor allocation by tightening control over land and capital markets. Such distortions lower allocative efficiency and increase firms’ financing constraints, thereby hindering innovation (Chen et al., 2023b).

The introduction of environmental targets can promote factor mobility, ease financing con- straints, and enhance firm-level productivity (Wang and Xu, 2022).

Moreover, it may incentivize firms to invest in green innovation (Zhu et al., 2022). This mechanism is supported by the "Porter Hypothesis" (Porter and van der Linde, 1995), which posits that well-designed environmental regu- lations, while imposing compliance costs, can stimulate innovation and long-term competitiveness.

2.3 Development Targets, Industrial Structure, and Carbon Emissions

Development targets may also influence carbon emissions through changes in industrial struc- ture. When local governments prioritize short-term economic output, they tend to subsidize industrial expansion—especially of large state-owned enterprises (SOEs)—to boost tax revenues and employment (Long and Ji, 2019; Tang et al., 2024). However, this bias toward traditional in- dustries often sacrifices innovation and sustainability. SOEs may receive preferential access to land and resources, but such advantages are associated with overcapacity, inefficiency, and ecological degradation. The expansion of secondary industry can thus hinder structural upgrading (Zhenget al., 2021), obstruct environmental protection (Cheng et al., 2020), and constrain carbon reduction efforts.

Incorporating environmental targets into development planning can reshape this trajectory in two ways. First, to meet both economic and environmental objectives, local governments may redirect resources toward cleaner service sectors. Second, objective environmental constraints can shift consumer preferences toward greener products (Zhang and Liu, 2018; Chen et al., 2018), driving structural change from the demand side. Given that industrial structure defines the types and scales of resources consumed, it becomes a fundamental determinant of carbon emissions.

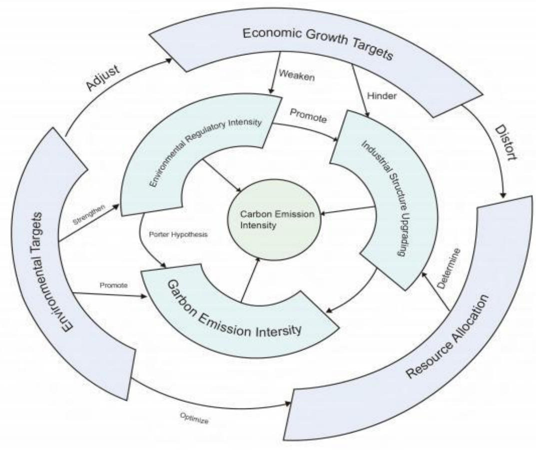

Figure 1: Conceptual mechanism: growth targets raise CER; environmental targets moderate this effect via regulation, innovation, and restructuring.

We propose the following hypotheses:

H1. Higher economic growth targets increase cities' carbon emission intensity (CER).

H2. When explicit environmental targets are incorporated alongside growth targets, they weaken the positive effect of growth targets on CER, transforming the relationship from substitution to complementarity.

3 Methods

3.1 Model Specification

To examine how local governments' economic growth targets and environmental targets affect carbon emission intensity (CER), we construct the following two-way fixed effects model:

$$CER_{it} = \alpha_0 + \beta_1 \cdot Pugap_{it} + \beta_2 \cdot eco_{it} + \beta_3 \cdot Pugap_{it} \times eco_{it} + \sum \beta_j \cdot Z_{jit} + \mu_i + \lambda_t + \varepsilon_{it}$$
(1)

where CERit denotes the carbon emission intensity of city i in year t ; $Pugap_{it}$ and eco_{it} represent the economic and environmental targets respectively; xit is a vector of control variables; μi and λt are city and year fixed effects; and εit is the random error term. The interaction term captures whether environmental targets weaken the effect of growth targets on CER.

3.2 Variable Construction

Carbon emission intensity. Carbon emission intensity (CERit) is defined as:

$$CER = \text{emission} / GDP_{\text{real}} \tag{2}$$

where Emissions it is the total CO2 emissions and GDp^{re},ital is GDP at 2005 constant prices.

The apparent consumption method is used to estimate CO2 emissions, while data from the China Emissions Accounts and Datasets (CEADs) and the sectoral accounting method are used for robustness checks.

Growth target. Following Du and Yi (2022), the economic growth target (pugap it) is measured as the difference between a city's GDP growth target and the corresponding provincial target. These data are manually collected from municipal government work reports from 2006 to 2019. For qualitative expressions such as "about," "higher than," or "around," we convert them to numerical values (e.g., midpoint or lower bound).

Environmental target. The environmental target variable (eco it) is constructed using text analysis of local government work reports. Following Chen and Chen (2018), we process the reports using Python for word segmentation, extract environment-related terms (e.g., "pollution," "low- carbon," "energy consumption," "PM2.5"), and calculate the normalized frequency of these terms to represent the salience of environmental governance objectives.

3.3 Control Variables and Data Sources

Control variables include indicators of human capital, financial development, population density, per capita GDP, foreign investment, urbanization, industrial structure, marketization, and infrastructure. Specifically, we measure human capital by the ratio of college students to total population; financial development by the ratio of bank loans and deposits to GDP; population density by the ratio of population to urban area; per capita GDP (in 2005 constant prices) as the level of economic development; foreign investment by actual utilized FDI as a share of GDP; urbanization by the urban population ratio; industrial structure by the share of secondary industry in GDP; marketization by the share of private and self-employed workers in total employment; and infrastructure by the ratio of fixed asset investment to GDP.

The dataset covers 278 prefecture-level cities in China from 2006 to 2019. The target variables are manually coded from government work reports, while control variables are obtained from the China Urban Statistical Yearbook, the China Regional Economic Statistical Yearbook, and provincial statistical yearbooks. After excluding cities with large missing values, a balanced panel dataset is obtained.

Table 1: Descriptive statistics of main variables

Variable	Mean	Std. Dev.	Min	Max
Carbon intensity (CER)†	0.076	0.074	0.005	1.308
Growth target gap (Pugap)‡	1.539	1.876	-9	14
Environmental target (eco)§	0.003	0.001	0	0.009
Per capita GDP (log, Pcg)	5.033	0.586	-0.511	7.602
Human capital	0.020	0.027	0	0.193
Financial development	2.254	1.154	0.588	13.53
Population density (log)	5.770	0.917	1.374	7.882
FDI	0.019	0.019	0	0.199
Urbanization rate	0.515	0.162	0.115	1
Industrial structure	0.871	0.082	0.501	1.059
Marketization	1.103	0.761	0.052	17.141
Infrastructure	27.357	63.709	0.366	3041.729

a CER = CO2/real GDP (2005 base).

b Pugap = city GDP growth target - provincial GDP growth target.

c eco = normalized frequency of environment-related terms in municipal Government Work Reports (text analysis).

4 Empirical Analysis

4.1 Baseline Estimates

We begin our empirical analysis by estimating the baseline relationship between local gov- ernment growth targets, environmental targets, and carbon emission intensity. Table 2 reports the two-way fixed effects estimates derived from Eq. (1).

Column (1) indicates a statistically significant and positive association between the growth target gap (Pugap) and carbon emission intensity (CER), suggesting that more aggressive economic growth targets are correlated with higher levels of carbon emissions (Zhou et al., 2015; Xu and Liu, 2017). It is important to note that while this baseline OLS result suggests a correlation, it may still be subject to omitted variable bias, such as unobserved differences in informal enforcement intensity across cities. We explicitly address these endogeneity concerns and establish causality using Instrumental Variables (IV) in Table 3 and a Difference-in-Differences (DID) framework in Section 5.

In Column (2), we introduce the environmental target variable and its interaction with the growth target. The interaction term is negative and statistically significant, implying that the presence of environmental targets weakens the carbon-intensifying effect of growth targets (Zhang and Wu, 2018). This finding offers empirical support for Hypothesis 1: environmental governance goals can moderate the environmental costs associated with ambitious economic growth agendas.

Table 2: Baseline estimates: growth and environmental targets on carbon intensity

	(1) CER	(2) CER
Growth target gap (Pugap)	0.003*** [5.60]	0.007*** [4.45]
Environmental target (eco)		0.430 [0.31]
Pugap × eco		-1.847*** [-2.64]
Controls	Yes	Yes
Year FE	Yes	Yes
City FE	Yes	Yes
Observations	3,628	3,628
Adj. R2	0.9643	0.9611

Notes: t statistics in square brackets; standard errors clustered at the city level. Two-way fixed effects (city and year). Controls include per-capita GDP, human capital, financial development, FDI,industrial structure, population density, urbanization, and infrastructure. ***p < 0.01, **p < 0.05, *p < 0. 10.

4.2 Robustness Checks

To assess the reliability of our baseline estimates, we conduct a set of robustness checks addressing concerns about endogeneity, measurement error, and external policy shocks. Table 3 reports the results across all specifications (Yang et al., 2023).

First, we address potential endogeneity by adopting an instrumental variable (IV) approach using two-stage least squares (2SLS). While the timing of annual government work reports the- oretically precedes carbon emissions within the same year—mitigating reverse causality con- cerns—unobserved factors may still confound the estimates. To tackle this, we follow Yang et al. (2023) and construct instruments for both the economic growth and environmental targets. For the growth target, we use the number of prefecture-level cities within a province and the lagged growth target. This instrument design follows prior research suggesting that local governments intensify economic growth ambitions due to promotional competition among officials (Zhou et al., 2015; Xu and Liu, 2017).

Given the fixed number of provincial-level promotion positions, a larger number of cities intensifies intra-provincial GDP competition, incentivizing local governments to propose higher growth targets. Since the number of prefecture-level cities remains constant during the sample period and is exogenous to carbon emissions, these instruments satisfy the relevance and exogeneity conditions.

For the environmental target, we use average ground slope and its lagged value as instruments. Cities with higher slopes tend to have underdeveloped economies, which makes them attractive for industrial agglomeration. These cities often face more regulatory scrutiny, prompting governments to signal commitment through explicit environmental targets in their annual reports. As ground slope is determined by geographic characteristics, it is unaffected by emissions and thus serves as a valid instrument. Given the time-invariant nature of both slope and city counts, we use their interaction with lagged targets as instruments. Column (1) of Table 3 shows that the IV estimates are consistent with the baseline, confirming the robustness of our findings after accounting for endogeneity.

Second, we verify robustness to alternative constructions of the dependent variable. While the baseline analysis uses apparent emissions accounting, we replace this with two alternative measures: one from the China Emissions Accounting Database (CEADs) and another from the sectoral accounting method. Regression results in Columns (2) and (3) show that the estimated coefficients for the growth target and its interaction with the environmental target remain statistically significant and directionally consistent with the baseline results, suggesting that the findings are not sensitive to how carbon intensity is measured.

Third, we exclude 113 cities designated as "key environmental protection cities" in the State Council's 2007 National Environmental Protection Plan for the 11th Five-Year Plan. These cities—including Beijing, Shanghai, and Shenzhen—may face distinct political pressures regarding environmental performance. Column (4) re-estimates the baseline model without these cities. The results remain robust, indicating that the main conclusions are not driven by this subset.

Fourth, we account for the possible exogenous policy shock introduced by the 2016 Paris Agreement, which intensified national commitments to carbon mitigation. Local governments may have become more environmentally responsive even in the absence of explicit environmental targets. To address this, we split the sample into two subperiods: 2006–2015 and 2016–2019. Column (5) presents the regression results for the post-agreement period. The interaction effect remains negative and statistically significant, underscoring the persistence of our findings.

Across all specifications, the positive effect of growth targets on carbon emission intensity remains statistically robust. Moreover, the mitigating role of environmental targets—captured through interaction terms—is consistently evident, affirming the credibility of the baseline model under multiple robustness scenarios.

Table 3: Robustness Checks

	(1) IV–2SLS	(2) CER1	(3) CER2	(4) Excl. key cities	(5) Paris split	
Pugap	0.008*	0.0006***	4.540*	0.010***	0.007***	0.012*
	[-1.69]	[4.66]	[1.88]	[4.37]	[3.67]	[1.78]
eco	-16.0884***	0.015	0.008***	1.302	-0.197	-0.301
	[-3.85]	[1.17]	[3.56]	[0.63]	[-0.10]	[-0.14]
Pugap × eco	-5.567**	-0.037***	-0.003***	-2.507**	-1.467*	-4.321*
	[2.43]	[-5.95]	[-3.32]	[-2.54]	[-1.76]	[-1.91]
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,628	3,628	3,628	2,154	2,592	1,036
Adj. R2	0.7112	0.8511	0.9160	0.9571	0.9758	0.9857

Notes: t statistics in square brackets; standard errors clustered at the city level. Two-way fixed effects (city and year). Column (1) reports IV–2SLS estimates; columns (2)–(4) use alternative CER constructions (alt aggregate, CEADs, and sectoral); column (5) excludes key cities; column (6) splits pre/post Paris Agreement. ***p < 0.01, **p < 0.05, *p < 0. 10.

4.3 Mechanism Testing

The empirical analysis above has validated Hypothesis 1. To further examine Hypothesis 2 and gain deeper insight into the mechanisms through which economic growth targets and environmental targets influence carbon emission intensity, we construct the following two-step mediation model:

$$M_{it} = \alpha_0 + \omega_1 \cdot Pugap_{it} + \omega_2 \cdot eco_{it} + \omega_3 \cdot Pugap_{it} \times \mathrm{eco}_{it} + \sum \omega_j \cdot Z_{jit} + \mu_i + \lambda_t + \varepsilon_{it} \tag{3}$$

$$CER_{it} = \alpha_0 + \kappa M_{it} + \sum \varphi_j \cdot Z_{jit} + \mu_i + \lambda_t + \varepsilon_{it} \tag{4}$$

In these equations, CERit denotes the carbon emission intensity of city i in year t, and Mit represents the mediating mechanism variable. We consider three potential channels:

- Environmental regulation, proxied by the comprehensive utilization rate of general indus- trial solid waste.
- Green innovation, measured by the total number of green patent applications, sourced from the National Intellectual Property Database.
- Industrial upgrading, calculated as the ratio of tertiary to secondary industry value-added.

The results of the mechanism tests are reported in Table 4. We find that the economic growth target gap (pugap) negatively affects all three mechanism variables, while the inclusion of environ- mental targets mitigates these effects through significant interaction terms. These results confirm

Hypothesis 2 and suggest that local government growth strategies shape carbon emission inten- sity through the pathways of environmental regulation, green innovation, and industrial structure transformation.

Table 4: Mechanism tests

	(1) Regulation	(2) Green innovation	(3) Industrial upgrading
Pugap	-0.008*	-0.178***	-0.179***
	[-1.69]	[-6.06]	[-4.16]
eco	-16.0884***	64.356**	-11.029***
	[-3.85]	[2.59]	[-2.80]
Pugap × eco	5.567**	31.441**	3.732**
	[2.43]	[2.52]	[1.97]
Controls	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
City FE	Yes	Yes	Yes
Observations	3,628	3,628	3,628
Adj. R2	0.7112	0.6441	0.8569

Notes: t statistics in square brackets; standard errors clustered at the city level. Two-way fixed effects (city and year). Mechanism proxies: Regulation = utilization rate of general industrial solid waste; Green innovation = number of green patent applications; Industrial upgrading = ratio of ter- tiary to secondary industry output. ***p < 0.01, **p < 0.05, *p < 0. 10.

4.4 Heterogeneity Analysis

Building on the baseline and robustness findings, we further investigate whether the effects of dual-target governance—economic growth targets coupled with environmental targets—vary across different types of cities. Specifically, we examine heterogeneity across three dimensions: economic development level, administrative rank, and resource dependence.

By Economic Development Level

Cities with differing levels of economic development may experience divergent effects of growth and environmental targets on carbon emission intensity. We divide the sample based on the median of per capita GDP, classifying cities with above-median GDP as economically developed and others as less-developed. Results are shown in Table 5.

Column (1) shows that in economically developed cities, the interaction between growth and environmental targets is statistically insignificant, suggesting limited moderation. Column (2), however, shows that in economically less-developed cities, the interaction term is significantly negative at the 5% level. This suggests that dual-target governance exerts a stronger mitigating effect on carbon emission intensity in underdeveloped regions. One possible explanation is that developed cities possess stronger infrastructure, financial institutions, and industrial bases, enabling them to pursue greener growth paths. In contrast, underdeveloped cities may attract pollution-intensive industries due to their geographic positioning and development incentives, which imposes greater pressure on environmental governance. Local governments in such cities are also more likely to prioritize short-term economic performance through productive investments and infrastructure development, which may delay structural transition and impede low-carbon transformation.

Table 5: Heterogeneity by economic development level

	(1) Developed	(2) Less-developed
Pugap	-0.004	0.001*
	[-0.93]	[1.76]
eco	1.217	0.649
	[2.53]	[1.05]
Pugap × eco	-0.237	-0.586**
	[-1.15]	[-2.16]
Controls	Yes	Yes
Year FE	Yes	Yes
City FE	Yes	Yes
Observations	1,800	1,828
Adj. R2	0.9538	0.9706

Notes: t statistics in square brackets; standard errors clustered atthe city level.Two-way fixed effects (city and year).City groups are split by the sample median of per capita GDP(baseline year).***p < 0.01, **p < 0.05, *p < 0. 10.

By Administrative Rank

Administrative hierarchy may also influence how cities implement and respond to dual-target governance. We define a dummy variable for administrative level: cities that are provincial capitals, directly governed municipalities, or sub-provincial cities are coded as 1; all other prefecture-level cities are coded as 0. Table 6presents the regression results.

Column (1) shows that for lower-level cities (Level = 0), the interaction term is significantly negative at the 1% level, indicating that environmental targets strongly moderate the growth-carbon intensity relationship. For higher-level cities (Level = 1), the interaction term is insignificant, possibly because these cities possess advanced development capabilities, favorable institutional environments, and greater autonomy in setting and achieving ambitious targets. Their superior access to resources and policy tools allows them to meet growth objectives without sacrificing environmental quality, weakening the observed moderating effect.

Table 6: Heterogeneity by administrative rank

	(1) Level 0	(2) Level 1
Pugap	0.009*** [5.03]	-0.008 [-0.57]
eco	-0.703 [-0.46]	-2.180 [-1.84]
Pugap × eco	-2.021*** [-2.61]	0.683 [1.20]
Controls	Yes	Yes
Year FE	Yes	Yes
City FE	Yes	Yes
Observations	3,120	508
Adj. R2	0.9538	0.9706

Notes: t statistics in square brackets; standard errors clustered at the city level. Two-way fixed effects(city and year).Level 1 includes provincial capitals, sub-provincial and plan-listed municipalities; Level 0 denotes other prefecture-level cities.***p < 0.01, **p < 0.05, *p < 0. 10.

By Resource Type

Finally, we examine whether resource dependence influences how dual-target governance affects carbon emissions. According to the State Council's national classification standard (Li et al., 2020), we classify cities as either resource-based or non-resource-based. Regression results are displayed in Table 7.

The positive effect of growth targets on carbon intensity is more pronounced in resource-based cities, while the moderating effect of environmental targets is significant only in non-resource-based cities. This may be because resource-based cities tend to have industrial structures heavily reliant on natural resource exploitation, with limited diversification or green innovation capacity. Such structural rigidity can impede low-carbon transitions. In contrast, non-resource-based cities are more capable of promoting structural upgrading, enabling more effective implementation of both growth and environmental targets (Zhong et al., 2024).

Table 7: Heterogeneity by resource type

	(1) Resource-based	(2) Non-resource-based
Pugap	0.008***	0.007***
	[2.64]	[3.35]
eco	3.299	-0.441
	[1.51]	[-0.02]
Pugap × eco	-1.501	-1.889**
	[-1.17]	[-2.24]
Controls	Yes	Yes
Year FE	Yes	Yes
City FE	Yes	Yes
Observations	1,644	1,984
Adj. R2	0.9471	0.9742

Notes: t statistics in square brackets; standard errors clustered at the city level.Two-way fixed effects (city and year). Resource types follow the State Council's classification in the "Sustainable Development Plan for Resource-based Cities (2013–2020)" (see Li et al.,2020). ***p < 0.01, **p < 0.05, *p < 0. 10.

5 Difference-in-Differences with EPL Reform

5.1 Policy Background and Identification Strategy

While the benchmark analysis uses textual frequencies of environmental terms as a proxy for local environmental targets, such proxies may reflect endogenous behavior by local officials and could suffer from measurement imprecision. To address this concern, we exploit the 2014 revision of China's Environmental Protection Law (EPL) as a quasi-natural experiment.

The new EPL, which came into effect in January 2015, introduced binding environmental performance assessments into the official cadre evaluation system. Article 26 of the revised law stipulates that "the state shall implement an environmental protection responsibility and appraisal system," linking local environmental outcomes directly with the political promotion of officials (Shi, 2022). This change helped overcome the earlier bias in local governance where economic growth was prioritized over environmental protection.

We implement a generalized difference-in-differences (DID) framework to estimate the effect of this reform on carbon emission intensity. The key treatment intensity variable is the gap between a city's economic growth target and that of its respective province, which proxies the local-level ambition for economic performance. The specification is as follows:

$$CER_{it} = \gamma_0 + \gamma_1 post_t \times Pugap_{it} + \gamma_2 \sum X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (5)$$

Here, PostEPLit equals 1 for years ≥ 2014 (announcement year) and 0 otherwise; Pugap it represents the difference between the municipal and provincial GDP growth targets. The interaction term captures the differential impact of the reform on cities with more ambitious growth targets.

μi and λt denote city and year fixed effects, respectively. As a robustness check, we also re-define PostE PL = 1 for years ≥ 2014 (implementation year); the results are similar (see Appendix Table S1). Table 8reports the DID regression results.

5.2 Main DID Results

Table 8 presents the DID estimates. Columns (1) and (2) report specifications with and without control variables, respectively. Across both, the interaction term is negative and statistically significant at the 1% level, suggesting that the EPL reform significantly reduced the marginal carbon cost of aggressive growth targets. This finding is consistent with the hypothesis that environmental performance accountability can discipline growth-driven emissions behavior, aligning with prior studies linking environmental regulation and political incentives to local pollution control (Oates and Schwab, 1988; Becker and Henderson, 2000; Shi, 2022).

Table 8: DID regression results around the 2014 EPL reform

	(1) With controls CER	(2) Without controls CER
Policy effect (PostEPL × Pugap)	-0.010*** [-2.61]	-0.002*** [-6.23]
Controls	Yes	No
Year FE	Yes	Yes
City FE	Yes	Yes
Observations	3,628	3,628
Adj. R2	0.7112	0.9496

Notes: t statistics in square brackets; standard errors clustered at the city level. Two-way fixed effects (city and year). PostE PL = 1 for years ≥ 2014 and 0 otherwise; the interaction PostE PL × Pugap captures how the 2014 Environmental Protection Law (EPL) changes the marginal effect of the city growth-target gap on carbon intensity (CER). Parallel-trends support is provided by the dynamic event-study (see Figure 2). ***p < 0.01, **p < 0.05, *p < 0. 10.

5.3 Parallel Trends Test

A key identification assumption for the DID model is that treatment and control groups exhibit parallel pre-treatment trends. To verify this, we conduct an event-study analysis by estimating dynamic treatment effects for each year before and after 2014. As shown in Figure 2, no significant divergence in carbon intensity trends is observed prior to the EPL reform, suggesting that the parallel trends assumption is satisfied.

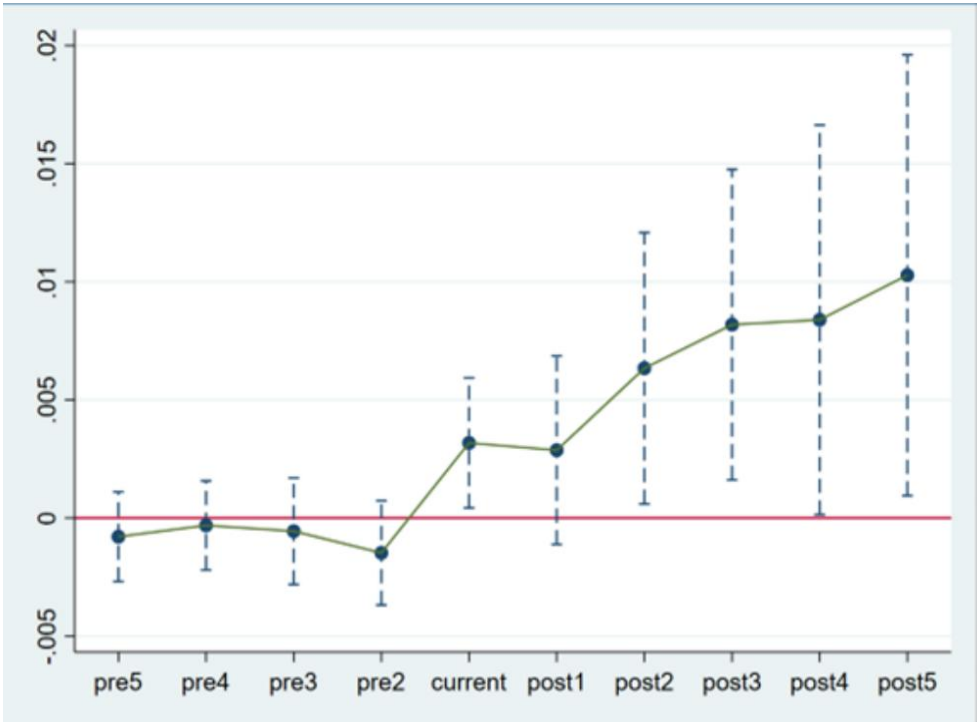

Figure 2: Parallel trends test: dynamic treatment effects before and after EPL reform

5.4 Placebo Test

To rule out the possibility that our results are driven by chance or unobserved time trends, we perform a placebo test. Specifically, we randomly assign placebo treatment years and treatment groups, repeat the regression 500 times, and examine the distribution of estimated coefficients. As shown in Figure 3, the placebo estimates center around zero and do not replicate the significant negative effect observed in the actual policy timing, reinforcing the robustness of our findings.

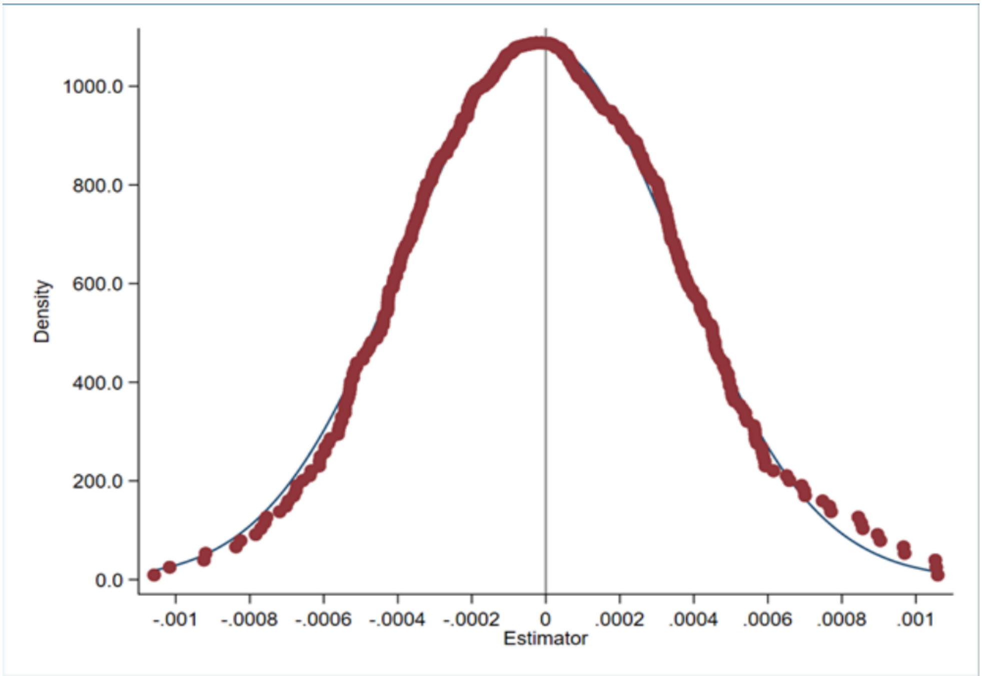

Figure 3: Placebo test: distribution of placebo DID coefficients

6. Conclusion

China's long-standing growth-centric development paradigm has produced remarkable eco- nomic achievements but also incurred substantial environmental costs, particularly in the form of excessive carbon emissions. Although environmental targets have gained policy prominence, their implementation often lags behind economic goals, especially under a hierarchical governance structure where cadre evaluation continues to favor GDP performance (Tang et al., 2024; Du and Yi, 2022). This study investigates whether and how the dual implementation of economic and environmental targets influences carbon emission intensity (CER) in Chinese cities.

Using panel data from 278 prefecture-level cities during 2006–2019, our empirical analysis yields several key findings. First, aggressive economic growth targets are significantly associated with higher carbon emission intensity, confirming that growth incentives drive up local carbon emissions (Xu and Liu, 2017; Li and Zhao, 2024). Second, environmental targets, when explicitly stated in local government work reports, significantly moderate this effect, indicating a shift from a substitutive to a complementary relationship between economic and environmental governance goals (Sun and Lin, 2018; Li and Chen, 2019). Third, mechanism analysis reveals three critical pathways through which local targets affect emissions: environmental regulation, green innovation, and industrial upgrading (Oates and Schwab, 1988; Lin and Du, 2013; Long and Ji, 2019).

Fourth, the heterogeneity analysis shows that the moderating effect of environmental targets is stronger in economically underdeveloped, lower-administrative-rank, and non-resource-based cities, which often face greater pressure from growth incentives and lack capacity for environmental enforcement(Zheng et al., 2021; Li et al., 2020; Zhong et al., 2024).

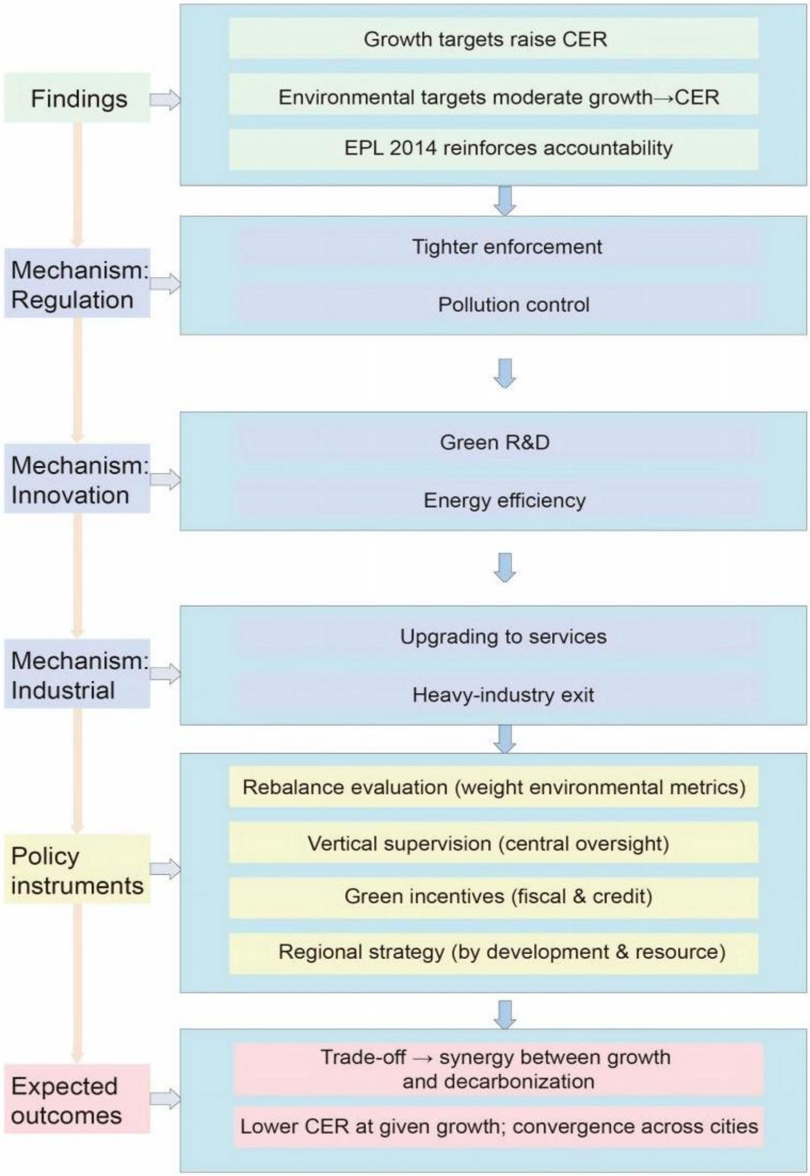

Figure 4: Conceptual framework of dual-target governance and carbon intensity outcomes.

Fifth, we employ a difference-in-differences (DID) strategy leveraging the 2014 revision of China's Environmental Protection Law (EPL) to further validate the moderating role of environmental accountability. Results show that the EPL reform significantly reduced the marginal carbon cost of growth, reinforcing the importance of formal institutional mechanisms in aligning local incentives with national environmental goals (Shi, 2022; Ma et al., 2023).

Figure 4 provides a visual summary of the analytical framework and findings. It illustrates how local growth targets increase carbon emissions via economic expansion mechanisms, while environmental targets—especially under binding institutional arrangements—can attenuate these effects through regulatory, technological, and structural channels.

Several policy implications follow from these findings. First, cadre evaluation systems should be recalibrated to reduce the overemphasis on economic performance and give greater weight to environmental outcomes. Second, vertical environmental governance should be strengthened to reduce discretion in local enforcement and enhance accountability. Third, more supportive financing tools and industrial policies are needed to incentivize green innovation and reduce the bias in resource allocation toward high-output but high-emission sectors. Finally, regional differentiation should be embraced in setting and evaluating development targets. City-specific characteristics such as development level, administrative rank, and resource endowment should inform locally adapted policy designs and emission reduction strategies. Crucially, to sustain the "synergy" observed in this study, environmental targets must be institutionalized within the evaluation framework—shifting from campaign-style governance to long-term, binding assessment metrics. This ensures that the complementarity between growth and environment endures beyond short-term policy cycles. Future research could build on this work by employing micro-level datasets. While our city-level analysis establishes the aggregate effect, firm-level data would allow for a more granular investigation into whether emissions reductions are achieved through genuine green innovation or simply through the relocation of polluting industries (pollution leakage) to neighboring jurisdictions.

This study is not without limitations. Our proxy for environmental targets—based on the frequency of environmental keywords in work reports—may not fully capture the actual strength or enforcement of environmental commitments. This reflects a broader "measurement gap" in governance literature regarding the quantification of administrative effort. Future studies could overcome this by integrating multi-source data, such as administrative penalty records or real-time pollution monitoring data, to construct a more multidimensional index of environmental governance. Additionally, potential spillover effects across city boundaries, such as industrial relocation, are not explicitly accounted for. Future research could build on this work by employing more granular data, such as firm-level emissions and innovation records, to examine the mechanisms more precisely. Comparative studies with other emerging economies could also enhance understanding of how institutional structures influence the trade-offs and synergies between economic growth and environmental governance.

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