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Environmental Regulation and Corporate Capital Allocation: How Low-Carbon Urban Policy Shapes Financialization and Competitive Resilience

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Abstract

In the context of the global low-carbon transition, elucidating the microeconomic implications of environmental regulation is crucial for effective policy design. This study leverages China's phased implementation of the Low-Carbon City Pilot (LCCP) policy as a quasi-natural experiment to examine its causal impact on corporate asset allocation and competitive resilience. Employing a multi-period difference-in-differences (DID) design on a dataset of Chinese A-share listed firms (2003–2024), we document three key findings. First, the LCCP policy significantly induces corporate financialization, as firms increase financial asset holdings driven by profit-seeking and precautionary motives to buffer against regulatory uncertainty. Second, financialization exerts a divergent "Dual Effect" on firm competitiveness: while it enhances Carbon Productivity through compliance efforts, it erodes Total Factor Productivity (TFP) via a resource crowding-out mechanism. Third, heterogeneity analysis reveals a notable "Compliance Cost Effect": contrary to the resource-buffering hypothesis, firms possessing robust green technological endowments incur higher substantive transformation costs, thereby experiencing a more pronounced short-term erosion in TFP compared to non-innovating peers. Furthermore, in heavy-polluting industries, we identify an underlying "Intertemporal Crowding-out Effect," wherein excessive financial asset allocation significantly displaces green investment with a two-year lag. These findings underscore the unintended costs borne by "first-movers" and suggest that policymakers should implement precision-guided compensatory mechanisms to prevent active responders from falling into a competitiveness trap.

Keywords: Environmental Regulation; Corporate Financialization; Dual-Dimension Competitiveness; Resource Crowding-out; Cumulative Competitiveness Loss

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1 INTRODUCTION

The industrialization process since the Anthropocene, while creating immense material wealth, has also pushed global environmental issues to a critical juncture necessitating urgent intervention (Steffen et al., 2018). Addressing climate change has transformed into a consensus agenda in global governance. To mitigate its outsized footprint on global climate change, the Chinese state articulated a binding agenda to cap carbon outputs by 2030 and realize a net-zero societal model by 2060. This aggressive timeline mandates a complete reorganization of the nation's economic foundations (Liu & Xu, 2022). Introduced under these transitional pressures in 2010, the local low-carbon initiative provides a massive structural testing ground. The ultimate objective of this spatial intervention is to transition away from emission-intensive developmental pathways, thereby proving that financial prosperity need not come at an ecological cost.

While a burgeoning strand of literature has confirmed the policy's efficacy in reducing aggregate emissions (Greenstone et al., 2012; Ai et al., 2025; Li et al., 2022; Liu & Xu, 2022;

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Salvia et al., 2021; Wen et al., 2022; Yang et al., 2023; Zhou et al., 2022) and promoting green innovation and technical change (Acemoglu et al., 2012; Aghion et al., 2016; Aghion et al., 2023), recent global evidence underscores the complex interplay between foreign direct investment, technology transfer, and carbon efficiency (Mebrek & Louail, 2025), in curbing industrial emissions (He et al., 2025). Furthermore, carbon transition risks and ESG disclosures have increasingly influenced corporate financing and investment behaviors (Bolton & Kacperczyk, 2021, 2023; Bolton et al., 2021; Cheng et al., 2014; Heinkel et al., 2001). Yet, a crucial "black box" remains locked: How does this environmental regulation reshape the internal capital allocation of micro-level firms, and does this reallocation foster sustainable competitive resilience or lead to a "competitiveness trap"?

These questions are paramount because corporate asset allocation is the micro-foundation of macro-economic transition. In the context of the "compliance costs" induced by environmental regulations, firms must navigate a strategic trade-off between "real investment" (e.g., R&D, equipment upgrades) and "financial investment" (e.g., holding liquid financial assets) (Demir, 2009). The recent global trend of corporate financialization—where non-financial firms increasingly derive profits from financial channels—has induced concerns about the potential crowding-out of real innovation (Krippner, 2005). The classical portfolio theory suggests that when the expected returns on real economy operations decline because of regulatory pressure, management has a compelling incentive to increase holdings of financial assets for arbitrage or hedging purposes (Tobin, 1965).

However, existing studies largely overlook this "Real–Virtual" trade-off mechanism under environmental regulation. Most research dichotomously focuses on whether regulations stimulate innovation ("Porter Hypothesis") or impose burdens ("Compliance Cost Hypothesis"). Consequently, the fact that firms might entirely bypass this dilemma by shifting resources toward the financial sector is left unexplored. If the LCCP policy unintentionally drives firms to "shift from real to virtual" (financialization) to hedge against compliance risks, it may generate a "masking effect": firms might appear profitable, or even "green," in the short term, while their core competitive resilience erodes over the long run.

This article develops a bipartite competitiveness framework to address the unresolved theoretical limitations. Our approach distinctly bifurcates "Green Competitiveness"—gauged by carbon returns—and "Traditional Competitiveness", denoted by total factor productivity. Recent studies highlight that modern sustainable growth increasingly depends on digital technology embeddedness and entrepreneurship to shift firms from passive compliance to active low-carbon innovation (Arshad et al., 2025; Chen et al., 2025; Zhao et al., 2023). Building on this dual paradigm, we exploit the phased deployment of ecological municipal zones as a quasi-experiment. Drawing on a 2003 – 2024 panel of non-financial domestic equities, we estimate multi-period difference-in-differences regressions to uncover how these regulatory interventions dictate capital structuring decisions and ultimately shape sustained corporate viability and firm survival.

Our findings reveal a complex picture of the policy’s microeconomic consequences. First, the LCCP policy significantly increases the degree of corporate financialization. This behavior is driven by "profit-chasing" and "precautionary savings" motives to buffer against regulatory shocks. Second, we identify a distinct divergence in competitiveness outcomes. While the policy successfully enhances "Green Competitiveness" (Carbon Productivity), it significantly suppresses "Traditional Competitiveness" (TFP). Mechanism tests confirm that excessive

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financialization acts as a "resource crowding-out" channel, displacing substantive R&D and physical investment. Third, and most critically, we document a "Competitiveness Trap" from a long-term dynamic perspective. Our heterogeneous event study shows that while low-financialization firms exhibit a "U-shaped" recovery in TFP, high-financialization firms experience a continuous and cumulative decline in productivity. By the 10^{th}-year post-policy, the cumulative competitiveness loss of high-financialization firms is approximately 2.4-times that of their counterparts. Finally, heterogeneity analysis based on Green Innovation Capability reveals a "Compliance Cost Effect," indicating that the short-term pains of transition are primarily borne by active responders with technological endowments.

This study makes three marginal contributions to the literature. First, it offers a novel perspective by linking environmental regulation to the "Financialization of the Real Economy." Unlike previous studies that focus on green innovation (Ambec et al., 2013), we identify financial asset allocation as a key transmission mechanism. We extend the "Investment Substitution" theory (Demir, 2009) to the context of environmental governance, verifying that financialization can serve as a "strategic shelter" for firms experiencing regulatory uncertainty.

Second, it deepens the theoretical understanding of "Competitiveness" by proposing a "Dual-Dimension" framework. We empirically disentangle the tension between "Green Performance" and "Core Productivity." This helps clarify the debate between the Porter Hypothesis and the Compliance Cost Hypothesis, suggesting that short-term green improvements may come at the cost of long-term TFP if driven by non-productive financial reallocation rather than substantive innovation.

Third, we provide nuanced evidence on the asymmetric impacts of regulation by identifying a "Compliance Cost Effect," contrasting with the traditional resource-buffering hypothesis. Our heterogeneity analysis reveals a notable phenomenon: the negative shock to Traditional Competitiveness (TFP) is concentrated among firms possessing robust green technological endowments, rather than those without. This finding suggests that "active responders" to the policy experience steeper compliance curves and incur substantial short-term transformation costs, whereas non-innovators may evade deep structural adjustments. Furthermore, within the heavy-polluting industry subsample, we identify an underlying "Intertemporal Crowding-out Effect," where the displacement of real green investment by financialization materializes with a significant two-year lag. By mapping these micro-pathways, this study highlights the potential "penalty for first-movers" and offers critical implications for designing compensatory mechanisms to prevent the erosion of industrial resilience.

2 THEORETICAL BACKGROUND

This study integrates the Resource-Based View (RBV) (Barney, 1991) and Dynamic Capability Theory to examine the strategic implications of environmental regulation. We conceptualize corporate green transformation as a critical process of accumulating specialized and non-substitutable resources. While the LCCP policy is designed to foster long-term dynamic capabilities, it may unintentionally trigger a competitiveness trap. From the RBV perspective, the diversion of scarce financial resources toward speculative financialization for short-term compliance depletes the essential capital required for R&D. This theoretical distinction between tactical financial survival and strategic resource accumulation suggests that intensive regulation may, paradoxically, induce productivity erosion through a mechanism of resource misallocation.

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From an institutional design perspective, the Chinese ecological pilot strategy signals a definitive break from authoritative compliance, leaning heavily into market-integrated regulatory frameworks. Promulgated in 2010 by the National Development and Reform Commission, this legislative wave introduces a massive environmental disruption, fundamentally rewriting the opportunity sets for corporate actors. Moving past rigid emission quotas, the initiative enforces a dual-pronged mechanism targeting both gross greenhouse quantities and efficiency metrics, effectively compelling firms to absorb the societal damages of their emissions. Decoding the true organizational response to these stringencies mandates a theoretical leap beyond the classic dichotomy opposing the green-innovation dividend (Porter & van der Linde, 1995) and the profitability-penalty paradigm (Jaffe et al., 1995). Although these foundational concepts brilliantly capture the internal budgetary warfare between ecological remediation and core production enhancements, they share a critical blind spot. Neither framework anticipates the contemporary corporate propensity to bypass tangible operational upgrades altogether, opting instead to siphon capital out of real-economy ventures for high-yield financial speculation.

The primary mechanism linking environmental regulation to corporate financialization is rooted in the "Investment Substitution Theory" under uncertainty. As delineated by Demir (Journal of Development Economics, 2009), when the risk-adjusted return on investment in the real economy declines relative to financial assets, rational firms will substitute fixed asset investment with financial asset holdings. The LCCP policy triggers this substitution through two channels: profit compression and uncertainty amplification. First, the internalization of environmental costs necessitates immediate expenditures on emission control technologies and equipment retrofitting, which, inevitably, reduces the profit margins of the firm’s main business operations. Second, and perhaps more critically, the policy introduces significant policy uncertainty regarding future emission quotas and carbon pricing. According to the theory of uncertainty shocks (Bloom, 2009; Fernandez-Villaverde et al., 2015; Gilchrist et al., 2014; Gulen & Ion, 2016; Kim & Kung, 2017), elevated uncertainty significantly dampens the responsiveness of real investment to price signals, inducing a "wait-and-see" behavior (Wang et al., 2014; Bradley et al., 2016; He et al., 2020). the responsiveness of real investment to price signals, inducing a "wait-and-see" behavior. In this context, financial assets serve as a "strategic shelter." Drawing on the precautionary savings motive (Almeida et al., 2004; Duchin et al., 2017; Gamba & Triantis, 2008), alongside agency problems (Jensen & Meckling, 1976), firms experiencing greater regulatory uncertainty have compelling incentives to hoard liquid financial assets to hedge against future liquidity shocks or to engage in "regulatory arbitrage" by smoothing earnings through financial gains. Consequently, faced with the dual pressure of declining real-sector returns and rising environmental uncertainty, regulated firms are compelled to expand their extent of financialization. This leads to our first hypothesis (H1): The implementation of the LCCP policy significantly drives the "financialization" of corporate asset allocation.

The downstream effects of reallocating capital toward capital markets are multifaceted. To accurately capture these dynamics, our methodology introduces a bipartite competitiveness taxonomy, effectively isolating emission-adjusted performance from baseline technological efficiency. Theoretical debates concerning internal asset deployment typically revolve around two opposing mechanisms: the precautionary savings channel and the investment displacement penalty. Some scholars (Stulz, 2022) argue that highly liquid portfolios provide a crucial buffer that funds research endeavors by resolving capital friction, a dynamic often moderated by corporate governance factors such as CEO career horizons and underlying ESG commitments

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(Ferreira et al., 2025). In stark contrast, macro-structural frameworks (Krippner, 2005; Orhangazi, 2008; Beck et al., 2010) heavily criticize the shift away from tangible production, highlighting severe resource starvation. Under the shadow of municipal ecological oversight, we project that such speculative behaviors will yield highly divergent outcomes depending on which facet of organizational durability is examined.

On the one hand, the mandatory nature of the LCCP policy compels firms to improve their "Green Competitiveness." Regardless of their investment strategy, firms must meet rigid emission targets to maintain their "license to operate." Consequently, even if firms divert capital to financial assets, they are likely to adopt end-of-pipe treatments or adjust production scales to satisfy regulatory requirements, thereby mechanically improving Carbon Productivity (output per unit of emissions). On the other hand, regarding "Traditional Competitiveness," the rise in financial asset allocation generates a severe resource misallocation effect (Hsieh & Klenow, Quarterly Journal of Economics, 2009). While emerging research emphasizes digital transformation as a key driver of structural market competitiveness (Enri-Peiró et al., 2025), financialization diverts scarce internal capital away from long-term, high-risk, but productivity-enhancing activities such as substantive R&D and human capital accumulation. This is particularly relevant considering external financial constraints and the evolving digital finance landscape (Feng et al., 2023; Hadlock & Pierce, 2010). As firms become increasingly reliant on financial channels for profit generation, their core technological capabilities erode, inducing a decline in TFP. This divergence creates a "masking effect" where apparent improvements in environmental metrics conceal the deterioration of industrial competitive resilience. Thus, we propose our second hypothesis (H2): Corporate financialization exerts a "dual effect" on competitive resilience: it passively enhances Green Competitiveness (Carbon Productivity) while actively suppressing Traditional Competitiveness (TFP) through a resource crowding-out mechanism.

Existing literature offers divergent views on how a firm's internal technological endowment conditions the impact of environmental regulation. On the one hand, the RBV suggests that green innovation capability acts as a buffer. Firms with accumulated green patents possess the "absorptive capacity" to adapt to new regulations at a lower marginal cost, potentially shielding their traditional competitiveness from the financialization shock.

On the other hand, the Compliance Cost Hypothesis suggest that "first-movers" in green innovation often become primary targets of regulatory enforcement. Under strict low-carbon policies, these firms are compelled to divert substantial financial and managerial resources toward substantive compliance activities—such as upgrading equipment and re-engineering production processes—rather than productive investment. This "crowding-out" effect could intensify the financial pressure, leading to a sharper short-term TFP decline compared to non-innovating firms that may evade deep structural adjustments.

Given these opposing theoretical mechanisms, we propose the following competing hypotheses:

Hypothesis 3a (Resource Buffering View): Green innovation capability positively moderates the impact of low-carbon policy on competitiveness. Firms with greater technological reserves can absorb regulatory shocks more effectively, thereby mitigating the decline in Traditional Competitiveness (TFP).

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Hypothesis 3b (Compliance Cost View): Green innovation capability negatively moderates the impact of low-carbon policy on competitiveness. Firms with robust green capabilities are primary regulatory targets and experience higher "compliance costs" and resource crowding-out in the short term, resulting in a more pronounced decline in Traditional Competitiveness compared to non-innovating firms.

3 RESEARCH OBJECTIVE, METHODOLOGY, AND DATA

3.1 Model Specification

Our identification strategy leverages the sequential introduction of the LCCP program to evaluate its causal influence on corporate capital strategies and the resulting shifts in organizational resilience. A multi-period DID framework perfectly accommodates the asynchronous nature of this quasi-exogenous event while capturing behavioral adjustments among individual enterprises. Utilizing two-way fixed effects allows us to strip away confounding variations stemming from permanent entity attributes and aggregate macroeconomic cycles, thereby yielding an unbiased estimate of the regulatory shock. We formalize the foundational empirical setup in the equation below:

$$Y_{i,t} = \alpha + \alpha_1 \cdot Policy_{i,t} + \alpha_2 \cdot Controls_{i,t} + \sum Year + \sum Firm + \varepsilon_{i,t} \tag{1}$$

Where the subscripts i and t denote the firm and year, respectively. The dependent variable $Y_{i,t}$ serves as a vector representing outcomes in two distinct stages, consistent with our theoretical framework. First, to test the direct impact of the policy on resource allocation strategy, $Y_{i,t}$ represents Financialization. Second, to assess the ultimate economic consequences, $Y_{i,t}$ represents Competitiveness. Specifically, we employ Carbon Productivity and Total Factor Productivity to proxy for green competitiveness and traditional market position, respectively.

The key independent variable is $Policy_{i,t}$, a dummy variable indicating the implementation of the LCCP policy. It takes the value of 1 if firm i is in a pilot city and year t is in or after the implementation period, and 0 otherwise. The coefficient α_1 estimates the average treatment effect of the policy on the respective dependent variables. $Controls_{i,t}$ represents a set of time-varying firm-level and regional control variables. $\sum$ Year and $\sum$ Firm denote year fixed effects and firm fixed effects, respectively, controlling for common macroeconomic shocks and time-invariant firm characteristics. Finally, $\varepsilon_{i,t}$ is the random error term. Standard errors are clustered at the city level to address potential serial correlation among firms within the same jurisdiction.

3.2 Data Source and Sample Selection

The empirical analysis relies on an initial cohort of domestically quoted corporations from 2003 through 2024. Firm-specific financial records originate from the CSMAR and CNRDS networks, whereas municipal-level controls and NDRC policy deployment schedules are extracted from official statistical digests and government archives, respectively.

Adhering to mainstream data refinement protocols, we systematically purge several firm categories. Financial intermediaries are excluded upfront due to their idiosyncratic capital compositions, which could systematically bias the measurement of tangible-sector financialization. We also eliminate publicly traded entities bearing irregular trading status

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labels (PT, ST, or *ST) to isolate our estimates from the confounding shocks of imminent insolvency or operational crises. Observations missing essential dimensions — notably emissions tracking and research funding—are dropped, as are heavily indebted entities where total liabilities surpass aggregate assets. Following these exclusions, the effective estimating sample stabilizes at 25,840 annual corporate observations. Ultimately, to prevent severe distributional skewness from driving our baseline coefficients, we truncate the extreme one percent of values at both ends for all continuous right-hand-side and dependent metrics.

3.3 Definitions of Variables

(1) Dependent Variables: Following our established theoretical architecture, the dependent indicators span two distinct corporate domains: internal capital allocation and comprehensive market viability. We initially utilize Fin_Asset to proxy the financialization degree, mathematically derived by scaling aggregate financial assets against total capitalization. To overcome consistency issues stemming from the 2018 Accounting Standards for Business Enterprises reform targeting monetary items, a time-adjusted numerator was formulated. Specifically, this top portion sums trading financial assets with derivative financial assets, alongside loans and advances. For observations preceding 2018, the calculation integrates held-to-maturity investments and available-for-sale financial assets. Post-2018, these exact categories shift to encompass standard debt investments, other debt investments, plus other equity instrument investments. Investment properties maintain a constant presence throughout the entire panel. A higher computed ratio explicitly denotes a strategic retreat from real economy operations toward virtual speculation.

Transitioning to organizational strength, Carb_Prod and TFP respectively evaluate green performance and structural productivity. We measure Carbon Productivity (Carb_Prod) utilizing the natural logarithm for the quotient of total operating revenue divided by aggregate carbon dioxide emissions. This formulation accurately captures the monetary benefit extracted per pollution unit. Concurrently, TFP signifies Total Factor Productivity, representing the bedrock of institutional competitiveness. To eliminate potential simultaneity biases inherent to production function models, building on foundational productivity estimation frameworks (Olley & Pakes, 1996; Blundell & Bond, 2000; Melitz, 2003; Bernard et al., 2007), we apply the Levinsohn and Petrin (2003) semi-parametric algorithm Their approach effectively controls for unobservable performance shocks by employing intermediate inputs as the primary balancing proxy.

(2) Main Treatment Variable: To capture the regulatory shock, we construct a dichotomous measure labeled Policy. We code this indicator by utilizing the three-phased rollout scheduling of green pilot jurisdictions established by the NDRC in 2010, 2012, and 2017. This specification equals one provided that an observation's corporate registration aligns geographically with an active trial zone and chronologically coincides with the post-reform window. All remaining untreated or pre-treatment firm-years default to a zero assignment.

(3) Control Variables: To isolate the targeted regulatory effects from potential confounding mechanisms, we draw upon prior seminal studies to introduce several organizational and municipal factors. Examining internal traits sequentially: Size embodies the natural log transformation of corporate wealth. We define Lev as the aggregate debt-to-asset proportion, while ROA tracks baseline profitability by comparing net income against existing properties. Moving forward, Growth represents year-over-year sales momentum. TobinQ acts as a market

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perception metric, derived by contrasting equity valuations with accounting book values. The Cash covariate isolates operational funding adequacy, computed utilizing net cash generation divided by total capitalization. Concluding the micro-level series, SOE operates as a binary flag capturing state-backed ultimate ownership. Addressing external macroeconomic environments, City_GDP_Growth absorbs the municipality's yearly economic progression, effectively netting out broader business cycle shocks. A thorough dictionary detailing these formulated measures exists within Table 1.

Table 1 Variable Definitions.
Source: Compiled by the author

Variable Name	Symbol	Definition
Financialization	Fin_Asset	Financial Assets / Total Assets (Adjusted for 2018 Standards)
Carbon Productivity	Carb_Prod	ln (Revenue / Total CO_2 Emissions)
Total Factor Productivity	TFP	Estimated using the LP method (Levinsohn and Petrin, 2003)
LCCP Policy	Policy	Dummy = 1 if firm in pilot city after policy year, 0 otherwise
Firm Size	Size	ln (Total Assets)
Leverage	Lev	Total Liabilities / Total Assets
Return on Assets	ROA	Net Profit / Total Assets
Growth	Growth	(Current Revenue - Last Revenue) / Last Revenue
Tobin's Q	TobinQ	Market Value / Total Assets
Cash Flow	Cash	Net Operating Cash Flow / Total Assets
State Ownership	SOE	Dummy =1 if State-Owned Enterprise, 0 otherwise
City GDP Growth	City_GDP	Annual growth rate of city GDP

Note: This table explains all the key variables.

3.4 Descriptive Statistics

Panel A of **Error! Unknown switch argument.** presents the descriptive statistics for the main variables applied in this study. For ease of presentation and interpretation, the dependent variables (Financialization, Carbon Productivity, and TFP) are multiplied by 100, and Total Assets are reported in billions of CNY.

As shown in Panel A of Table 2, the mean value of Financialization (Fin_Asset) is 6.789 with a standard deviation of 9.667, indicating significant heterogeneity in asset allocation strategies among the sampled firms, with some exhibiting a greater tendency toward financialization. Regarding corporate competitiveness, the mean value of Carbon Productivity (Carb_Prod) is 59.734, while its standard deviation is relatively high at 88.638, highlighting a marked polarization in firms' low-carbon transition efficiency. The mean value of TFP is 867.448, showing a stable distribution across the sample.

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Averaging 0.581, the central regulatory dummy demonstrates that environmental constraints actively cover exactly 58.1 percent of the total annual corporate records. Because this specific ratio reflects a reasonably symmetrical allocation separating the treated entities from the untreated subsets, it structurally justifies our reliance on the chosen difference-in-differences analytical architecture.

Among the included right-hand-side controls, the organizational wealth parameter demonstrates a mean hovering around 168.4 billion CNY, accurately reflecting the immense capitalization characteristic of the A-share market. Concurrently, the average financial leverage stands at 0.419, signaling prudent debt structures across the cohort. To systematically purge extreme value distortions, all unconstrained micro-level indicators are symmetrically winsorized at the 1% and 99% cutoffs. Because the resulting standard deviations exhibit well-behaved variations, our dataset establishes a highly reliable baseline for the forthcoming econometric modeling.

Table 2 (Panel A) Descriptive Statistics.
Source: Compiled by the author

Variables	N	Mean	SD	Min	Max
Carb_Prod	23,177	59.73	88.64	0.49	3,462.49
TFP	23,177	867.45	103.97	664.15	1,145.65
Fin_Asset	23,177	6.79	9.67	0	85.73
Policy	23,177	0.58	0.49	0	1
Assets	23,177	168.36	461.33	4.84	3,348.16
FirmAge	23,177	10.54	7.04	1	29
Lev	23,177	0.42	0.20	0.06	0.84
Cash	23,177	0.05	0.07	-0.13	0.24
TobinQ	23,177	2.55	1.74	0.86	10.04
Top10	23,177	58.66	15.18	23.82	91.03
Duality	22,650	1.74	0.44	1	2
IndepBoard	23,175	0.37	0.05	0.29	0.57
SOE	23,177	0.41	0.49	0	1
CityGDP	23,177	0.10	0.05	0.01	0.24

Notes: (1) The dependent variables (Fin_Asset, Carb_Prod, TFP) are multiplied by 100.(2)The unit of Total Assets is billion CNY.(3) N denotes the number of observations, SD denotes standard deviation.

Pearson pairwise statistics covering the fundamental dataset dimensions are detailed within the Panel B of Table 2. The focal policy indicator demonstrates a statistically meaningful, upward covariance with organizational financialization behaviors, thereby offering preliminary validation for our theoretical expectations. Beyond these baseline relationships, we observe no excessive linear dependence across the suite of explanatory and auxiliary regressors. This lack of high-magnitude cross-correlations ensures that structural multicollinearity poses no threat to the accuracy of upcoming causal estimations. Further diagnostic checks utilizing variance inflation parameters corroborate this safety margin, as the recorded metrics strictly adhere to standard tolerance boundaries.

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Table 2 (Panel B).Pearson correlation matrix
Source: Compiled by the author

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) Carb_Prod	1													
(2) TFP	.10***	1												
(3)Fin_Asset	.09***	.04***	1											
(4) Policy	.14***	.09***	.11***	1										
(5) Assets	.07***	.57***	.06***	.10***	1									
(6) FirmAge	.19***	.44***	.28***	.09***	.21***	1								
(7) Lev	.07***	.52***	-.06***	-.01	.33***	.32***	1							
(8) Cash	-.02**	.11***	-.01	-.04***	.02***	.01	-.15***	1						
(9) TobinQ	-.10***	-.34***	-.09***	.01	-.21***	-.33***	-.42***	.16***	1					
(10) Top10	-.11***	.11***	-.11***	.05***	.21***	-.34***	-.09***	.12***	.14***	1				
(11) Duality	-.02***	.15***	.03***	-.12***	.08***	.21***	.16***	.01*	-.16***	-.03***	1			
(12) IndepBoard	.06***	.05***	.05***	.12***	.11***	.01	.01	-.03***	.03***	.03***	-.12***	1		
(13) SOE	-.03***	.30***	.04***	-.15***	.23***	.43***	.32***	.01**	-.26***	-.01	.32***	-.06***	1	
(14) CityGDP	-.32***	-.13***	-.09***	-.33***	-.08***	-.20***	.03***	-.04***	.03***	.06***	.08***	-.10***	.17***	1

Notes: Asterisks (***, **, and *) identify statistical meaningfulness at the 0.01, 0.05, and 0.10 probability boundaries.

4 RESULTS AND DISCUSSION

4.1 Baseline Regression Results

The fundamental estimations linking the low-carbon initiative to capital structuring and subsequent firm survival are detailed within Table 3. We present the financialization outcomes in Column (1), while Columns (2) and (3) document variations in ecological superiority (Carbon Productivity) and overall structural efficiency (Total Factor Productivity). Every specified equation partials out unobservable entity-level and annual variations, utilizing standard errors adjusted for intra-city correlation.

Regarding the initial findings in Column (1), the focal Policy variable yields a positive estimate of 0.8088, securely crossing the 5% statistical confidence bound. We interpret this coefficient as robust evidence that regulatory shocks actively stimulate speculative asset hoarding. This phenomenon corroborates theoretical arguments predicting precautionary savings alongside investment displacement. Navigating severe regulatory expenses and the erratic nature of environmental oversight, managers proactively drain finite liquidity from orthodox industrial projects. These resources are instead redeployed toward high-liquidity financial vehicles offering short-run profits, exemplifying a decisive capital flight away from the real economy.

Evaluating the ecological impact through Column (2), the measured parameter for Policy stands at 2.95 concerning Carb_Prod, exhibiting high precision at the 1% significance mark. The data strongly indicate an effective environmental rectification process driven by the municipal mandates. Through a rigid enforcement mechanism, the intervention strictly mandates lower pollution intensity across manufacturing processes, elevating underlying eco-technological competencies and fulfilling overarching governmental climate agendas.

However, Columns (3) reveals the potential economic costs of the policy. The regression coefficient of Policy on TFP is -4.83 and significantly negative at the 5% level. Interpreting this in conjunction with the results of Columns (1), this finding provides robust support for the

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"resource crowding-out effect." Since firms rely excessively on financial asset allocation to buffer against policy shocks, this non-productive resource transfer crowds out funds that would otherwise be allocated to core technological innovation and equipment upgrading, leading to a decline in resource allocation efficiency. In other words, while the policy has improved "green" performance, it has exerted a negative shock on firms' "core" productivity in the short term, reflecting the "pains" of the low-carbon transition process.

Table 3 Baseline Regression Results
Source: Compiled by the author

Variables	(1)	(2)	(3)
	Financialization	Carbon Prod.	TFP
Policy	0.81**	2.95***	-4.83**
	(2.14)	(2.68)	(-2.02)
Size	-0.12	0.06***	0.23***
	(-3.31)	(1.34)	(7.65)
FirmAge	0.61	-0.38	0.12***
	(1.39)	(-1.04)	(4.62)
Leverage	-6.43***	0.25***	0.86***
	(-8.26)	(4.77)	(13.34)
CashFlow	-2.66***	0.09	1.10***
	(-2.35)	(1.02)	(15.98)
TobinQ	-0.31***	0.01**	0.00
	(-4.07)	(2.32)	(-0.92)
Top10	-0.08***	0.00	0.00**
	(-8.01)	(1.41)	(2.23)
ShareBalance	0.37*	0.01	0.00
	(1.89)	(0.37)	(0.11)
IndepBoard	-0.91	-0.14	-0.27**
	(-0.35)	(-0.77)	(-2.34)
SOE	-0.78	0.04	-0.01
	(-1.30)	(1.48)	(-0.34)
CityGDP	3.62	-0.14	0.05
	(1.35)	(-0.64)	(0.27)
Constant	7.96*	4.38	6.91***
	(1.69)	(1.14)	(24.12)
Observations	22,649	22,649	22,649
R-squared	0.63	0.71	0.90
Firm FE	YES	YES	YES
Year FE	YES	YES	YES

Note: The robust t-statistic in parentheses. *p<0.10, **p<0.05, ***p<0.01.

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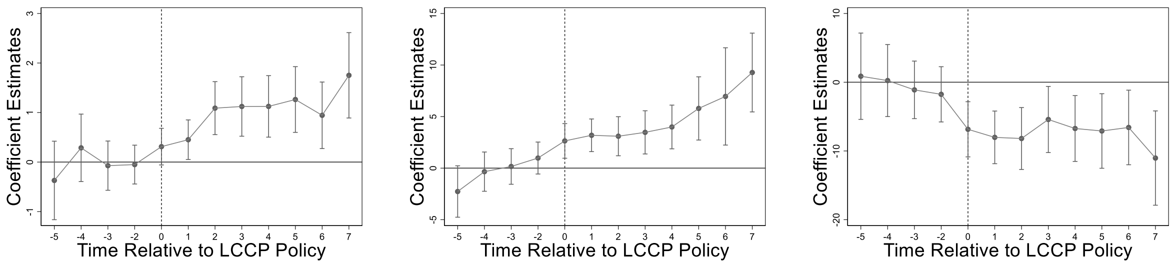
4.2 Robustness Checks

(1) Parallel Trend Test

A fundamental prerequisite for causal inference in any staggered difference-in-differences framework is the presence of identical historical trajectories among the treated and unexposed cohorts before the intervention. To empirically validate this precondition while simultaneously mapping the time-varying impacts of the exogenous shock, we estimate a dynamic event-study specification. Our designated timeframe captures half a decade preceding the regulation and extends through a seven-year post-treatment horizon.

The resulting parameter estimates, bounded by ninety-five percent precision intervals, are graphically detailed within Figure 1 across three core dimensions: firm-level financialization (Panel A), carbon-based efficiency (Panel B), and overall factor productivity (Panel C). Visual inspection of these charts reveals that all pretreatment parameters (where the temporal indicator is strictly negative) hover closely around the null line, with their respective confidence boundaries consistently crossing zero. Such patterns provide compelling evidence that before the rollout of the ecological mandates, both corporate groups exhibited statistically indistinguishable pathways concerning resource deployment, emission effectiveness, and operational output, firmly establishing the necessary common trends foundation.

Following the policy implementation, the dynamic effects diverge significantly across the outcomes: First, the coefficients for Financialization (Panel A) become significantly positive and exhibit an upward trend, suggesting that firms spiked their allocation to financial assets in response to environmental regulatory pressure. Second, the coefficients for Carbon Productivity (Panel B) show a significant and sustained increase, confirming that the policy has effectively enhanced corporate environmental performance over the long term. Third, in stark contrast, the coefficients for TFP (Panel C) drop below zero immediately after implementation and remain significantly negative. This aligns with our baseline findings, indicating that the shift from "real to virtual" activities and the burden of compliance costs have exerted a persistent negative shock on firms' core productive efficiency in the short to medium term. In summary, the parallel trend tests provide robust support for our main conclusions.



(Panel A) (Panel B) (Panel C)

Figure 1.Parallel Trend Tests.
Source: Compiled by the author

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(2) Placebo Test

To mitigate concerns regarding unobservable confounders and confirm that our primary findings do not stem from random statistical fluctuations, we execute a falsification exercise in the spirit of Chetty et al. (2009). In practice, artificial ecological zone designations were randomly allocated across municipalities within the dataset. During this procedure, both the intervention timeline and the aggregate count of affected regions precisely matched the genuine regulatory rollout. Subsequent to creating an artificial interaction estimator, we recalculated our main specification. By iterating this stochastic shuffling five hundred times, we generated an empirical density comprising fictitious estimators alongside their associated statistical significance metrics.

The resulting graphical representation in Figure 2 displays the probability density curve for the simulated parameters (referenced on the secondary axis) against their p-values (primary axis) concerning the Total Factor Productivity regressions. Visual inspection confirms that these fictitious parameters tightly cluster near the zero mark, exhibiting a bell-shaped curve where the vast majority of probability values fail to meet the ten percent threshold. Conversely, the authentic parameter derived from our actual estimation stands at −4.83, highlighted via a perpendicular dotted crimson marker. Such a magnitude positions itself distantly at the negative extreme of the simulated curve, entirely divorced from the cluster of randomized outcomes.

Additionally, we conducted identical placebo tests for Corporate Financialization (Fin_Asset) and Carbon Productivity (Carb_Prod). The results (omitted for brevity) indicate that the true coefficients for these variables (0.809 and 2.950, respectively) similarly lie significantly outside the distributions of the placebo estimates, falling into the extreme right tails. In summary, this battery of tests firmly eliminates the threat of spurious statistical noise governing the regulatory outcomes, ultimately validating the absolute integrity of our baseline assertions.

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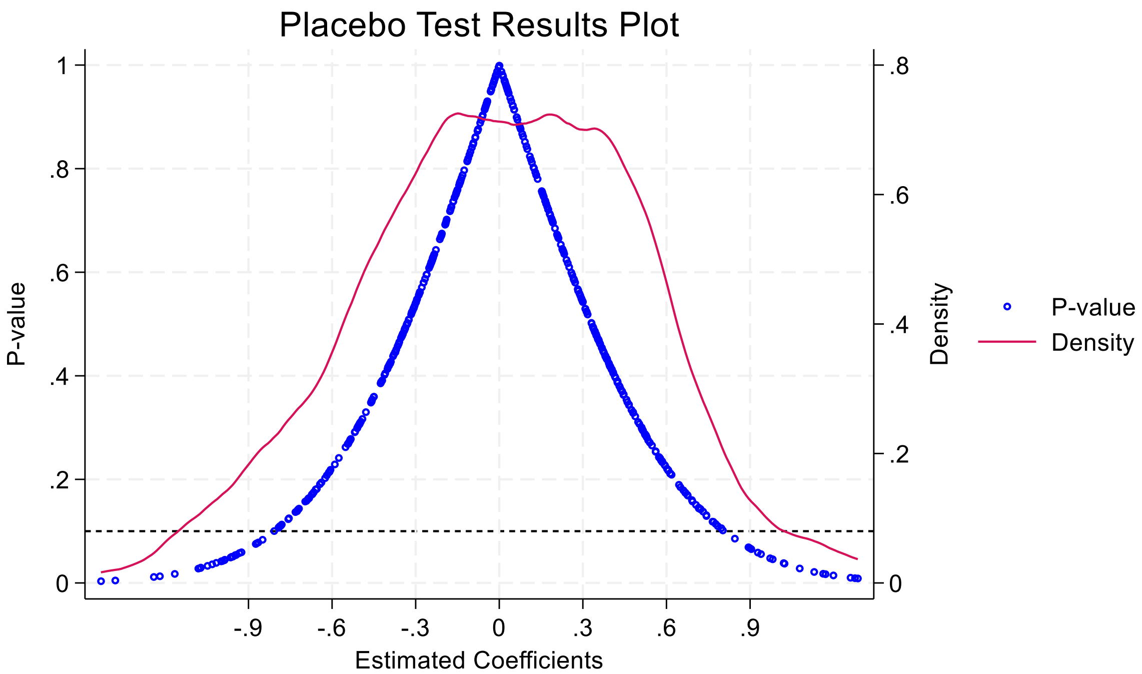

Figure 2.Placebo test.
Source: Compiled by the author

(3) Propensity Score Matching

Because the designation of municipal pilot zones is rarely strictly exogenous—often covarying with local macroeconomic conditions and underlying corporate traits—our baseline estimations might suffer from non-random assignment bias. we mitigate this empirical challenge by adopting a propensity score matching framework (Rosenbaum & Rubin, 1983). By incorporating fundamental firm-level attributes, including total assets and financial leverage, as predictive covariates, we execute a one-to-one nearest-neighbor pairing protocol. This procedure successfully isolates a structurally equivalent cohort of non-treated enterprises to serve as a reliable counterfactual.

We provide visual confirmation regarding the reliability of our pseudo-population via Figures 3 and 4. As captured by the dotted markers in the third chart, severe structural discrepancies initially plagued the right-hand-side variables when comparing treated firms against untreated entities. Once the matching algorithm concludes, the revised deviations—symbolized by crosses—plummet dramatically, coalescing around the zero benchmark without exceeding a 10% maximum magnitude. Transitioning to Figure 4, one can observe the propensity probabilities modeled as kernel density plots. The post-intervention curves for both subgroups exhibit near-flawless convergence. This graphical evidence verifies that underlying traits are now symmetrically aligned, fulfilling both the baseline balancing criterion and the vital common support prerequisite.

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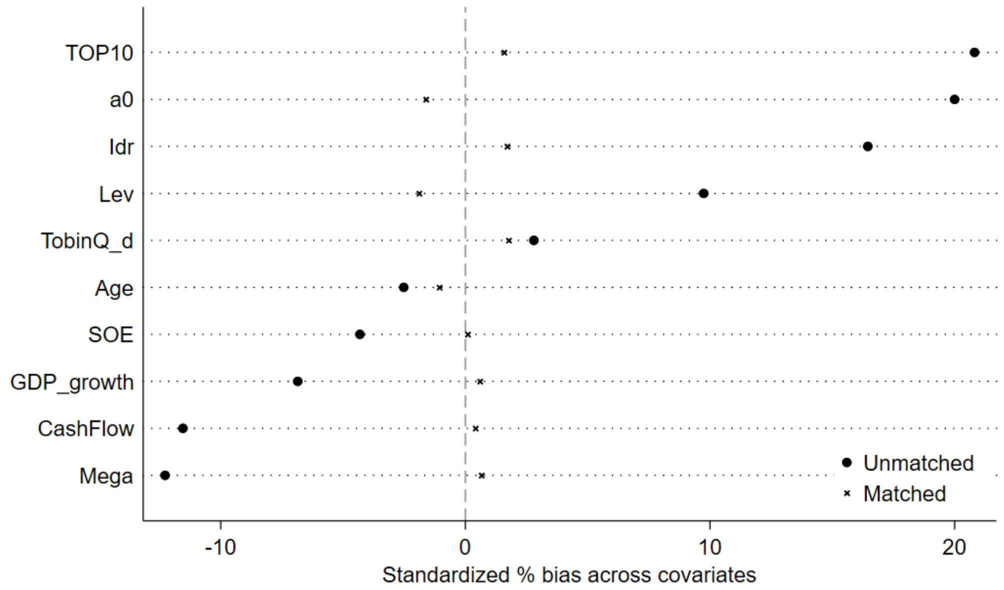

Figure 3.The Balancing Plot.
Source: Compiled by the author

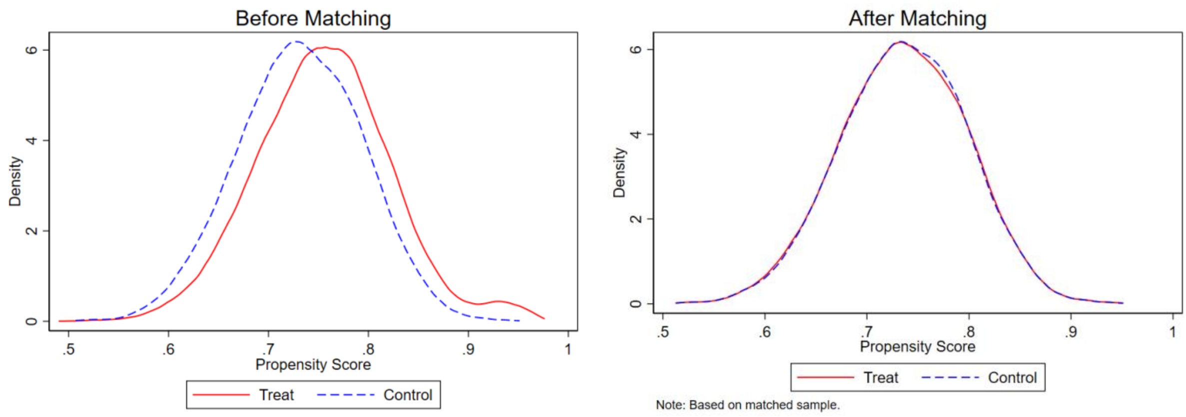

Figure 4.The Density Plot
Source: Compiled by the author

We proceed to apply our main econometric specification to this balanced cohort, detailing the ensuing outcomes within Table 4. Adjusting for observable pretreatment imbalances leaves the core arguments intact. The focal interaction term generates a statistically meaningful magnitude of 5.767 concerning carbon returns (Column 2), firmly establishing the environmental dividend. Furthermore, speculative portfolio accumulation tracks consistently, recording an outcome of 0.196 in Column 1. Of greatest theoretical consequence is the TFP estimation found in Column 3, which preserves its stark negative form (−5.639, holding at $p < 0.1$). Such robustness checks strictly mirror our primary deductions. They demonstrate definitively how mandatory ecological expenses, coupled with diverted liquidity, drastically suppress fundamental productive operations.

Table 4 The Regression Table
Source: Compiled by the author

Variables	(1) Fin	(2) Carb	(3) TFP
Policy	0.20	5.77***	-5.64*
	(0.38)	(2.64)	(-1.69)
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	8,851	8,851	8,851
R-squared	0.67	0.80	0.90

Note: The robust t-statistic in parentheses. *p<0.10, **p<0.05, ***p<0.01.

(4) Excluding Other Policy Interferences

During the sample period, the Carbon Emission Trading (CET) Pilot, launched in 2013 (Zhang et al., 2021), significantly overlapped with the LCCP policy in terms of timing and coverage (e.g., in Beijing, Shanghai, and Guangdong). Since the CET policy directly affects firms' abatement costs and production decisions through market-based mechanisms, failing to control for it could induce confounding effects. To address this, we explicitly included an interaction term for the Carbon Emission Trading Pilot (DID_{CET}) in our baseline model.

Error! Unknown switch argument. reports the regression results. The findings show that, even after controlling for the CET policy: First, the impact of the LCCP policy on Carbon Productivity (Column 2) remains significantly positive at the 1% level (coefficient = 3.798), indicating that the LCCP policy has an independent "green effect." Second, the impact on Corporate Financialization (Column 1) remains significantly positive (coefficient = 0.821). Third, and most crucially, the coefficient on TFP (Column 3) remains significantly negative (coefficient = -3.953, $p < 0.1$). This reaffirms our core conclusion: even after excluding the interference of other major environmental regulations, the compliance costs and resource crowding-out effects induced by the LCCP policy significantly inhibit corporate productive efficiency.

Table 5 Robustness Check: Excluding Carbon Trading Pilot Interference.
Source: Compiled by the author

Variables	(1) Fin	(2) Carb	(3) TFP
LCCP Policy	0.82*	3.80***	-3.95*
	(1.93)	(3.13)	(-1.71)
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	22,634	22,634	22,634

Note: The robust t-statistic in parentheses. *p<0.10, **p<0.05, ***p<0.01.

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4.3 Mechanism Analysis: Dual Pathways of Traditional and Green Competitiveness

To clarify the differentiated impacts of the LCCP policy on corporate "Traditional Competitiveness (TFP)" and "Green Competitiveness (Carbon Performance)," this study employs the three-step approach combined with the Bootstrap method (500 replications) to rigorously test the mediating effects of Financialization (Fin), R&D Intensity (R&D), and Green Patents (GreenPat). **Error! Unknown switch argument.** reports the regression results and the Bootstrap 95% confidence intervals.

First, the Dominant Mechanism of "Shifting from Real to Virtual" for Traditional Competitiveness (Columns 1 – 4). Columns (1) – (2) examine the financialization channel. The stepwise regression results show that the policy significantly increases corporate financialization (coefficient = 0.806**), which in turn considerably inhibits TFP (coefficient = -0.477***). The Bootstrap test indicates that the 95% confidence interval for this indirect path is [-0.550, -0.220], which does not include zero. This provides robust evidence confirming that "financial crowding-out" is the core robust mechanism driving the decline in corporate traditional competitiveness. Columns (3) – (4) examine the R&D channel. Although stepwise regression suggests that the policy forces an increase in R&D intensity, which is negatively correlated with TFP (-426.719***), the Bootstrap test shows a confidence interval of [-0.838, 0.550], which includes zero (indicating an insignificant mediation effect). This result carries important economic implications: it rules out "compliance R&D costs" as the primary cause of the TFP decline, further corroborating that the drop in productivity is mainly driven by resource misallocation induced by financialization.

Second, the "Superficial" Improvement Mechanism for Green Competitiveness (Columns 5 – 6). Columns (5) – (6) examine the green innovation channel. Stepwise regression shows that the policy significantly stimulates green patent applications (coefficient = 0.942**) and has a significant positive total effect on carbon performance (coefficient = 0.949**). However, the Bootstrap test yields a confidence interval of [-0.020, 0.015], which includes zero. This "statistical non-significance" reveals the non-technical nature of the current improvement in carbon performance. Owing to the lag in translating green patents into actual productivity, or because patent applications may be driven more by strategic compliance, current carbon reductions may rely more on end-of-pipe treatments or production adjustments rather than substantive technological progress. This further confirms that, in the short term, the LCCP policy may induce firms to adopt non-technical measures to meet compliance pressures, thereby masking a lack of long-term green competitiveness.

In summary, the mechanism tests demonstrate that the LCCP policy substantively damages corporate traditional competitiveness through the robust channel of "financialization." However, its enhancement of green competitiveness has not yet formed a robust technological support path, exhibiting characteristics of "superficial prosperity."

It is noteworthy that while our baseline results confirm a significant decline in absolute TFP, further analysis on the "Relative Distance to Industry Frontier" yielded statistically insignificant results. This implies that the LCCP policy acts as a systemic shock affecting the entire industry. Both industry leaders and followers experience similar "financialization incentives" and "resource crowding-out" pressures, which induces a universal downward shift in the productivity distribution rather than merely expanding the gap between leaders and laggards.

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While the empirical evidence robustly confirms the transmission from the LCCP policy to financialization and the subsequent erosion of TFP, this sequential degradation theoretically culminates in the impairment of ultimate firm performance. We conceptualize TFP as the most critical leading indicator within the competitiveness trap framework. A decline in technical efficiency and resource allocation efficiency typically precedes and fundamentally drives the deterioration of accounting-based profitability. Although the long-term impact on final financial performance may be subject to various external market noises, the observed structural decline in TFP captures the onset of competitive erosion, providing a cohesive mechanistic foundation for the entire story.

Table 6 Mechanism Test.
Source: Compiled by the author

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Outcomes	Fin	TFP	R&D	TFP	GreenPat	Carb
Policy	0.81**	-4.60*	0.01*	-5.134**	0.94**	0.971**
	(2.20)	(-1.97)	(1.91)	(-2.21)	(2.01)	(2.03)
Fin		-0.48***				
		(-5.20)				
R&D Intensity				-426.72***		
				(-7.79)		
Green Patents						0.01
						(-0.31)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	20,873	20,873	20,873	20,873	20,873	20,873
R-squared	0.64	0.9	0.87	0.96	0.69	0.7
Bootstrap Test						
Ind_Eff 95% CI	[-0.55,-0.22]		[-0.84,0.55]		[-0.02,0.02]	
Conclusion	Significant		Insignificant		Insignificant	

Note: The robust t-statistic in parentheses. *p<0.10, **p<0.05, ***p<0.01.

4.4 Heterogeneity Analysis

Firms exhibit substantial variations regarding their asset bases, government linkages, and industry profiles. Consequently, the firm-level responses to the municipal low-carbon mandates are unlikely to be uniform across the board. To properly explore these diverse boundary conditions, the current section conducts a series of heterogeneity tests. We specifically examine how the regulatory consequences diverge when accounting for the fundamental nature of corporate property rights and the existing magnitude of environmental footprints.

(1) Heterogeneity Analysis Based on Ownership Structure

State-owned enterprises (SOEs) and non-state-owned enterprises (Non-SOEs) differ fundamentally in budget constraints and operational goals. Table 7 (Panel A) reports the subsample regression results based on ownership.

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Regarding Traditional Competitiveness (TFP) (Columns 1 – 2), the results indicate that the LCCP policy significantly inhibits the Total Factor Productivity of Non-SOEs (coefficient = -5.187, $p < 0.05$), while the negative impact on SOEs is statistically insignificant. This finding aligns with the "credit constraint" logic: compared to SOEs, Non-SOEs experience more stringent financing constraints. Under the shock of compliance costs induced by environmental regulations, Non-SOEs lack external financial support and are more likely to crowd-out productive investments or "shift from real to virtual" to smooth profits, leading to a significant decline in real productivity. In contrast, SOEs, leveraging their "soft budget constraints" advantage, can effectively buffer the resource reallocation pressure induced by the policy.

Regarding Green Competitiveness (Carbon Performance) (Columns 3 – 4), the policy's enhancement effect on the carbon performance of SOEs is significantly positive (coefficient = 1.331, $p < 0.1$), while the impact on Non-SOEs is insignificant. This primarily reflects the "political response" attribute of SOEs. Under the "Dual Carbon" goals, SOEs bear greater social responsibilities and emission reduction targets. Consequently, their willingness and capacity to invest in green transformation are stronger than those of Non-SOEs, whose primary objective is profit maximization.

Table 7 (Panel A).Heterogeneity Analysis by Ownership
Source: Compiled by the author

Variables	Non-SOE (TFP)	SOE (TFP)	Non-SOE (Carb)	SOE (Carb)
Policy	-5.19**	-3.02	0.13	1.33*
	(-2.03)	(-0.86)	(0.25)	(1.87)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	12,443	8,393	12,443	8,393
R-squared	0.89	0.91	0.79	0.6

Note: The robust t-statistic in parentheses. *p<0.10, **p<0.05, ***p<0.01.

(2) Heterogeneity by Green Innovation Capability

Furthermore, we examined how a firm's green technology reserve conditions the net policy effect. Given the zero-inflation characteristic of green patent data, we divided the sample into the "No Green Capability Group" (Patent Stock=0) and the "High Green Capability Group" (Patent Stock>0).
Panel B of Table 7 reveals a striking result: the negative shock of the LCCP policy on TFP is concentrated in the "High Green Capability Group" (Column 2, Coef = -7.060, $p < 0.05$), while the "No Green Capability Group" was not significantly affected (Column 1). This suggests a "Compliance Cost Effect." Firms with existing green foundations are often the primary targets of environmental regulation. The policy compels them to divert substantial resources from productive activities to environmental compliance and technological upgrading in the short

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term, leading to rising costs and a temporary decline in TFP. In contrast, firms without green accumulation may be on the regulatory fringe, evading deep structural adjustments.

Table 7 (Panel B).Heterogeneity by Green Innovation Capability
Source: Compiled by the author

Variables	(1) TFP	(2) TFP
	Low Green Cap (=0)	High Green Cap (>0)
Policy	-2.43	-7.06**
	(-0.91)	(-2.23)
Controls	Yes	Yes
Firm FE	Yes	Yes
Year FE	Yes	Yes
Observations	14,988	5,623
R-squared	0.88	0.94

Note: The robust t-statistic in parentheses. *p<0.10, **p<0.05, ***p<0.01.

(3) Heterogeneity Analysis Based on Pollution Intensity

The financial burden imposed by green mandates often elicits asymmetrical responses depending on an organization's specific industry profile. To account for this vulnerability difference, the dataset is bifurcated into emission-intensive enterprises and cleaner firms, relying upon the regulatory sector definitions established by the Ministry of Environmental Protection. Panel C of Table 7 displays the corresponding regression outputs for this cross-sectional division.

The results show that the shock of the LCCP policy is mainly concentrated on Light-polluting Enterprises. Regarding TFP (Columns 1 – 2), the regression coefficient for Light-polluting firms is significantly negative (-7.657, $p < 0.01$), whereas Heavy-polluting firms do not show a significant decline. This may be because light-polluting industries (such as textiles and manufacturing) mostly operate in perfectly competitive markets with thin profit margins and extreme sensitivity to cost fluctuations; thus, additional compliance costs induce severe disturbances to their productive efficiency. In contrast, heavy-polluting industries (such as energy and chemicals) often possess high asset specificity and industry barriers, or even enjoy implicit local government protection, thereby displaying immense rigidity against policy shocks.

Regarding Carbon Performance (Columns 3 – 4), Light-polluting firms exhibit a significant improvement in carbon performance (coefficient = 1.012, $p < 0.1$). This suggests that, owing to the relatively lower difficulty of technological retrofitting in light-polluting industries, these firms respond more flexibly and rapidly to the policy, achieving green performance improvements through quicker adjustments. Conversely, the green transformation of heavy-polluting firms is a long-term process, and the policy effects have not yet fully manifested in the short term.

In summary, the heterogeneity analysis demonstrates that the reshaping effect of the LCCP policy on competitiveness is non-uniform. The policy imposes a "productivity pain" primarily on Non-SOEs and Light-polluting firms, while the "green dividend" is more evident among SOEs and Light-polluting firms that are more flexible in transformation.

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Table 7 (Panel C).Heterogeneity Analysis by Pollution Intensity
Source: Compiled by the author

Variables	Heavy (TFP)	Light (TFP)	Heavy (Carb)	Light (Carb)
Policy	-2.04	-7.66***	0.96	1.01*
	(-0.59)	(-2.67)	(1.04)	(1.78)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	6,028	14,835	6,028	14,835
R-squared	0.92	0.9	0.77	0.68

Note: The robust t-statistic in parentheses. *p<0.10, **p<0.05, ***p<0.01.

(4) Further Analysis: The Intertemporal Crowding-out Effect in Heavy-polluting Industries

It is noteworthy that while our previous results indicate that heavy-polluting firms exhibit a higher propensity for financialization under the low-carbon policy shock, a critical question remains: how does this resource allocation preference specifically erode their long-term competitiveness? To address this, we further examined the dynamic impact of financialization on substantive Green Investment within the heavy-polluting subsample.

Considering that large-scale environmental and technological upgrade projects in industrial firms typically involve extended planning and budget approval cycles, the displacement of real resources by financial assets often exhibits a time lag rather than occurring immediately. Therefore, we constructed regression models including both current and lagged terms. Panel D of Table 7 reports the detailed results. Columns (1) and (2) show that while the coefficients for current and one-year lagged financialization are negative, they are statistically insignificant. This suggests that the crowding-out effect is not immediate. However, Column (3) reveals that financialization lagged by two periods has a significant negative impact on green investment.

This trend—shifting from insignificant to significant—provides a robust confirmation of the existence of an "Intertemporal Crowding-out Effect." Specifically, excessive allocation to financial assets substantively cuts into the firm’s budget for green transformation after a lag of approximately two years. This cumulative deprivation of core real investment explains why these firms eventually fall into the "Competitiveness Trap" discussed earlier.

Table 7 (Panel D).The Intertemporal Crowding-out Effect in Heavy-polluting Industries
Source: Compiled by the author

Variables	Green Investment	Green Investment	Green Investment
	(1) Current	(2) Lag 1	(3) Lag 2
fint	-0.01		
	(-1.45)		
fin_{t-1}		-0.01	
		(-1.24)	
fin_{t-2}			-0.01*
			(-1.90)

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Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	6347	5728	5218
R-squared	0.37	0.37	0.39

Note: The robust t-statistic in parentheses. *p<0.10, **p<0.05, ***p<0.01.

4.5 Long-term Dynamics and Cumulative Competitiveness Loss

Existing literature often focuses on the average treatment effect of environmental regulations. However, identifying whether financialization creates a temporary shock or a permanent "lock-in" effect requires a dynamic perspective over an extended horizon. To address the concern that financialization might erode long-term competitive resilience, we adopt a heterogeneous event study approach to track the dynamic evolution of TFP for up to 10 years post-policy.

We stratify the sample into "High-Financialization" and "Low-Financialization" groups based on the median value of corporate financial asset holdings. Figure 5 plots the dynamic treatment effects for both groups. The results reveal a striking divergence in evolutionary paths. For the Low-Financialization group (blue line), the policy shock on TFP is relatively mild and exhibits signs of fluctuation without a precipitous decline. In stark contrast, the High-Financialization group (red line) experiences a persistent and deepening decline in TFP, with the negative gap widening significantly over time.

To quantify this impact, we apply the event study methodology to estimate the "Cumulative Competitiveness Loss" by summing the dynamic coefficients over the 10-year post-treatment window. The calculation is specified as $\mathrm{CumLoss} = \sum_{t=1}^{10} \beta_t$. The results show that by Year +10, the High-Financialization group experiences a cumulative TFP loss of 108.38, whereas the Low-Financialization group incurs a loss of 45.61. The cumulative loss for highly financialized firms is approximately 2.4-times that of their counterparts. This evidence provides robust support for the "Competitiveness Trap" hypothesis: excessive allocation of capital to financial assets acts as a mechanism that locks firms into a low-productivity trajectory, preventing long-term recovery under environmental regulation.

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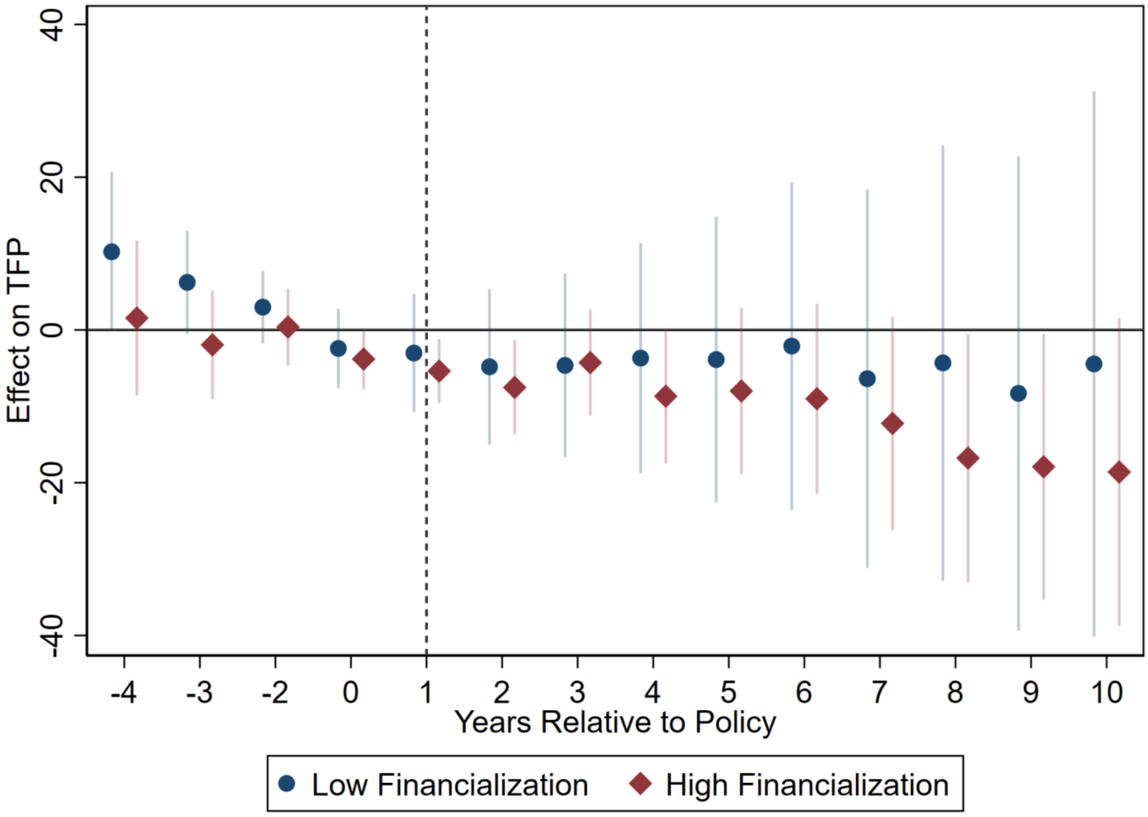

Figure 5.Dynamic Trajectories of Competitive Resilience: High vs. Low Financialization
Source: Compiled by the author

5 CONCLUSIONS

5.1 Main Research Conclusions

Leveraging the staggered introduction of the LCCP initiative across China as a quasi-exogenous setting, we investigate how these ecological mandates reshape intra-firm asset deployment and alter long-term organizational endurance. The empirical strategy relies on applying a multi-period Difference-in-Differences model to a longitudinal dataset capturing publicly quoted, non-financial corporations between 2003 and 2024. Following stringent diagnostics to rule out unobserved confounding factors and verify baseline stability, we document the ensuing principal outcomes.

First, environmental regulation significantly impacts the structure of corporate capital allocation, manifested as an intensified trend of "financialization." Empirical results indicate that the implementation of the LCCP policy leads to a significant increase in the proportion of financial assets held by firms in pilot cities. Mechanism analysis reveals that this structural adjustment is not merely a "reservoir effect" driven by abundant cash flow. Instead, it represents a strategic response driven by "profit-chasing" and "precautionary savings" motives under the dual pressures of rising compliance costs and declining profit margins in the main business. Firms tend to allocate capital to high-yield financial assets to smooth profit fluctuations, thereby mitigating the short-term financial shock of environmental regulations.

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Second, excessive financialization exerts a "dual effect" on competitive resilience and exhibits significant "resource crowding-out" characteristics. We constructed a dual-dimension evaluation framework comprising "Green Competitiveness" (measured by Carbon Productivity) and "Traditional Competitiveness" (measured by TFP). The findings show that while environmental regulation forces firms to improve Carbon Productivity—achieving a formal green transformation — it significantly suppresses TFP from the perspective of core competitiveness. Mediation analysis demonstrates that financial asset allocation plays a partial mediating role; firms excessively divert limited internal resources toward the financial sector, substantially crowding-out real investments in R&D and equipment upgrades, leading to a "hollowing out" of core technical capabilities.

Third, financialization leads firms into a long-term "Competitiveness Trap." Dynamic analysis based on a heterogeneous event study reveals a significant divergence in the long-term performance of firms with different levels of financial asset allocation. Low-financialization firms exhibit a "U-shaped" recovery in TFP after a brief period of regulatory pain, demonstrating significant competitive resilience. In contrast, high-financialization firms experience a continuous decline in TFP. Our calculations estimate that by Year 10 post-policy, the Cumulative Competitiveness Loss of high-financialization firms is approximately 2.4-times that of low-financialization firms. This finding provides robust confirmation that short-term financial hedging through financialization comes at the expense of long-term core competitiveness and sustainable development capabilities.

Fourth, the microeconomic consequences of environmental regulation exhibit significant structural divergence across firm endowments and industry attributes. Regarding ownership structure, the inhibitory effect of the low-carbon policy on TFP is primarily concentrated in Non-SOEs. Experiencing more stringent financing constraints, these private firms are more prone to shift capital from real to virtual sectors to smooth profits under the shock of compliance costs. In contrast, SOEs leverage soft budget constraints to effectively buffer resource reallocation pressures, and driven by greater social responsibilities, exhibit a more significant enhancement in green competitiveness. Furthermore, the negative productivity shock is notably concentrated in light-polluting enterprises. Operating predominantly in highly competitive markets with thin profit margins, these firms are highly sensitive to cost fluctuations induced by additional compliance burdens. Conversely, heavy-polluting firms demonstrate greater short-term rigidity against policy shocks owing to high asset specificity and industry barriers. Finally, and somewhat paradoxically, the erosion of traditional competitiveness is concentrated among active responders, namely firms possessing robust green technological endowments. As primary targets of environmental regulation, these first-movers are compelled to divert substantial productive resources toward substantive environmental compliance in the short term. This induces a pronounced Compliance Cost Effect, inducing a temporary but steep decline in productivity, whereas non-innovating firms often remain on the regulatory fringe and evade deep structural adjustments.

5.2 Policy and Managerial Implications

Based on the empirical findings, mitigating the shift from real to virtual sectors and fostering high-quality green transformation necessitates precision-guided interventions from both policymakers and corporate leaders. From a macroeconomic perspective, policymakers must transcend single-dimensional carbon reduction targets by establishing a dual-evaluation mechanism that simultaneously assesses emission performance and economic resilience. To

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address the pronounced Compliance Cost Effect borne by active responders, blanket penalties must be replaced with differentiated regulatory tools. Specifically, we recommend implementing tax credits strictly linked to real investment thresholds and substantive R&D expenditures, alongside tailored green financial regulations that penalize excessive financial arbitrage while rewarding genuine technological upgrading. Furthermore, regulatory authorities should closely monitor abnormal fluctuations in corporate asset allocation, potentially incorporating indicators such as the ratio of financial assets to substantive innovation expenditures within mandatory environmental, social, and governance disclosure frameworks. This approach directs capital market attention toward long-term core competitiveness rather than short-term financial smoothing.

Beyond macroeconomic design, our findings offer critical strategic guidance for corporate managers navigating the low-carbon transition, particularly regarding the theoretical distinction between short-term compliance and long-term resilience. Drawing upon the dynamic capability theory, managers must recognize that static responses—such as relying on the financialization shelter to smooth earnings or adopting superficial end-of-pipe treatments—are profoundly insufficient for sustained market leadership. While reallocating capital toward high-yield financial assets may temporarily buffer regulatory shocks, it inherently triggers an intertemporal crowding-out effect that gradually erodes core technical capabilities. Therefore, corporate leaders must cultivate dynamic capabilities to continuously reconfigure internal resources, establishing explicit internal investment boundaries to ensure that liquid assets function as a proactive reservoir for substantive innovation rather than a permanent substitute for real capital expenditures.

Furthermore, viewed through the lens of the RBV, environmental regulation should not be perceived merely as an exogenous constraint, but as a pivotal catalyst for accumulating unique strategic assets. Our evidence indicates that firms with robust green technological endowments suffer disproportionately from short-term productivity shocks. However, rather than abandoning environmental initiatives, managers should leverage these accumulated green patents and technical knowledge as rare and inimitable resources to construct a long-term competitive moat. By aligning short-term financial hedging strategies directly with long-term technological roadmaps, particularly within resource-constrained private enterprises and highly competitive light-polluting industries, managers can effectively transform initial compliance pain into a durable first-mover advantage. This strategic alignment ultimately enables firms to escape the competitiveness trap and achieve sustainable industrial leadership.

5.3 Limitations and Future Directions

Constrained by the research perspective and data availability, this study has the following limitations that merit further exploration. First, corporate competitiveness is an inherently multidimensional factorial space. This research primarily employs TFP and Carbon Productivity as core proxies for efficiency and green transformation. Future studies could expand this construct by incorporating a broader set of metrics, such as green patent citations, to assess innovation quality, as well as changes in market share and export competitiveness, to elucidate how environmental regulations reconfigure the competitive landscape.

Second, the complete causal chain from financialization to ultimate long-term performance warrants further investigation. Although we theoretically identify and empirically test the "competitiveness trap" through the mediation of financialization, data constraints prevented a

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formal, multi-stage longitudinal mediation analysis linking these factors directly to final financial performance. Future research could utilize dynamic structural models to further clarify the intertemporal dynamics of this mechanistic story.

Third, the distinction between "Substantive" and "Strategic" green innovation needs to be enhanced. While we distinguish between green and traditional competitiveness, limited by the granularity of patent data, we could not ascertain whether firms engaged in breakthrough underlying technological innovation or merely strategic "greenwashing" to cater to policies. Future research could combine patent text analysis and R&D personnel structure to identify the technological substance of corporate green transformation more precisely.

Fourth, the discussion on supply chain spillover effects and long-term rebalancing mechanisms remains insufficient. This study explores the internal capital allocation of regulated firms, but the financialization of core firms may generate a "Cascading Effect" through the supply chain. Future research could examine whether a "Financialization Threshold Effect" exists over an extended cycle and whether firms can repair damaged competitive resilience through subsequent asset-structure rebalancing. These discussions on non-linear relationships and dynamic repair mechanisms will contribute to a more comprehensive understanding of the long-term micro-consequences of environmental regulation.

References

1. Acemoglu, D., Aghion, P., Bursztyn, L., & Hemous, D. (2012). The environment and directed technical change. *American Economic Review*, 102(1), 131-166.https://doi.org/10.1257/aer.102.1.131
2. Aghion, P., Bergeaud, A., & Van Reenen, J. (2023). The impact of regulation on innovation. *American Economic Review*, 113(11), 2894-2936.https://doi.org/10.1257/aer.20210107
3. Aghion, P., Dechezlepretre, A., Hemous, D., Martin, R., & Van Reenen, J. (2016). Carbon taxes, path dependency, and directed technical change: Evidence from the auto industry. *Journal of Political Economy*, 124(1), 1-51.https://doi.org/10.1086/684581
4. Ai, M., Wang, P., & Bu, Y. (2025). Climate policy and inclusive green growth: The role of China's low-carbon city pilot policy. *Journal of Cleaner Production*, 519, 145959.https://doi.org/10.1016/j.jclepro.2025.145959
5. Almeida, H., Campello, M., & Weisbach, M. S. (2004). The cash flow sensitivity of cash. *The Journal of Finance*, 59(4), 1777-1804.https://doi.org/10.1111/j.1540-6261.2004.00679.x
6. Ambec, S., Cohen, M. A., Elgie, S., & Lanoie, P. (2013). The Porter hypothesis at 20: Can environmental regulation enhance innovation and competitiveness? *Review of Environmental Economics and Policy*, 7(1), 2-22.https://doi.org/10.1093/reep/res016
7. Arshad, Z., Madaleno, M., Lillebø, A. I., & Vieira, H. (2025). Decoding sustainable growth: The role of digital technology and entrepreneurship in carbon reduction. *Sustainable Technology and Entrepreneurship*, 4(1), 100094. https://doi.org/10.1016/j.stae.2024.100094
8. Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, 17(1), 99-120https://doi.org/10.1177/014920639101700108

https://doi.org/10.7441/joc.2026.02.09

9. Beck, T., Levine, R., & Levkov, A. (2010). Big bad banks? The winners and losers from bank deregulation in the United States. *The Journal of Finance*, 65(5), 1637-1667.https://doi.org/10.1111/j.1540-6261.2010.01589.x

10. Bernard, A. B., Jensen, J. B., Redding, S. J., & Schott, P. K. (2007). Firms in international trade. *Journal of Economic Perspectives*, 21(3), 105-130.https://doi.org/10.1257/jep.21.3.105

11. Bloom, N. (2009). The impact of uncertainty shocks. *Econometrica*, 77(3), 623-685. https://doi.org/10.3982/ECTA6248

12. Blundell, R., & Bond, S. (2000). GMM estimation with persistent panel data: An application to production functions. *Econometric Reviews*, 19(3), 321-340.https://doi.org/10.1080/07474930008800475

13. Bolton, P., & Kacperczyk, M. (2021). Do investors care about carbon risk? *Journal of Financial Economics*, 142(2), 517-549.https://doi.org/10.1016/j.jfineco.2021.05.008

14. Bolton, P., & Kacperczyk, M. (2023). Global pricing of carbon-transition risk. *The Journal of Finance*, 78(6), 3677-3754.https://doi.org/10.1111/jofi.13272

15. Bolton, P., Reichelstein, S. J., Kacperczyk, M. T., Leuz, C., Ormazabal, G., & Schoenmaker, D. (2021). Mandatory corporate carbon disclosures and the path to net zero. *Management and Business Review*, 1(3), 21-28.https://doi.org/10.1177/2694105820210103003

16. Bradley, D., Pantzalis, C., & Yuan, X. (2016). Policy risk, corporate political strategies, and the cost of debt. *Journal of Corporate Finance*, 40, 254-275.https://doi.org/10.1016/j.jcorpfin.2016.08.001

17. Chen, N., Hu, Y., & Wang, L. (2025). Enhancing enterprises' green and low-carbon innovation through digital technology embeddedness: From passive response to active innovation. *Journal of Innovation & Knowledge*, 10(5), 100801. https://10.1016/j.jik.2025.100801

18. Cheng, B., Ioannou, I., & Serafeim, G. (2014). Corporate social responsibility and access to finance. *Strategic Management Journal*, 35(1), 1-23.https://doi.org/10.1002/smj.2131

19. Chetty, R., Looney, A., & Kroft, K. (2009). Salience and taxation: Theory and evidence. *American Economic Review*, 99(4), 1145-1177.https://doi.org/10.1257/aer.99.4.1145

20. Demir, F. (2009). Financial liberalization, private investment and portfolio choice: Financialization of real sectors in emerging markets. *Journal of Development Economics*, 88(2), 314-324.https://doi.org/10.1016/j.jdeveco.2008.04.002

21. Duchin, R., Gilbert, T., Harford, J., & Hrdlicka, C. (2017). Precautionary savings with risky assets: When cash is not cash. *The Journal of Finance*, 72(2), 793-852.https://doi.org/10.1111/jofi.12490

22. Enri-Peiró, S., González-Arroyo, G., & Guijarro-García, M. (2025). The role of digital transformation as a key driver of competitiveness in small and medium-sized enterprises. *ESIC Market*, 56(3), e423. https://doi.org/10.7200/esicm.56.423

23. Feng, Y., Meng, M., & Li, G. (2023). Impact of digital finance on the asset allocation of small- and medium-sized enterprises in China: Mediating role of financing constraints. *Journal of Innovation & Knowledge*, 8(3), 100405.https://doi.org/10.1016/j.jik.2023.100405

https://doi.org/10.7441/joc.2026.02.09

24. Fernandez-Villaverde, J., Guerron-Quintana, P., Kuester, K., & Rubio-Ramirez, J. (2015). Fiscal volatility shocks and economic activity. *American Economic Review*, 105(11), 3352-3384.https://doi.org/10.1257/aer.20121236

25. Ferreira, L., Torres, P., & Augusto, M. (2025). The moderating effect of power distance on the relationship between CEO career horizon and ESG performance. *Sustainable Technology and Entrepreneurship*, 4(3), 100107. https://doi.org/10.1016/j.stae.2025.100107

26. Gamba, A., & Triantis, A. (2008). The value of financial flexibility. *The Journal of Finance*, 63(5), 2263-2296.https://doi.org/10.1111/j.1540-6261.2008.01397.x

27. Gilchrist, S., Sim, J. W., & Zakrajsek, E. (2014). Uncertainty, financial frictions, and investment dynamics (NBER Working Paper No. 20038). *National Bureau of Economic Research*.https://doi.org/10.3386/w20038

28. Greenstone, M., List, J. A., & Syverson, C. (2012). The effects of environmental regulation on the competitiveness of U.S. manufacturing (NBER Working Paper No. 18392). *National Bureau of Economic Research*.https://doi.org/10.3386/w18392

29. Gulen, H., & Ion, M. (2016). Policy uncertainty and corporate investment. *The Review of Financial Studies*, 29(3), 523-564.https://doi.org/10.1093/rfs/hhv050

30. Hadlock, C. J., & Pierce, J. R. (2010). New evidence on measuring financial constraints: Moving beyond the KZ index. *The Review of Financial Studies*, 23(5), 1909-1940.https://doi.org/10.1093/rfs/hhq009

31. He, G., Wang, S., & Zhang, B. (2020). Watering down environmental regulation in China. *The Quarterly Journal of Economics*, 135(4), 2135-2185.https://doi.org/10.1093/qje/qjaa024

32. He, S., Xu, S., & Zou, A. X. (2025). Does green technological diversification impact industrial carbon emissions efficiency? The role of technological specialisation. *Journal of Innovation & Knowledge*, 10(3), 100730. https://10.1016/j.jik.2025.100730

33. Heinkel, R., Kraus, A., & Zechner, J. (2001). The effect of green investment on corporate behavior. *Journal of Financial and Quantitative Analysis*, 36(4), 431-449.https://doi.org/10.2307/2676219

34. Hsieh, C.-T., & Klenow, P. J. (2009). Misallocation and manufacturing TFP in China and India. *The Quarterly Journal of Economics*, 124(4), 1403-1448.https://doi.org/10.1162/qjec.2009.124.4.1403

35. Jaffe, A. B., Peterson, S. R., Portney, P. R., & Stavins, R. N. (1995). Environmental regulation and the competitiveness of US manufacturing: what does the evidence tell us? *Journal of Economic literature*, 33(1), 132-163. https://www.jstor.org/stable/2728912

36. Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, 3(4), 305-360.https://doi.org/10.1016/0304-405X(76)90026-X

37. Kim, H., & Kung, H. (2017). The asset redeployability channel: How uncertainty affects corporate investment. *The Review of Financial Studies*, 30(1), 245-280.https://doi.org/10.1093/rfs/hhv076

38. Krippner, G. R. (2005). The financialization of the American economy. *Socio-Economic Review*, 3(2), 173-208.https://doi.org/10.1093/ser/mwi008

39. Levinsohn, J., & Petrin, A. (2003). Estimating production functions using inputs to control for unobservables. *The Review of Economic Studies*, 70(2), 317-341.https://doi.org/10.1111/1467-937X.00246

40. Li, J., Fang, L., Chen, S., & Mao, H. (2022). Can low-carbon pilot policy improve atmospheric environmental performance in China? A quasi-natural experiment approach. *Environmental Impact Assessment Review*, 96, 106807.https://doi.org/10.1016/j.eiar.2022.106807

41. Liu, X., & Xu, H. (2022). Does low-carbon pilot city policy induce low-carbon choices in residents' living: Holistic and single dual perspective. *Journal of Environmental Management*, 324, 116353.https://doi.org/10.1016/j.jenvman.2022.116353

42. Mebrek, N., & Louail, B. (2025). Foreign direct investment, technology transfer and carbon emissions in MENA countries: economic drivers and environmental consequences (1990-2022). *ESIC Market*, 56(2), e410. https://doi.org/10.7200/esicm.56.410

43. Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica*, 71(6), 1695-1725.https://doi.org/10.1111/1468-0262.00467

44. Olley, G. S., & Pakes, A. (1996). The dynamics of productivity in the telecommunications equipment industry. *Econometrica*, 64(6), 1263-1297.https://doi.org/10.2307/2171831

45. Orhangazi, O. (2008). Financialisation and capital accumulation in the non-financial corporate sector: A theoretical and empirical investigation on the U.S. economy: 1973-2003. *Cambridge Journal of Economics*, 32(6), 863-886.https://doi.org/10.1093/cje/ben009

46. Porter, M. E., & van der Linde, C. (1995). Toward a new conception of the environment-competitiveness relationship. *Journal of Economic Perspectives*, 9(4), 97-118.https://doi.org/10.1257/jep.9.4.97

47. Rosenbaum, P. R., & Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika*, 70(1), 41-55.https://doi.org/10.1093/biomet/70.1.41

48. Salvia, M., Reckien, D., Pietrapertosa, F., Eckersley, P., Spyridaki, N.-A., Krook-Riekkola, A., Olazabal, M., De Gregorio Hurtado, S., Simoes, S. G., Geneletti, D., Viguié, V., Fokaides, P. A., Ioannou, B. I., Flamos, A., Csete, M. S., Buzasi, A., Orru, H., de Boer, C., Foley, A., ... Heidrich, O. (2021). Will climate mitigation ambitions lead to carbon neutrality? An analysis of the local-level plans of 327 cities in the EU. *Renewable and Sustainable Energy Reviews*, 135, 110253.https://doi.org/10.1016/j.rser.2020.110253

49. Steffen, W., Rockstrom, J., Richardson, K., Lenton, T. M., Folke, C., Liverman, D., Summerhayes, C. P., Barnosky, A. D., Cornell, S. E., Crucifix, M., Donges, J. F., Fetzer, I., Lade, S. J., Scheffer, M., Winkelmann, R., & Schellnhuber, H. J. (2018). Trajectories of the Earth system in the Anthropocene. *Proceedings of the National Academy of Sciences of the United States of America*, 115(33), 8252-8259.https://doi.org/10.1073/pnas.1810141115

https://doi.org/10.7441/joc.2026.02.09

50. Stulz, R. M. (2022). Rethinking risk management. *Journal of Applied Corporate Finance*, 9(3), 8 -25.https://doi.org/10.1111/jacf.12486
51. Tobin, J. (1965). Money and economic growth. *Econometrica*, 33(4), 671-684.https://doi.org/10.2307/1910352
52. Wang, Y., Chen, C. R., & Huang, Y. S. (2014). Economic policy uncertainty and corporate investment: Evidence from China. *Pacific-Basin Finance Journal*, 26, 227-243.https://doi.org/10.1016/j.pacfin.2013.12.008
53. Wen, S., Jia, Z., & Chen, X. (2022). Can low-carbon city pilot policies significantly improve carbon emission efficiency? Empirical evidence from China. *Journal of Cleaner Production*, 346, 131131.https://doi.org/10.1016/j.jclepro.2022.131131
54. Yang, S., Jahanger, A., & Hossain, M. R. (2023). How effective has the low-carbon city pilot policy been as an environmental intervention in curbing pollution? Evidence from Chinese industrial enterprises. *Energy Economics*, 118, 106523.https://doi.org/10.1016/j.eneco.2023.106523
55. Zhang, S., Wang, Y., Hao, Y., & Liu, Z. (2021). Shooting two hawks with one arrow: Could China's emission trading scheme promote green development efficiency and regional carbon equality? *Energy Economics*, 101, 105412.https://doi.org/10.1016/j.eneco.2021.105412
56. Zhao, S., Zhang, L., An, H., Peng, L., Zhou, H., & Hu, F. (2023). Has China's low-carbon strategy pushed forward the digital transformation of manufacturing enterprises? Evidence from the low-carbon city pilot policy. *Environmental Impact Assessment Review*, 102, 107184.https://doi.org/10.1016/j.eiar.2023.107184
57. Zhou, Q., Cui, X., Ni, H., & Gong, L. (2022). The impact of environmental regulation policy on firms' energy-saving behavior: A quasi-natural experiment based on China's low-carbon pilot city policy. *Resources Policy*, 76, 102538.https://doi.org/10.1016/j.resourpol.2021.102538

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