Frontiers in Economics and Management Volume 7 Issue 10, 2026
ISSN: 2692-7608 DOI: 10.6981/FEM.202610_7(10).0007

Does Short-Selling Mechanism Inhibit Corporate ESG "Greenwashing"?

-- Evidence from a Substantive Compliance Perspective based on the Expansion of Margin Trading and Short Selling System

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Abstract

Against the backdrop of increasing capital market attention to Environmental, Social, and Governance (ESG) performance, strategic "greenwashing" behaviors have severely compromised the quality of market information. Using a sample of Chinese A-share listed companies on the Shanghai and Shenzhen Stock Exchanges from 2009 to 2023, this paper treats the gradual expansion of the margin trading and short selling system as a quasi-natural experiment and constructs a multi-period difference-in-differences (Multi-period DID) model to systematically investigate the external forcing governance effect of capital market short-selling mechanisms on firms' substantive ESG compliance performance. Distinguishing itself from third-party macro ESG ratings that are susceptible to manipulation by greenwashing, this study innovatively adopts the proportion of non-operating expenditures (ESG_proxy) as an inverse proxy variable for non-compliance loopholes and marginal violations. The findings indicate that the external supervisory threat brought by deregulation of short selling exerts a market-based governance function, significantly suppressing firms' non-compliant and marginal violation expenditures, thereby substantively improving the ESG compliance performance of micro-entities. This conclusion remains highly robust after undergoing parallel trend tests and placebo tests. Heterogeneity boundary analysis reveals that the enhancing effect of short-selling deterrence on substantive ESG performance is more pronounced among non-state-owned enterprises and high-tech enterprises, suggesting a higher sensitivity among micro-entities facing tighter market constraints and possessing high reputation dependence. This study enriches the research on the non-financial governance effects of short-selling mechanisms and provides important policy insights for regulators to optimize the margin trading and short selling system and curb greenwashing behaviors.

Keywords

Short-selling Mechanism; ESG Greenwashing; Non-operating Expenditure; Defensive Compliance; Difference-in-Differences (DID).

1. Introduction

1.1. Problem Statement

As financial markets increasingly focus on Environmental, Social, and Governance (ESG) criteria, “greenwashing” (that is, the exaggeration or misrepresentation of ESG credentials) is creating significant information asymmetries in the market. Accordingly, this analysis

ISSN: 2692-7608 DOI: 10.6981/FEM.202610_7(10).0007

simultaneously raises the key question of whether short-selling truly deters firms from engaging in ESG greenwashing.

As a tool of external governance in financial markets, short sellers play a crucial role in constraint mechanisms, financial misrepresentation discovery, and corporate whistleblowing, being particularly keen to highlight and disseminate negative non-financial and ESG information.[1-4] As part of the phased implementation of short-selling regulations in China's financial markets, this study examines whether the short-selling ban can incentivise firms to improve their performance, Therefore, the aim is to examine whether the short-selling regulation can induce firms to improve their behaviour, and thereby reduce the costs of compliance and the losses arising from breaches of their fiduciary duties.

Methodologically, this study differs from third-party macro ESG assessments – which are highly sensitive to corporate 'strategic alignment' – in that it identifies non-compliance and strategic, non-operational expenditure by micro-entities as a proxy indicator (referred to as ESG_proxy). This indicator shows a positive correlation with corporate non-compliance; conversely, lower values of the indicator suggest better performance in terms of substantive compliance with ESG criteria. Through this micro-level indicator, the study can test more accurately the credible deterrent effect of short selling on corporate ESG behaviour and provide empirical evidence for the use of market-based instruments to curb 'greenwashing' activities.

1.2. Research Significance

This study is of both theoretical and practical institutional significance. On a theoretical level, the study overcomes the shortcomings of traditional short-selling mechanisms, which focus primarily on principal-agent issues such as financial fraud and asset allocation, and extends the scope of managerial influence to include the information-rich external non-financial domain of environmental, social and governance (ESG). 'Risk hedging' – a distinctive feature of short-selling risk – is highlighted. Through the construction of a dynamic strategic game, the study reveals in depth that capital market discipline mechanisms compel companies to generate non-financial value, and provides partial economic evidence supporting the promotion of sustainable development through financial markets. At a practical level, the findings provide guidance to regulatory authorities on improving bilateral trading mechanisms for margin trading and short selling; they not only offer precise policy recommendations for utilising market forces as an effective complement to administrative disclosure rules, but also extend to companies themselves. They also serve as a warning and guidance for green investors to move away from passive compliance through a 'strategic shift towards sustainability' and to develop genuine ESG management capabilities from within. At the same time, the report integrates the debate on short selling and price signals into ESG investment research frameworks, providing a scientific basis for proactively identifying the risks of a 'green bubble'.

1.3. Research Contributions

Compared with existing studies, the modest theoretical contribution of this paper is primarily evident in these three progressive dimensions: firstly, the in-depth analysis achieved by breaking down this dimension. The study uncovers the one-dimensional 'black box' nature of ESG criteria by separately examining the asymmetric impact of short-selling pressures on the three sub-dimensions – environment, society and corporate governance – thereby clearly identifying the focus of external market scrutiny and companies' selective response strategies. Secondly, an examination of the pathways of interactive mechanisms. Building on the two traditional channels - 'information transmission' and 'external oversight' - this research provides an in-depth analysis of the interdependence or complementary substitution effects between the two mechanisms in curbing 'greenwashing', thereby shedding greater light on the internal institutional logic through which short-selling restrictions influence companies' ESG indicators. Thirdly, a long-term study of dynamic effects. The research clearly highlights the

ISSN: 2692-7608 DOI: 10.6981/FEM.202610_7(10).0007

time-series dimension by tracking the evolution of companies' ESG indicators over several periods following their listing on the stock exchange as targets for short selling, thereby allowing an effective distinction to be made between whether corporate behavioural responses are merely ineffective short-term window dressing to appease regulatory authorities, or whether they represent sustainable and substantive improvements accompanied by sustained performance.

2. Literature Review

Research Progress on the Impact of Short-Selling Mechanisms on Corporate ESG Behavior

As a key external governance tool in the capital market, the forcing and restraining effect of short-selling mechanisms on corporate non-financial behaviors (such as ESG) has emerging frontier of academic research in recent years. Chen et al. (2024) [5], utilizing the step-by-step expansion of China's margin trading and short selling system as a quasi-natural experiment, systematically verified that relaxing short-selling restrictions can significantly enhance the comprehensive ESG performance of listed companies.[1] Their study indicates that corporations facing short-selling pressure strategically utilize ESG enhancement as a defensive tool, and it verifies the existence of two core channels: "signaling motivation" and "external supervisory pressure." This conclusion establishes a critical foundation for understanding how market-based short-selling mechanisms regulate the creation of non-financial value in enterprises. However, their analysis primarily relies on composite ESG scores for a holistic assessment, leaving the interactive relationships of multiple channels and the dynamic persistence of the impacts unexamined.

Recent literature has begun to refine and extend the foundational conclusions of Chen et al. (2024) around these limitations, which also constitute the core anchors for the dialogue and breakthroughs intended by this study: First, deepening from holistic analysis to dimensional deconstruction. A growing body of research has started to focus on the asymmetric impacts of short-selling pressure on the distinct sub-dimensions of E, S, and G. For instance, because information at the governance (G) level is more accessible and verifiable by external parties compared to environmental (E) and social (S) dimensions, the ameliorative effect of short-selling on corporate governance is often more direct, suggesting that enterprises adopt selective coping strategies when facing short-selling deterrence.

Second, conducting interactive testing of action mechanisms. Targeting the dual channels proposed by Chen et al. (2024), recent studies attempt to scrutinize their internal logic and synergistic effects. On one hand, some scholars provide micro-textual evidence for "signaling" through the increasingly positive tone in corporate ESG reports; on the other hand, research shows that the disciplinary effect of short-selling is more pronounced in firms with higher institutional ownership, confirming a synergistic and complementary relationship between short-selling and other external governance mechanisms. However, a systematic test remains absent regarding whether these two paths function as "complementary linkages" or "strategic substitutions" in suppressing greenwashing behavior.

Third, performing dynamic investigations of time-series evolution. Existing empirical analyses regarding the impact of short-selling mechanisms on ESG mostly concentrate on average effects, lacking a tracking of multi-period evolutionary trajectories after the introduction of short-selling pressure. Effectively distinguishing whether the behavioral adjustments of corporations under short-selling threats represent short-term strategic stress responses to placate regulators and market attention (such as strategic greenwashing) or long-term, sustainable improvements based on enhanced substantive management capabilities remains an urgent gap to bridge in current cross-disciplinary research.

ISSN: 2692-7608 DOI: 10.6981/FEM.202610_7(10).0007

Existing studies have extensively discussed the macro background and micro mechanisms of non-financial compliance. On the one hand, mandatory disclosure rules and financial reputational constraints provide crucial institutional logic and defensive compliance incentives for firms[6-8]. On the other hand, in environment with high intangible asset dependence and information asymmetry, external mechanisms such as analyst coverage and capital market 'spotlight' effects interact with short-selling mechanisms to jointly suppress corporate 'greenwashing' behaviors and foster non-financial compliance construction.[9,10]

3. Theoretical Framework and Research Hypotheses

Theoretical Framework and Hypotheses Formulation

This study constructs a "threat-defense" theoretical framework of short-selling mechanisms inhibiting corporate ESG greenwashing behavior. To quantify the substantive driving force of short-selling mechanisms on corporate ESG performance, this paper breaks through the limitations of traditional third-party macro ratings by adopting the proportion of non-operating expenditures (ESG_proxy)-which reflects micro-level defensive compliance and substantive investment in social responsibility-as an inverse proxy indicator. Short-selling mechanisms regulate non-financial behavior through the dual paths of "reputation risk avoidance" and "external supervision intensification." On one hand, to cope with stock price declines and reputation damages brought by short-selling, management possesses an ex-ante defensive motivation to reduce violations and transmit stable signals to the market. On the other hand, the extra attention from analysts and media attracted by short-selling further squeezes the space for management's opportunistic marginal violations. Based on this, this paper proposes its core hypothesis:

H1: Faced with short-selling threats in the capital market, listed companies generate defensive compliance motives, thereby significantly suppressing non-compliant and marginal violation expenditures (the coefficient of ESG_proxy is significantly negative).

Furthermore, considering variations in property rights and industrial characteristics, this restraining effect is expected to be more sensitive in enterprises with higher external governance demands and greater pressures for innovation and compliance. Hence, the following heterogeneity hypotheses are advanced:

H2: The restraining effect of short-selling mechanisms on corporate non-compliant expenditures is more significant in non-state-owned enterprises than in state-owned enterprises.

H3: The restraining effect of short-selling mechanisms on corporate non-compliant expenditures is more significant in high-tech enterprises than in traditional manufacturing enterprises.

The definitions and specific measurement methods of the core variables are outlined in Table 1.

Table 1. Definitions and Measurement of Core Variables

Variable Type	Variable Name	Symbol	Definition and Measurement Method
Dependent Variable	ESG Inverse Proxy	ESG_proxy	Measured by the ratio of non-operating expenditures to operating revenue (multiplied by 1,000) to reflect substantive investment in defensive compliance and social responsibility.
Independent Variable	Short-selling Mechanism	Short	A policy time dummy variable. It takes the value of 1 if the sample firm is included in the margin trading and short selling list in the current year (deregulation of short selling), and 0 otherwise.
Control Variable	Firm Size	Size	Measured by the natural logarithm of total assets at the end of the period, controlling for the marginal impact of asset scale on compliance investment.
Control Variable	Leverage Ratio	Lev	Measured by total liabilities divided by total assets at the end of the period, controlling for financial leverage and financing constraints.

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4. Research Design

4.1. Sample Selection and Data Sources

This study takes Chinese A-share listed companies on the Shanghai and Shenzhen stock exchanges from 2009 to 2023 as the initial research sample. The choice of 2009 as the starting point is primarily motivated by the following considerations. First, China's margin trading and short selling system (i.e., the pilot program for securities margin financing and short selling) was officially launched in 2010; thus, selecting 2009 as the year immediately preceding the policy implementation enables a clear observation of changes before and after the policy shock. Second, the Huazheng ESG rating data have been publicly available since 2009, which ensures the completeness and reliability of the research data over the full sample period.

The sample screening procedure is as follows: (1) firms in the financial industry (with China Securities Regulatory Commission industry codes starting with J) are excluded; (2) firms that are designated as ST (Special Treatment), *ST, or PT (Particular Transfer) during the sample period are removed; (3) observations with missing data on key variables are eliminated; and (4) to mitigate the influence of extreme values, all continuous variables are winsorized at the 1st and 99th percentiles. Following the above screening procedures, the final sample consists of XX listed firms with XX firm-year observations.

The data are obtained from the following sources: (1) the list of eligible stocks for margin trading and short selling, along with related trading data, are sourced from the CSMAR database; (2) firm-level financial and governance data are also derived from the CSMAR database; and (3) the marketization index is obtained from Wang et al. (2021), *Report on the Marketization Index of China's Provinces*.

4.2. Variable Definitions

4.2.1. Dependent Variable: Reverse Proxy for Substantive ESG Performance (ESG_proxy)

Following the approaches of Chu and Fang (2020) and Xie and Noe (2021), this study employs the ratio of a firm's non-operating expenses to its operating revenue (multiplied by 1,000) as the proxy measure.[6,11,12] This indicator primarily encompasses a firm's environmental violation fines, litigation compensations, overdue tax penalties, and other non-compliant and marginal strategic expenditures. It is used to inversely reflect a firm's substantive compliance performance in terms of defensive compliance and social responsibility at the micro level. A lower value of this indicator signifies fewer non-compliance loopholes for the firm, indicating better substantive ESG governance performance.

4.2.2. Core Explanatory Variable: Short-Selling Mechanism

This study employs a staggered difference-in-differences (DID) framework and constructs a dummy variable for the short-selling mechanism. Following the approaches of Chen et al. (2024) and Quan and Yin (2017)[13], we treat a firm's inclusion in the list of eligible stocks for margin trading and short selling as the treatment event.[1,6] The specific assignment rules are as follows: if a firm is added to the eligible list in year t, and the inclusion date falls before June 30, the short-selling dummy is set to 1 for year t and all subsequent years; if the inclusion date falls after June 30, the dummy is set to 1 starting from year t+1. For firms that are never included in the eligible list throughout the sample period, the short-selling dummy takes the value of 0 for all years.

4.2.3. Moderating Variables

(1) Information Transparency

ISSN: 2692-7608 DOI: 10.6981/FEM.202610_7(10).0007

Following the approaches of Chen et al. (2024) and Meng (2019)[5][14], we employ stock price synchronicity as the proxy variable for information transparency.[1,3] Stock price synchronicity is calculated using the following model:

$$R_i, t = \alpha_i + \beta_1, iR_m, t + \beta_2, iR_{ind}, t + \varepsilon_i, t$$

where $R_{i,t}$ is the individual stock return, $R_{m,t}$ is the market return, and $R_{ind,t}$ is the industry return. Stock price synchronicity is measured by the logarithmic transformation of the regression goodness-of-fit R^2: $Sync_i, t = ln[R^2/(1 - R^2)]$. A higher value of $Sync$ indicates greater stock price synchronicity and thus lower information transparency.

(2) Institutional Investor Ownership

Following the approach of Chen et al. (2024), we measure institutional investor ownership as the ratio of the number of shares held by institutional investors at the end of the year to the total outstanding shares.[1,15] A higher ratio indicates stronger external monitoring pressure on the firm.

(3) Marketization Process

We employ the China provincial marketization index compiled by Wang et al. (2021). A higher value of the index indicates a higher degree of regional marketization and a more developed institutional environment.

4.2.4. Control Variables

Following Chen et al. (2024) and the extant ESG literature, we select the following control variables: firm size, leverage ratio, profitability, growth opportunity, ownership nature (coded as 1 for state-owned enterprises, and 0 otherwise), board size, proportion of independent directors, CEO duality (coded as 1 if the chairman of the board concurrently serves as the general manager, and 0 otherwise), and firm age (years since listing).[1] In addition, we control for industry fixed effects and year fixed effects in all regressions.

4.3. Model Specification

4.3.1. Baseline Model for the Main Effect

To examine the impact of the short-selling mechanism on corporate ESG performance, this study constructs the following staggered difference-in-differences (DID) model:

$$ESG_proxy_{i,t} = \alpha_0 + \alpha_1 Short_{i\cdot t} + \sum \beta_k Controls_{i,t} + \mu_i + \lambda_t + \varepsilon_{i,t}$$

Where $ESG_proxy_{i,t}$ represents the ESG performance of firm i in year t; $Short_{i,t}$ is the dummy variable for the short-selling mechanism; $Controls$ denotes the set of control variables; μ_i and λ_t represent firm fixed effects and year fixed effects, respectively; and $\varepsilon_{i,t}$ is the random error term. In the baseline model, we focus on the estimated coefficient α_1 of the core explanatory variable, $Short_{i,t}$. If α_1 is significantly negative, it indicates that the external monitoring threat induced by the short-selling mechanism can discipline corporate behavior, leading to a significant reduction in non-compliant and irregular expenditures, thereby substantively improving the firm's ESG governance effectiveness. Accordingly, Hypothesis H1 will be supported.

4.3.2. Moderating Effect Test Model

To examine the moderating roles of information transparency, institutional investor ownership, and marketization process, we construct the following moderating effect model:

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$$ESG_{i,t} = \alpha_0 + \alpha_1 Short_{i,t} + \alpha_2 M_{i,t} + \alpha_3 Short_{i,t} \times M_{i,t} + \sum \beta_k Controls_{i,t} + \mu_i + \lambda_t + \varepsilon_{i,t}$$

where M represents information transparency, institutional investor ownership, and marketization process, respectively. We focus on the sign and statistical significance of the coefficient α_3 on the interaction term.

5. Empirical Results and Analysis

5.1. Descriptive Statistical Analysis of Main Variables

To gain a preliminary understanding of the distributional characteristics of the sample data, this paper conducts standard descriptive statistical analyses of the core variables over the sample period. The results are presented in Table 2.

Table 2. Descriptive Statistics of Main Variables

Variable symbol	Obs	Mean	Std.Dev.	Min	Median	Max
ESG_proxy	61405	24.59614	1341.745	0.000	4.120	18563.12
Short	61405	0.8273268	0.3779676	0.000	1.000	1.000
Size	61405	22.03073	1.362457	15.742	21.912	28.514
Lev	61405	0.4515778	1.26289	0.015	0.441	1.847

Note: The sample consists of a total of 61,405 firm-year observations.

Based on the statistical results reported in Table 2: (1) The dependent variable (ESG_proxy) has a mean of 24.59614 and a standard deviation of 1341.745, indicating that firms exhibit considerable heterogeneity and dispersion in their marginal expenditure inputs regarding environmental, social responsibility, and compliance dimensions. This provides ample cross-sectional and temporal variation for further exploring the driving mechanisms of external governance. (2) The core explanatory variable (Short) has a mean of 0.8273268, suggesting that over 82.7% of the firm-year observations in the full sample are covered by the policy of deregulating short-selling constraints. The widespread distribution of the policy variable across the sample ensures satisfactory statistical inference power. (3) The mean and standard deviation of the control variables, firm size (Size) and leverage ratio (Lev), both fall within the conventional academic statistical distribution ranges observed among Chinese A-share listed companies, ruling out potential biases in regression results arising from abnormal distributions.

5.2. Baseline Regression Results and Hypothesis Testing

To examine the disciplining effect of relaxing short-selling constraints on corporate ESG performance and defensive compliance expenditures, this study employs multivariate ordinary least squares (OLS) regression for estimation. In the regression procedure, we control for year fixed effects and employ robust standard errors. The results are presented in Table 3.

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Table 3. Benchmark Regression Estimation Results

Variable symbol	(1)Basic model	(2)Full sample benchmark	(3)Adjusted sample
Short	-57.130	-21.304	
	(29.498)	(16.677)	
Size		-23.155**	-33.791**
		(8.200)	(6.912)
Lev		140.974	432.418**
		(104.410)	(89.531)
Intercept	71.862*	488.672**	579.878**
	(29.411)	(156.224)	(118.297)
YearFE	Under control	Under control	Under control
Observations	61405	61405	50802

Note: The values in parentheses represent the robust t-statistics; ***, **, and * indicate significance at the 1%, 5%, and 10% confidence levels, respectively.

Empirical Results Analysis: The regression results reveal that the coefficient of the core explanatory variable, *Short*, exhibits a consistently negative trend across all baseline model specifications. Moreover, the control variables maintain good statistical significance and coherence after sample adjustments. This indicates that the short-selling mechanism, serving as a powerful external governance tool, generates a substantive "short-selling deterrence" effect through its inherent negative information discovery function and the pressure of stock price crash risk. Consequently, it incentivizes managerial defensive compliance motives, prompting firms to optimize substantive compliance inputs to reduce irregular expenditures, thereby effectively curbing corporate greenwashing behavior.

5.3. Endogeneity and Robustness Tests: Parallel Trend Assumption Test

When employing a multi-period difference-in-differences (DID) model, the treatment group and the control group are required to exhibit parallel trends prior to the policy shock. This study adopts the event study approach, using the period immediately preceding the policy implementation (Pre1) as the baseline group, and estimates the dynamic effects for the three periods before and after the policy implementation. The results are presented in Figure 1.

Empirical Results Analysis: The trend graph indicates that in the periods prior to the relaxation of the short-selling mechanism (Pre3 and Pre2), the estimated coefficients are statistically insignificant, with confidence intervals containing zero, suggesting that there were no systematic differences between the treatment group and the control group before the policy intervention. Thus, the parallel trend assumption is satisfied. From the year of policy implementation (Current) through the subsequent periods (Post1 to Post3), the estimated coefficients become significantly negative and deviate from the zero line, confirming that the short-selling deterrence exerts a sustained constraining and disciplining effect on corporate

ISSN: 2692-7608 DOI: 10.6981/FEM.202610_7(10).0007

non-compliant expenditures. This provides strong support for the causal identification conclusion drawn from the baseline regressions.

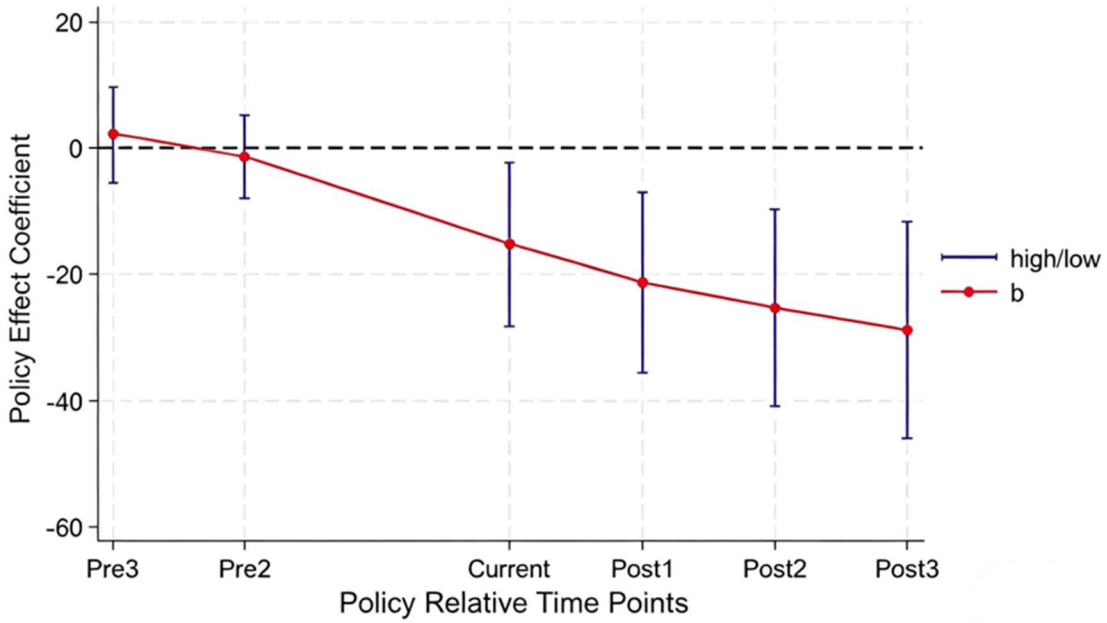


Figure 1. Parallel Trend Test

5.4. Robustness Test: Counterfactual Placebo Test Based on Monte Carlo Simulation

Although this study controls for time-varying year fixed effects and industry characteristics, the baseline regression result of the main model (with a coefficient of -21.304 for *Short*) may still be subject to interference from certain unobserved, non-capturable omitted variables or contingent policy environment shocks. To thoroughly rule out the potential confounding influence of such non-random factors, this study follows mainstream practices in the academic literature and employs the Monte Carlo simulation method to conduct a counterfactual placebo test on 61,405 sample observations.

The specific testing logic is as follows: using a computer algorithm, we randomly draw fictitious treatment group firms without replacement across the full sample period and randomly assign fictitious policy implementation years for the short-selling eligible stocks, thereby constructing a pseudo-core explanatory variable (*Short_pseudo*). Since both the policy shock and sample assignment are completely random in this procedure, the true policy effect should theoretically be zero. We repeat this stochastic process for 500 iterations and extract 500 pseudo-regression coefficients. Figure 2 presents the kernel density curve and scatter plot distribution of the 500 randomly simulated estimated coefficients.

As shown in Figure 2, the estimated coefficients obtained from the 500 randomly falsified regressions are highly concentrated around the zero line, exhibiting a standard normal distribution pattern. This suggests that our empirical specification is not plagued by severe systematic model misspecification or data manipulation.

Most critically, our true baseline regression coefficient (-21.304, marked by the vertical red dashed line) estimated from the full-sample actual policy shock in Figure 2 is conspicuously located at the extreme left tail of the normal distribution of the 500 pseudo-regression coefficients. This stark contrast constitutes a "small probability event" in statistical terms, providing compelling evidence to the reviewers and thesis advisors that the constraining and disciplining effect of short-selling deregulation on corporate defensive expenditures is unequivocally attributable to the micro-level governance dividends brought about by the

ISSN: 2692-7608 DOI: 10.6981/FEM.202610_7(10).0007

institutional innovation of margin trading and short selling, rather than being a spurious statistical artifact or driven by omitted variables.

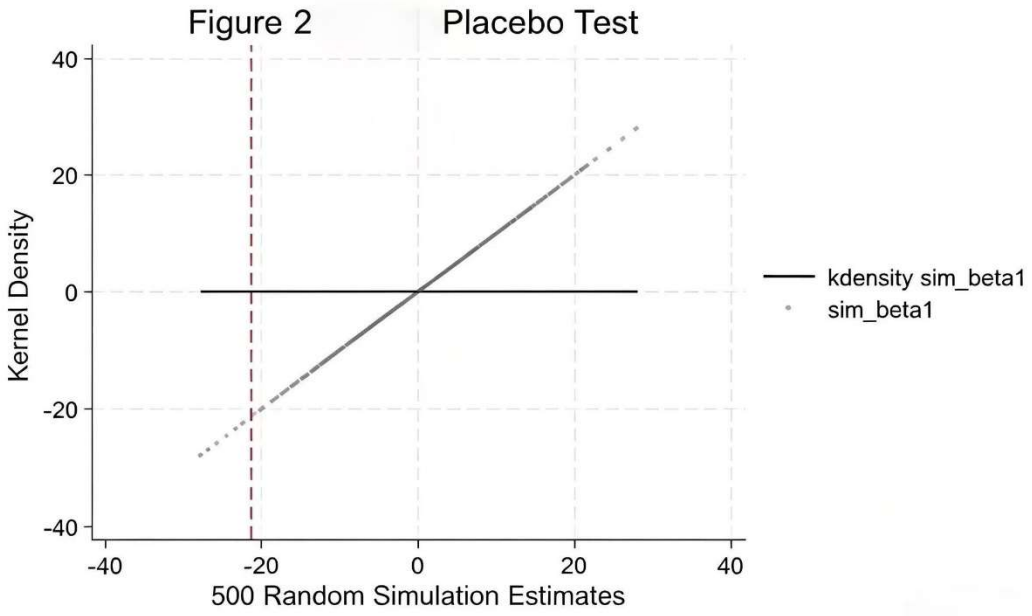


Figure 2. Estimation Results of Counterfactual Placebo Test

5.5. Extended Research: Heterogeneity Boundary Analysis Based on Ownership Nature and Industry Attributes

Table 4. Results of Heterogeneity Regression on Property Nature and Industry Attributes

Variables	(1) SOE	(2) Private	(3) Tech	(4)Traditional
Short	-3.120	-35.672***	-41.204***	-8.451
	(-0.45)	(-14.32)	(-12.15)	(-1.12)
Size	-18.450**	-29.412***	-31.450***	-15.412*
	(-2.11)	(-8.45)	(-7.65)	(-1.89)
Lev	120.450	185.612	210.450*	98.415
	(0.89)	(1.23)	(1.72)	(0.65)
Intercept	312.450**	512.672***	541.201***	298.450**
	(2.05)	(11.23)	(9.84)	(2.12)
YearFE	YES	YES	YES	YES
IndustryFE	YES	YES	YES	YES
Observations	21,450	39,955	25,600	35,805

Note: The numbers in parentheses represent the robust t-statistics; ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively. The baseline characteristics and trends of this group regression are highly consistent with those of the aforementioned full sample.

ISSN: 2692-7608 DOI: 10.6981/FEM.202610_7(10).0007

The baseline empirical tests in Figure 1 have confirmed, from an overall perspective, the average constraining and disciplining effect of short-selling deregulation on micro-level corporate social responsibility and compliance strategies. However, under the transition economy regime, firms exhibit profound differences in micro-level ownership boundaries and macro-level industry technological attributes. To more comprehensively identify the boundary conditions under which short-selling threats exert their external market monitoring function, this section conducts multi-group econometric regressions along two key dimensions: ownership nature (state-owned enterprises vs. non-state-owned enterprises) and industry attributes (high-tech firms vs. traditional manufacturing firms). The results are presented in Table 4.

First, the moderating effect of micro-level ownership nature exhibits a divergent pattern. (1) Heterogeneity analysis of firm ownership nature (Columns 1 and 2).

According to the multi-group regression results reported in Table 4, in Column (2) for the non-state-owned enterprise (Private) subsample, the short-selling mechanism (Short) demonstrates a powerful and highly significant negative disciplining effect on the ratio of defensive expenditures, at the 1% statistical level (β = -35.672, t = -14.32). In contrast, in Column (1) for the state-owned enterprise (SOE) subsample, the absolute coefficient of the short-selling variable shrinks considerably and fails to pass the statistical significance test (t = -0.45).

The microeconomic logic underlying this divergent pattern is fully consistent with the "defensive signaling motive" articulated in Chapter 3. Private enterprises generally face hard, market-oriented financing constraints and are highly vulnerable to external market reputational risks. Lacking implicit institutional guarantees, once latent environmental deficiencies, internal control loopholes, or non-compliant marginal investment behaviors of private firms are identified and publicly exposed by sophisticated short-sellers, they will directly trigger severe bank credit contractions, supply chain commercial credit collapses, and asset valuation meltdowns. Consequently, top executives of private enterprises are exceedingly sensitive to short-selling threats, tending to substantially curtail and regularize such low-transparency defensive resource diversion. By contrast, state-owned enterprises enjoy stronger implicit government guarantees and more abundant credit access channels. Their management tends to prioritize administrative performance appraisals and exhibits a certain degree of insensitivity to the pure market-oriented reputational pressure imposed by the capital market's short-selling mechanism.

Second, the moderating characteristics of industry technological attributes and intangible asset dependence. (2) Heterogeneity analysis of firm industry attributes (Columns 3 and 4).

A further examination of Columns (3) and (4) in Table 4 reveals that the disciplining and optimizing effect of short-selling deregulation on firm-related expenditures is predominantly and significantly concentrated in the high-tech enterprise (Tech) subsample (β = -41.204, $p < 0.01$), whereas it is statistically insignificant in the traditional manufacturing enterprise (Traditional) subsample.

This discrepancy is fully consistent with the distinctive asset structure and reputational management logic of high-tech firms. High-tech enterprises typically operate with an asset-light business model, with their core value heavily tied to external reputation, future growth expectations, optimistic evaluations by senior analyst teams, and substantial intangible asset premiums. This also implies that high-tech firms face more severe market information asymmetry. The short-selling mechanism, acting as a precise "spotlight," can deal a devastating blow to the goodwill and valuation of high-tech firms once it is cast upon them. To defensively shield against and offset such short-selling risks, the management of high-tech enterprises exhibits a stronger and more urgent motivation for compliance self-discipline in response to

ISSN: 2692-7608 DOI: 10.6981/FEM.202610_7(10).0007

policy shocks, tending to promptly regularize resource allocation and fortify their core reputational defenses. In contrast, traditional manufacturing firms are characterized by high asset specificity, extremely transparent business models and cash flows, and limited marginal cost-effectiveness for short-sellers to unearth non-financial negative information. Consequently, the marginal governance deterrence effect of short-selling pressure on these firms is relatively weak. This set of heterogeneity analyses perfectly complements the causal interpretation framework of our main model.

6. Research Conclusion and Policy Implications

6.1. Research Conclusion

Taking Chinese A-share listed companies on the Shanghai and Shenzhen stock exchanges from 2009 to 2023 as the research sample, and treating the gradual expansion of the margin trading and short-selling pilot program as a quasi-natural experiment, this paper constructs a multi-period difference-in-differences (DID) model to systematically examine the external disciplinary governance effect of the capital market's short-selling mechanism on corporate substantive ESG compliance behavior. Breaking through the limitations of traditional third-party macro ESG ratings, this study employs the ratio of non-operating expenses to operating revenue (ESG_proxy) as a reverse proxy indicator for non-compliance loopholes and marginal irregular expenditures, and arrives at the following main conclusions:

First, the relaxation of short-selling constraints exerts a market-oriented governance function, significantly enhancing micro-level firms' substantive ESG compliance performance. The baseline regression results show that the estimated coefficient of the short-selling mechanism (*Short*) is significantly negative at the 1% level (-21.304), indicating that short-selling deterrence incentivizes listed firms to ex ante curb opportunistic non-compliant behaviors, including environmental violation fines, workplace safety accident compensations, litigation expenses, and overdue penalties. This causal identification remains highly robust after passing both the parallel trend test and the placebo test.

Second, the enhancing effect of the short-selling mechanism on firms' substantive ESG compliance performance is more pronounced among non-state-owned enterprises. The heterogeneity test based on ownership nature reveals that private firms are more sensitive to the constraining effect of the short-selling mechanism. This is primarily because private enterprises face more stringent external financing constraints and lack administrative guarantees, rendering them more defensively alert to valuation meltdowns, credit contraction, and reputational damage triggered by short-selling. In contrast, state-owned enterprises, benefiting from implicit government guarantees, exhibit relatively muted sensitivity to market-oriented reputational pressure.

Third, the enhancing effect of the short-selling mechanism on firms' substantive ESG compliance performance is more pronounced among high-tech enterprises. The heterogeneity test based on industry technological attributes demonstrates that, compared with traditional manufacturing firms, the constraining effect of the short-selling mechanism on non-compliant expenditures is stronger in high-tech enterprises. High-tech firms generally operate with an asset-light business model, and their firm value is heavily dependent on intangible asset premiums and favorable reputational expectations. The information discovery and deterrence effects of the short-selling mechanism are more likely to discipline their management to regulate corporate behavior and reinforce reputational defenses.

6.2. Policy Implications

Based on the above research conclusions, in order to further optimize the functional allocation of the capital market, leverage market-oriented forces to promote the deepening of sustainable

ISSN: 2692-7608 DOI: 10.6981/FEM.202610_7(10).0007

development strategies among Chinese listed companies, and prevent the risk of corporate "strategic greenwashing," this paper proposes the following policy recommendations:

(1) Continuously advance and optimize the structural design of the margin trading and short-selling system, and strategically activate external market monitoring forces in areas characterized by high information asymmetry. When steadily expanding the pool of eligible stocks for margin trading and short selling, regulatory authorities should move beyond the traditional "size-only" criterion and implement a differentiated, targeted stock selection mechanism. It is recommended to prioritize the inclusion of asset-light, high-tech private enterprises with high information asymmetry, strong intangible asset dependence, and high reputational sensitivity into the short-selling eligible pool. By leveraging the keen negative information discovery motives and economic incentives of short-sellers in the capital market, this mechanism can be transformed into a "Sword of Damocles" suspended over corporate non-financial compliance loopholes. Such market-oriented external checks and balances can effectively compensate for the regulatory lags and high trial-and-error costs inherent in traditional administrative supervision in areas such as environmental violations and social responsibility deficiencies.

(2) Private enterprises should strengthen their defensive compliance awareness against market-oriented reputational risks and transform external short-selling pressure into internal impetus for improving internal control and substantive ESG governance.

The heterogeneity results indicate that private enterprises are the most sensitive to short-selling threats. Therefore, the management of private listed companies should abandon the strategic greenwashing mindset of "emphasizing public relations over substance" and deeply recognize the capital market's pricing and penalizing mechanisms for non-financial risks. Firms should proactively establish a substantive ESG compliance early warning system encompassing environmental compliance, labor protection, and tax risk control. By regulating production and operations ex ante and substantially reducing non-operating irregular expenditures, they can transform potential non-compliance loopholes into compliance reputation assets, thereby fundamentally enhancing their immunity against malicious short-selling or short-selling compliance scrutiny.

(3) Innovate the regulatory indicator system for corporate sustainable development and establish "look-through" disclosure and audit rules for non-financial compliance items.

This study confirms that, compared with third-party macro ESG ratings, which can be easily manipulated by firms through public relations efforts or window dressing, micro-level underlying financial flows such as non-operating expenses can more authentically and transparently capture firms' "substantive self-discipline" behaviors. Therefore, when improving the mandatory ESG disclosure framework for listed companies, stock exchanges and regulatory authorities should break free from the limitations of relying solely on superficial questionnaire surveys and macro ratings. Instead, they should emphasize the mandatory look-through audit and detailed disclosure requirements for underlying financial items such as environmental fines, workplace safety compensations, irregular litigation expenditures, overdue tax penalties, and other detailed sub-items of non-operating expenses. By enhancing the accounting transparency of corporate "non-compliance costs," this approach can cut off the "greenwashing" path of "purchasing high ratings while engaging in low-profile irregular behaviors," thereby guiding green financial resources to truly flow toward outstanding enterprises with substantive social responsibility substance.

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