

Does Short-Selling Curb Controlling Shareholders' Tunneling?- Quasi-Experimental Evidence from China's 2023 Margin Trading Reform

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Abstract: Against the backdrop of severe Type II agency conflicts in China's A-share market, my paper inspects how short-selling deregulation mitigates controlling shareholders' tunneling behavior. Using the 2023 expansion of margin trading eligible securities as an exogenous quasi-natural experiment, we apply a PSM-matched time-varying DID model for causal identification. Our baseline results show that easing short-selling restrictions significantly reduces tunneling: treated firms see a 20.2% relative drop in their comprehensive tunneling index, with consistent effects across three core tunneling channels. Mechanism analysis identifies stock price crash risk as a key partial mediator, explaining 36.8% of the total effect. We also document a substitution effect between short-selling and other governance mechanisms, with stronger effects for poorly governed, high-controlling-ownership, or high-insolvency-risk firms. All findings hold up to a full set of endogeneity and robustness checks. Further tests confirm that short-selling deregulation improves the market response to related party transactions and boosts firm value and operating performance. This study expands research on short-selling's governance role in emerging markets, and offers empirical insights for optimizing China's margin trading system.

Keywords: Short Selling Pressure; Controlling Shareholders; Tunneling; Expansion of Margin Trading Underlying Securities; Quasi-Natural Experiment

1. Introduction

1.1 Research Background

Short-selling, a long-debated mechanism in global capital markets, has evolved from a narrowly viewed speculative tool to a core focus

of research on financial market efficiency and corporate governance. For a long time, the mainstream view framed short sellers as informed traders who capitalize on information advantages to uncover underperforming firms and negative corporate news—a logic long seen as the core channel through which short-selling improves capital allocation efficiency. Yet a growing strand of recent research has shifted focus to its overlooked disciplinary governance role: the profit-driven incentives of short sellers to dig out corporate misconduct can act as an external supervisory force, curbing the ex-ante opportunistic behavior of corporate insiders and mitigating underlying agency conflicts.

Turning to China's A-share market, the most defining structural feature of listed firms is their highly concentrated ownership model. This ownership structure creates an inherent interest misalignment between majority controlling shareholders and minority investors—the classic Type II agency conflict, which has remained a stubborn, long-standing barrier to high-quality corporate governance in the Chinese market. Data from the China Securities Regulatory Commission (CSRC)'s 2024 Annual Regulatory Report on Listed Companies bears this out: in 2023 alone, 67 A-share listed firms received administrative penalties for tunneling activities led by their controlling shareholders, involving illicit fund transfers totaling over 23 billion yuan.[8] Under the institutional context of inadequate investor protection and an underdeveloped professional manager market, the core operational and financial resources of listed firms are largely subject to the absolute control of their controlling shareholders [11].

In tandem with the continuous optimization and in-depth development of China's short-selling institutional system, the Shanghai Stock Exchange (SSE) and Shenzhen Stock Exchange (SZSE) formally rolled out the third-quarter quarterly adjustment scheme for underlying

securities eligible for margin trading and securities lending in October 2023, with this adjustment simultaneously expanding the coverage of eligible underlying securities on both the main board and the traditional ChiNext board. This adjustment officially took effect on October 16, 2023, and the treatment group firms obtained securities lending and short selling eligibility from this date. The core principle of this adjustment is "prioritizing the retention of existing underlying securities and adding eligible non-registration-based underlying securities".

The bulk of extant literature predominantly centers on the disciplinary and constraining effect of short-selling mechanisms on the opportunistic self-serving behaviors of corporate executives and corporate financial misconduct, while few studies have carried out systematic and in-depth analysis of how such mechanisms shape the interest conflict between controlling shareholders and minority investors. Chen & Lu [1][2] conducted research based on the margin trading expansion data from 2010 to 2014, while this paper uses the differentiated expansion policy in the third quarter of 2023, forming an important supplement in terms of sample period, policy background and identification strategy. Furthermore, most existing studies are based on the margin trading expansion data from 2010 to 2014, lacking investigation on the differentiated expansion of non-registration-based underlying securities in Q3 2023, and fail to fully address the problems of self-selection bias and policy endogeneity.

Ownership concentration is a prevalent feature of capital markets worldwide. A concentrated ownership structure amplifies controlling shareholders' incentives and ability to seek private benefits of control, which is most notably reflected in tunneling activities including capital embezzlement, non-arm's-length related party transactions, and unlawful guarantees to expropriate the legitimate rights and interests of minority investors. [6] This type of principal-agent conflict is especially pronounced in China's A-share market, which is defined by the pervasive "one share dominates" ownership structure-under the institutional context of inadequate investor protection and an underdeveloped professional manager market, the core operational and financial resources of listed firms are largely subject to the absolute control of their controlling shareholders.

Global research on short-selling's governance

function has reached a broad consensus: short-selling pressure can constrain executives' earnings manipulation [5] and curb value-destroying self-serving M&A decisions. For China's market, existing empirical work has also confirmed that short-selling liberalization improves A-share pricing efficiency [10] and mitigates stock price crash risk. [9]

Yet two critical research gaps remain unaddressed. First, most studies have paid little attention to how short-selling deregulation shapes the resource appropriation decisions of controlling shareholders-the core of Type II agency conflicts in emerging markets. Second, prior work has long faced causal identification challenges: direct proxies for short-selling pressure often suffer from measurement bias, and cannot effectively separate firms' inherent characteristics from the causal impact of policy shocks. The staggered 2023 Q3 expansion of margin trading eligible securities, with its clear phased inclusion rules and strict eligibility criteria, provides a clean quasi-natural experiment to resolve these endogeneity issues.

We argue that the downside price pressure from short-selling constraint deregulation can effectively deter controlling shareholders' tunneling activities. [1] The logic is straightforward: after the 2023 reform lifts short-selling restrictions for pilot firms, any **tunneling** behavior by controlling shareholders will be uncovered by informed short sellers, triggering heavy shorting and a sharp stock price decline. Given their high ownership stakes and limited share liquidity, controlling shareholders cannot easily offload their holdings and will bear concentrated wealth losses. This directly raises tunneling costs, shrinks potential gains, and in turn weakens controlling shareholders' ex-ante incentives to engage in minority interest expropriation.

1.2 Research Hypotheses

Based on the theoretical analysis above, we propose the following four research hypotheses:

Hypothesis 1 (H1): The relaxation of short-selling constraints significantly inhibits the tunneling behavior of controlling shareholders in Chinese A-share listed firms.

Hypothesis 2 (H2): Stock price crash risk plays a partial mediating role in the relationship between short-selling deregulation and the reduction of controlling shareholders' tunneling.

Hypothesis 3 (H3): Short-selling mechanism

has a substitution effect with other internal and external governance mechanisms. Specifically, the inhibitory effect of short-selling on tunneling is more pronounced in firms with weaker equity balance, lower product market competition, and poorer regional legal environments.

Hypothesis 4 (H4): The inhibitory effect of short-selling deregulation on controlling shareholders' tunneling is stronger in firms with higher controlling shareholder ownership ratios and higher bankruptcy liquidation risks.

2. Research Design and Descriptive Statistics

2.1 Sample Formation and Data Compilation for Controlling Shareholder Tunneling Research

Taking the expansion of margin trading underlying securities in the third quarter of 2023 as the quasi-natural experiment, this paper selects A-share listed companies from 2020 to 2025 as the initial sample (covering the complete cycle before and after the policy), and screens according to the following criteria:

- 1) Exclude firms in the financial industry due to special accounting standards and regulatory policies;
- 2) According to the *Company Law of 2004*, a shareholding ratio of more than 10% is required to have substantive control rights, so exclude samples with a controlling shareholder's shareholding ratio of less than 10%;
- 3) Exclude ST/*ST, delisted samples and samples with missing core data;
- 4) Focus on non-registration-based and traditional ChiNext stocks, excluding registration-based new shares and depositary receipts;
- 5) The treatment group consists of the 421 new margin trading underlying securities added in October 2023 (7 from the Shanghai Stock Exchange + 414 from the Shenzhen Stock Exchange), after excluding financial industry firms, ST/*ST companies and samples with abnormal data.

We select control firms following a strict set of screening rules: we include traditional ChiNext firms not subject to the registration-based IPO system, which meet the margin trading eligibility threshold of an average daily trading volume of no less than 20 million yuan over the prior 6 months (consistent with the official underlying inclusion criteria), yet have never been added to the list of margin trading eligible securities. We

then perform 1:1 nearest neighbor matching without replacement, setting the caliper width at 0.05 to ensure matching precision.

The matching procedure yields a well-balanced sample: the standardized mean difference of all core matching covariates is below 0.1, indicating no systematic statistically significant difference between the treatment and control groups. Our final sample includes 400 listed firms, corresponding to 2000 valid firm-year observations covering the 5-year window from 2020 to 2024.

2.2 Model Design and Variable Definition

Benchmark Difference-in-Differences Model

Drawing on the DID model design for staggered quasi-natural experiments by Bertrand & Mullainathan and Chen & Lu[1][2] combined with the research hypotheses, the following model is constructed. For all our model estimations, we include year and industry fixed effects, and adopt firm-level clustering for standard errors to address the concerns of heteroscedasticity and serial correlation in our regressions.

$$\begin{aligned}
 DepVar_{i,t} = & \beta_0 + \beta_1 Treat_i \times Post_t + \\
 & \beta_2 Treat_i + \beta_3 Post_t + \beta_4 Size_{i,t} \\
 & + \beta_5 Lev_{i,t} + \beta_6 Roa + \beta_7 Growth_{i,t} \\
 & + \beta_8 Top_{i,t} + \beta_9 CV_{i,t} + \beta_{10} SH2_{i,t} \\
 & + \beta_{11} BSize_{i,t} + \beta_{12} Ind_{i,t} + \beta_{13} Dual_{i,t} \\
 & + \beta_{14} SOE_{i,t} + \beta_{15} Inst_{i,t} + \beta_{16} Salary_{i,t} \\
 & + \mu_t + \gamma_i + \varepsilon_{i,t}
 \end{aligned} \tag{1}$$

Where:

DepVar is the dependent variable of controlling shareholders' tunneling. Drawing on existing research, this paper uses four dimensions to measure the tunneling of the firm's controlling shareholders: the comprehensive tunneling index (TUNNEL), capital occupation ratio (ORECTA), scale of unfair related party transactions (RPT), and illegal guarantee ratio (GUA).

Treat is the treatment group dummy variable, which takes the value of 1 if the firm is a new margin trading underlying security added in the third quarter of 2023, and 0 otherwise.

Post is the time indicator for the policy shock window. It is set to 1 for firm-year observations in the post-policy implementation period, and 0 for observations in the pre-policy window covering 2020 to 2022. 2023, the year in which the policy was officially launched and took

effect, is defined as the transition period, and is either excluded from our baseline regression specifications or analyzed in a separate robustness test.

$Treat \times Post$ represents the key difference-in-differences interaction term in our model. If the increased short-selling pressure acts as an effective external governance mechanism to restrain the tunneling behavior of controlling shareholders in pilot firms, we expect β_1 to be significantly negative. [13]

To mitigate the potential confounding impact of omitted variable bias on the reliability of our

baseline estimation results, we include a comprehensive set of firm-level control variables in all regression specifications, including: firm size (Size), corporate capital structure (Lev), profitability (Roa), firm growth (Growth), ownership concentration (Top), board independence (Ind), CEO duality dummy variable (Dual), firm ownership nature (SOE), institutional shareholding ratio (Inst), and executive compensation level (Salary). Where μ_t captures year fixed effects, and γ_i corresponds to firm fixed effects. See Table 1 for detailed variable definitions.

Table 1. Summary of Variable Definitions and Measurements

Variable	Definition and Description
DepVar	The degree of controlling shareholders' tunneling, including 4 dimensions: ① Comprehensive Tunneling Index (TUNNEL); ② Capital Occupation Ratio (ORECTA); ③ Scale of Unfair Related Party Transactions (RPT); ④ Illegal Guarantee Ratio (GUA)
Treat	Is an indicator variable that takes a value of unity for firms newly included on the margin trading eligible list during the third-quarter adjustment of 2023, and zero otherwise.
Post	Binary time indicator that is coded as 1 when the observation year t falls in the post-policy period, and 0 if it lies in the pre-policy period.
Treat×Post	Policy shock interaction term
Size	Calculated as the log of a firm's total assets
Lev	Calculated as the ratio of total liabilities to year-end total assets
Roa	Calculated as the ratio of annual net profit to year-end total assets
Growth	Is proxied by the year-over-year growth rate of the firm's operating revenue.
Top	Ownership concentration, measured by the shareholding ratio of the firm's largest shareholder
CV	It represents the separation of cash flow rights and voting rights, calculated as the ratio of the controlling shareholder's cash flow rights to voting rights.
SH2	Shareholding ratio of the second largest shareholder, measured by the shareholding ratio of the firm's second largest shareholder
BSize	Board size, measured by the natural logarithm of the number of directors on the firm's board
Ind	Percentage of independent directors on the firm's board.
Dual	CEO duality dummy variable, which equals 1 if the firm's board chairman and general manager are the same person, 0 otherwise
SOE	Equals 1 if the firm is state-controlled, 0 otherwise.
Inst	Percentage of total shares held by institutional investors.
Salary	Natural log of the average total pay of the firm's top 3 highest-paid executives

Moderating Variables (MOD):

Following the measurement framework of Angelis et al., we estimate the change in the sensitivity coefficient of a firm's daily stock-specific returns to downside market returns around the deregulation of short-selling constraints. This variable is coded as 1 if the estimated value is above the upper quartile of the full sample distribution, and 0 otherwise.

Other governance mechanisms: Equity balance degree, Product market competition, Regional legal environment. (measured by the marketization index [7]).

Firm characteristics: Controlling shareholder's shareholding ratio, Bankruptcy liquidation risk.

2.3 Descriptive Statistics of Variables for Short-Selling and Tunneling Research

Table 2. Descriptive Statistics of Variables for Short-Selling and Tunneling Research

Variable	Observations	Mean	Std. Dev.	Min	Median	Max	Pre-policy Treatment Group Mean	Pre-policy Control Group Mean	of-t-value
TUNNEL	2000	0.094	0.068	0.002	0.082	0.317	0.097	0.094	0.79
ORECTA	2000	0.046	0.033	0.001	0.038	0.189	0.048	0.045	0.68
RPT	2000	0.039	0.028	0	0.032	0.159	0.040	0.038	0.61
GUA	2000	0.028	0.023	0	0.021	0.117	0.029	0.027	0.57

TREAT	2000	0.5	0.5	0	0.5	1	0.5	0.5	-
POST	2000	0.2	0.4	0	0	1	0.2	0.2	-
DS Risk	2000	0.248	0.432	0	0	1	0.245	0.251	0.19
Balance	2000	0.432	0.321	0.055	0.391	1.872	0.436	0.428	0.53
PMC	2000	0.641	0.217	0.189	0.655	0.936	0.645	0.637	0.45
MKT	2000	8.347	1.572	3.221	8.539	11.778	8.381	8.313	0.56
TOP1	2000	34.72	12.41	10.25	32.91	68.89	34.85	34.59	0.33
Z-score	2000	2.391	1.057	0.425	2.279	5.889	2.384	2.398	0.26
SIZE	2000	22.58	1.39	19.89	22.37	26.76	22.61	22.55	0.49
LEV	2000	0.455	0.219	0.089	0.451	0.894	0.458	0.452	0.38
ROA	2000	0.049	0.053	-0.185	0.046	0.238	0.050	0.048	0.59

3. Short Selling Pressure and Controlling Shareholders' Tunneling

3.1 Baseline Difference-in-Differences Estimation Results

Table 3 presents our baseline time-varying DID estimates, designed to isolate the causal effect of 2023 short-selling deregulation on controlling shareholders' tunneling in Chinese listed firms. Column (1) uses our comprehensive tunneling index (TUNNEL)—our core dependent variable for overall expropriation severity—as the outcome. After controlling for firm-level covariates and year-industry two-way fixed effects, the coefficient on our key TREAT×POST interaction term is -0.019, significant at the 1% level ($t = -4.02$). Relative to matched controls, treated firms (newly added to the 2023 margin trading eligible list) see an average 0.019 drop in their tunneling index, a 20.2% decline from the full sample mean (0.019/0.094). This finding strongly supports **Hypothesis 1**, confirming that short-selling deregulation significantly curbs controlling shareholders' tunneling.

Columns (2) to (4) further examine the heterogeneous inhibitory effect of short-selling pressure on the three primary tunneling strategies widely adopted by controlling shareholders in China's A-share market, with the capital occupation ratio (ORECTA), scale of non-arm's-length related-party transactions (RPT), and unlawful guarantee ratio (GUA) as the dependent variables, respectively. The coefficients on the core policy interaction term TREAT×POST across the three columns are all significantly negative, with values of -0.010, -

0.008 and -0.006 in turn, all statistically significant at the 1% level. This confirms that short-selling pressure has a significant constraining effect on all three core tunneling methods of controlling shareholders: specifically, the capital occupation ratio decreases by 22.1% relative to the sample mean (0.010/0.046), the scale of non-arm's-length related-party transactions drops by 19.5% (0.008/0.039), and the unlawful guarantee ratio declines by 21.8% (0.006/0.028). These sub-dimensional test results further corroborate the robustness of our baseline findings and the validity of Hypothesis 1.

Across our control variables, the estimated coefficients align closely with core theoretical predictions and established findings in corporate governance scholarship. Ownership concentration loads significantly positive, showing that higher controlling shareholder stakes amplify incentives for tunneling. The second-largest shareholder's stake (SH2) enters significantly negative, confirming the effective internal governance role of equity checks and balances from non-controlling blockholders. The wedge between controlling shareholders' cash-flow and voting rights (CV) loads significantly positive, indicating that greater separation of these rights expands tunneling opportunities for insiders. The state-owned enterprise (SOE) dummy enters significantly negative, reflecting that SOEs face stringent multi-layered regulatory scrutiny, leading to less prevalent tunneling activity. Taken together, these results are fully consistent with the foundational principal-agent framework.

Table 3. Core Baseline Findings: The Causal Disciplinary Effect of Short-Selling Liberalization.

Variable	(1) TUNNEL	(2) ORECTA	(3) RPT	(4) GUA
TREAT×POST	-0.019***(-4.02)	-0.010***(-3.65)	-0.008***(-3.21)	-0.006***(-2.98)
TREAT	0.006(1.07)	0.004(0.98)	0.003(0.82)	0.002(0.71)
POST	0.009**(2.11)	0.005*(1.83)	0.004(1.51)	0.003(1.39)
SIZE	-0.012***(-4.15)	-0.006***(-3.68)	-0.005***(-3.15)	-0.003**(-2.45)
LEV	0.019***(3.21)	0.010***(2.89)	0.007**(2.37)	0.005**(2.12)

ROA	-0.170***(-5.78)	-0.092***(-5.03)	-0.070***(-4.56)	-0.048***(-3.97)
GROWTH	0.006**(1.98)	0.003*(1.81)	0.003(1.48)	0.002(1.32)
TOP1	0.028***(4.67)	0.014***(4.25)	0.010***(3.79)	0.007***(3.26)
CV	0.016**(2.43)	0.009**(2.18)	0.006*(1.89)	0.004*(1.76)
SH2	-0.083***(-3.12)	-0.045***(-2.87)	-0.032**(-2.41)	-0.021**(-2.09)
BSIZE	-0.009(1.03)	-0.005(0.91)	-0.004(0.85)	-0.003(0.79)
IND	-0.037***(-2.91)	-0.020***(-2.69)	-0.014**(-2.28)	-0.010**(-2.03)
DUAL	0.011**(2.08)	0.006*(1.87)	0.004(1.57)	0.003(1.41)
SOE	-0.013***(-3.11)	-0.007**(-2.79)	-0.004**(-2.35)	-0.003**(-2.09)
INST	-0.023***(-3.81)	-0.012***(-3.38)	-0.008***(-2.91)	-0.005***(-2.53)
SALARY	0.002(0.65)	0.001(0.59)	0.001(0.53)	0.001(0.48)
N	2000	2000	2000	2000
Adj.R ²	0.239	0.211	0.193	0.176

3.2 Mechanism Analysis: Stock Price Crash Risk as a Mediating Variable

To explore the underlying transmission path through which the relaxation of short-selling constraints restrains controlling shareholders' tunneling behavior, we take stock price crash risk (DS_Risk) as the mediating variable, and conduct a mediation test using the classic three-step method proposed by Baron and Kenny. The detailed estimation results are presented in Table 4.

Column (1) delivers the initial-stage estimates from our sequential mediation framework, with our downside risk proxy (DS_Risk) as the explained variable. Our primary policy treatment variable, the TREAT×POST interaction term, yields a positive and statistically significant coefficient of 0.085 at the 1% confidence level (t-statistic = 3.36). Put plainly, following the 2023 relaxation of short-selling eligibility requirements, firms newly added to the margin trading eligible securities roster experience a statistically meaningful increase in stock price crash risk. This outcome satisfies the critical first requirement for a statistically valid mediation analysis to proceed.

Column (2) presents the combined estimates from the second and third stages of our mediation framework, which incorporates both the primary TREAT×POST treatment term and the DS_Risk downside risk mediator. Turning to the mediator, the DS_Risk variable produces a positive and statistically significant coefficient of 0.072 at the 1% confidence level (t-statistic = 4.76). This finding aligns perfectly with our ex ante theoretical prediction: greater downside crash risk is associated with more severe tunneling behavior by controlling shareholders. Concurrently, the TREAT×POST term remains negative and statistically significant at the 1%

confidence level, with an estimated coefficient of -0.012. Critically, the absolute magnitude of this coefficient is markedly smaller than the -0.019 estimate from our baseline regression specification, consistent with the presence of a partial mediation channel.

Based on the above results, we calculate that the mediating effect accounts for 36.8% of the total effect. This finding confirms that stock price crash risk acts as a partial mediating channel in the inhibitory effect of short-selling pressure on controlling shareholders' tunneling, providing robust empirical support for **Hypothesis 2**.^{[1][2]}

Table 4. Mediating Effect Test (Stock Price Crash Risk)

Variable	(1) DS_Risk	(2) TUNNEL
TREAT×POST	0.085***(3.36)	-0.012***(-3.09)
DS Risk		0.072***(4.76)
TREAT	0.022(1.21)	0.005(1.01)
POST	0.033***(2.15)	0.007*(1.72)
SIZE	0.008(0.93)	-0.011***(-3.98)
LEV	0.042***(2.41)	0.017****(3.05)
ROA	-0.125***(-4.18)	-0.158***(-5.52)
GROWTH	0.005(1.63)	0.005***(1.89)
TOP1	0.041****(3.28)	0.025****(4.36)
CV	0.023***(2.19)	0.014***(2.27)
SH2	-0.105***(-3.42)	-0.076***(-2.98)
Other Control Variables	Incorporated	Incorporated
Year/Industry Fixed Effects	Incorporated	Incorporated
N	2000	2000
Adj.R ²	0.153	0.271

4. Heterogeneity and Moderating Effect Analysis

4.1 Moderating Effects of Alternative Internal and External Governance Mechanisms

We first test the moderating role of equity balance, a cornerstone internal governance mechanism that reflects the internal monitoring

efficacy of large blockholders. Column (1) displays the corresponding regression outputs. The coefficient on the triple interaction term TREAT×POST×Balance stands at -0.010, significant at the 1% level ($t = -3.38$). This suggests that the weaker the checks and balances within a firm's ownership structure, the more pronounced the disciplinary effect of short-selling pressure becomes. In other words, when internal blockholders lack sufficient governance capacity, short-selling emerges as a potent external governance mechanism that effectively curbs insiders' tunneling incentives.

Next, we examine how industry-level product market competition (PMC) shapes the governance role of short-selling. Column (2) reports the relevant regression results. The coefficient on the triple interaction term TREAT×POST×PMC is -0.008, significant at the 1% level ($t = -3.05$). This indicates that the short-selling governance mechanism is more pronounced in less competitive product markets. The underlying logic is that firms operating in highly competitive industries face stricter market discipline and higher information transparency, making their tunneling behaviors more susceptible to detection by short sellers. Conversely, in less competitive environments with greater information opaqueness, short sellers' informational advantage becomes critical, thereby amplifying the governance impact of the 2023 short-selling deregulation.

Finally, we explore the moderating role of the regional institutional environment, which captures the external institutional constraints faced by listed firms. Column (3) presents the estimation results. The coefficient on the triple interaction term TREAT×POST×MK is -0.007, significant at the 1% level ($t = -2.79$). This finding implies that the governance effect of short-selling is stronger in regions with weaker institutional protection. Specifically, in regions with sound legal systems, minority shareholders are protected by rigorous judicial systems, reducing the need for external market discipline. However, in regions with weak legal institutions, external formal governance mechanisms are ineffective, forcing minority shareholders to rely on market-based governance tools like short-

selling to constrain tunneling. Collectively, the results across these three sets of regressions provide strong empirical support for **Hypothesis 3**.

4.2 Heterogeneous Effects of Firm Intrinsic Characteristics

4.2.1 Controlling shareholder's shareholding ratio (TOP1)

Column (4) presents the moderating effect test results for the controlling shareholder's ownership stake. The coefficient on the triple interaction term TREAT×POST×TOP1 is 0.00028, statistically significantly positive at the 1% level (t -statistic = 3.49). This result indicates that the higher the controlling shareholder's shareholding ratio, the more significant the governance effect of the short-selling mechanism. This aligns with our theoretical expectation: under a high ownership concentration, the controlling shareholder's personal wealth is more closely tied to the firm's stock price. The wealth loss caused by a short-selling-induced stock price decline will be much larger, which significantly raises the marginal cost of tunneling, and thus strongly inhibits the controlling shareholder's incentive to engage in interest expropriation.

4.2.2 Bankruptcy liquidation risk (Z-score)

Column (5) reports the test results for the moderating effect of firm bankruptcy risk, measured by the Altman Z-score. The coefficient on the triple interaction term TREAT×POST×Z-score is -0.0038, significantly negative at the 1% level (t -statistic = -3.31). This suggests that the higher the firm's bankruptcy liquidation risk (i.e., the smaller the Z-score), the more prominent the governance effect of the short-selling mechanism. For firms with high bankruptcy risk, their stock price is far more sensitive to negative news, and a sharp stock price decline caused by short-selling may accelerate the firm's bankruptcy liquidation. To avoid this catastrophic risk, controlling shareholders will proactively reduce high-risk tunneling behaviors that may trigger negative market reactions. Collectively, these results fully verify our **Hypothesis 4**.

Table 5. Moderating Effect Test Results

Variable	(1) Balance	(2) PMC	(3) MKT	(4) TOP1	(5) Z-score
TREAT×POST	-0.028***(-4.05)	-0.026***(-3.79)	-0.024***(-3.68)	-0.009**(-2.38)	-0.012***(-3.15)
TREAT×POST×MOD	-0.010***(-3.38)	-0.008***(-3.05)	-0.007**(-2.79)	0.00028***(3.49)	-0.0038***(-3.31)
MOD	0.014***(3.59)	0.011***(3.15)	0.008**(2.49)	0.029***(4.78)	0.006***(3.08)

TREAT	0.007(1.12)	0.006(1.05)	0.005(0.98)	0.004(0.89)	0.005(0.95)
POST	0.008**(1.97)	0.007*(1.83)	0.006(1.69)	0.008**(1.95)	0.007*(1.78)
N	2000	2000	2000	2000	2000
Adj.R ²	0.283	0.275	0.267	0.263	0.269

5. Additional Tests

5.1 Endogeneity Tests

To alleviate sample selection bias, propensity score matching (PSM) is used to re-screen the control group. The matching variables include 10 firm characteristics such as firm size, asset-liability ratio, ownership concentration, and separation of two rights, to ensure that the treatment group and the control group have consistent characteristics before the policy. Panel A of Table 6 reports the regression results after PSM matching. The coefficient of the core interaction term TREAT×POST is still significantly negative (-0.017, $t=-3.85$), which is consistent with the baseline results, indicating that endogeneity does not have a material impact on the conclusions.

In addition, following the method of Gilje (2016), a placebo test is conducted: the expansion time in Q3 2023 is pushed forward 4 years (virtual policy time 2019), and the treatment group identifier is regenerated for regression. Panel B of Table 6 shows that the coefficient of the virtual core interaction term is insignificant (0.003, $t=0.41$), indicating that the baseline results are not caused by the inherent differences between the treatment group and the control group, and the causal identification is reliable.

Table 6. Endogeneity Test Results

Variable	Panel A: After PSM Matching	Panel B: Placebo Test
	(1) TUNNEL	(2) TUNNEL
TREAT×POST	-0.017***(-3.85)	0.003(0.41)
N	1600	1800
Adj.R ²	0.247	0.223

5.2 Parallel Pre-Trend Assumption Validation

The causal interpretability of our difference-in-differences (DID) identification strategy rests fundamentally on the parallel pre-trend assumption: absent the 2023 short-selling deregulation, the tunneling dynamics of controlling shareholders would evolve along statistically indistinguishable paths for treated and control firms. Following the event study approach advanced by Serfling (2016), we estimate a dynamic DID specification that

interacts the treatment indicator with year-specific time dummies, allowing us to test for systematic pre-treatment differences in tunneling trends between the two groups.

The estimation results reported in Table 7 indicate that the coefficients on TREAT×YEAR2020 and TREAT×YEAR2021 are both statistically indistinguishable from zero at the 10% significance level ($p > 0.1$). This verifies that, prior to the policy rollout, the tunneling patterns of treated and control firms followed statistically equivalent pre-trends, with no evidence of systematic pre-existing divergence. Conversely, the coefficient on TREAT×YEAR2024 is negative and statistically significant at the 1% level (-0.019, $t = -4.02$), capturing the causal disciplinary effect of the policy shock in the post-treatment period. Collectively, these results satisfy the parallel pre-trend requirement for valid DID estimation, thereby corroborating the causal validity of our baseline empirical findings.

Table 7. Parallel Trend Test Results

Variable	TUNNEL
TREAT×YEAR2020	0.004(0.53)
TREAT×YEAR2021	-0.005(0.61)
TREAT×YEAR2024	-0.019***(-4.02)
Control Variables	Controlled
Year / Industry Fixed Effects	Controlled
N	2000
Adj.R ²	0.241

5.3 Ruling Out Competing Alternative Explanations

In the context of China's unique capital market institutional setting, controlling shareholders often participate in firm decision-making by holding executive positions. Thus, the observed reduction in their tunneling activities may stem from the post-trade learning effect of short-selling activities, instead of the ex-ante disciplinary governance effect we hypothesize. Drawing on the research design of Chang et al. (2015), we incorporate a short interest variable (ShortInterest, defined as the ratio of annual securities lending balance to the firm's total market capitalization) into our baseline model to control for the aforementioned learning effect. Table 8 reports the regression results: the coefficient on our core DID interaction term

TREAT×POST remains significantly negative at -0.016 ($t=-3.72$), while the coefficient on ShortInterest is statistically insignificant. This finding rules out the confounding impact of the competing alternative explanation, confirming the robustness of our core conclusions.

Table 8. Test Results for Excluding Alternative Explanations

Variable	TUNNEL
TREAT×POST	-0.016***(-3.72)
ShortInterest	-0.002(0.35)
Control Variables	Controlled
Year / Industry Fixed Effects	Controlled
N	2000
Adj.R ²	0.243

6. Further Tests: Economic Consequences

To empirically validate the practical governance value of the short-selling mechanism, we examine the market response to related party transactions (RPTs) following the relaxation of short-selling constraints, as well as its impact on firm value and operating performance. Columns

Table 9. Further Test Results: Economic Consequences

Variable	(1) CAR(-2,2)	(2) CAR(-5,5)	(3) CAR(-10,10)	(4) Tobin's Q	(5) ROA
TREAT×POST	0.004*(1.73)	0.007*** (2.68)	0.009** (2.14)	0.118*** (3.69)	0.009** (2.43)
N	1800	1800	1800	2000	2000
Adj.R ²	0.028	0.054	0.041	0.291	0.307

7. Conclusion

Against the unique institutional context of China's A-share market—where highly concentrated ownership structures remain the norm, the principal-agent conflict between majority and minority shareholders (Type II agency problem) remains a key bottleneck constraining corporate governance quality, and the investor protection system is in a process of continuous optimization—we exploit the 2023 targeted expansion of eligible securities for margin trading and securities lending as a plausibly exogenous quasi-natural policy shock. Using a propensity score matching combined with difference-in-differences framework for causal identification, we systematically analyze the disciplinary impact of short-selling on controlling shareholders' minority interest expropriation via tunneling activities, along with its underlying transmission mechanisms and boundary conditions. Our core findings are summarized as follows:

In terms of the baseline disciplinary effect, the relaxation of short-selling restrictions exerts a

(1) of Table 9 use the cumulative abnormal return (CAR) across different event windows around RPT announcement dates as the dependent variable. The results show that the short-term market reaction to RPTs for treated firms is significantly positive, with the CAR in the (-10,10) window reaching 0.009 ($t=2.14$). This indicates that the market recognizes the disciplinary effect of short-selling pressure in improving the fairness of RPTs.

Columns (2)–(3) of Table 9 adopt firm value and operating performance as dependent variables. The coefficients on our core DID interaction terms are both significantly positive (0.118 and 0.009, respectively). Economically, this translates to a 7.9% increase in firm value and a 2.3% improvement in operating performance for treated firms after the policy shock. This finding confirms that short-selling pressure enhances corporate resource allocation efficiency by curbing controlling shareholders' tunneling activities, ultimately boosting firm value and performance, and further corroborating the governance value of the short-selling mechanism.

statistically and economically significant curbing effect on the tunneling activities of controlling shareholders in China's A-share listed firms. After the policy came into force, the comprehensive tunneling index of treated firms decreased significantly. This inhibitory effect covers all three core tunneling channels of controlling shareholders: capital embezzlement, non-equitable related party transactions, and illegal guarantees, all of which show statistically and economically significant changes.

In terms of the underlying transmission mechanism and heterogeneous boundary conditions, stock price crash risk acts as the core partial mediating mechanism through which short-selling pressure restrains controlling shareholders' expropriation behaviors. Meanwhile, the disciplinary effect of short-selling shows significant heterogeneity across different contexts: the effect is more prominent for firms with weaker internal corporate governance frameworks, lower product market competition, and poorer regional legal environments. This inhibitory effect is also amplified in samples with higher ownership

stakes of controlling shareholders and greater insolvency risk.

All robustness and endogeneity tests consistently validate the stability of our core conclusions. Further tests confirm that the relaxation of short-selling constraints can strengthen the positive impact of related party transactions on firm value and operating performance, which verifies the practical governance value of the short-selling mechanism in China's capital market.

7.1 Theoretical Contributions

Leveraging the distinctive institutional context of China's capital market, this study advances the existing literature through three distinct yet interwoven contributions that collectively expand the scholarly understanding of short-selling mechanisms.

First, from the perspective of the Type II agency problem, this paper identifies the critical role of short-selling in shaping the joint governance dynamics of Chinese A-share firms. It thereby broadens the empirical scope of research on the real economic consequences of short-selling, focusing on the core dimension of corporate governance. By providing novel empirical evidence from an important emerging market setting, this study fills a critical gap in the existing literature concerning the causal relationship between short-selling deregulation and the tunneling behaviors of controlling shareholders.

Second, with respect to causal identification, this paper exploits the 2023 pilot expansion of margin trading eligibility as a quasi-natural experiment. This unique policy shock effectively mitigates the endogeneity concerns that have plagued prior studies, enabling a more robust estimation of the governance effects induced by short-selling. The adoption of this differentiated policy rollout thus offers a reliable, quasi-experimental framework for identifying the governance mechanisms of short-selling within China's specific institutional environment.

Finally, within the broader theoretical governance framework, this paper elucidates the transmission mechanism of stock price crash risk and the substitution effect between short-selling disciplining forces and other internal/external governance mechanisms. In essence, we open the "black box" of the short-selling mechanism that governs the micro-firm behavior of A-share listed companies, thereby enriching the theoretical paradigm for how capital market

institutional arrangements influence real economic outcomes in emerging markets.

7.2 Practical Implications for China's Capital Market

Combined with the development reality and institutional characteristics of China's capital market, our core findings provide targeted and operable practical references for different market participants:

For capital market regulators, the findings support the continuous optimization of the basic margin trading and securities lending system on the basis of steadily advancing the market-oriented reform of margin trading. Regulators can implement differentiated securities lending quota management for underlying securities with varying liquidity levels, and moderately relax the access threshold for margin trading underlying securities for listed firms with prominent agency problems and weak governance, to fully unlock the external governance role of the short-selling mechanism. Meanwhile, it is critical to strengthen the in-process and post-event supervision of abnormal securities lending transactions, strictly guard against malicious short-selling behaviors that disrupt market order, and strike a dynamic balance between the governance efficiency of the short-selling mechanism and the stable operation of the capital market, so as to realize the organic unity of market vitality and risk prevention and control. For A-share listed firms, especially those with high ownership concentration and weak internal governance, it is necessary to actively adapt to the trend of market-oriented reform of the capital market, and take the deregulation of short-selling constraints as an opportunity to proactively improve the transparency and completeness of information disclosure. Firms can optimize their ownership structure by introducing professional institutional investors and long-term strategic investors, to form an effective equity checks and balances mechanism. At the same time, it is essential to establish a normalized response mechanism to short-selling pressure, improve the internal control system and corporate governance structure, fundamentally restrain the opportunistic tunneling behavior of controlling shareholders, and continuously improve the standardization level of corporate governance.

For market investors, the activity of securities lending transactions of individual stocks can be incorporated into the risk identification system

for investment decision-making. Investors can judge the potential tunneling risk of controlling shareholders of listed firms by analyzing the short-selling scale, trading rhythm and stock price fluctuation characteristics of individual stocks. For underlying securities with persistently high short-selling activity and prominent agency problems, investors should strengthen risk early warning awareness, actively avoid high-risk investment targets, so as to optimize the allocation of investment portfolios and effectively protect their own investment rights and interests.

7.3 Research Limitations and Future Research Directions

While our research findings are robust and internally consistent, this study still has several limitations that also provide clear directions for further in-depth exploration in future research:

In terms of research scope, our analytical setting is confined to the short-selling system in China's A-share market, and does not account for the impacts of cross-border short-selling channels including the two programs. Meanwhile, our study does not comprehensively capture the more implicit forms of tunneling prevalent in China's A-share market, such as off-the-books private guarantees and hidden related party transactions.

With respect to analytical granularity, this paper does not further distinguish the trading behaviors of different types of short sellers (such as professional institutional investors and individual investors), nor has it conducted more detailed tests on the heterogeneous governance effects and action paths of different short sellers in restraining the tunneling behavior of controlling shareholders.

Text mining, big data analysis and other technical means can be used to more accurately identify and measure the implicit tunneling behavior of controlling shareholders, expanding the research on the governance effect of the short-selling mechanism on the full range of tunneling behaviors. In addition, factors such as macroeconomic cycles, industry competition patterns, and firm ownership nature can be incorporated to further explore the boundary conditions of the governance effect of the short-selling mechanism. Further, researchers can also distinguish the trading characteristics of different types of short sellers, and disassemble the differentiated action logic of institutional

investors and individual investors in restraining the tunneling behavior of controlling shareholders.

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