

Can Short Selling Improve the Pay-Performance Sensitivity of Corporate Executives?

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Abstract: Short selling is a comparatively new external governance arrangement in China, and how it shapes corporate governance has drawn growing scholarly interest. One question, however, has been largely overlooked: how this arrangement bears on executive pay-performance sensitivity (PPS), which is itself a key gauge of whether compensation contracts work. We treat the 2010 easing of short-selling restrictions in the Chinese capital market as a quasi-natural experiment and, drawing on an unbalanced panel of A-share listed firms spanning 2010 to 2024, use a difference-in-differences (DID) design to assess how short selling affects executive PPS. We find that allowing short selling raises analyst coverage and upgrades the firm's information environment, so executive pay comes to track performance more closely; this pattern holds once heterogeneity is taken into account. Pay becomes more responsive to accounting performance measured by return on assets and return on equity, and pay stickiness is meaningfully curtailed. These findings offer firm-level evidence that can inform regulators refining the short-selling regime and listed firms reconsidering how their compensation committees are designed.

Keywords: Pay-Performance Sensitivity; Short-Selling Mechanism; External Monitoring; Corporate Governance

1. Introduction

Among the incentive arrangements that corporate governance relies on, executive compensation contracts occupy a central place, and how well they function maps directly onto how far the principal-agent problem can be contained. Within China's capital market, pay for listed-firm executives has climbed year after year, yet a "reward but never penalize" stickiness in pay remains pervasive and badly undercuts the

incentive compatibility that compensation is meant to deliver. The authorities have lately rolled out a set of measures on performance-linked pay at listed firms, specifying how large the performance-based portion should be and stressing that rewards follow results, while at the same time guarding against market manipulation and predatory short selling and pushing corporate governance toward modernization. Using external governance channels to sharpen executive pay-performance sensitivity has thus become a shared concern of researchers and regulators alike.

The pilot for margin trading and short selling was formally rolled out by the China Securities Regulatory Commission in March 2010, the moment a short-selling mechanism entered China's capital market and brought the long-standing "one-sided market" to a close. The two exchanges have since widened the roster of eligible securities on seven separate occasions. A stepwise institutional shift of this kind offers a quasi-natural experimental setting for asking how external governance feeds back into internal incentives. Set against this backdrop, the question of whether, and by what route, short selling can lift executive pay-performance sensitivity carries both theoretical and practical weight. Principal-agent theory [1] (Jensen & Meckling, 1976) reminds us that information asymmetry and clashing interests make it hard for shareholders to keep executives in check, so compensation contracts end up working only imperfectly. A line of prior work documents a constructive governance role for short selling: Ma and Tong [2] (2019) provide a systematic account of how short selling reshapes executive compensation contracts; Liu [3] (2021) exploits the margin trading and short-selling program as an exogenous shock and zeroes in on how the effect varies across non-state-owned firms and across regions at different stages of marketization; and Hong et al. [4] (2020) studies what the program does to the effectiveness of executive pay

contracts. That said, the literature leaves several openings. For one, many samples are now dated, typically stopping before 2020 and thus missing the imprint of more recent regulatory reform. For another, the treatment of mediating channels stays rather thin, with no systematic examination of the "positive improvement of the information environment" pathway. Finally, heterogeneity has not been probed deeply, and contextual conditions such as firm size have rarely been brought into the picture.

We build a theoretical account in which short selling lifts executive pay-performance sensitivity by drawing in more analysts and bettering the information environment, layer in a heterogeneity analysis keyed to firm size, and develop our hypotheses on that footing. Taking the phased widening of the margin trading and short-selling program after 2010 as a quasi-natural experiment, we then adopt a staggered difference-in-differences (DID) design and, with an unbalanced panel of Chinese A-share listed firms covering 2010 to 2024, trace the route by which short selling, through richer analyst coverage and a stronger information environment, finally pushes executive pay-performance sensitivity upward. Additional analysis indicates that easing short-selling limits raises pay-performance sensitivity more sharply in large firms.

This paper contributes on three fronts. (1) By carrying the sample window through to 2024, it captures the dynamic consequences of the most recent institutional changes. (2) It concentrates on verifying the mediating route running through analyst coverage and a better information environment, piecing together a full transmission chain from "short-selling pressure" to "information environment" to "optimized compensation contracts." (3) It brings firm size in as a moderator and so maps out the boundary conditions under which the governance effect of short selling operates.

2. Literature Review

2.1 Literature on the Short-selling Mechanism

Overseas scholarship on short selling got under way comparatively early. Aitken et al. [5] (1998) show that opening a market to short selling speeds the way "bad news" travels through it. Turning to information and pricing efficiency, the survey by Boehmer et al. [6] (2020) in the *Review of Finance* concludes that short selling chiefly

sharpens pricing efficiency in mature markets. Working with Chinese data, Li et al. [7] (2015), writing in the *Economic Research Journal*, report that short selling markedly improves the pricing efficiency of China's stock market while damping idiosyncratic price volatility. Quan and Yin [8] (2017), in the *Journal of Management World*, find that the Chinese variant of short selling lifts both the volume and the quality of corporate innovation, and does so more strongly where governance is weaker. On the heterogeneity side and the role of the institutional setting, Zhu et al. [9] (2022), in the *Journal of Finance and Economics*, record a favorable effect of loosening short-sale constraints on the labor income share of firms.

2.2 Literature on Executive Pay-performance Sensitivity

From the vantage point of principal-agent theory, information asymmetry together with governance shortcomings tends to hold executive pay-performance sensitivity down. Studies in this vein cluster around the principal-agent problem and gravitate toward three themes: the incentive role and effectiveness of compensation, the stickiness of pay, and the strengthening of corporate governance. Fang et al. [10] (2016) trace an indirect path, showing that short selling sharpens contract effectiveness by reining in earnings management. Chinese scholars, treating the margin trading and short-selling program as an exogenous shock, have built up a substantial body of evidence. In a much-cited piece in the *Nankai Business Review*, Ma and Tong [2] (2019) report that short selling appreciably raises executive pay-performance sensitivity and, above all, tempers pay stickiness when performance slips, with the effect standing out in firms whose governance is weaker and whose information asymmetry is more acute. Liu [3] (2021), in *Finance and Trade Research*, corroborates the rise in pay-performance sensitivity and notes that it runs stronger in non-state-owned firms and in more market-oriented regions. Hong and Chu [11] (2020) add that loosening short-selling constraints not only lifts the level of cash pay but also refines the structure of equity incentives.

3. Theoretical Analysis and Hypothesis Development

Executive pay-performance sensitivity sits at the heart of principal-agent theory. In a now-classic contribution to the *Journal of Political Economy*,

Jensen and Murphy [12] (1990) argue that, given the information asymmetry and conflicting interests separating shareholders from executives, optimal contracting calls for executive pay to be bound tightly to firm performance, the better to secure incentive compatibility and hold agency costs down. As a foundational lens in both corporate governance and contract theory, principal-agent theory traces the problem to the bond between a firm's owners and its managers. Two strains of tension lie at its core: one surfaces as conflicting interests, the other as information asymmetry. Reading executive pay-performance sensitivity off these two problems brings two points to the fore. The first, and more basic, is the conflict of interest itself: shareholders want firm value maximized, whereas executives want their own utility maximized, and because the two goals do not line up neatly, executives may trade away shareholder interests for private gain. Such conflict bites harder in large firms, where information asymmetry runs deeper and competing interests loom larger; sprawling operations and many tiers of hierarchy make it difficult for outside shareholders to gauge what executives have truly accomplished. Executives in large firms also tend to hold more power and enjoy wider room for private benefit, so pay stickiness grows more severe. The second problem, information asymmetry, is what ultimately makes incentives incompatible: unable to track managers' effort or the quality of their choices accurately and promptly, shareholders leave executives an opening to chase private benefit through devices such as earnings management and short-termism, which drives agency costs up and pulls pay sensitivity down.

H1. Relaxing short-selling constraints increases executive pay-performance sensitivity.

By what mechanism, then, does short selling reach executive pay-performance sensitivity? Our view is that two channels do most of the work. The first runs through analysts. Functioning as key information intermediaries, analysts gather, interpret, and relay corporate information and in doing so ease information asymmetry [13] (Healy & Palepu, 2001). A sizable literature finds that analyst following holds earnings management in check and lifts information transparency, to the benefit of governance [9] (Zhu et al., 2022). Once short selling is permitted, short sellers' digging for negative information draws additional analyst attention to the firm and nudges analysts toward

sharper, less dispersed forecasts. Prior evidence confirms that a stock newly added to the eligible list attracts noticeably more analysts and sees its forecast quality rise. With analyst coverage up and the information environment improved, shareholders and boards can read executives' true performance more accurately and accordingly craft compensation contracts more tightly tied to performance, which in the end lifts pay-performance sensitivity. This "constructive information flow" channel sits alongside the "restraint of negative conduct" pathway underscored by Geng et al. [14] (2021) and forms the theoretical contribution of our study. We therefore advance Hypothesis 2.

H2. The short-selling mechanism increases executive pay-performance sensitivity by increasing analyst coverage and improving the information environment.

The second channel concerns firm size as a moderator. Size weighs heavily on both how compensation contracts are designed and how well external governance performs. Larger firms usually carry deeper information asymmetry and more intricate governance structures, and although their executives are paid more, their pay can also be stickier. Such firms likewise command greater attention from the market and the media, so the information-gathering and monitoring functions of short selling may be brought to bear more easily. On that reasoning, we expect short selling to raise executive pay-performance sensitivity more decisively in large firms. Examining this heterogeneity helps delineate the boundary conditions of the governance effect of short selling and adds to the literature on external governance. We therefore advance Hypothesis 3.

H3. The effect of relaxing short-selling constraints on pay-performance sensitivity is more pronounced among large firms.

4. Empirical Results and Analysis

Drawing on an unbalanced panel of Chinese A-share listed firms over 2010 to 2024, this section puts the effect of relaxing short-selling constraints on executive pay-performance sensitivity to an empirical test. Since margin trading and short selling were not launched until March 2010, the point from which a short-selling mechanism existed at all, the sample opens in 2010. We drop financial firms, ST and *ST firms, and observations missing key variables, and we winsorize every continuous variable at the 1st and

99th percentiles. Financial, governance, and executive-pay data come from the China Stock Market and Accounting Research (CSMAR) database, and the eligible-securities list together with each inclusion date is taken from the announcements of the Shanghai and Shenzhen stock exchanges. Every regression rests on a high-dimensional fixed-effects model that nets out firm and year effects at once, with standard errors clustered by firm. How short selling governs executive compensation has been a much-discussed question of late [2][11][14] (Ma & Tong, 2019; Hong & Chu, 2020; Geng et al., 2021), and our identification leans on the familiar strategy of reading the phased expansion of eligible securities as a quasi-natural experiment [9] (Zhu et al., 2022).

The dependent variable is executive

compensation, defined as the natural logarithm of one plus the combined pay of the firm's top three executives. On the explanatory side sit a short-selling-eligibility dummy and firm performance, the latter proxied by return on assets (ROA); we mean-center each and take their product to form the Short $\times$ Performance interaction, whose coefficient is what pins down the effect of relaxing short-selling constraints on executive pay-performance sensitivity. The specification additionally holds constant a set of firm and governance characteristics: firm size, leverage, revenue growth, board size, the share of independent directors, CEO duality, the stake of the largest shareholder, ownership type, listing age, and analyst coverage. Table 1 lays out the notation and measurement of the principal variables.

Table 1. Variable Definitions and Measurement

Variable	Symbol	Type	Definition and measurement
Executive compensation	LnPay	Dependent	Natural log of the total compensation of the top three executives, plus one
Short-selling eligibility	Short	Explanatory	Equals 1 from the year the stock enters the eligible list, 0 otherwise
Firm performance	Perf	Explanatory	Return on assets: net profit divided by total assets
Short $\times$ Performance	Short $\times$ Perf	Core	Product of the mean-centered Short and Performance
Analyst coverage	Analyst	Mechanism	Natural log of the number of analysts following the firm, plus one
Firm size	Size	Control	Natural log of total assets at year-end
Leverage	Lev	Control	Total liabilities divided by total assets at year-end
Revenue growth	Growth	Control	Year-on-year growth rate of operating revenue
Board size	Board	Control	Natural log of the number of directors
Independent-director ratio	Indep	Control	Proportion of independent directors on the board
CEO duality	Dual	Control	Equals 1 if the chair and CEO are the same person, 0 otherwise
Largest-shareholder ownership	Top1	Control	Shares held by the largest shareholder as a share of total shares
Ownership type	SOE	Control	Equals 1 if state-controlled, 0 otherwise
Listing age	Age	Control	Natural log of the number of years listed, plus one

Note: Which controls to include, and how to measure them, follows established practice in the executive-pay and corporate-governance literature [2][11] (Ma & Tong, 2019; Hong & Chu, 2020). For robustness, the dependent variable is switched to the log of the average pay of the top three executives and performance is switched to return on equity (ROE), while cash holdings, executive shareholding, institutional ownership, and firm risk enter the extended regressions as optional controls. Time-invariant regressors such

as ownership type are swept out by firm fixed effects in the two-way fixed-effects setup.

4.1 Descriptive Statistics

Table 2 sets out the descriptive statistics for the main variables. Executive compensation, the dependent variable, averages 14.642 with a standard deviation of 0.709. The spread of the control variables lines up broadly with earlier studies, and winsorizing leaves no conspicuous outliers behind.

Table 2. Descriptive Statistics of the Main Variables

Variable	N	Mean	SD	Min	Median	Max
Executive compensation (LnPay)	47801	14.642	0.709	12.946	14.618	16.581
Return on assets (ROA)	47801	0.039	0.064	-0.203	0.039	0.207
Return on equity (ROE)	47742	0.059	0.128	-0.576	0.071	0.331
Short-selling eligibility (Short)	47801	0.412	0.492	0.000	0.000	1.000

Performance decline (Down)	45030	0.468	0.499	0.000	0.000	1.000
Firm size (Size)	47801	22.186	1.294	19.926	21.983	26.071
Leverage (Lev)	47801	0.413	0.208	0.055	0.402	0.889
Revenue growth (Growth)	47801	0.139	0.337	-0.516	0.092	1.740
Board size (Board)	47801	2.110	0.195	1.609	2.197	2.565
Independent-director ratio (Indep)	47801	37.731	5.340	33.330	36.360	57.140
CEO duality (Dual)	47801	0.304	0.460	0.000	0.000	1.000
Largest-shareholder ownership (Top1)	47801	0.338	0.148	0.088	0.315	0.727
State ownership (SOE)	47801	0.341	0.474	0.000	0.000	1.000
Listing age (Age)	47801	2.036	0.957	0.000	2.197	3.401
Analyst coverage (Analyst)	47801	1.312	1.181	0.000	1.099	3.761
Cash holdings (Cash)	47801	0.193	0.139	0.016	0.154	0.681
Executive shareholding (Mshare)	46519	14.961	20.162	0.000	1.798	67.960
Institutional ownership (Insti)	47757	0.429	0.249	0.005	0.440	0.906
Firm risk (Risk)	45363	0.127	0.062	0.042	0.114	0.392
Information asymmetry (InfoAsym)	26542	0.307	0.411	0.000	0.184	2.914
R&D intensity (RDRatio)	33022	5.682	6.035	0.030	4.060	35.850
Risk-taking (RiskTaking)	40186	0.029	0.031	0.001	0.018	0.168

Note: Information asymmetry, R&D intensity, and risk-taking serve as mechanism-test variables; data availability limits their sample sizes, with information asymmetry observable only from 2012 onward.

4.2 Correlation Analysis and Multicollinearity Test

Table 3 presents the Pearson correlations among the main variables. To check for multicollinearity we turn to the variance inflation factor (VIF); every variable's VIF sits well under the customary cutoff of 10, and the average is 1.51, so multicollinearity poses no real concern for the model.

Table 3. Correlation Matrix of the Main Variables

Variable	LnPay	Short	ROA	Size	Lev	Growth
LnPay	1.000					
Short	0.384	1.000				
ROA	0.133	0.012	1.000			
Size	0.438	0.478	-0.018	1.000		
Lev	0.073	0.069	-0.383	0.493	1.000	
Growth	0.019	-0.055	0.288	0.031	0.027	1.000

Note: Any correlation coefficient exceeding 0.02

in absolute value is significant at the 1% level. The mean VIF is 1.51.

4.3 Baseline Regression Results

Table 4 lays out the baseline estimates. Column (1) carries only short-selling eligibility and firm performance; column (2) brings in their mean-centered interaction; and column (3) adds the full slate of firm and governance controls. The Short $\times$ Performance interaction is the central term measuring how the short-selling regime bears on pay-performance sensitivity.

The estimates show the Short $\times$ Performance term staying significantly positive throughout: it registers 0.504 (significant at the 1% level) in column (2) and, once every control is in place, 0.201 (significant at the 5% level) in column (3). Put differently, firms newly admitted to the eligible list display markedly tighter linkage between executive pay and performance than firms left outside it, so relaxing short-selling constraints reinforces the incentive bite of executive compensation contracts. Hypothesis H1 thus finds support [2][14] (Ma & Tong, 2019; Geng et al., 2021).

Table 4. Relaxation of Short-Selling Constraints and Executive Pay-Performance Sensitivity: Baseline Regression

Variable	(1)	(2)	(3)
Short-selling eligibility (Short)	0.098*** (0.010)	0.099*** (0.010)	0.017* (0.010)
Firm performance (Perf)	1.202*** (0.060)	1.210*** (0.059)	1.045*** (0.060)
Short $\times$ Performance		0.504*** (0.095)	0.201** (0.091)
Firm size (Size)			0.212*** (0.011)
Leverage (Lev)			0.021 (0.035)
Revenue growth (Growth)			-0.014** (0.006)

Board size (Board)			0.159*** (0.035)
Independent-director ratio (Indep)			0.000 (0.001)
CEO duality (Dual)			-0.031*** (0.009)
Largest-shareholder ownership (Top1)			-0.262*** (0.065)
State ownership (SOE)			(Absorbed)
Listing age (Age)			0.014* (0.009)
Analyst coverage (Analyst)			0.041*** (0.004)
Firm fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Observations	47740	47740	47740
Adjusted R ²	0.780	0.780	0.801

Note: Firm-level cluster-robust standard errors appear in parentheses; *, **, and *** mark significance at the 10%, 5%, and 1% levels, respectively. Time-invariant variables are absorbed by firm fixed effects, as in the tables that follow.

4.4 Test under the Bad-News Scenario

Extending the baseline, Table 5 introduces a triple interaction among short selling, performance, and a performance-decline indicator. Its coefficient comes in at 0.197, matching in sign the conjecture

Table 5. Bad-News Scenario Test: Triple Interaction and Subsample Regressions

Variable	Full sample (triple)	Performance-decline	Performance-upturn
Short-selling eligibility (Short)	0.023** (0.010)	0.028** (0.013)	0.015 (0.011)
Firm performance (Perf)	1.243*** (0.084)	0.797*** (0.074)	1.352*** (0.103)
Performance decline (Down)	-0.007* (0.003)		
Short × Performance	0.101 (0.131)	0.180 (0.121)	0.277* (0.147)
Short × Decline	0.003 (0.007)		
Performance × Decline	-0.380*** (0.063)		
Short × Performance × Decline	0.197 (0.123)		
Control variables	Yes	Yes	Yes
Firm / Year fixed effects	Yes	Yes	Yes
Observations	44788	20361	23270
Adjusted R ²	0.800	0.785	0.805

Note: Column (2) covers the performance-decline (Down = 1) subsample and column (3) the performance-upturn (Down = 0) subsample; the controls match Table 4 and are suppressed here to save space.

4.5 Mechanism Test: the Information-environment (Analyst Coverage) Channel

One route by which short selling could deliver its compensation-governance effect runs as follows: short sellers, motivated to surface and publicize a firm's negative information, draw more analysts to the stock and thereby brighten its information environment, which lets shareholders peg executive pay more precisely to genuine performance [15][16] (Li & Ma, 2017; Yao & Li, 2018). Table 6 examines this information-

that the effect intensifies under bad news, yet it falls short of the 10% threshold ($p \approx 0.11$). Splitting the sample, in fact, places Short × Performance higher in the performance-upturn group (0.277, significant at the 10% level) than in the performance-decline group (0.180, not significant). The auxiliary prediction that the effect is stronger when news is bad therefore lacks robust backing; we keep it as an exploratory conjecture, and it leaves the validity of the core result H1 untouched.

environment route: column (1) takes analyst coverage as the dependent variable, while column (2) folds analyst coverage and its interaction with performance into the main model.

The results bear this out: short-selling eligibility raises analyst coverage by a significant margin (coefficient 0.112, significant at the 1% level), so path a holds; the analyst-coverage-by-performance interaction is significantly positive (0.227, significant at the 1% level), meaning that heavier analyst following goes hand in hand with stronger pay-performance sensitivity. Once this channel enters the model, the Short × Performance coefficient drops from its baseline 0.201 to 0.119 and loses significance, a sign that the short-selling regime's effect on pay-performance sensitivity flows in large part

through the analyst-coverage information channel. We probe the indirect effect further with a Sobel test and a firm-clustered bootstrap (1,000 replications): the indirect effect comes to 0.006, and its bootstrap 95% confidence interval, [0.0039, 0.0084], lies clear of zero ($p < 0.001$), so the mediation is statistically real. On balance,

Hypothesis H2 holds: short selling lifts executive pay-performance sensitivity by widening analyst coverage and improving the information environment, in keeping with the price-discovery and external-monitoring roles of short selling [2][14] (Ma & Tong, 2019; Geng et al., 2021).

Table 6. Mechanism Test: The Information-Environment (Analyst Coverage) Channel

Variable	(1) Analyst coverage	(2) Executive compensation
Short-selling eligibility (Short)	0.112*** (0.019)	0.017* (0.010)
Firm performance (Perf)		1.100*** (0.060)
Short $\times$ Performance		0.119 (0.091)
Analyst coverage		0.038*** (0.004)
Analyst coverage $\times$ Performance		0.227*** (0.041)
Firm size (Size)	0.546*** (0.017)	0.218*** (0.011)
Leverage (Lev)	-0.944*** (0.059)	0.006 (0.035)
Revenue growth (Growth)	0.240*** (0.012)	-0.016** (0.006)
Board size (Board)	0.084 (0.062)	0.157*** (0.035)
Independent-director ratio (Indep)	0.001 (0.002)	0.000 (0.001)
CEO duality (Dual)	0.039** (0.017)	-0.031*** (0.009)
Largest-shareholder ownership (Top1)	0.332*** (0.113)	-0.254*** (0.065)
State ownership (SOE)	(Absorbed)	(Absorbed)
Listing age (Age)	-0.097*** (0.017)	0.016* (0.009)
Firm / Year fixed effects	Yes	Yes
Observations	47740	47740
Adjusted R ²	0.664	0.802

Note: Column (1) uses analyst coverage as the dependent variable and accordingly omits it from the controls. For the indirect effect, the Sobel test and a bootstrap (1,000 replications, clustered by firm) return a 95% confidence interval of [0.0039, 0.0084], which excludes zero.

For contrast, we put two rival channels to the test: information asymmetry and executive risk-taking (Table 7). Short-selling eligibility leaves analysts' earnings-forecast dispersion (our information-asymmetry proxy) essentially unmoved, and its bearing on risk-taking and R&D intensity is

likewise insignificant and negative in sign; under the bootstrap, none of the corresponding indirect effects reaches significance. The implication is that short selling exerts its compensation-governance effect mainly by improving the information environment captured through analyst coverage, rather than through a conventional fall in information asymmetry or a rise in risk-taking. The negative coefficient on risk-taking squares with the "pressure view" [11] (Hong & Chu, 2020).

Table 7. Screening of Alternative Channels: Information Asymmetry and Executive Risk-Taking

Variable	Info. asymmetry	Exec. comp.	Risk-taking	Exec. comp.	R&D intensity
Short-selling eligibility (Short)	-0.008 (0.010)	0.029** (0.011)	-0.001 (0.001)	0.024** (0.010)	0.148 (0.094)
Firm performance (Perf)		1.298*** (0.089)		1.750*** (0.088)	
Short $\times$ Performance		0.080 (0.125)		0.101 (0.097)	
Info. asymmetry $\times$ Performance		-0.310*** (0.105)			
Risk-taking $\times$ Performance				-12.559*** (0.937)	
Control variables	Yes	Yes	Yes	Yes	Yes
Firm / Year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	26218	26218	39749	39749	32946
Adjusted R ²	0.194	0.824	0.379	0.799	0.854

Note: The dependent variables in columns (1), (3), and (5) are information asymmetry, risk-taking,

and R&D intensity, respectively; columns (2) and (4) take executive compensation as the dependent variable and include the relevant mediator together with its interaction with performance; controls remain as before. Because risk-taking is small in magnitude, its interaction coefficient is large in absolute terms.

4.6 Heterogeneity Analysis: Firm Size

Hypothesis H3 holds that short selling moves pay-performance sensitivity more forcefully in large firms, the reasoning being that bigger firms run more transparent information environments and pull in more short sellers and analysts, so external governance pressure converts more readily into better compensation contracts. Panel

Table 8. Panel A Heterogeneity Analysis: Ownership Type and Analyst Coverage

Variable	SOEs	Non-SOEs	High analyst	Low analyst
Short-selling eligibility (Short)	0.022 (0.014)	0.010 (0.013)	0.026** (0.011)	0.003 (0.017)
Firm performance (Perf)	1.508*** (0.122)	0.872*** (0.067)	1.391*** (0.087)	0.711*** (0.079)
Short $\times$ Performance	0.184 (0.186)	0.143 (0.103)	0.096 (0.124)	0.090 (0.137)
Control variables	Yes	Yes	Yes	Yes
Firm / Year fixed effects	Yes	Yes	Yes	Yes
Observations	16297	31443	26093	20597
Adjusted R ²	0.784	0.814	0.832	0.777

Note: Analyst coverage is divided into high and low groups at the sample median; controls are those of Table 4.

Table 9. Panel B Heterogeneity Analysis: Firm Size

Variable	Large firms	Small firms
Short-selling eligibility (Short)	0.047*** (0.012)	0.015 (0.016)
Firm performance (Perf)	1.136*** (0.094)	0.745*** (0.075)
Short $\times$ Performance	0.409*** (0.131)	-0.174 (0.120)
Control variables	Yes	Yes
Firm / Year fixed effects	Yes	Yes
Observations	23699	23601
Adjusted R ²	0.801	0.802

A of Table 8 first partitions the sample by ownership type and by the median of analyst coverage; across every one of these subsamples the Short $\times$ Performance interaction stays insignificant, and the gaps between groups are slight. Panel B, reported in Table 9, instead cuts the sample at the median of firm size: the Short $\times$ Performance interaction reaches 0.409 (significant at the 1% level) among large firms yet remains insignificant among small ones. A formal check, the triple interaction of short selling, performance, and a large-firm dummy, returns a coefficient of 0.494, significant at the 1% level ($p = 0.003$), which statistically pins down the difference in sensitivity across the two groups. H3 is borne out.

Note: Groups are formed at the sample median of firm size; the Short $\times$ Performance $\times$ Large triple-interaction coefficient is 0.494 ($p = 0.003$), and the difference across groups is significant at the 1% level.

4.7 Robustness Checks

Table 10 reports three alternative specifications: one swaps the dependent variable for the average-pay measure of the top three executives, another replaces performance with return on equity (ROE), and a third adds optional controls such as cash holdings. Across them the Short $\times$ Performance interaction comes in at 0.203 (significant at the 5% level), 0.118 (significant at the 1% level), and 0.168 (significant at the 10% level), with both sign and significance in line with the baseline.

Table 10. Robustness Checks: Variable Replacement and Extended Controls

Variable	Average-pay measure	Performance = ROE	With optional controls
Short-selling eligibility (Short)	0.016* (0.010)	0.018* (0.010)	0.021** (0.010)
Firm performance (Perf)	1.046*** (0.060)	0.443*** (0.026)	1.015*** (0.061)
Short $\times$ Performance	0.203** (0.091)	0.118*** (0.045)	0.168* (0.094)
Firm size (Size)	0.212*** (0.011)	0.208*** (0.011)	0.203*** (0.011)
Leverage (Lev)	0.020 (0.035)	0.013 (0.035)	0.028 (0.036)
Revenue growth (Growth)	-0.014** (0.006)	-0.010 (0.006)	-0.017*** (0.007)
Board size (Board)	0.159*** (0.035)	0.162*** (0.035)	0.162*** (0.037)

Independent-director ratio (Indep)	0.000 (0.001)	0.000 (0.001)	0.001 (0.001)
CEO duality (Dual)	-0.031*** (0.009)	-0.031*** (0.009)	-0.032*** (0.009)
Largest-shareholder ownership (Top1)	-0.262*** (0.065)	-0.273*** (0.065)	-0.292*** (0.069)
State ownership (SOE)	(Absorbed)	(Absorbed)	(Absorbed)
Listing age (Age)	0.014 (0.009)	0.000 (0.009)	0.008 (0.011)
Analyst coverage (Analyst)	0.041*** (0.004)	0.043*** (0.004)	0.044*** (0.004)
Optional controls	—	—	Included
Firm / Year fixed effects	Yes	Yes	Yes
Observations	47740	47681	43936
Adjusted R ²	0.801	0.801	0.801

Note: In column (2), "firm performance" and "Short $\times$ Performance" refer to return on equity (ROE) and its mean-centered interaction; the optional controls in column (3) are cash holdings, executive shareholding, institutional ownership, and firm risk.

Beyond these, the parallel-trends test (Table 11) shows the performance interaction terms to be insignificant in every pre-treatment period, with a joint-test F of 1.01 ($p = 0.364$), so the parallel-trends assumption is satisfied; the interaction two periods after treatment turns significantly positive (0.217, at the 10% level), which says the strengthening effect builds up gradually once treatment occurs, in keeping with how compensation contracts are typically reset on an annual cycle. In the propensity-score-matched difference-in-differences (PSM-DID) exercise, the Short $\times$ Performance coefficient is 0.066, positive in sign but not significant; since matching shrinks the sample sharply and saps statistical power, and since the baseline, variable-replacement, and parallel-trends results all back the main effect firmly, this does not unsettle the overall conclusion. The placebo test then assigns treatment at random 500 times, and not one pseudo-treatment produces a pseudo-coefficient as large as the actual estimate (0.201), for an empirical p-value of 0.000, confirming that the main effect is not an artifact of random sampling noise.

Table 11. Parallel Trends and Dynamic Effects

Performance interaction term	Coefficient (SE)
Performance $\times$ 2 periods before	0.123 (0.088)
Performance $\times$ 1 period before	-0.062 (0.082)
Performance $\times$ current period	-0.016 (0.117)
Performance $\times$ 1 period after	0.024 (0.111)
Performance $\times$ 2 periods after	0.217* (0.116)
Pre-treatment joint test F(2, 5201)	1.01 ($p = 0.364$)

Note: The model includes firm and year fixed effects together with the full set of controls, and standard errors are clustered by firm; the control group is made up of firms never placed on the short-selling eligible list during the sample window.

5. Conclusions and Implications

5.1 Conclusions

Working with a sample of Chinese A-share listed firms over 2010 to 2024 and treating the phased expansion of the margin trading and short-selling eligible list as a quasi-natural experiment, this paper applies a two-way fixed-effects model to study how relaxing short-selling constraints affects executive pay-performance sensitivity and through what mechanism. The main findings are as follows.

First, loosening short-selling constraints lifts executive pay-performance sensitivity by a significant margin, which supports Hypothesis H1. The baseline Short $\times$ Performance coefficient of 0.201, significantly positive at the 5% level, says that once a firm joins the eligible list the responsiveness of its executives' pay to performance rises appreciably, and that short selling sharpens the incentive effectiveness of executive compensation contracts. The conclusion survives switching the dependent variable, switching the performance measure, and broadening the controls, and it clears both the placebo test (empirical $p = 0.000$) and the parallel-trends test (pre-treatment joint test $p = 0.364$), so the evidence is robust and trustworthy. Second, short selling works chiefly by drawing in more analysts and bettering the information environment, which supports Hypothesis H2. Eligibility raises analyst coverage significantly (coefficient 0.112, significant at the 1% level); the analyst-coverage-by-performance interaction is significantly positive (0.227, significant at the 1%

level); and the bootstrap 95% confidence interval for the indirect effect, [0.0039, 0.0084], excludes zero. With this channel in the model the Short $\times$ Performance interaction is no longer significant, indicating that the strengthening effect is realized largely through a better information environment. The two competing channels, a drop in information asymmetry and a rise in executive risk-taking, draw no empirical support.

Third, the effect of relaxing short-selling constraints on pay-performance sensitivity stands out among large firms, which supports Hypothesis H3. Within the large-firm subsample the Short $\times$ Performance interaction is 0.409 (significant at the 1% level), whereas for small firms it is insignificant; the Short $\times$ Performance $\times$ Large triple-interaction coefficient of 0.494, significant at the 1% level ($p = 0.003$), statistically confirms the size-based heterogeneity. This fits the logic that large firms keep more transparent information environments, attract more outside scrutiny, and pass governance pressure through to compensation contracts more readily.

On a related point, the auxiliary prediction that the strengthening effect is more marked under bad news is not robustly supported: although the triple interaction carries the anticipated sign, it does not clear the 10% threshold ($p \approx 0.11$). We accordingly retain it as an exploratory conjecture, one that leaves the validity of the core result H1 intact.

5.2 Policy and Managerial Implications

First, for regulators: the menu of eligible securities for margin trading and short selling deserves to be widened steadily and the trading rules around short selling refined further, so that its price-discovery and external-monitoring functions are put to full use. Short selling is better seen as a market-based institutional complement for improving executive compensation contracts and for raising the allocative efficiency of the capital market than as a mere source of market volatility.

Second, for listed firms: they would do well to raise the quality and transparency of their disclosure so as to draw more analyst coverage and outside attention, which in turn lets shareholders tie executive pay more accurately to true performance and, under the discipline of external governance, refine the design of compensation contracts and ease principal-agent conflicts.

Third, the governance effect of short selling is not uniform across firm sizes. In small- and mid-cap firms, where information environments are thinner and outside attention scarcer, short selling transmits only weakly; these firms should put more weight on getting internal governance mechanisms such as the board and equity incentives to work in concert, rather than leaning on external market discipline alone.

5.3 Limitations and Future Research

First, we capture the information-environment channel with analyst coverage. While this does mirror the outward result of short sellers' information mining, it cannot trace the full process by which short-selling activity reshapes the information environment; the mediator is identified outside an experimental design, so omitted variables may still cloud the causal chain. Future work could go deeper by pairing granular short-selling transaction data with finer measures of the information environment.

Second, a stock's entry onto the eligible list is not wholly random. We address this with propensity-score-matched difference-in-differences and a placebo test, yet PSM-DID shrinks the matched sample sharply and limits statistical power, which renders the core interaction term insignificant; future studies could test the external validity of these conclusions over a longer horizon and with a larger sample.

Third, the auxiliary prediction about bad news is not robustly supported, and whether short selling's effect on compensation contracts aligns better with the "pressure view" or the "constraint view" remains an open question. Settling it will require sharper identification drawing on more granular trading features such as negative earnings surprises and short-selling volume.

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