Proceedings of the 10th International Conference on Economic Management and Green Development
DOI: 10.54254/2754-1169/2026.35903

Can the Convexity of Equity Incentive Contracts Shape Executive Risk Preferences and Innovation Orientation?

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Abstract. Using Chinese A-share listed firms from 2005 to 2024, this paper systematically identifies whether equity incentives shape executive risk preferences and further affect firms' innovation orientation. To mitigate the negative weights and "bad comparison" problem of two-way fixed effects estimators under staggered adoption, this paper introduces cohort-robust estimators, randomization inference, two-way clustered standard errors, firm-block bootstrap mediation tests, and dose-response curves in addition to conventional event studies. The main findings are as follows. First, the implementation of equity incentives significantly increases executive risk preferences; in the cohort-robust event study, pre-treatment trends are flat and post-treatment effects increase monotonically. Second, the positive effect on innovation orientation is highly fragile: although the static model yields a significantly positive estimate, the Sun-Abraham estimates decline after treatment and even become significantly negative, suggesting that the positive coefficient from conventional TWFE is mainly driven by bias from staggered treatment. Third, the stimulated risk preference is consistently translated into real R&D investment, but not into innovation discourse in annual reports. Fourth, incentive intensity exhibits an inverted U-shaped relationship with both risk preference and innovation orientation. Accordingly, this paper argues that the policy value of equity incentives lies in channeling induced risk taking into real R&D investment and long-term value creation through moderate intensity, longer contract duration, and innovation-oriented performance clauses.

Keywords: Equity incentives, Contract convexity, Executive risk preference, Staggered difference-in-differences

1. Introduction

Equity incentives are a core governance instrument through which listed firms link managerial wealth to shareholder value. Since the promulgation of the Measures for the Administration of Equity Incentives of Listed Companies (Trial) in 2005 and the gradual standardization of related institutions, Chinese A-share listed firms have widely adopted stock options, restricted stock, and executive shareholding arrangements in an attempt to alleviate agency conflicts arising from the separation of ownership and control. However, innovation activities are characterized by high investment, long cycles, irreversibility, and highly uncertain outcomes. Whether equity incentives encourage executives to bear innovation-related risks, or instead induce conservatism, short-term

DOI: 10.54254/2754-1169/2026.35903

arbitrage, or selective disclosure because of wealth binding and exercise-performance pressure, remains a central debate in corporate finance and corporate governance. What exactly does the "convexity" of incentive contracts reshape in executives: the willingness to bear uncertainty, or an observable innovation posture? Are the two necessarily aligned?

The key to this debate is that equity incentives are not merely a change in compensation level; they alter the shape of executives' payoff functions. Option-like contracts feature typical convexity: losses are limited in downside states, while payoffs expand as stock prices rise in upside states. Following the contract-convexity logic of Guay and Ross, a convex payoff structure reduces risk-averse managers' perceived penalty for failure and thereby increases their willingness to take risks [1, 2]. In China's capital market, restricted stock is used more frequently, and exercise or vesting conditions are often tied to net profit, operating revenue, or stock price performance. When executives' wealth is excessively concentrated in firm value, motives for risk avoidance and short-term market-value management may also strengthen simultaneously [3]. Therefore, the research question of this paper is: what type of risk preference do incentive contracts shape, and how, and under what conditions, is it transmitted to innovation orientation and real R&D investment?

Using a long panel of Chinese A-share listed firms from 2005 to 2024, this paper incorporates three layers - willingness to take risk, innovation discourse, and real R&D investment - into a unified empirical framework. Methodologically, this paper goes beyond the static two-way fixed effects (TWFE) regressions commonly used in prior studies. Because equity incentives are adopted in a staggered manner across 20 annual cohorts in the sample, the standard TWFE difference-in-differences coefficient may be biased by the bad comparison in which already treated units serve as controls. Accordingly, this paper introduces the Goodman-Bacon decomposition perspective (never-treated firms, the clean controls, account for 47.3% of the sample) and re-estimates dynamic effects using the interaction-weighted cohort-robust estimator of Sun and Abraham, supplemented by randomization inference, two-way clustering, bootstrap mediation, and dose-response analysis [4, 5].

The marginal contributions of this paper are threefold. First, in terms of the research question, it strictly distinguishes contract convexity, risk preference, and innovation into three layers - willingness, resources, and discourse - correcting the practice of equating innovation simply with annual-report keywords or a single output indicator, and revealing the boundary of the "malleability" of equity-incentive effects. Second, in terms of policy implications, the analysis advances from "whether to implement equity incentives" to "how to design equity incentives," and provides actionable ranges of incentive intensity and recommendations by comparing inverted U-shaped turning points and contract forms. This study both extends a localized theoretical framework for the transmission from contract convexity to executive risk behavior and provides implementable quantitative empirical evidence for the refined design of equity-incentive schemes in A-share firms and for long-term innovation-governance regulation in capital markets.

2. Literature review and research hypotheses

Principal-agent theory holds that the separation of ownership and control may lead managers to avoid risk, pursue private benefits, or prefer short-term verifiable projects [6]. Related studies by Jensen and Murphy and Yang emphasize that performance-based incentive contracts can alleviate goal conflicts between shareholders and managers [7, 8]. Lu et al. discuss the institutional background and governance motives behind listed firms' choice of equity-incentive plans and note that incentives in the Chinese context often have a "welfare-oriented" character [9, 10]. From the perspective of investment behavior, Lu and Zhang find that equity incentives reduce agency costs by restraining inefficient investment [10]. Xu further points out that equity incentives can alleviate investment distortions induced by uncertainty. These studies provide a foundation for understanding the governance effects of equity incentives, but pay insufficient attention to "executive risk preference," an intermediate mechanism closer to the contract payoff function [11]. Meanwhile, corporate governance quality and ownership type jointly affect corporate innovation, and corporate governance has a stronger innovation-promoting effect in private firms, indicating that the innovation effect of incentive contracts must be understood within governance structures and ownership constraints [12].

Regarding equity incentives and risk taking, existing research offers two competing explanations. The first is the agency-cost, or risk-alignment, hypothesis: equity-based incentives improve interest alignment between managers and shareholders and, through option convexity, increase managers' willingness to undertake risky projects with positive net present value. The second is the risk-aversion, or wealth-concentration, hypothesis: once executives' human capital and personal wealth are highly tied to the firm, they may become more concerned about fluctuations in firm value and instead reduce risk taking. Focusing on these two mechanisms, Li and Zhang find an inverted U-shaped relationship between executive shareholding and risk taking, with a turning point of approximately 18%-20%, and the relationship is significant only in highly competitive industries. Recent studies that place compensation incentives and equity incentives in the same framework also find that both types of incentives promote corporate innovation; however, risk taking acts as a partial mediator for compensation incentives and may play a masking role for equity incentives, further indicating that the risk-taking mechanism is not linearly consistent [13]. Furthermore, tax and fee policies can increase corporate risk taking through cash-flow and technological-progress effects, and risk taking changes the value of firms' growth options and liquidation options under different performance states [14, 15]. This paper agrees that the above mechanisms are not mutually exclusive and further argues that incentive intensity and contract form determine which mechanism dominates. This constitutes the theoretical basis for the tests of inverted U-shaped effects, contract-design heterogeneity, and long-term value orientation [3].

Regarding equity incentives and corporate innovation, Tian and Meng use the 2008 memorandum of the China Securities Regulatory Commission as a quasi-natural experiment and, using PSM+DID, find that equity incentives significantly promote innovation input and output, with stronger effects in private firms, firms with higher stock-price informativeness, and firms that include core technical personnel [16]. From the perspective of contract heterogeneity, Li et al. find that equity-incentive plans significantly improve innovation input and output, mainly by increasing corporate risk taking, stabilizing innovation teams, strengthening interest alignment, and enhancing monitoring effects [17]. From the perspective of executives' innovation awareness, Huang and Shao emphasize that managerial cognition affects innovation performance through the mediation of R&D investment [18]. Meanwhile, the executive incentives affect innovation investment through dual motivations, and that slack resources and the corporate life cycle moderate this effect [19]. Notably, text- or discourse-based measures of innovation orientation may be affected by annual-report templates, regulatory discourse, and disclosure strategies, and cannot be mechanically equated with patent output or R&D investment. Therefore, in the empirical analysis this paper simultaneously examines innovation keywords (discourse), alternative innovation indicators, and the R&D expense ratio (real input), and re-evaluates the robustness of innovation effects using cohort-robust methods [12].

Based on the above theory, this paper proposes the following research hypotheses:

H1: Holding other conditions constant, the implementation of equity incentives significantly increases executive risk preferences.

DOI: 10.54254/2754-1169/2026.35903

H2a (discourse hypothesis): Equity incentives enhance firms' innovation orientation, measured by innovation discourse in annual reports.

H2b (fragility hypothesis): After mitigating staggered-treatment bias, the positive effect of equity incentives on innovation discourse is not robust and may even turn negative.

H3: Executive risk preference plays a mediating role in the effect of equity incentives on innovation, but this mediation is reflected more in real R&D investment than in innovation discourse.

H4: There is an inverted U-shaped relationship between equity-incentive intensity and executive risk preference as well as innovation orientation.

H5: Contract form affects incentive effectiveness. Although stock options have stronger theoretical convexity, under China's institutional environment, restricted stock may exhibit a stronger actual risk-shaping effect because of stable coverage and clearer constraints.

3. Research design

3.1. Data sources and sample processing

This paper takes Chinese A-share listed firms from 2005 to 2024 as the initial sample and merges six data modules: equity-incentive indicators, equity-incentive plan and implementation details, executive risk preference, executives' innovation-awareness culture, profitability indicators, and raw financial data (see Table 1). After excluding financial firms, ST/PT firms, and observations with missing core variables, the final sample contains 54,795 firm-year observations covering 5,442 listed firms. Among them, 4,890 observations correspond to firms implementing equity incentives in the current year; 2,866 firms implemented equity incentives at least once during the sample period (ever treated), and 2,576 firms never implemented them (clean controls). Continuous variables are winsorized at the 1st and 99th percentiles. All data are obtained from listed firms' financial reports and the CSMAR database.

Table 1. Data sources and variable construction

Data module	Variables used
Equity-incentive indicators	Incentive, Option, Stock, SIP, SIV, executive shareholding ratio
Equity-incentive plans	Plan announcement date, proportion of total incentive shares, validity period, incentive target
Implementation details	Number implemented, completion status, exercise price, underlying asset
Executive risk preference	Executive risk preference ($risk_{pca}$), summed reference coefficients ($risk_{sum}$)
Innovation awareness culture	Keyword frequencies for innovation, autonomy, R&D, scientific research, new products, new technologies, and related terms
Profitability	ROA, ROE, R&D expense ratio, net profit margin
Raw financial data	Assets, liabilities, revenue, cash flow, capital expenditure, financial assets

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3.2. Variable definitions and measurement

The dependent variables are divided into three layers. (1) Executive risk preference ($risk_{pca}$): measured comprehensively using standard principal component analysis, with summed reference coefficients ($risk_{sum}$) used as an alternative indicator. (2) Innovation orientation ($innov_{log}$): following the text-analysis method of Huang Shanshan and Shao Yinghong, measured as the natural logarithm of one plus the frequency of keywords such as innovation, autonomy, R&D, scientific research, new products, new technologies, development, research, and patents in annual reports, with the keyword frequency ratio ($innov_{ratio}$) used as an alternative. (3) Real R&D investment (rd_{ratio}): measured by "R&D expenses/ operating revenue", to identify whether risk preference is transformed into actual resource allocation. This three-layer classification isused to distinguish among "willingness, resources, and discourse" [18].

The core explanatory variables capture the design of equity-incentive contracts. Incentive is a dummy variable indicating whether the firm implements equity incentives in the current year. Option and Stock denote stock options and restricted stock, respectively. SIP is the ratio of equity-incentive shares to total share capital, namely incentive intensity, and its squared term SIP^2 is constructed to test for an inverted U-shaped relationship [3, 20]. SIV indicates whether the validity period exceeds five years. Mholdrate2 measures the number of shares held by the executive team as a proportion of total share capital. Control variables include firm size (log assets), leverage, ROA, operating cash flow/assets, operating revenue growth, and the financial-asset ratio, all of which are standard controls in the corporate finance literature. The baseline model controls for firm and year two-way fixed effects, with standard errors clustered at the firm level.

3.3. Identification strategy

This paper adopts a progressively strengthened identification strategy. The baseline model is a two-way fixed effects specification:

$$Y_{it} = \beta \cdot Incentive_{it} + \gamma \cdot Controls_{it} + \mu_i + \lambda_t + \varepsilon_{it} \tag{1}$$

where μ_i , λ_t denote firm and year fixed effects, respectively. Due to equity incentives are adopted in a staggered manner during the sample period, the two-way fixed effects DID estimator is a weighted average of multiple 2x2 comparisons. The bad comparison in which "already treated units serve as controls for later-treated units" introduces negative weights and contaminates the estimates.

To address this issue, this paper further: (1) constructs a conventional event study using the first implementation as the event point to test parallel trends; (2) adopts the Sun and Abraham interaction-weighted estimator, using never-treated firms as clean controls and aggregating relative-time effects weighted by cohort shares, thereby obtaining a dynamic path free from negative-weight contamination [5]; (3) implements PSM-DID based on nearest-neighbor matching of pre-treatment firm characteristics; (4) conducts 500 rounds of randomization inference by permuting treatment status and implementation timing to obtain nonparametric placebo p-values; and (5) reports standard errors clustered two ways by firm and year.

In terms of mechanism, this paper verifies the effect of incentives on risk preference (path a, namely the discourse hypothesis), then incorporates risk preference into models of innovation discourse and R&D investment, respectively (path b, namely the fragility hypothesis), and uses a firm-block bootstrap to provide confidence intervals for the indirect effects.

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4. Empirical results and analysis

4.1. Descriptive statistics

To present the distributional characteristics of the core variables intuitively, this paper conducts descriptive statistical analysis for all sample variables; the results are reported in Table 2.

Table 2. Descriptive statistics of main variables

Variable	N	Mean	Standard deviation	P25	Median	P75
Equity incentive	54,795	0.0892	0.2851	0.0000	0.0000	0.0000
Incentive intensity	54,795	0.0027	0.0124	0.0000	0.0000	0.0000
Executive shareholding incentive	54,795	0.0795	0.1462	0.0000	0.0014	0.0857
Risk preference	54,795	-0.0147	0.4965	-0.2524	0.0241	0.2770
Innovation orientation	54,795	3.7807	0.9862	3.2581	3.8918	4.4543
Innovation keyword frequency ratio	54,795	0.0056	0.0033	0.0032	0.0053	0.0075
R&D expense ratio	25,998	0.0561	0.0696	0.0214	0.0405	0.0651
Firm size	54,795	22.0732	1.3213	21.1481	21.8804	22.7915
Asset-liability ratio	54,795	0.4252	0.6211	0.2535	0.4134	0.5751
Return on assets	54,795	0.0470	3.2426	0.0122	0.0367	0.0668
Operating cash flow	54,795	0.0471	0.0787	0.0084	0.0466	0.0880
Revenue growth rate	49,352	0.4789	23.3370	-0.0444	0.0931	0.2564

Table 2 shows that the proportion of observations implementing equity incentives is 8.92%, indicating that equity incentives have become an important but not universal long-term incentive instrument among A-share listed firms. The mean of incentive intensity (SIP) is low and the distribution is right-skewed, implying that using only the implementation dummy would underestimate differences in contract intensity. This provides the basis for introducing SIP and its squared term below. The mean innovation orientation is approximately 3.78 and slightly above the median, suggesting that innovation-related statements in listed firms' annual reports are relatively common.

Figures 1 and 2 present the annual trends in the proportion of firms implementing equity incentives and innovation orientation, as well as the trends in risk preference and innovation orientation for treated and control groups, providing intuitive background for the subsequent DID identification.

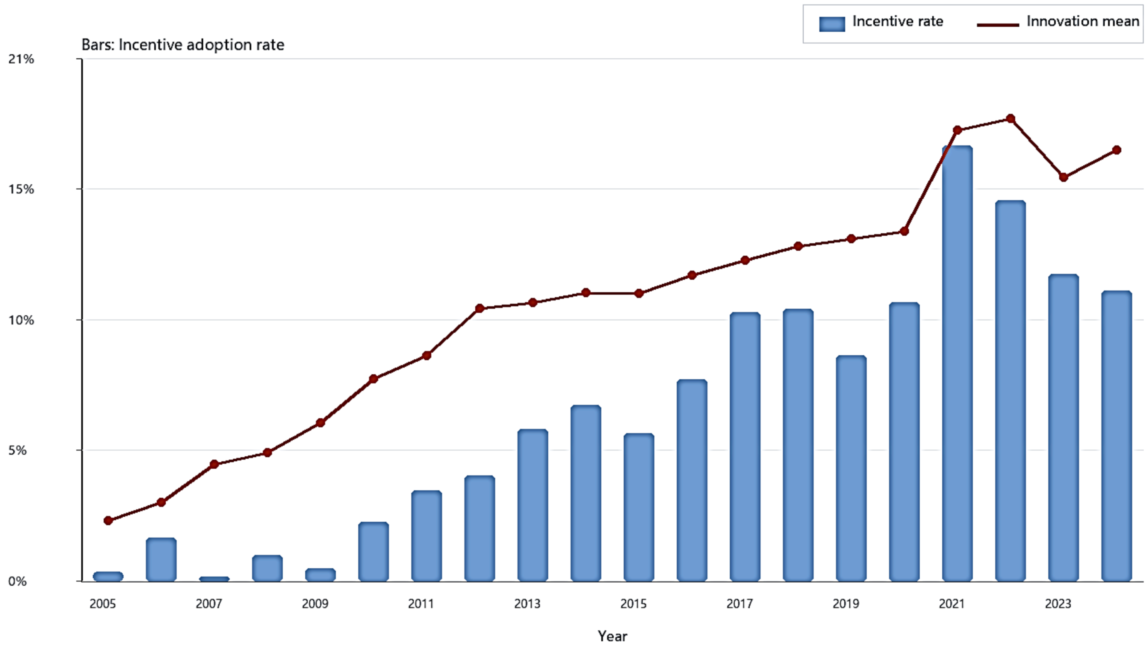

Figure 1. Expansion of equity-incentive implementation and annual trends in innovation orientation (photo credit: original)

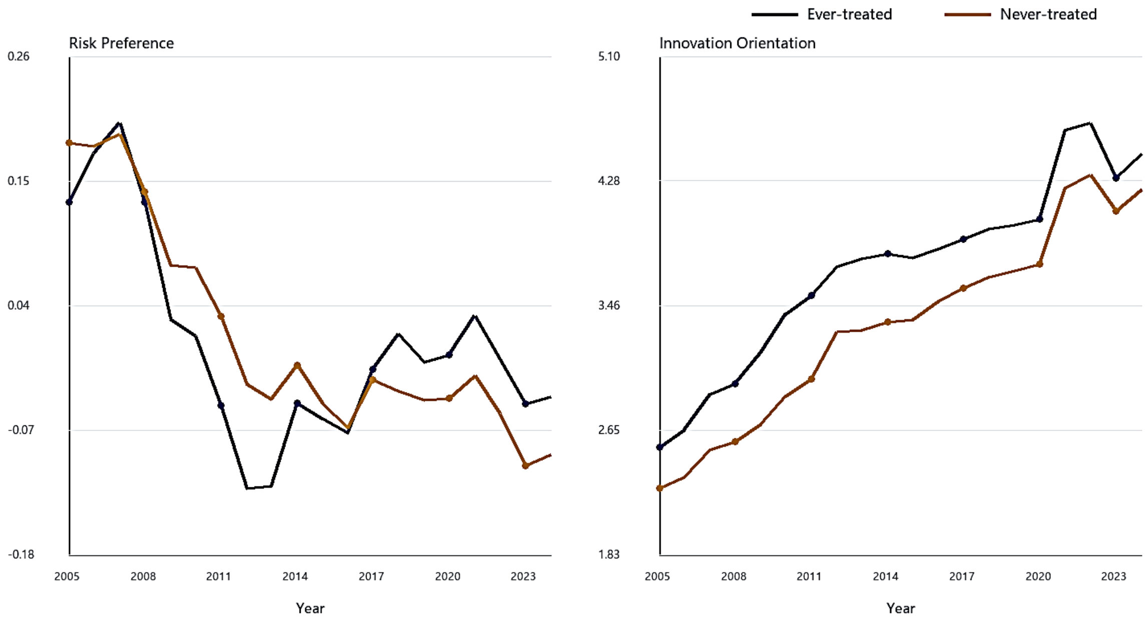

Figure 2. Trends in risk preference and innovation orientation for treated and control groups (photo credit: original)

4.2. Baseline regressions and contract-design differences

To examine how contract convexity theory applies differently in the domestic market, this section decomposes incentives into multidimensional indicators, including implementation status, type of underlying asset, and contract duration, and regresses risk preference and annual-report innovation discourse on these indicators using the baseline two-way fixed effects model. Table 3 compares the significance of marginal effects across different incentive contracts, preliminarily confirming that

DOI: 10.54254/2754-1169/2026.35903

restricted stock has a stronger effect in shaping executive risk behavior and distinguishing the short-term positive association with innovation orientation in the static model.

Table 3. Equity incentives, contract design, and executive risk preference/innovation orientation

Variable	Risk preference (1)	Innovation orientation (2)	Innovation orientation (3)
Equity incentive: Incentive	0.025*** (0.005)	0.017** (0.009)	
Stock option: Option	0.010 (0.012)		0.024 (0.020)
Restricted stock: Stock	0.029*** (0.008)		0.013 (0.014)
Validity period over five years: SIV	0.014 (0.013)		0.035 (0.026)
Executive shareholding ratio: Mholdrate2	-0.061* (0.035)		0.287*** (0.061)
Control variables	Yes	Yes	Yes
Firm/year fixed effects	Yes/Yes	Yes/Yes	Yes/Yes
N	49353	49353	49353
Within R^2	0.187	0.018	0.019

Note: Robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. All models control for firm size, leverage, ROA, operating cash flow, revenue growth, and the financial-asset ratio.

Table 3 shows that the baseline coefficient of equity incentives on executive risk preference is 0.025 and significant at the 1% level, supporting H1. The baseline coefficient on innovation orientation is 0.017 and significantly positive in the static two-way fixed effects model, preliminarily supporting H2a. However, as shown below, this innovation effect is not robust after mitigating staggered-treatment bias, suggesting that H2a may be a product of estimator choice.

In terms of contract form, the effect of restricted stock on risk preference is 0.029, whereas the coefficient on stock options is 0.010. This difference is inconsistent with the intuition that "stronger option convexity necessarily implies greater effectiveness" and instead supports the China-context inference in H5. A possible reason is that restricted stock is used frequently in China's A-share market, covers stable groups of recipients, and changes executives' actual wealth exposure more directly through lock-up periods and staged vesting arrangements. Although stock options have stronger theoretical convexity, their risk-tolerance function may be weakened by exercise prices, performance assessments, and the "out-of-the-money" state when stock prices are close to exercise prices. The executive shareholding ratio has a negative effect on risk preference and a positive effect on innovation orientation, indicating that shareholding is not a pure risk incentive: strong wealth binding reduces the willingness to take risks while strengthening managers' motivation to maintain long-term strategic narratives in public disclosure. Figure 3 depicts the marginal effects and confidence intervals of different contract designs.

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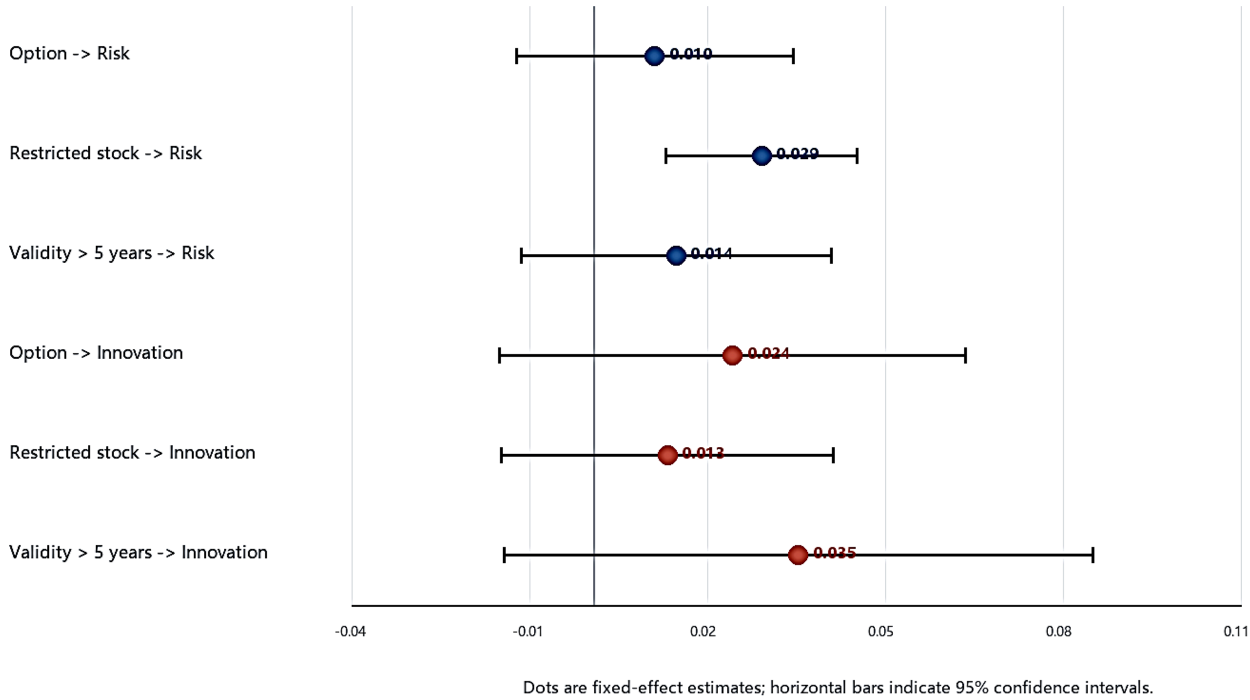

Figure 3. Marginal effects of contract-design differences (photo credit: original)

Note: Dots are coefficients; Lines are 95% confidence intervals

4.3. Mechanism tests and nonlinearity in incentive intensity

Building on the preceding analysis, this paper conducts mediation-transmission tests and nonlinear tests of incentive intensity, distinguishes the differentiated transmission paths from risk preference to "innovation discourse" and "real R&D investment," and introduces the quadratic term of incentive intensity to verify the inverted U-shaped threshold effect. Table 4integrates four sets of regression results and intuitively reveals that risk preference can stably promote only real R&D investment, while incentive intensity has an optimal range.

Table 4. Mechanism tests and nonlinearity in incentive intensity (inverted U shape)

Variable	Innovation-orientation mechanism	Risk-preference nonlinearity	Innovation-orientation nonlinearity	R&D expense ratio
Equity incentive: Incentive	0.018** (0.009)			0.000 (0.000)
Risk preference: Risk Pref	-0.018* (0.010)			0.002*** (0.001)
Incentive intensity: SIP		1.515*** (0.481)	2.093** (0.844)	
Incentive intensity²: SIP²		-20.735** (9.816)	-38.439** (16.473)	

DOI: 10.54254/2754-1169/2026.35903

Table 4. (continued)

Control variables	Yes	Yes	Yes	Yes
Firm/year fixed effects	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes
N	49353	49353	49353	24072
Within R^2	0.018	0.187	0.018	0.136

Note: All models control for firm and year fixed effects and the baseline control variables. Robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 4 shows that the coefficient of risk preference in the innovation-discourse model is -0.018, whereas the coefficient in the R&D expense ratio model is 0.002. This means that the risk preference induced by equity incentives is more likely to be translated first into real R&D investment rather than an immediate expansion of annual-report innovation discourse. To provide a statistically stricter assessment, this paper further estimates confidence intervals for mediation indirect effects using a firm-block bootstrap with 400 resamples (see Table 5). When R&D investment is the outcome, the 95% confidence interval of the indirect effect is [0.00002, 0.00008], excluding zero and therefore significant. When innovation discourse is the outcome, the interval is [-0.00061, 0.00078], including zero and therefore insignificant. This provides direct and robust evidence for H3: risk taking is a necessary condition for innovation resource allocation, but not a sufficient condition for innovation narratives.

Table 5. Mediation test of risk preference (mutual validation by Sobel and bootstrap methods)

Outcome variable	Total effect c	Direct effect c'	Path a	Path b	Indirect effect	Sobel z
Innovation orientation	0.0174**	0.0179**	0.0250***	-0.0176*	-0.00044*	-1.662
R&D expense ratio	0.0001	0.0000	0.0250***	0.0020***	0.00005***	2.894

Note: Path a is equity incentives -> risk preference. Path b is risk preference -> outcome. The Sobel z test assesses the significance of the indirect effect and is cross-validated using firm-block bootstrap confidence intervals. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

The nonlinear results support H4. In the risk-preference model, the linear term of SIP is 1.515 and the squared term is -20.735. In the innovation-orientation model, the linear term of SIP is 2.093 and the squared term is -38.439. The implied inverted U-shaped turning points are approximately 3.65% and 2.72%, respectively (Figure 4), indicating that moderate incentives are most conducive to stimulating risk taking and innovation expression, whereas excessive intensity may suppress the effect because of excessive wealth concentration, exercise pressure, or short-term stock-price management. This turning point is logically consistent with the inverted U-shaped relationship between executive shareholding and risk taking documented by Li and Zhang, and provides a direct quantitative reference for listed firms when setting incentive ratios [3].

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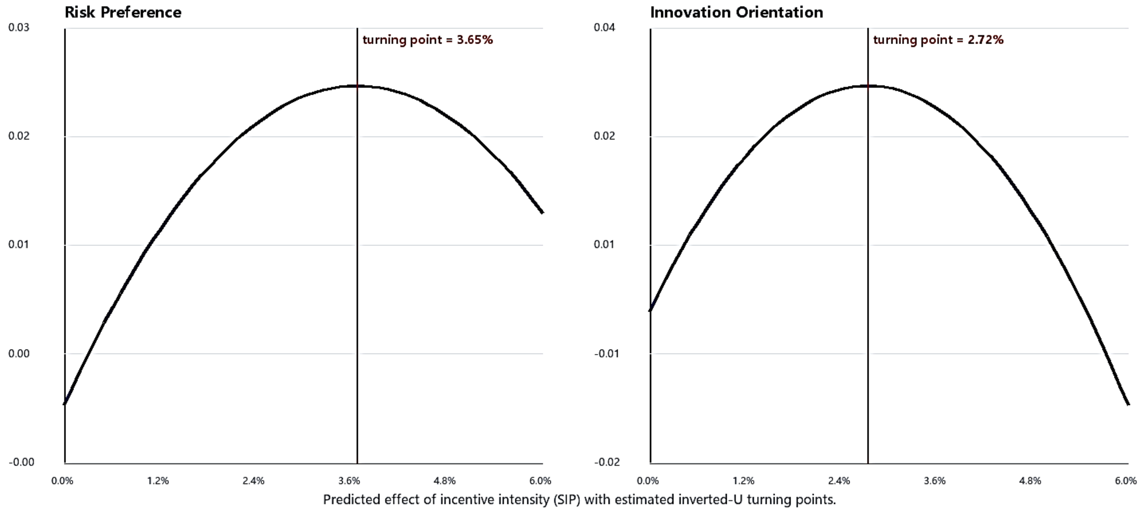

Figure 4. Dose-response curves and inverted U-shaped turning points for incentive intensity (SIP) (photo credit: original)

4.4. Dynamic effects: Conventional event study and sun-abraham cohort-robust estimation

Figures 5-6 report the conventional TWFE event study, while the right columns present the core innovation, namely the Sun and Abraham cohort-robust estimates. Table 6 further reports the latter coefficients aggregated by relative time [5]. For risk preference, both methods show that coefficients before first implementation are statistically insignificant and fluctuate around zero, providing strong support for the parallel-trends assumption. Beginning in the implementation year, the effects become significantly positive and increase monotonically, reaching 0.096 in year +4 and 0.130 in year >=+6, indicating a clear and persistently strengthening post-treatment path.

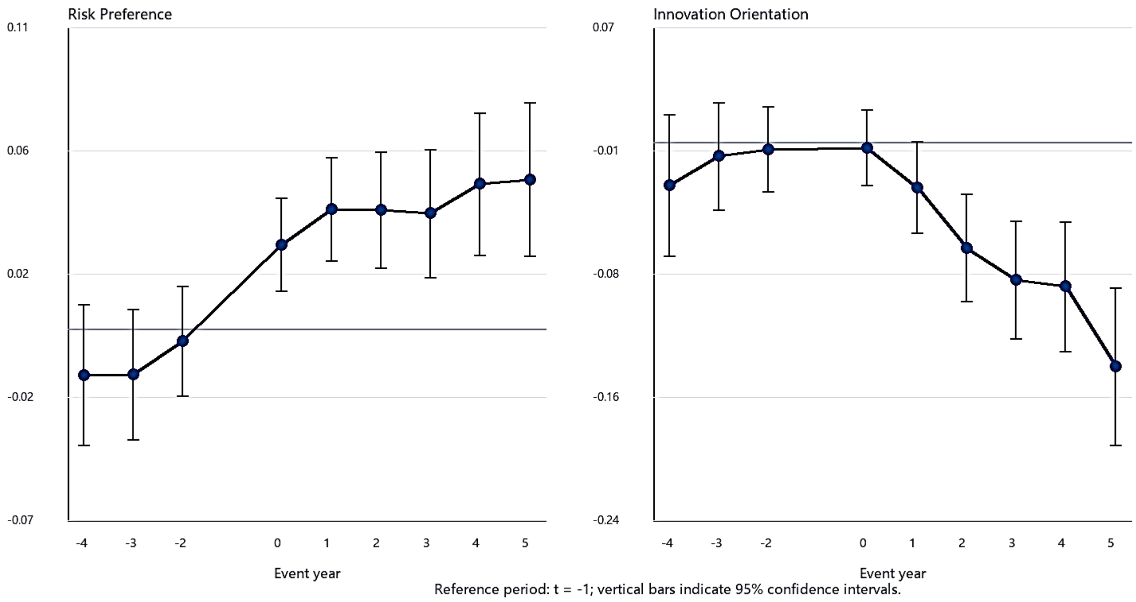

Figure 5. Conventional event study: dynamic effects before and after the first implementation of equity Incentives (photo credit: original)

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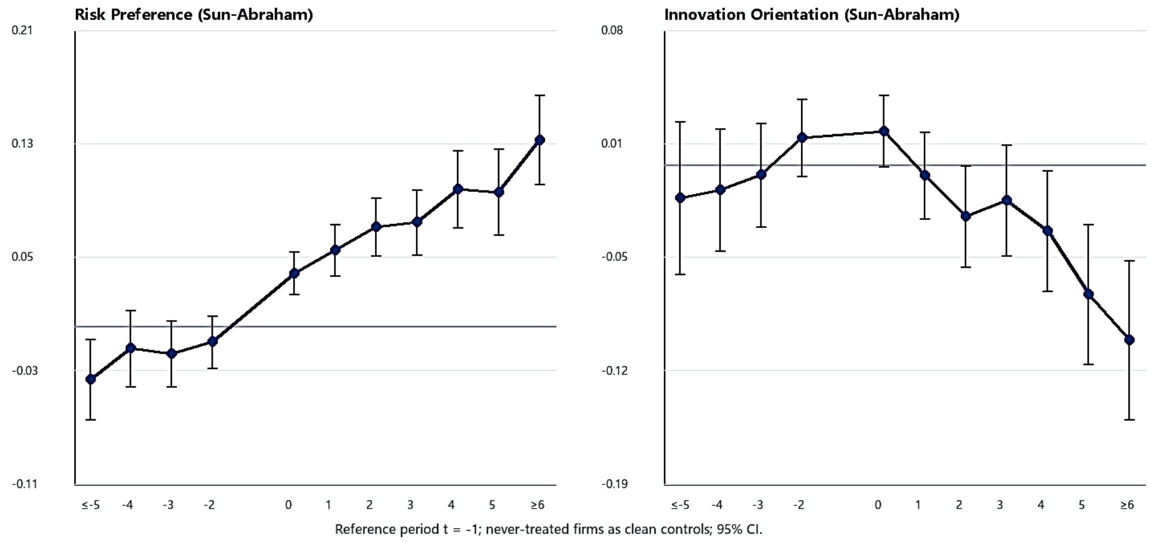

Figure 6. Sun-abraham cohort-robust dynamic effects (never-treated firms as clean controls) (photo credit: original)

Table 6. Sun-abraham interaction-weighted dynamic effect estimates

Relative time	Risk preference (SA)	Innovation orientation (SA)
≤-5	-0.037*** (0.014)	-0.019 (0.023)
-4	-0.015 (0.014)	-0.015(0.019)
-3	-0.019 (0.012)	-0.006 (0.016)
-2	-0.011 (0.009)	0.017 (0.012)
0 (implementation year)	0.037*** (0.008)	0.020* (0.011)
+1	0.053*** (0.009)	-0.006 (0.013)
+2	0.070*** (0.010)	-0.030** (0.015)
+3	0.072*** (0.011)	-0.021 (0.017)
+4	0.096*** (0.014)	-0.039** (0.018)
+5	0.094*** (0.015)	-0.077*** (0.021)
≥+6	0.130*** (0.016)	-0.104*** (0.024)

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Note: The base period is the year before first implementation (t=-1). Firms that never implemented equity incentives are used as clean controls. Relative-time effects are aggregated using cohort-share weights. Standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

The comparison for innovation orientation is particularly revealing. In the static TWFE model, equity incentives have a significantly positive effect on innovation discourse (Table6), but the Sun-Abraham estimates show that pre-treatment trends are basically flat, the implementation year exhibits only a weak positive effect, and the effect subsequently turns from positive to negative and continues to decline, falling to -0.077 and -0.104 in years +5 and +6, respectively, with statistical significance. This indicates that the positive "innovation-promoting" coefficient obtained from conventional TWFE is mainly bias generated by "bad comparisons" under the staggered-treatment structure rather than a true causal effect. Once clean controls and cohort-robust weights are used, the positive effect collapses, strongly supporting the fragility hypothesis H2b. Combined with the mechanism tests, these results show that equity incentives stably change the tendency to bear uncertainty and its translation into R&D investment, rather than expanding innovation narratives at the annual-report level.

4.5. Robustness and endogeneity tests

To rule out interference from measurement, sample shocks, endogeneity, and estimation bias, this paper designs multidimensional robustness and placebo tests. Table 7 summarizes multiple tests, including alternative variables, PSM-DID, randomization inference, and two-way clustering.

Table 7. Robustness and endogeneity tests

Test design	Risk preference	Innovation orientation
Alternative dependent variable	0.062*** (0.021)	-0.000 (0.000)
Explanatory variable lagged by one period	0.010 (0.009)	0.001 (0.016)
Plan-disclosed incentive ratio (linear/quadratic)	1.915*** (0.657) -36.248* (19.445)	1.412 (1.140) -15.854 (32.509)
Excluding 2008 and 2020-2022	0.029*** (0.007)	0.017 (0.012)
Industry-year fixed effects	0.022*** (0.005)	0.013 (0.008)
Two-way clustered standard errors	0.025*** (0.004)	0.017*** (0.006)
PSM-DID	0.042*** (0.008)	0.023 (0.016)
Randomization inference (500 replications, RI-p)	0.048 [p=0.000]	-0.035 [p=0.040]

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Table 7. (continued)

Random placebo test (false timing)	-0.002 (0.009)	-0.003 (0.016)

Note: PSM-DID is based on nearest-neighbor matching using pre-treatment firm characteristics. The matched sample contains 31,452 observations, and the average propensity-score distance is 0.0008. Randomization inference permutes treatment status and implementation timing 500 times; nonparametric placebo p-values are reported in brackets. Two-way clustering refers to standard errors clustered by firm and year. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 7 shows that the risk-preference results are extremely stable: the coefficient is 0.062 when using the alternative risk indicator; 0.029 after excluding the 2008 financial crisis and the 2020-2022 pandemic shock; 0.022 after adding industry-year fixed effects; 0.025 with two-way clustered standard errors; and 0.042 for the PSM-DID treatment effect. In randomization inference, the observed coefficient of 0.048 lies far outside the permutation null distribution (see Figure7), while the random placebo test based on false treatment timing is insignificant. By contrast, innovation orientation is unstable across alternative indicators, industry-year fixed effects, PSM-DID, and randomization inference; randomization inference even yields a significantly negative result, consistent with the Sun-Abraham findings.

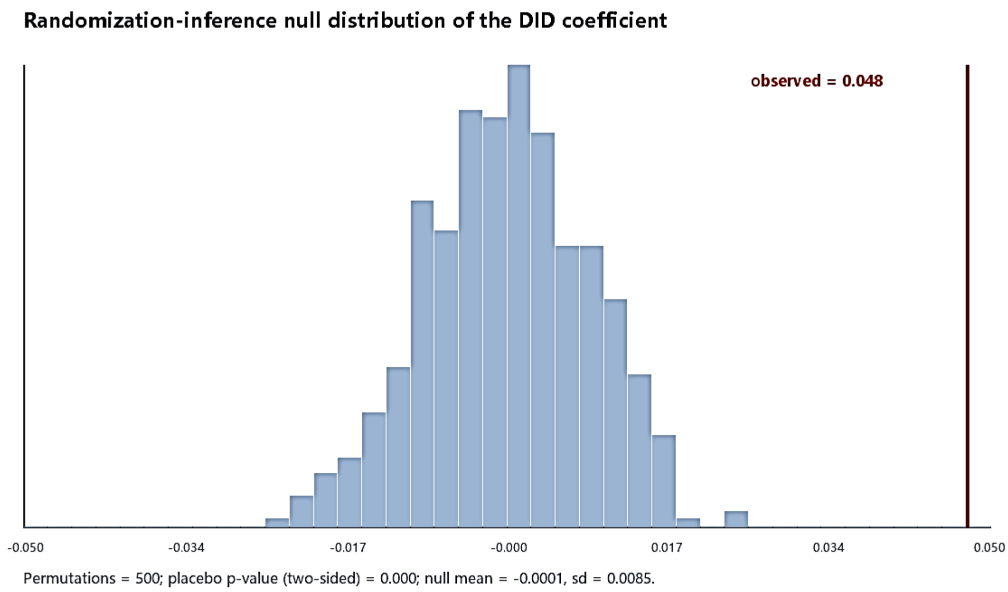

Figure 7. Null distribution from randomization inference for the risk-preference DID coefficient (red line indicates the observed value) (photo credit: original)

4.6. Heterogeneity analysis

This paper forms groups by annual medians of firm size, leverage, and innovation foundation. Table 8 reports the treatment effects for each group.

Table 8. Heterogeneity analysis

Group	Risk preference	Innovation orientation	Risk N	Innovation N
Small firms	0.029*** (0.008)	0.010 (0.012)	23,276	23,276

DOI: 10.54254/2754-1169/2026.35903

Table 8. (continued)

Large firms	0.019*** (0.006)	0.024* (0.012)	26,077	26,077
Low-leverage firms	0.024*** (0.007)	-0.001 (0.012)	23,544	23,544
High-leverage firms	0.024*** (0.007)	0.032*** (0.012)	25,809	25,809
Low innovation foundation	0.038*** (0.009)	0.030* (0.015)	24,316	24,316
High innovation foundation	0.017*** (0.006)	0.005 (0.009)	25,037	25,037

Note: Small/large size, low/high leverage, and low/high innovation foundation are all grouped by annual medians. Robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

First, the risk-preference effect is stronger among small firms and firms with a low innovation foundation, indicating that equity incentives have a more pronounced behavioral activation effect for firms that originally have weaker risk-taking capacity or insufficient innovation accumulation. Second, the weak positive effect on innovation orientation, or discourse, is mainly concentrated among large firms, high-leverage firms, and firms with a low innovation foundation. Large firms have more complete R&D organizations and disclosure capacity; high-leverage firms face stronger external monitoring and debt-service pressure; and firms with a low innovation foundation have greater room for strategic transformation. These firms are therefore more likely to translate incentives into observable innovation expression. Third, the innovation-orientation effect is insignificant among firms with a high innovation foundation, implying that firms already possessing innovation capabilities may not need to further signal innovation commitment through annual-report discourse. It should be emphasized that, because the innovation-discourse effect is not robust overall under cohort-robust estimation, the heterogeneity results for innovation should be interpreted cautiously as indicating where a static positive correlation is more likely to appear, rather than as robust causal effects.

5. Conclusion

The core conclusion of this paper can be summarized as follows: risk preference is significantly shaped, whereas innovation conversion is conditional. Based on a long panel of A-share listed firms from 2005 to 2024, this paper finds that equity incentives significantly increase executive risk preferences, and this conclusion survives a comprehensive set of tests, including alternative indicators, exclusion of shock years, industry-year fixed effects, two-way clustering, PSM-DID, randomization inference, and Sun-Abraham cohort-robust event studies. It can therefore be confirmed that equity-based incentive contracts do have a behavior-shaping function and can change executives' choice tendencies when facing uncertainty. In the static TWFE model, equity incentives are positively associated with innovation discourse. However, the Sun-Abraham estimates and randomization inference show that, after mitigating staggered-treatment bias, this positive relationship is not robust and even turns negative. At the same time, risk preference stably promotes real R&D investment but does not stably strengthen innovation discourse. This indicates that innovation is not a mechanical result of risk taking, but rather the outcome of the joint effects of contract duration, assessment targets, organizational resources, disclosure strategies, and external financing constraints. Equity incentives can provide the motivation to bear risk, but institutional arrangements are still needed to channel that motivation into long-term R&D activities.

Accordingly, this paper proposes the following policy recommendations. First, listed firms should shift from "implementing incentive plans" to "optimizing contract design" by incorporating long-term indicators such as R&D intensity, key technological milestones, invention-patent quality, and the share of revenue from new products into vesting or exercise conditions, thereby reducing the sole weight placed on short-term profit and stock-price indicators. Second, incentive intensity should remain moderate. The inverted U-shaped turning points estimated in this paper indicate that incentives that are too low are insufficient to change behavior, whereas excessive incentives may induce wealth concentration, risk avoidance, or short-term arbitrage. Firms should set incentive ratios by considering share-capital size, industry technology cycles, and executives' wealth exposure. Third, the governance implications of stock options, restricted stock, and executive shareholding should be distinguished. For firms that need to tolerate failure and exploratory R&D, longer validity periods and deferred vesting arrangements may be strengthened. For mature firms, restricted stock should be prevented from degenerating into short-term performance rewards. For regulators, the focus of equity-incentive supervision should not stop at the number of plans and compliant disclosure, but should examine whether plans serve long-term value creation. For investors, the evaluation of equity incentives should jointly consider contract intensity, validity period, assessment indicators, and changes in R&D investment. Equity-incentive announcements should not be treated simply as positive signals, and increases in "innovation discourse" should not be used to directly infer improvements in innovation capability.

Because of data limitations, the innovation-orientation measure in this paper is mainly constructed from annual-report keywords and has not yet systematically incorporated variables such as patent quality, the proportion of invention patents, analyst attention, ownership type, and ownership concentration. Further combining the textual clauses of incentive plans, executives' personal career histories, and patent-level microdata would help identify the heterogeneous effects of incentive contracts across executive types, ownership structures, and industry technology cycles.

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