

# Relative Versus Absolute Performance Evaluation and CEO Decision-Making

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## Abstract

We provide new evidence on how performance-based compensation plans affect CEO decision-making, especially risk-taking. Our main finding is that relative performance evaluation (RPE) plans provide incentives for CEOs to make decisions that generate more idiosyncratic performance outcomes; absolute performance evaluation (APE) plans do not. After switches from APE to RPE, the correlation between firm stock return and industry index return falls and firm idiosyncratic risk increases. Further, switches to RPE are followed by larger deviations in financial, investment, and operating policies from industry norms (i.e., more idiosyncratic strategies). All results are opposite for switches to APE.

## I. Introduction

Studies of the relation between CEO incentives and decision-making often examine whether equity-based incentives, specifically stock and stock options, provide risk-taking incentives. Such studies typically examine the relation between measures of firm-level risk, including firm policy variables and stock return risk, and CEO risk-taking incentives as captured by CEO vega, the sensitivity of CEO wealth to changes in equity risk. To date, much of the work in this area focuses on time-vesting grants of stock and options (see Coles, Daniel, and Naveen (2006), Hayes, Lemmon, and Qiu (2012), and Shue and Townsend (2017), among many

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We thank John Graham, Lok-Si Jeong, Swaminathan Kalpathy (discussant), Yen-Jung Lee (discussant), and Yan Luo (discussant) for helpful comments. We also thank participants at the 2017 Annual Meeting of the Financial Management Association International and 2018 International Conference of Taiwan Finance Association and seminar participants at The Ohio State University, National Taiwan University, Yuan Ze University, and Chung Yuan Christian University. We offer special thanks to Jeffrey Coles (the referee) and Paul Malatesta (the editor) for their insightful comments. Wruck is grateful for research support from the Dice Center for Financial Economics at The Ohio State University Fisher College of Business. Wu is grateful for research support from the Center for Research in Econometric Theory and Applications (grant no. 108L900201) and from The Featured Areas Research Center Program within the framework of the Higher Education Sprout Project by the Ministry of Education (MOE) in Taiwan. Wu also acknowledges financial support from the Ministry of Science and Technology in Taiwan (MOST 107-2410-H-002-057-MY2).

others). There is far less work, and thus much more to learn, regarding how performance-based compensation plans affect CEO decision-making (Edmans, Gabaix, and Jenter (2017)). This topic is particularly important in light of the dramatic shift from time-vesting and seniority-based option grants to performance-based compensation plans that followed the 2005 adoption of Financial Accounting Standard (FAS) 123R (Gerakos, Ittner, and Larcker (2007), Camara and Henderson (2009), Bettis, Bizjak, Coles, and Kalpathy (2010), (2018), Li and Wang (2016), and De Angelis and Grinstein (2020)).

This article examines how managerial decision-making and risk-taking are affected when a firm grants a performance-based compensation plan to its CEO. Performance metrics used in such compensation plans fall into one of two categories: relative or absolute. In relative performance evaluation (RPE) plans, performance metrics are defined relative to a benchmark, most often the performance of a group of peer firms or a published index. In absolute performance evaluation (APE) plans, targets are defined in terms of the firm's own performance; once targets are set the performance of peer firms or indices do not affect payouts. A plan's performance-vesting (p-v) schedule specifies performance metrics (stock-based, accounting-based, and/or others), the back-end payout, how performance metrics are associated with the back-end payout, and the time frame over which the payout is made.

Our approach, detailed below, contributes to the literature in at least two important ways. First, we focus on the fact that incentives are created, not only by the type of back-end instrument paid out by a plan (stock, options, or cash) and by the shape of the p-v grant schedules, but by the category of performance metric used in its p-v schedule. In particular, we focus on the differences between the tournament-style incentives created by RPE plans versus the incentives created by APE plans. Second, our main research design takes advantage of the little-known fact that it is not uncommon for firms to switch from APE to RPE plans and vice versa. Focusing on switches, we employ a difference in differences (DID) research design that captures how CEO decision-making and risk-taking change when a firm chooses to switch from one type of performance-based compensation plan to another. Our approach also takes into account the fact that CEO incentives are created when a compensation plan is *granted* to the CEO rather than when payouts associated with a plan are realized.

Our primary hypothesis, developed below, is that all else constant, switches from APE to RPE plans create incentives for the CEO to undertake decisions that make her firm less similar to its peers. Put differently, the tournament-style incentives created by RPE plans motivate the CEO to increase firm-level idiosyncratic risk and to select more idiosyncratic firm-level policies. APE plans do not have such incentives. Thus, switches from RPE to APE plans motivate the CEO to behave in an opposite way. All our findings are consistent with these predictions.

Specifically, our DID analysis demonstrates that following a switch from APE to RPE, measures of a firm's idiosyncratic risk increase relative to those firms that did not switch. The opposite finding holds for firms that switch from RPE to APE. Further, these differences are economically significant. Following a switch to RPE (APE), measures of firm-level idiosyncratic risk are higher (lower) by as much as 34.8% (19.8%) relative to the pre-switch average. All DID models include firm and

year fixed effects. Further, our results are robust after controlling for characteristics of a plan's p-v grant schedule, other elements of CEO compensation, and CEO and firm characteristics. Results are also robust to CEO turnover events in the pre- and post-switch periods, addressing the concern that switches in plan type occurs when there is a new CEO to match her propensity for risk-taking. We also run models with year and CEO-firm fixed effects, which control for endogenous CEO-firm matching and the time-invariant characteristics of CEOs and firms. Our findings remain unchanged.

It is possible that our results are driven by reverse causality or that omitted variables or hidden factors jointly determine the type of performance-based compensation plan used by a firm and its idiosyncratic risk. We tackle the challenges posed by these concerns by conducting a battery of additional analyses and robustness checks. Specifically, we perform a falsification test in which we (falsely) assume that a switch from one plan type to the other occurred 1 year before the actual switch. The estimated placebo treatment effect is statistically indistinguishable from zero. We also address the possibility that ex ante differences in measures of idiosyncratic risk drive the decision to switch performance plan type rather than vice versa. We find no evidence that this is the case. We then form matched samples comprised of matched firm-year pairs with similar propensities to switch from one plan type to the other ex ante but different switching outcomes ex post. Results estimated using these matched samples confirm our findings. We also conduct 2-stage least squares (2SLS) with valid instruments (IVs) and subsample analyses to assess whether our findings are driven by hidden factors or omitted variables. Again, our primary findings remain the same.

Further, we test whether the higher (lower) idiosyncratic risk associated with switches from APE to RPE (RPE to APE) is reflected in firm-level policy choices. If firm-level policy choices are an important mechanism driving idiosyncratic risk, we should observe that firms switching from APE to RPE (RPE to APE) adopt policies that are less (more) similar to those of peer firms. We measure policy dissimilarity as the absolute value of differences in corporate policies between focal firms and the median values among their industry peers. Results show that firms switching to RPE (APE) demonstrate larger (smaller) deviations in financial and investment policies from industry norms relative to nonswitchers. Further, firms switching to RPE (APE) tend to subsequently invest (not invest) in business segments and acquire (not acquire) targets in industries outside their primary SIC code. Overall, these results are consistent with the idea of CEO decision-making as a mechanism through which switches between RPE and APE plans influence measures of the firm's idiosyncratic risk.

Finally, we assess whether convexity in the ex ante p-v grant schedule and back-end payouts of stock is more strongly associated with idiosyncratic risk-taking for firms with RPE plans relative to those with APE plans. Using triple difference specifications, we show that this is not the case. This is reassuring, as our data show that more APE plans (48.14%) than RPE plans (41.08%) have convex grant schedules. This fact works against our finding that convexity in the p-v grant schedule for RPE plans increases idiosyncratic risk-taking incentives. Indeed, it suggests that it is the tournament-style incentives induced by RPE plans that matter for risk-taking. We also test whether the higher (lower) idiosyncratic risk associated

with switches from APE to RPE (RPE to APE) is reflected in alternative measures of firm-specific risk. We find that it is; switches to RPE (APE) are followed by an increase (decrease) in the vulnerability of the firm's stock to extreme negative stock price movements and higher (lower) credit risk.

The rest of this article is organized as follows: In [Section II](#), we develop our hypotheses and briefly describe our primary contribution. [Section III](#) presents data and descriptive analyses. [Section IV](#) presents our idiosyncratic risk results, robustness checks, and analyses to address endogeneity concerns. [Section V](#) presents the analysis of firm-level policies and other analyses. [Section VI](#) concludes.

## II. Hypothesis Development and Our Contribution

### A. Hypothesis Development

As stated above, our primary hypothesis is that all else constant, switches from APE to RPE plans create incentives for the CEO to adopt differentiating strategies that make her firm less similar to its peers. This implies that RPE plans provide incentives to increase firm-specific risk and to select more idiosyncratic firm-level policies. Put differently, RPE provides CEOs with a disincentive to herd, or follow the crowd, with respect to firm policies. Switches from RPE to APE plans create the opposite incentives. Thus, following a switch from APE to RPE, we predict that a firm's performance will be less correlated with the performance of its industry peers and, relatedly, its idiosyncratic risk will increase.<sup>1</sup> For switches from RPE to APE, predictions are the opposite.

There are at least two potential mechanisms through which RPE plans provide stronger idiosyncratic risk-taking incentives relative to APE. First, by setting performance targets on a relative basis, RPE plans create external (or inter-firm) tournament incentives. This provides incentives for the CEO to make firm-level policy decisions with more idiosyncratic performance outcomes. In this way, the CEO increases the likelihood of outperforming the RPE performance benchmark by distinguishing her firm from the competition. If her policies deliver positive results, her compensation is higher (e.g., Kneiber and Thurman (1994), Brown, Harlow, and Starks (1996), Kempf and Ruenzi (2008), and Coles, Li, and Wang (2018)).

The tournament-style incentives provided by RPE are analogous to the incentives provided by indexed stock options (options whose exercise price is tied to a market or industry index). This is because, like indexed options, payouts under RPE plans depend on the firm's performance relative to a benchmark. The value of

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<sup>1</sup>A simple example helps illustrate the differences in incentives under RPE versus APE. Suppose there are two projects with equal expected net present values except for the correlation between their performance and industry peer performance. A CEO compensated under APE will be indifferent between the two. If, however, the Board of Directors switches that CEO to an RPE plan, because the RPE payoff depends on her firm's performance relative to performance of peer firms in the horse race, she will be motivated to differentiate her firm's performance from peers and prefer the project with lower correlation. As a result of this change in incentives, over time the firm's performance will become less correlated with the performance of its peers and its idiosyncratic component of total firm risk may increase. If the same CEO is switched back to an APE plan, she will again become indifferent and the firm's performance will drift back, becoming more correlated with the performance of its peers.

standard, nonindexed, stock options depends on total risk and thus creates incentives to increase total risk. In contrast, Johnson and Tian (2000), (2004), and Duan and Wei (2005) show that the value of indexed stock options depends only on idiosyncratic risk; indexed options are in the money only if the stock price outperforms the relevant index. Thus, a CEO compensated under RPE has incentives to make decisions that differentiate her firm's performance from that of its peers in the horse race.

Second, the convexity of the grant date (ex ante) p-v schedule and/or the convexity of the schedule of ex post realized payouts could result in amplified risk-taking incentives for RPE plans relative to APE plans.<sup>2</sup> To understand how this might be possible, it is important to first understand how the p-v grant schedules of performance-based compensation plans are structured. Most commonly, performance-based compensation plans reward the CEO with award "units" comprised of stock, stock options, cash, or a combination among these. These units are called back-end units. Under a typical p-v grant schedule, the CEO does not receive any back-end units until a minimum performance threshold is met, at which point the p-v schedule jumps to some positive number of units. There is also typically a performance ceiling beyond which no additional units are awarded. Between the performance threshold and the performance ceiling is the incentive zone.

For performance in the incentive zone, the number of back-end units to be granted typically increases with the performance metric. For many plans, the p-v schedule is convex in the incentive zone (see examples 2 and 3 in Supplementary Material Appendix B), potentially increasing risk-taking incentives. However, it is not uncommon for the p-v schedule to be concave in the incentive zone (see Bettis et al. (2018), Figure 1a), potentially reducing risk-taking incentives. Bettis et al. (2018) measure the grant date (ex ante) discounted expected value of the ex post realized payout associated with APE plans (which they term "economic value"). For plans using accounting-based performance metrics, they estimate both a marginal and an aggregate "accounting vega." Marginal (aggregate) accounting vega is the change in economic value for a 0.01 change in the accounting metric's volatility (in both stock return volatility and the accounting metric's volatility). Based on their findings, they argue that convexity in an APE plan's p-v grant schedule can amplify risk-taking incentives by way of both the standard measure of CEO vega and their new vega measures.

Our data show that the vast majority of RPE plans use stock performance metrics, while the vast majority of APE plans use accounting-based performance metrics. Holden and Kim (2017) show that because each of a wide variety of accounting performance metrics has its own stochastic process, not to mention the joint stochastic processes between stock return and each accounting metric, the accuracy of marginal and aggregate accounting vegas depends on the assumed underlying stochastic process. While some studies report a positive relationship between accounting metrics and stock return, others report a negative or no relationship at all (Riffe and Thompson (1998), Bushman, Lerman, and Zhang (2016)).

<sup>2</sup>The ex post realized value of a p-v award is the number of back-end units earned through the p-v schedule based on realized performance multiplied by the realized value per unit of the back-end instrument.

Thus, even if the p-v schedule for an APE plan provides risk-taking incentives, those incentives may pertain primarily to the variability of the relevant accounting metric. They do not necessarily translate into greater stock return variability or greater firm-specific risk. Thus, we test whether convexity in the p-v schedule amplifies risk-taking incentives more for RPE plans than for APE plans.

Further, our data show that the vast majority of RPE plans use stock in back-end units, while the vast majority of APE plans use cash. If the use of stock in back-end units enhances the risk-taking incentives reflected in a plan's p-v schedule, p-v convexity could again amplify risk-taking incentives more for RPE than for APE plans. When the back-end payout is cash, as it is in most APE plans, the ex post realized award schedule will look exactly like the ex ante p-v grant schedule. However, if the back-end payout is stock and the performance metric is stock performance, which is the case for many RPE plans, then both the number of back-end units paid out and the value of those units increase with stock price. Thus, the ex post schedule of the value of the stock award will generally be convex, or more specifically quadratic, in stock price in the incentive zone.

It is important to note that the alternative to our primary hypothesis is meaningful (see, e.g., Ozdenoren and Yuan (2017), Albuquerque, Cabral, and Guedes (2019)). Using RPE with a market or industry index as the performance benchmark allows shareholders to insulate a risk-averse CEO from poor performance due to systematic risk. However, the CEO remains exposed to idiosyncratic risk. Shielding a risk-averse CEO from systematic risk while exposing her to idiosyncratic risk could provide her with incentives to take on systematic risk and eschew idiosyncratic risk. Consequently, it is not necessarily the case that RPE plans provide incentives to increase firm-specific risk; it will depend on whether the tournament-style incentives of RPE generate an expected payout that is high enough to overcome risk-aversion.

## B. Our Primary Contribution

There is an ongoing debate as to whether the structure of CEO compensation contracts affects managerial risk-taking incentives. For example, Hayes et al. (2012) examine time-based vesting option grants around the 2005 adoption of FAS 123R and find that the decline in option usage is unrelated to changes in firm risk. However, their approach overlooks the fact that there was, at the same time, a dramatic shift away from the use of time-based vesting option grants to performance-based vesting compensation plans (e.g., Li and Wang (2016), Bettis et al. (2018)). We weigh in on this debate by providing evidence on the risk-taking incentives generated by performance-based compensation plans. More specifically, this article contributes to the contract design literature and managerial risk-taking literature by showing that the tournament-style incentives induced by RPE contracts motivate idiosyncratic risk-taking. Park and Vrettos (2015) is perhaps the most relevant prior study. Based on a single year of hand-collected data, they examine the interaction between the risk-taking incentives provided by CEO stock options (standard CEO vega) and the use (or not) of RPE plans. They find that the use of RPE plans dampens the incentives provided by CEO options to take on

systematic risk (Armstrong and Vashishtha (2012)) and enhances option-based incentives to take on idiosyncratic risk.

Our study uses 17 years of compensation plan data (1998–2014) from the Institutional Shareholder Services (ISS) Incentive Lab database, in addition to data from other sources. Our findings differ from Park and Vrettos (2015) in many important respects. First, they find no evidence that the use of an RPE plan, in and of itself, is related to risk-taking incentives. In contrast, we show that after firms switch from APE to RPE (RPE to APE) they have relatively higher (lower) idiosyncratic risk. Further, Park and Vrettos (2015) do not provide evidence on how the use of RPE versus APE affects CEO decision-making. We show that firms switching from APE to RPE (RPE to APE) adopt financial, investment, and acquisition policies that are more (less) idiosyncratic and dissimilar (similar) to those of their industry peers. Further, our more extensive data allow us to examine whether and how other features of performance-based compensation plans, such as p-v grant schedule convexity and form of back-end payout, affect idiosyncratic risk-taking. Finally, our battery of robustness tests and additional analyses enable us to draw causal inferences. In summary, our study not only extends and complements prior work in the contract design and managerial risk-taking literature, but provides new findings and insights using far more extensive data.

### III. Data and Summary Statistics

#### A. Sample Selection

Detailed data on performance-based CEO compensation plans are obtained from Institutional Shareholder Services' (ISS) Incentive Lab Database.<sup>3</sup> Additional data on CEO compensation, CEO characteristics, corporate governance, and other firm and industry characteristics are obtained from ExecuComp, Equilar Consultants, Risk Metrics, and Compustat, respectively. Components of firm risk are estimated using data from the Center for Research in Security Prices (CRSP) and the 48 industry portfolio data from the Kenneth R. French data library. For firm-years with missing CEO characteristic data in the above databases, data are hand-collected from SEC filings. Financial firms (SIC codes between 6000 and 6999) and utilities (SIC codes between 4900 and 4999) are excluded from the sample. The sample period is 1998 to 2014 (17 years). We eliminate firm-years in which only time-based vesting plans (i.e., nonperformance-vesting plans) are used. This sharpens our tests by allowing us to concentrate on the type of performance evaluation used

<sup>3</sup>The ISS database contains compensation data from proxy statements (DEF 14A) for named executive officers of large publicly traded companies in the USA. For each year from 1998 through 2014, public firms are ranked based on average market capitalization for each day in the month of November. For the top 750 firms in each year, executive compensation data are collected from proxy statements. S&P 500 firms are always included in the database regardless of whether or not they rank in the top 750. If a "new" firm appears in the top 750 for a specific year, its information is backfilled to 1998 (or the firm's IPO date) and the database continues to track the company even if it falls out of the top 750. If a firm is acquired, goes private or goes out of business, its historical data continues to be carried in the database. In total, the database has over 2,000 unique companies, of which about 1,200 were active as of 2014.

(RPE vs. APE).<sup>4</sup> Detailed definitions of all variables used in this study can be found in Supplementary Material Appendix A.

## B. Summary Statistics

Table 1 summarizes the characteristics of our sample of CEO performance-based compensation plans. ISS Incentive Lab database provides a variable (PERFORMANCE\_TYPE in ISS) that classifies a firm's use of performance-based compensation as APE only, RPE only, or a mixture of both APE and RPE plans in the same year. We define an RPE year as a firm-year in which at least one of its CEO's compensation plans relies on performance benchmarks set relative to a specified group of peer firms or a published index. We define an APE year as a firm-year in which its CEO's compensation plan relies exclusively on performance targets defined in absolute terms. As discussed in more detail below, the characteristics of our sample of performance-based compensation plans are similar to prior studies.

Supplementary Material Appendix B presents three examples of the ways in which RPE performance benchmarks are set. Example 1 is Campbell Soup Company's RPE plan for the 2007–2009 performance period. Under this plan, the company's total stock return (TSR) is ranked relative to the TSR of 10 peer firms. The performance target is a rank of fifth or sixth out of 11 firms (the 10 peer firms plus Campbell Soup Company). The ex ante payout function is a step function that specifies the CEO's payout as a percentage of the number of target shares. For example, if the firm ranks first then the CEO receives 200% of the target shares and if it ranks tenth or eleventh then the CEO receives no shares.

Example 2 is Dow Inc.'s RPE plan for the 2006–2008 performance period. Under this plan, the company's TSR is assessed relative to the average TSR for 14 peer firms. If performance is more than 5% below the peer average (performance threshold), the CEO receives no shares. For performance ranging from 5% below the peer average to the peer average (performance target), the CEO receives between 35% and 100% of target shares on a linear schedule. For performance ranging from the peer average to 5% above the peer average (performance ceiling), the CEO receives between 100% and 200% of target shares on a linear schedule. For performance greater than 5% above the peer average, no additional shares are awarded. Note that the p-v grant schedule is piecewise-linear and the ex ante payout function is convex in TSR relative to peer average in the incentive zone.

Example 3 is International Flavors & Fragrances Inc.'s (IFF's) RPE plan for the 2007–2009 performance period. Under this plan, the company's TSR is assessed as a percentile of the S&P 500. If performance is below the 40th percentile of the S&P 500 (performance threshold), the CEO receives no shares. For performance ranging from the 40th to the 55th percentile of the S&P 500 (performance target), the CEO receives between 25% and 100% of target shares on a linear schedule. For performance ranging from the 55th percentile to the 75th percentile of the S&P 500 (performance ceiling), the CEO receives between 100% and 200% of target shares on a linear schedule.

<sup>4</sup>We do not lose much data as a result of this restriction. The ISS Incentive Lab database includes 14,733 firm-years in which some form of time-based vesting CEO compensation is granted, representing 1,461 unique firms. Of these 14,733 firm-years, 3,262 also grant RPE plans and 8,296 also grant APE plans, leaving only 3,175 firm-years in which only time-based vesting plan is granted.



Panel A of Table 1 presents information on how our sample of 18,251 firm-years is divided between RPE and APE firm-years. RPE is used in approximately 26% of firm-years (4,761 firm-years for 904 unique firms) and APE is used in approximately 74% of firm-years (13,490 firm-years for 1,730 unique firms).<sup>5</sup> Firms sometimes award multiple grants to CEOs in a given firm-year, so we also present information at the grant level where the split between RPE and APE is 23%

TABLE 1  
Summary of the Characteristics of CEO RPE and APE Plans

Panel A of Table 1 summarizes the firm-level distribution of relative versus absolute performance-based compensation plans for their CEOs, plan duration, and plan payout as a fraction of total CEO compensation. Panel A also reports the grant-level frequencies of relative versus absolute performance-based compensation plans for their CEOs. Panel B summarizes the firm-level frequencies of types of performance metrics used. Panel C summarizes the types of payouts used. Panel D summarizes the grant date performance-vesting schedules. NA means not applicable.

	RPE Plans	APE Plans	Total
<i>Panel A. Relative Versus Absolute Performance Plans<sup>5</sup></i>			
Number of firm-years	4,761 (26.1%)	13,490 (73.9%)	18,251 (100.0%)
Number of grants	5,914 (22.9%)	19,909 (77.1%)	25,823 (100%)
Duration of plan (years)	2.62 mean 3.00 median	1.39 mean 1.00 median	
Fraction of total CEO compensation	28.54% (25.14%)	29.97% (22.49%)	
No. of obs.	3,717	9,686	
<i>Panel B. Types of Performance Metrics Used<sup>††</sup></i>			
Stock price metrics only	3,140 (66.0%)	155 (1.1%)	3,295 (18.1%)
Accounting metrics only	962 (20.2%)	5,479 (40.6%)	6,441 (35.3%)
Both stock price and accounting metrics only	491 (10.3%)	243 (1.8%)	734 (4.0%)
Other performance metrics only	40 (0.8%)	659 (4.9%)	699 (3.8%)
Any other combination	128 (2.7%)	6,954 (51.6%)	7,082 (38.8%)
<i>Panel C. Types of Back-End Instruments Paid Out by Plans<sup>†††</sup></i>			
Stock-based payout only	2,992 (62.8%)	1,316 (9.8%)	4,308 (23.6%)
Stock only	2,927 (61.5%)	1,136 (8.4%)	4,063 (22.3%)
Option only	40 (0.8%)	149 (1.1%)	189 (1.0%)
Both stock and options	25 (0.5%)	31 (0.2%)	56 (0.3%)
Cash only	1,263 (26.5%)	8,578 (63.6%)	9,841 (53.9%)
Annual cash only	606 (12.7%)	7,604 (56.4%)	8,210 (45.0%)
Long-term cash only	578 (12.1%)	474 (3.5%)	1,052 (5.8%)
Both annual and long-term	79 (1.7%)	500 (3.7%)	579 (3.2%)
Both stock-based and cash	506 (10.6%)	3,596 (26.7%)	4,102 (22.5%)

(continued on next page)

<sup>5</sup>This is similar to the 24% RPE/76% non-RPE composition of hand-collected 1-year samples used in prior studies (Gong, Li, and Shin (2011), Park and Vrettos (2015)).

TABLE 1 (continued)  
 Summary of the Characteristics of CEO RPE and APE Plans

<i>Panel D. Performance-Vesting Grant Schedule Characteristics<sup>††††</sup></i>		
	RPE Plans	APE Plans
	Mean (Median)	Mean (Median)
Threshold payout as % of target payout	30.67% (30.00%)	20.00% (16.67%)
No. of obs.	4,339	13,490
Maximum payout as % of target payout	188.18% (200.00%)	188.33% (199.13%)
No. of obs.	4,335	12,031
Plans with convex payoff function (%)	41.08%	48.14%
	Percentile Difference	Standardized
Actual less threshold in grant year	23.05 (25.00)	0.035 (0.018)
No. of obs.	2,976	10,611
Actual less target in grant year	-3.11 (0.00)	-0.053 (-0.004)
No. of obs.	3,193	11,886
Target as % of peer performance	54.93% (50.00%)	NA
No. of obs.	4,076	
Threshold as % of peer performance	29.74% (25.82%)	NA
No. of obs.	3,930	
Maximum as % of peer performance	83.32% (80.00%)	NA
No. of obs.	3,810	
% of plans that do not disclose target that state reason is due to confidentiality	1.02%	1.81%

<sup>†</sup> The fraction of total CEO compensation that RPE (APE) represents for RPE (APE)-granting firms based on reported fair market value (FMV) at the date of RPE (APE) grant or the grant-date value of the target award when FMV is not available.

<sup>††</sup> Stock price metrics include stock return or stock price level. Accounting metrics include earnings, growth in earnings, EPS, growth in EPS, ROA, ROI, ROS, sales, sales growth, operating income, growth in operating income, operating margin, EBITDA, EBITDA growth, EBITDA margin, EBIT, EBIT growth, EBIT margin, EBT, EBT growth, EBT margin, cash flow, cash flow per share, cash flow growth, economic value added (EVA), EVA growth, EVA per share, etc. Other performance metrics include measures such as productivity, ethics, customer satisfaction (loyalty), employee work safety (health, safety, and environmental performance), success in damage prevention, etc. Supplementary Material Appendix B provides examples of plans that use other performance metrics.

<sup>†††</sup> Stock awards include restricted stock, restricted stock units, phantom stock, phantom stock units, and common stock equivalents. Option awards include stock options, stock appreciation rights, and other instruments with option-like features. Cash is defined as an annual or long-term payout in cash. Long-term cash is primarily the payout of long-term cash performance units.

<sup>††††</sup> Payout is based on grant date fair value. For a restricted stock (option) award, grant date fair value is the stock price per unit (Black-Scholes option value per unit) on the grant date times the threshold, target, and maximum units of that back-end instrument. For a cash award, firms report the actual cash value at threshold, target, and maximum. Actual less threshold and Actual less target performance in the grant year are standardized by total assets when the plan performance metric is dollar earnings or sales measure, or by actual stock price when the plan performance metric is the stock price. For other performance metrics, such as EPS, ROA, ROE and growth rates, differences are unstandardized.

and 77%, respectively. RPE plans typically have longer duration than APE plans; the mean (median) duration of RPE plans is 2.62 (3.00) years versus 1.39 (1.00) years for APE plans. Mean RPE and APE grant date fair values represent approximately 30% of a CEO's total annual compensation. Thus, when used, performance-based compensation plans represent a significant fraction of total CEO pay.

Panel B of Table 1 summarizes the type of performance metrics used. Stock performance metrics are used in 66.0% of RPE firm-years, but in only 1.1% of APE firm-years. In contrast, accounting performance metrics are used in only 20.2% of RPE firm-years, but in 40.6% of APE firm-years. Therefore, switches in performance-based compensation plans are often associated with a change in

performance metrics. Performance metrics that are neither stock price- nor accounting-based are less commonly used (4.9% of APE firm-years and 0.8% of RPE firm-years). Supplementary Material Appendix B, example 4, provides examples of plans that use such performance metrics.

Panel C of Table 1 presents the type of back-end instruments paid out. Among RPE plans, 62.8% use stock or options as the back-end instrument: 61.5% grant only stock, 0.8% grant only options, and 0.5% grant both stock and options. In contrast, 63.6% of APE plans use cash as the back-end instrument: 56.4% grant only annual cash awards, 3.5% grant only long-term cash awards, and 3.7% grant both annual and long-term cash awards. Therefore, switches in performance-based compensation plans often lead to a significant change in the type of back-end instrument. In addition, it is worth noting that as only 0.8% of the CEO RPE plans use options as the back-end instrument, our findings regarding the risk-taking incentive properties of CEO RPE plans are not driven by the risk-taking incentives of granted options.

Panel D of Table 1 summarizes details of the grant date (ex ante) p-v schedules. For plans using cash as the back-end instrument, the value of the threshold, target, and maximum awards is expressed in terms of actual value at grant date. For plans using stock or options as the back-end instrument, the value of the threshold, target, and maximum awards is expressed in terms of grant date fair value. Relative to target payout, on average (or at the median), threshold payout is set slightly higher for RPE than for APE plans. Maximum payout is set similarly for the two types of plans. Following Bennett, Bettis, Gopalan, and Milbourn (2017), we define payout-performance convexity as a binary variable that equals 1 if the slope to the left of the target performance scaled by the slope to the right of the target performance is less than 1, and zero otherwise.

Our data show a little over 40% of RPE and almost 50% of APE plans have convex payout-performance functions, suggesting that neither type of plan consistently provides risk-taking incentives through convexity in its p-v grant schedule. For CEO RPE plans, target (threshold) performance is 3.11 percentile points higher (23 percentile points lower) on average than the actual performance in the grant year and is set at the 55th (30th) percentile of peer performance. For CEO APE plans, target (threshold) performance, standardized as appropriate, is 0.053 higher (0.035 lower) on average than the actual performance in the grant year.<sup>6</sup> Detailed information on the characteristics of performance peers and performance benchmarks for CEO RPE plans can be found in Supplementary Material Appendix C. In summary, the structure of performance-based compensation contracts differs between RPE and APE plans and across firms using the same type of plan. Therefore, it is important to control for the contractual features of performance-based compensation plans in order to examine whether the incentives induced by RPE versus APE differ with respect to idiosyncratic risk-taking.

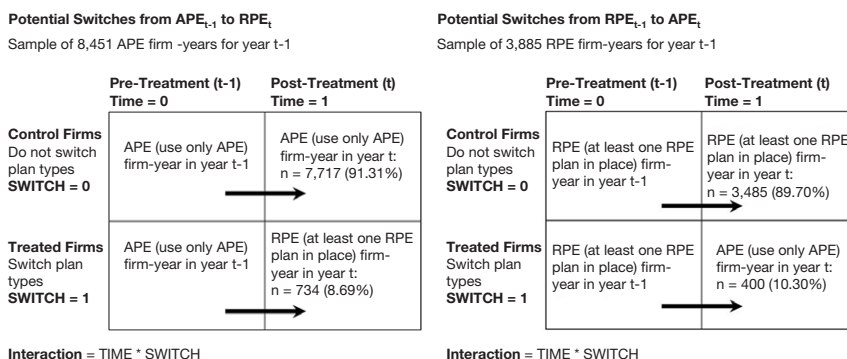
<sup>6</sup>Following Bennett et al. (2017), for APE plans we compute actual less threshold and actual less target. For dollar earnings and sales performance metrics, these differences are standardized by total assets. For stock price performance metrics, these differences are standardized by actual stock price on the grant date. For other performance metrics, such as EPS, ROA, ROE, and growth rates, these differences are unstandardized.

However, before moving to our main analyses, we verify empirically that each plan type influences CEO compensation in a way that is consistent with evidence supporting the use of weak-form RPE. More specifically, weak-form tests of RPE regress total CEO compensation (or changes in the log of total compensation) on own firm stock return and peer firm stock return, along with various control variables. If firms use RPE, the coefficient on peer firm return will be significantly negative, reflecting the fact that RPE nets out peer firm performance in assessing CEO performance (see, e.g., Garvey and Milbourn (2006), Albuquerque (2009), Gong et al. (2011), and Jayaraman, Milbourn, Peters, and Seo (2020)). We run similar analyses and find evidence of weak-form RPE use *only* by sample firms that actually use RPE performance plans. Details of this analysis are presented in Supplementary Material Appendix D.

#### IV. Does the Use of RPE Versus APE Influence Firm-Level Idiosyncratic Risk?

##### A. Baseline Difference-In-Differences Models

We use a difference-in-differences (DID) research design in our main analysis, which is summarized in the diagram below:



DID models of potential switches from APE to RPE are based on an initial sample comprised of all APE firm-years. A firm-year is classified as an APE firm-year if the CEO's performance-based compensation plans in that year rely exclusively on a target or targets defined in absolute terms (8,451 firm-years). For potential switches from RPE to APE, our initial sample is comprised of all RPE firm-years. A firm-year is classified as an RPE firm-year if at least one of the CEO's performance-based compensation plans in that year relies on performance benchmarks set relative to a specified group of firms or a published index (3,885 firm-years).<sup>7</sup> Thus, in the pre-treatment period (TIME = 0, YEAR = t-1) all firms have

<sup>7</sup>The number of firm-years used in our analysis is less than the 13,490 APE firm-years and 4,761 RPE firm-years reported in Table 1. This is because firms that use performance-based compensation plans in only 1 year or only in nonconsecutive years are dropped from the analysis and also due to lack of data availability for some variables.

the same performance-based compensation plan classification. We then observe whether or not each firm switches in the following year ( $\text{TIME} = 1$ ,  $\text{YEAR} = t$ ). Firms that do not switch form the control group ( $\text{SWITCH} = 0$  for both the pre- and post-treatment year). Firms that switch form the treated group ( $\text{SWITCH} = 1$  for both the pre- and post-treatment year).<sup>8</sup> The diagram above provides descriptive statistics regarding the frequency of switches from APE to RPE and vice versa for our sample. As it shows, switches between plan types are not uncommon; 734 (8.7%) of APE firms in year  $t - 1$  switch to RPE in year  $t$ , while 400 (10.3%) of RPE firms in year  $t - 1$  switch to APE in year  $t$ .

Panel A of Table 2 presents results from our baseline DID models. The dependent variables are three different measures of idiosyncratic risk: i) the correlation of firm returns with industry index returns ( $\text{IND\_INDEX\_CORRELATION}$ ), ii) idiosyncratic stock return risk ( $\text{IDIOSYNCRATIC\_RISK}$ ), and iii) idiosyncratic stock return risk as a proportion of TSR risk ( $\text{IDIOSYNCRATIC/TOTAL\_RISK}$ ). They are computed using daily data and are measured in year  $t + 1$  (the year following a firm's decision to switch from APE to RPE or to continue with APE and vice versa).  $\text{IDIOSYNCRATIC\_RISK}$  is the square root of the residual variance from a regression of the firm's daily stock return on the return to the CRSP value-weighted daily market index and the return to its Fama–French (1997) value-weighted daily industry index.  $\text{TOTAL\_RETURN\_RISK}$  is the standard deviation of the firm's daily stock return. The model estimated is:

$$\begin{aligned} \text{IDIOSYNCRATIC\_RISK Measure}_{i,t+1} &= \beta_0 + \beta_1(\text{TIME}_t \times \text{SWITCH}_t) \\ &+ \text{Year and firm fixed effects} + \varepsilon_{i,t+1}. \end{aligned}$$

All specifications include firm and year fixed effects, which subsume the standalone effects of the  $\text{TIME}$  and  $\text{SWITCH}$  indicator variables (Bakke, Mahmudi, Fernando, and Salas (2016)).<sup>9</sup> The main coefficient of interest is  $\beta_1$ , the coefficient for the DID interaction variable; if it is significant, then it shows that after controlling for firm and year fixed effects, performance-based compensation plan status in year  $t$  has a significant effect on the relevant measure of idiosyncratic risk in year  $t + 1$ .

Results from baseline models are consistent with our predictions that switching from APE to RPE creates incentives to increase idiosyncratic risk and reduce the correlation between a firm's performance and the performance of its industry peers.  $\text{IND\_INDEX\_CORRELATION}$  is lower for firms switching to RPE (model 1, coefficient of  $-0.0402$ ) relative to APE firms that do not switch and higher for firms switching to APE (model 2, coefficient of  $0.0284$ ) relative to RPE firms that do not

<sup>8</sup>As a robustness check, we define a firm-year as an RPE year if the firm exclusively uses RPE and a firm-year as an APE year if the firm exclusively uses APE. We lose observations under this definition of RPE, but our main findings are robust to the use of this smaller sample. As another robustness check, we define a firm-year as an RPE year if the firm exclusively uses RPE and a firm-year as an APE year if the firm uses APE or a combination of RPE and APE. Under this definition, the design becomes highly imbalanced and our findings are not significant.

<sup>9</sup>In untabulated tests, we replace firm and year fixed effects with the  $\text{TIME}$  and  $\text{SWITCH}$  indicator variables and our findings persist.

TABLE 2  
 Difference in Differences Regressions: Is RPE Associated With  
 Higher Idiosyncratic Risk Relative to APE?

Dependent variables in Table 2 are Industry index return correlation (IND\_INDEX\_CORRELATION), IDIOSYNCRATIC\_RISK, and IDIOSYNCRATIC/TOTAL\_RISK for year  $t + 1$ . We include firm and year fixed effects, which subsume Time and Switch as standalone (i.e., not interacted) indicator variables. Variables are defined in the Appendix. Firm and year fixed effects are included in all models.  $t$ -values are based on robust standard errors clustered by firm and by year (2-way) and are reported in parentheses. Chow tests examine whether the coefficients for INTERACTION (Time period indicator  $\times$  Plan switch indicator) differ significantly across analogous regression models. \*, \*\*, and \*\*\* indicate significance at the 10%, 5%, and 1% levels, respectively.

	IND_INDEX_CORRELATION <sub>t+1</sub>		IDIOSYNCRATIC_RISK <sub>t+1</sub>		IDIOSYNCRATIC/ TOTAL_RISK <sub>t+1</sub>	
	APE <sub>t-1</sub> → RPE <sub>t</sub>	RPE <sub>t-1</sub> → APE <sub>t</sub>	APE <sub>t-1</sub> → RPE <sub>t</sub>	RPE <sub>t-1</sub> → APE <sub>t</sub>	APE <sub>t-1</sub> → RPE <sub>t</sub>	RPE <sub>t-1</sub> → APE <sub>t</sub>
	1	2	3	4	5	6
<i>Panel A. Baseline Models</i>						
INTERACTION (TIME $\times$ SWITCH)	-0.0402*** (-5.36)	0.0284*** (2.69)	0.0398*** (12.93)	-0.0200*** (-3.03)	0.0608*** (7.57)	-0.0255** (-1.99)
Constant	0.4228*** (35.00)	0.5861*** (34.65)	0.1186*** (44.46)	0.0812*** (20.62)	0.7543*** (69.26)	0.6114*** (31.82)
R <sup>2</sup>	0.6857	0.8076	0.7997	0.9356	0.6964	0.7501
No. of obs.	15,392	7,304	15,392	7,304	15,392	7,304
Test of coeff. for INTERACTION		(1) vs. (2)		(3) vs. (4)		(5) vs. (6)
[p-Value]		[0.000]		[0.000]		[0.000]
<i>Panel B. Models Including Controls for Other Plan Features</i>						
INTERACTION (TIME $\times$ SWITCH)	-0.0457*** (-3.86)	0.0260* (1.70)	0.0410*** (8.47)	-0.0206*** (-3.06)	0.0724*** (7.60)	-0.0398** (-1.99)
PLAN_CONVEXITY_INDICATOR	0.0298** (2.08)	0.0371*** (4.68)	-0.0056 (-0.95)	-0.0106** (-2.07)	-0.0151 (-0.97)	-0.0516*** (-3.67)
ln(PLAN_DURATION)	0.0104* (1.76)	-0.0490*** (-4.73)	-0.0088*** (-3.63)	0.0109*** (4.06)	-0.0209*** (-3.26)	0.0190*** (2.71)
STOCK_AWARD_INDICATOR	-0.0116*** (-7.25)	-0.0119*** (-3.12)	0.0092*** (14.01)	0.0091*** (3.35)	0.0140*** (9.30)	0.0159** (2.35)
STOCK_METRIC_INDICATOR	0.0032 (0.58)	-0.0080 (-1.44)	-0.0031 (-1.38)	0.0087** (2.35)	0.0004 (0.06)	0.0144 (1.42)
Constant	0.4134*** (25.53)	0.5643*** (30.62)	0.1153*** (33.30)	0.0784*** (13.21)	0.7609*** (49.67)	0.6308*** (21.87)
R <sup>2</sup>	0.6889	0.8118	0.8041	0.9392	0.6994	0.7537
No. of obs.	11,047	5,632	11,047	5,632	11,047	5,632
Test of coeff. for INTERACTION		(1) vs. (2)		(3) vs. (4)		(5) vs. (6)
[p-Value]		[0.067]		[0.000]		[0.001]
<i>Panel C. Models Including Controls for Other Plan Features and Target Actual Performance Indicator</i>						
INTERACTION (TIME $\times$ SWITCH)	-0.0770*** (-5.48)	0.0716*** (3.44)	0.0475*** (7.85)	-0.0285*** (-2.73)	0.0980*** (6.41)	-0.0562* (-1.83)
PLAN_CONVEXITY_INDICATOR	0.0341* (1.91)	0.0394*** (4.45)	-0.0106 (-1.37)	-0.0118*** (-2.83)	-0.0223 (-1.14)	-0.0628*** (-3.85)
ln(PLAN_DURATION)	0.0153* (1.93)	0.0087 (1.36)	-0.0092*** (-2.66)	-0.0042 (-1.59)	-0.0221** (-2.54)	-0.0035 (-0.41)
STOCK_AWARD_INDICATOR	-0.02217*** (-10.35)	-0.0114*** (-2.64)	0.0106*** (11.36)	0.0088*** (4.32)	0.0234*** (9.91)	0.0145*** (2.67)
STOCK_METRIC_INDICATOR	0.0071 (1.06)	-0.0033 (-0.50)	-0.0057* (-1.95)	0.0025 (0.81)	-0.0056 (-0.76)	0.0070 (0.85)
STOCK_AWARD_INDICATOR $\times$ STOCK_METRIC_INDICATOR	-0.0736*** (-3.22)	-0.0319*** (-2.98)	0.0516*** (5.20)	0.0238*** (4.73)	0.0960*** (3.83)	0.0331** (2.48)
TARGET > ACTUAL_ INDICATOR	-0.0191*** (-3.83)	-0.0231*** (-5.09)	0.0021*** (6.11)	0.0011*** (3.81)	0.0243*** (4.32)	0.0269*** (4.82)
Constant	0.4777*** (25.37)	0.5926*** (24.23)	0.1049*** (18.40)	0.0706*** (14.61)	0.7031*** (35.33)	0.6067*** (14.59)
R <sup>2</sup>	0.7367	0.7688	0.8453	0.9512	0.7485	0.7726
No. of obs.	9,354	5,263	9,354	5,263	9,354	5,263
Test of coeff. for INTERACTION		(1) vs. (2)		(3) vs. (4)		(5) vs. (6)
[p-Value]		[0.000]		[0.018]		[0.056]

(continued on next page)

TABLE 2 (continued)  
 Difference in Differences Regressions: Is RPE Associated With  
 Higher Idiosyncratic Risk Relative to APE?

	IND_INDEX_CORRELATION <sub>t-1</sub>		IDIOSYNCRATIC_RISK <sub>t-1</sub>		IDIOSYNCRATIC/ TOTAL_RISK <sub>t-1</sub>	
	APE <sub>t-1</sub> → RPE <sub>t</sub>	RPE <sub>t-1</sub> → APE <sub>t</sub>	APE <sub>t-1</sub> → RPE <sub>t</sub>	RPE <sub>t-1</sub> → APE <sub>t</sub>	APE <sub>t-1</sub> → RPE <sub>t</sub>	RPE <sub>t-1</sub> → APE <sub>t</sub>
	1	2	3	4	5	6
<i>Panel D. Models Including Controls for Other Plan Features and Characteristics of CEOs and Firms</i>						
INTERACTION (TIME × SWITCH)	-0.0488** (-2.18)	0.0346** (2.39)	0.0225*** (5.17)	-0.0148** (-2.56)	0.0430*** (3.73)	-0.0326** (-2.03)
PLAN_CONVEXITY_INDICATOR	0.0115 (0.60)	0.0111 (1.02)	0.0012 (0.17)	-0.0093** (-2.45)	0.0054 (0.25)	-0.0405*** (-3.62)
ln(PLAN_DURATION)	0.0075 (0.90)	-0.0072 (-1.51)	-0.0070** (-2.24)	0.0168*** (3.27)	-0.0146 (-1.54)	0.0137** (1.98)
STOCK_AWARD_INDICATOR	-0.0848*** (-6.84)	-0.0146*** (-4.28)	0.0040*** (5.84)	0.0060*** (3.43)	0.0846*** (6.02)	0.0190*** (4.55)
STOCK_METRIC_INDICATOR	-0.0204 (-0.82)	0.0005 (0.08)	-0.0010 (-0.34)	0.0035 (1.05)	0.0081 (0.29)	0.0096 (1.40)
<i>Controls</i>						
ln(1 + PRIOR_CEO_VEGA)	-0.0057** (-2.03)	0.0021 (0.67)	-0.0070*** (-6.69)	-0.0086*** (-5.76)	-0.0032 (-1.01)	-0.0017 (-0.36)
ln(1 + PRIOR_CEO_DELTA)	-0.0141*** (-3.24)	-0.0101* (-1.84)	0.0106** (6.58)	0.0172*** (6.70)	0.0114** (2.31)	0.0194*** (2.77)
CEO_SALARY_COMP	0.0451** (2.06)	0.1110*** (2.79)	-0.0325*** (-3.98)	-0.0449*** (-4.04)	-0.1360*** (-3.08)	-0.1048** (-2.13)
ln(1 + CEO_TENURE)	0.0034 (0.53)	0.0097 (1.44)	0.0009 (0.38)	-0.0072** (-2.30)	-0.0108 (-1.50)	-0.0096 (-1.19)
NEW_AND_OUTSIDE_CEO	-0.0080 (-0.56)	-0.0137 (-0.80)	0.0005 (0.09)	0.0039 (0.46)	0.0102 (0.62)	0.0149 (0.77)
CEO_EMPL_CONTRACT	0.1563*** (21.41)	0.1407*** (19.30)	-0.0514*** (-18.90)	-0.0517*** (-15.19)	-0.1734*** (-20.99)	-0.1708*** (-19.11)
FOUNDER	0.0095 (0.35)	-0.0950** (-1.96)	-0.0196* (-1.95)	0.0805*** (3.55)	-0.0622** (-2.03)	0.1179* (1.95)
CEO_DUALITY	0.0378*** (3.85)	-0.0095 (-0.94)	-0.0133*** (-3.64)	0.0047 (1.02)	-0.0221** (-1.99)	0.0316*** (2.59)
INST_OWNERSHIP	0.0044*** (15.83)	0.0055*** (15.63)	-0.0019*** (-18.38)	-0.0037*** (-21.65)	-0.0051*** (-16.14)	-0.0038*** (-12.31)
ln(SALES)	0.0110 (1.05)	-0.0115 (-1.08)	0.0248*** (6.33)	0.0160*** (3.02)	-0.0201* (-1.70)	0.0166 (1.28)
ln(FIRM_AGE)	-0.1109*** (-7.93)	-0.1157*** (-6.62)	0.0612*** (11.74)	0.0930*** (11.59)	0.1522*** (9.67)	0.1297*** (6.09)
TOBIN'S_Q	-0.0002 (-0.04)	-0.0052 (-0.73)	0.0073*** (5.25)	0.0042 (1.18)	0.0006 (0.14)	0.0008 (0.10)
PP&E	0.2552*** (3.83)	0.0083 (0.15)	-0.0764*** (-3.08)	0.0945*** (3.57)	-0.2187*** (-2.90)	0.1035 (1.51)
IND_ADJ_ROA	0.0167 (0.56)	0.0998*** (3.14)	-0.0224** (-2.03)	0.0202 (1.24)	-0.0366 (-1.09)	-0.0817** (-2.07)
IND_ADJ_STOCK_RETURN	-0.0024 (-0.55)	0.0075 (0.91)	-0.0077*** (-4.71)	-0.0109** (-2.42)	-0.0038 (-0.77)	-0.0075 (-0.74)
LEVERAGE	0.0038 (0.10)	-0.1138** (-2.34)	0.0995*** (7.35)	0.0725*** (3.10)	0.0363 (0.88)	0.2566*** (4.32)
Constant	0.0881 (1.18)	0.5241*** (5.91)	0.1061*** (6.29)	0.0733*** (4.28)	1.0140*** (12.24)	0.3615*** (2.98)
R <sup>2</sup>	0.7563	0.7783	0.9023	0.9670	0.7540	0.7869
No. of obs.	9,307	5,092	9,307	5,092	9,307	5,092
Test of coeff. for INTERACTION		(1) vs. (2)		(3) vs. (4)		(5) vs. (6)
[p-Value]		[0.027]		[0.006]		[0.043]

switch. For firms switching to RPE (APE), subsequent IDIOSYNCRATIC\_RISK is relatively higher (lower), as reflected in positive (negative) coefficient on the DID interaction term of 0.0398 (-0.0200) in model 3 (model 4). Models 5 and 6 show that IDIOSYNCRATIC/TOTAL\_RISK is significantly higher for firms switching

to RPE and lower for firms switching to APE, respectively. DID interaction term coefficients are statistically significantly different from each other across corresponding regression models (i.e.,  $\beta_1$  in models 1 versus 2, 3 versus 4, and 5 versus 6).<sup>10</sup>

Further, switches between types of performance-based compensation plans lead to economically significant changes in the dependent variables. Following a switch to RPE (APE), *IND\_INDEX\_CORRELATION* is lower (higher) by 8.0% (5.1%), *IDIOSYNCRATIC\_RISK* increases (decreases) by 34.8% (19.8%), and *IDIOSYNCRATIC/TOTAL\_RISK* is higher (lower) by 11.7% (4.5%), relative to the pre-switch mean.<sup>11</sup> The significance of our DID results suggests that switches in a CEO's performance plan type over a single year are sufficient to alter risk-taking incentives in a meaningful way. On closer inspection, however, the fact that the duration of APE plans is typically 1 year (see [Table 1](#)), suggests that firms switching to RPE are not generally subject to conflicting incentives from overlapping plans. The duration of RPE plans is typically 3 years, suggesting that firms switching to APE are more subject to conflicting incentives from overlapping plans, but this works against us finding significant results. Although the statistical and economic significances are weaker following a switch from RPE to APE, the results remain significant and are robust to alternative tests performed below.

## B. Controlling for Contractual Features of Performance-Based Compensation Plans

Contractual features of CEO performance-based compensation plans, other than the use of relative versus absolute performance targets, can affect CEO risk-taking incentives. Thus, it is important to control for these features to ensure that they do not drive our findings. Results from DID models that include controls for such contractual features are presented in Panel B of [Table 2](#). It is worth noting that because DID estimation includes firm-year observations for both pre- and post-treatment years, these contractual variables capture the features of both prior

<sup>10</sup>This study's sample period is from 1998 to 2014. However, prior to 2006, many of the details of CEO performance-based compensation plans were not required to be disclosed in SEC filings. Thus, for the pre-2006 period, the identification of APE and RPE is based on voluntary disclosures, which could be subject to self-selection biases. To address the potential impact of such misclassification, we split the sample observations into pre- and post-disclosure periods (1998–2005 and 2007–2014, respectively). The frequency of switches from APE to RPE is somewhat higher at 9.6%, while the frequency of switches from RPE to APE is somewhat lower at 8.8% following the SEC's 2006 mandatory executive compensation disclosure rules. Robustness tests (untabulated) show that our main results hold for both subperiods.

<sup>11</sup>Pre-treatment mean *IND\_INDEX\_CORRELATION*, *IDIOSYNCRATIC\_RISK*, and *IDIOSYNCRATIC/TOTAL\_RISK* prior to potential switches from APE to RPE are 0.5046%, 0.1145%, and 51.9%, respectively. For switchers relative to nonswitchers, *IND\_INDEX\_CORRELATION*, *IDIOSYNCRATIC\_RISK*, and *IDIOSYNCRATIC/TOTAL\_RISK* in year  $t + 1$  differ by  $-0.0402\%$ ,  $0.0398\%$ , and  $6.08\%$ , respectively. These translate into percentage changes of  $-7.97\%$ ,  $34.76\%$ , and  $11.71\%$ , respectively. Preceding potential switches from RPE to APE, mean *IND\_INDEX\_CORRELATION*, *IDIOSYNCRATIC\_RISK*, and *IDIOSYNCRATIC/TOTAL\_RISK* are  $0.5537\%$ ,  $0.1012\%$ , and  $56.2\%$ , respectively. For switchers relative to nonswitchers, *IND\_INDEX\_CORRELATION*, *IDIOSYNCRATIC\_RISK*, and *IDIOSYNCRATIC/TOTAL\_RISK* in year  $t + 1$  differ by  $0.0284\%$ ,  $-0.0200\%$ , and  $-2.55\%$ , respectively. These translate into percentage changes of  $5.13\%$ ,  $-19.77\%$ , and  $-4.54\%$ , respectively.



plans (in place in pre-treatment YEAR  $t - 1$ , TIME = 0) and new plans (in place in post-treatment YEAR  $t$ , TIME = 1).

Specific features controlled for are the convexity of the grant date (ex ante) payout-performance schedule around target performance (PLAN\_CONVEXITY\_INDICATOR), the natural log of the number of months between start and end of a plan's performance measurement period ( $\ln(\text{PLAN\_DURATION})$ ), form of payout using an indicator variable that equals 1 for stock or options as the back-end instrument, and zero for cash as the back-end instrument (STOCK\_AWARD\_INDICATOR), and type of performance metric using an indicator variable that equals 1 for stock performance metrics, and zero otherwise (STOCK\_METRIC\_INDICATOR).<sup>12</sup> As Panel B of Table 2 shows, even after controlling for these plan features, the sign, magnitude, and statistical significance of the DID interaction variable coefficients ( $\beta_1$ ) are similar to those in Panel A. Differences between  $\beta_1$  coefficients across corresponding models remain significant as well. Therefore, while some of the plan feature variables are statistically significant, they do not drive our findings.

The PLAN\_CONVEXITY\_INDICATOR variable is positively associated with IND\_INDEX\_CORRELATION and negatively associated with idiosyncratic risk measures across all models. This suggests that the risk-taking incentives provided by plan convexity encourage systematic, rather than idiosyncratic, risk-taking. Coefficients for  $\ln(\text{PLAN\_DURATION})$  carry the opposite sign of the DID interaction coefficient.<sup>13</sup> As explained earlier, plans with stock-based payouts should create stronger risk-taking incentives than plans that pay out in cash. Indeed, the STOCK\_AWARD\_INDICATOR is negatively associated with IND\_INDEX\_CORRELATION and positively associated with idiosyncratic risk measures across all six models. Because accounting-based performance metrics are more subject to managerial discretion (Bennett et al. (2017), Gong, Li, and Yin (2019)), they might dampen risk-taking incentives associated with a performance-based compensation plan. Furthermore, as explained earlier, plans using accounting-based performance metrics may create incentives to increase the variability of that metric, but this does not necessarily translate into incentives to increase stock return variability. With the exception of model 4, the coefficient for the STOCK\_METRIC\_INDICATOR variable is insignificant.

The difficulty of hitting a plan's performance target might also influence risk-taking incentives. Easy targets provide little incentive. In contrast, the more challenging the performance targets, the stronger are the incentives to "swing for

<sup>12</sup>Including plan feature variables reduces the number of observations from 15,392 to 11,047 firm-years (28% reduction) for potential switches from APE to RPE and from 7,304 to 5,632 firm-years (23% reduction) for potential switches from RPE to APE.

<sup>13</sup>The literature is ambiguous regarding the effect of plan duration on risk-taking. Some studies argue that CEOs take less risk the more frequently their performance is evaluated (e.g., Thaler, Tversky, Kahneman, and Schwartz (1997)), this suggests that plans with longer duration will be associated with more risk-taking. In contrast, other studies argue that CEOs take more risk when their performance is evaluated more frequently (e.g., Eriksen and Kvaløy (2014)), this suggests that plans with shorter duration will be associated with more risk-taking. In addition, Gopalan, Milbourn, Song, and Thakor (2014) find that riskier firms offer shorter CEO pay duration contracts.

the fences” and adopt riskier strategies.<sup>14</sup> Panel C of Table 2 adds a TARGET>ACTUAL\_INDICATOR variable, which equals 1 if firm performance in year  $t$  ( $t - 1$ ) is below the plan’s performance target for the new (prior) grant.<sup>15</sup> The TARGET>ACTUAL\_INDICATOR is negatively associated with IND\_INDEX\_CORRELATION and positively associated with idiosyncratic risk measures for all six models, suggesting a potential asymmetry in risk-taking at different levels of actual relative to target performance. This finding also suggests that if a firm’s actual performance is above its performance target, the CEO may engage in strategic mimicry or herding behavior.<sup>16</sup> Because the inclusion of this variable results in a substantial loss of observations, we do not include it in subsequent analyses. We also include the interaction of STOCK\_AWARD\_INDICATOR variable with STOCK\_METRIC\_INDICATOR variable to control for the possibility that the payoff function is more convex when both features are at play. The sign and significance of this interaction variable are similar to those for the STOCK\_AWARD\_INDICATOR variable.

### C. Models With Additional Control Variables

Firm fixed effects control only for time-invariant firm characteristics. Thus, in our next set of models, we include variables that control for time-varying elements of CEO compensation, CEO and firm characteristics, and CEO turnover events. While there is no consensus regarding the ideal control variables to include in our regressions, we survey the literature for commonly used control variables and include them in our models. Panel D of Table 2 presents the results. Firm-level control variables are INST\_OWNERSHIP,  $\ln(\text{SALES})$ ,  $\ln(\text{FIRM\_AGE})$ , TOBIN’S\_Q, PP&E (net property, plant, and equipment scaled by total assets), IND\_ADJ\_ROA, IND\_ADJ\_STOCK\_RETURN, and LEVERAGE. Coefficients for these controls are broadly consistent with prior studies.

To address concerns that some elements of a CEO’s compensation package have payoff profiles that could affect risk-taking incentives, we include  $\ln(1 + \text{PRIOR\_CEO\_VEGA})$ ,  $\ln(1 + \text{PRIOR\_CEO\_DELTA})$ ,<sup>17</sup> and the ratio of the CEO’s

<sup>14</sup>Cabral (2003) formalizes the intuition that laggards have little to lose and deliberately adopt riskier strategies when they are behind in the tournament (e.g., they have incentives to pursue a “Hail Mary” strategy). Knoeber and Thurman (1994) and Brown et al. (1996) show empirically that those who are unlikely to win a tournament adopt riskier strategies. In contrast, Brown (2011) provides evidence that when golfers are confronted with a superstar competitor (e.g., Tiger Woods), they do not adopt riskier strategies.

<sup>15</sup>Genakos and Pagliero (2012) show an inverted-U relationship between risk-taking and rank. Indeed, laggards tend to take greater risks than leader. However, catching up with the leaders becomes progressively more unlikely as one moves down in ranking and may reduce risk-taking when one is far from the competitors. This finding motivates our use of the TARGET>ACTUAL\_INDICATOR rather than the actual difference between a plan’s performance target and the performance measure in the grant year.

<sup>16</sup>We are grateful to Professor John Graham for pointing out the relevance of the herding literature as it pertains to the impact of the difficulty of hitting a plan’s performance target on idiosyncratic risk-taking behavior (e.g., Graham (1999)).

<sup>17</sup>Following Appendix A of Hayes et al. (2012), we measure the risk-neutral (Black–Scholes) CEO vega using ExecuComp data on option exercise price and option terms, the annual standard deviation of a firm’s stock return based on returns from the preceding 36 months and annual dividend yield averaged

salary to total compensation (CEO\_SALARY\_COMP).<sup>18</sup> Consistent with prior research (e.g., Armstrong and Vashishtha (2012)),  $\ln(1 + \text{PRIOR\_CEO\_VEGA})$  is significantly negatively associated with IDIOSYNCRATIC\_RISK for switches in both directions (models 3 and 4).  $\ln(1 + \text{PRIOR\_CEO\_DELTA})$  is significantly negatively associated with IND\_INDEX\_CORRELATION and positively associated with both idiosyncratic risk measures. CEO\_SALARY\_COMP is significantly positively associated with IND\_INDEX\_CORRELATION, and negatively associated with both idiosyncratic risk measures for switches in both directions.

To address a potential concern that CEO turnover or CEO risk-taking characteristics drive our findings, we include  $\ln(1 + \text{CEO\_TENURE})$ , and indicator variables for whether or not the CEO joined the firm no more than 2 years earlier (NEW\_AND\_OUTSIDE\_CEO), has an explicit employment contract (CEO\_EMPL\_CONTRACT), is a founder of the firm (FOUNDER), or chairs the firm's board of directors (CEO\_DUALITY). The only variable that is consistently significant is the CEO\_EMPL\_CONTRACT indicator, which is positively associated with IND\_INDEX\_CORRELATION and negatively associated with both idiosyncratic risk measures across models. This finding is consistent with Gillan, Hartzell, and Parrino (2009) who find that by providing CEOs with guaranteed compensation and job security, explicit employment agreements dampen risk-taking incentives. To further rule out the possibility that CEO turnover or CEO risk-taking characteristics drive our findings, we rerun all Table 2 models with year and CEO-firm fixed effects, which control for endogenous CEO-firm matching and time-invariant characteristics of CEOs and firms. Our (untabulated) findings remain unchanged. To summarize, even after including additional controls, the sign, magnitude, and significance of DID interaction variable coefficients ( $\beta_1$ ) remain similar to those in Panel A. Further, DID interaction coefficients remain statistically significantly different across corresponding regression models. Thus, our results are robust to these controls.

Models are also estimated under alternative DID research designs that require 2 or 3 consecutive years of APE or RPE use prior to potential switches. These research designs impose substantial data restrictions and result in a much smaller number of observations for estimation. Even so, results (untabulated) are similar to Table 2 findings.<sup>19</sup> Finally, models are estimated for first-time RPE and APE adoptions. First-time adoptions could provide a stronger "treatment" effect because

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over the same period. To make sure that it is not the use of options as a back-end instrument in prior p-v plans (in place in YEAR  $t - 1$ , TIME = 0) or in new p-v plans (in place in YEAR  $t$ , TIME = 1) that drives the significance of CEO vega, we calculate  $\ln(1 + \text{PRIOR\_CEO\_VEGA})$  based on the CEO's total portfolio of option grants prior to YEAR  $t - 1$  (YEAR  $t$ ) for the pre-switching (post-switching) period. Similarly, we calculate  $\ln(1 + \text{PRIOR\_CEO\_DELTA})$  based on a CEO's total portfolio of granted shares and options prior to YEAR  $t - 1$  (YEAR  $t$ ) for pre-switching (post-switching) period.

<sup>18</sup>We focus on the salary component of cash compensation and exclude cash bonus because the typical CEO cash bonus contract has option-like features (Shaw and Zhang (2010)).

<sup>19</sup>These multi-year window research designs have disadvantages and advantages. Because the median RPE award vesting period is 3 years, the effect of a new RPE grant on managerial behavior is more difficult to isolate from the effect of an RPE award that was granted (e.g., 2 years ago). On the positive side, based on 2 (3) years of data, it is easier to visually inspect whether pre-treatment trends satisfy the parallel trends assumption, which is a key identifying assumption underlying the DID estimation technique.

they are not contaminated by prior, possibly overlapping performance-based compensation plans of the same type (Bettis, Bizjak, Coles, and Young (2014)). Results presented in Supplementary Material Appendix E are also consistent with Table 2 findings.

#### D. Further Robustness Checks

In our DID setting, identification is not perfect as the treatment is not random but is based on a potentially endogenous decision (i.e., switching performance-based compensation plan type). Further, it is possible that omitted variables or hidden factors jointly determine the design of CEO compensation contracts and a firm's industry index correlation and idiosyncratic risk. Still another potential concern is the possibility of reverse causality. For example, a CEO might decide to adjust strategy in YEAR  $t - 1$  and then, in YEAR  $t$ , switch to the type of performance plan that will generate the highest pay under the new strategy.<sup>20</sup> In the previous section, we explored the sensitivity of our treatment effect to the inclusion of controls and fixed effects. To further confirm the validity of our main results, we undertake a variety of robustness checks to address these concerns.

##### 1. Parallel Trends Assumption and Placebo Test

A causal interpretation of our main results requires that the parallel trends assumption underlying DID be satisfied. Evidence of changes in the outcome variables for treated firms, relative to control firms, prior to actual switches in performance-based compensation plan type would cast doubt on the validity of our findings. Specifically, it would imply a violation of the assumption that, in the absence of treatment, treated and control firms will experience *ex ante* parallel trends in the outcome variables. In Panel A of Table 3, we perform a falsification test in which we falsely assume that switches in the type of performance-based compensation plan occurred 1 year before switching firms actually do so. The coefficient for  $\text{INTERACTION}^{-1} (\text{TIME}^{-1} \times \text{SWITCH})$ , which equals 1 for firms that will actually switch to a different type of performance-based compensation plan in the following year and zero otherwise, is the estimated placebo treatment effect.

Results show that it is statistically indistinguishable from zero, providing evidence that changes in  $\text{IND\_INDEX\_CORRELATION}$  and idiosyncratic risk for treated firms relative to control firms occur *after* switches in performance plan type, but not before. Overall, this falsification test confirms that, in the absence of treatment, both treated and control firms exhibit similar trends in the outcome variables.

##### 2. Matched Pair Analysis

We further address the possibility of reverse causality by forming matched pairs of treated and control firms based on logistic models that estimate the propensity to switch from APE to RPE and from RPE to APE (presented in

<sup>20</sup>Bhagat, Brickley, and Lease (1985) suggest that compensation contracts may be adopted for signaling reasons (e.g., because insiders are optimistic about the firm's future, rather than to motivate managers). Garvey and Milbourn (2006) suggest that CEOs are more likely to push for the adoption of RPE plans during bad times in order to avoid lower pay, while they are more likely to push to drop RPE plans during good times in order to enjoy pay increases.

**TABLE 3**  
**Robustness Checks: Timing of Changes in Risk and Matched Pair Analysis**

Dependent variables in Table 3 are Industry index return correlation (IND\_INDEX\_CORRELATION), IDIOSYNCRATIC\_RISK, and IDIOSYNCRATIC/TOTAL\_RISK for year  $t + 1$ . Variables are defined in the Appendix. Panel A presents tests of the parallel trends assumption. In Panels B and C, Models (1), (3), and (5) use 605 matched pairs (a total of 1,210 firm-years) that use APE in year  $t - 1$  and either switch to RPE or not in the following year  $t$ . Models (2), (4), and (6) use 322 matched pairs (a total of 644 firm-years) that use RPE in year  $t - 1$  and either switch to APE or not in the following year  $t$ . Matches are based on Mahalanobis distance covariate matching or nearest neighbor propensity scores matching using models presented in Supplementary Material Appendix F, Table F1. Panel D uses 3,980 matched pairs of RPE and APE firm-years (a total of 7,960 firm-years) and matches are based on Mahalanobis distance covariate matching or nearest-neighbor propensity scores matching using models presented in Supplementary Material Appendix F, Table F2. Controls, firm and year fixed effects, and a constant are included in all models.  $t$ -values are based on robust standard errors clustered by firm and by year (2-way) and are reported in parentheses. Chow tests examine whether the coefficients for Interaction in Panel A and Switch Indicator in Panels B and C differ significantly across analogous regression models. \*, \*\*, and \*\*\* indicate significance at the 10%, 5%, and 1% levels, respectively.

	IND_INDEX_CORRELATION <sub><math>t+1</math></sub>		IDIOSYNCRATIC_RISK <sub><math>t+1</math></sub>		IDIOSYNCRATIC/ TOTAL_RISK <sub><math>t+1</math></sub>	
	APE <sub><math>t-1</math></sub> → RPE <sub><math>t</math></sub>	RPE <sub><math>t-1</math></sub> → APE <sub><math>t</math></sub>	APE <sub><math>t-1</math></sub> → RPE <sub><math>t</math></sub>	RPE <sub><math>t-1</math></sub> → APE <sub><math>t</math></sub>	APE <sub><math>t-1</math></sub> → RPE <sub><math>t</math></sub>	RPE <sub><math>t-1</math></sub> → APE <sub><math>t</math></sub>
	1	2	3	4	5	6
<i>Panel A. Timing of Changes in Risk</i>						
INTERACTION <sup>-1</sup> (TIME <sup>-1</sup> × SWITCH)	-0.0047 (-0.40)	0.0069 (0.66)	0.0037 (1.00)	-0.0039 (-0.48)	0.0098 (1.02)	-0.0323 (-1.52)
INTERACTION (TIME × SWITCH)	-0.0498** (-2.21)	0.0384*** (2.72)	0.0234*** (5.27)	-0.0114** (-2.01)	0.0452*** (3.86)	-0.0432** (-2.41)
PLAN_CONVEXITY_INDICATOR	0.0117 (0.61)	0.0111 (1.02)	0.0013 (0.18)	-0.0094** (-2.45)	0.0051 (0.24)	-0.0407*** (-3.64)
ln(PLAN_DURATION)	0.0076 (0.91)	-0.0070 (-1.49)	-0.0069** (-2.23)	0.0166*** (3.24)	-0.0147 (-1.56)	0.0136** (1.96)
STOCK_AWARD_INDICATOR	-0.0848*** (-6.84)	-0.0145*** (-4.26)	0.0040*** (5.83)	0.0060*** (3.43)	0.0846*** (6.02)	0.0189*** (4.53)
STOCK_METRIC_INDICATOR	-0.0203 (-0.82)	0.0005 (0.08)	-0.0010 (-0.34)	0.0035 (1.05)	0.0080 (0.28)	0.0094 (1.37)
$R^2$	0.7568	0.7783	0.9023	0.9670	0.7544	0.7869
No. of obs.	9,307	5,092	9,307	5,092	9,307	5,092
Test of coeff. for INTERACTION <sup>-1</sup>		(1) vs. (2)		(3) vs. (4)		(5) vs. (6)
[ $p$ -Value]		[0.910]		[0.945]		[0.741]
Test of coeff. for INTERACTION		(1) vs. (2)		(3) vs. (4)		(5) vs. (6)
[ $p$ -Value]		[0.019]		[0.032]		[0.041]
<i>Panel B. Analysis Using Mahalanobis Distance Metric Matched Pairs</i>						
SWITCH_INDICATOR	-0.0581*** (-2.79)	0.0426** (2.50)	0.0440*** (5.33)	-0.0171*** (-2.71)	0.0904*** (3.19)	-0.0411*** (-2.59)
PLAN_CONVEXITY_INDICATOR	0.0833** (2.26)	0.0020 (0.10)	-0.0021 (-0.16)	-0.0165** (-2.15)	-0.0239 (-0.71)	-0.0057 (-0.32)
ln(PLAN_DURATION)	0.0239 (0.60)	-0.0036 (-0.13)	-0.0322** (-2.18)	-0.0153 (-1.29)	-0.0297 (-0.75)	0.0016 (0.05)
STOCK_AWARD_INDICATOR	-0.0084 (-0.58)	-0.0163** (-2.52)	0.0102** (2.45)	0.0017 (0.53)	0.0216* (1.89)	0.0077 (1.18)
STOCK_METRIC_INDICATOR	0.0397 (1.24)	-0.0036 (-0.52)	0.0019 (0.21)	-0.0009 (-0.14)	-0.0187 (-0.73)	0.0211 (1.27)
$R^2$	0.6356	0.7610	0.8588	0.9038	0.6621	0.8053
Test of coeff. for SWITCH_INDICATOR		(1) vs. (2)		(3) vs. (4)		(5) vs. (6)
[ $p$ -Value]		[0.0037]		[0.0000]		[0.0010]
<i>Panel C. Analysis Using Propensity Score Matched Pairs</i>						
SWITCH_INDICATOR	-0.0601*** (-2.73)	0.0308** (2.52)	0.0456*** (4.95)	-0.0217** (-2.31)	0.0721*** (2.91)	-0.0473*** (-2.71)
PLAN_CONVEXITY_INDICATOR	0.1499*** (4.36)	0.0206 (1.16)	-0.0249 (-1.30)	-0.0047 (-0.50)	-0.0209 (-0.70)	-0.0013 (-0.06)
ln(PLAN_DURATION)	0.0263 (0.73)	-0.0015 (-0.05)	-0.0353*** (-2.60)	-0.0015 (-0.18)	-0.0369 (-0.93)	-0.0551 (-1.51)
STOCK_AWARD_INDICATOR	-0.0190** (-1.97)	-0.0109* (-1.73)	0.0139*** (2.59)	0.0021 (1.43)	0.0214* (1.88)	0.0054 (0.61)
STOCK_METRIC_INDICATOR	0.0311 (1.45)	-0.0165 (-1.09)	-0.0030 (-0.25)	0.0060 (0.99)	-0.0212 (-0.84)	-0.0000 (-0.00)
$R^2$	0.5968	0.7351	0.8530	0.9192	0.6077	0.7528
Test of coeff. for SWITCH_INDICATOR [ $p$ -value]		(1) vs. (2) [0.0003]		(3) vs. (4) [0.0001]		(5) vs. (6) [0.0002]

(continued on next page)

TABLE 3 (continued)  
 Robustness Checks: Timing of Changes in Risk and Matched Pair Analysis

Panel D. Analysis Using Matched Pairs From Model of Propensity to Choose RPE

	IND_INDEX_CORRELATION <sub>t+1</sub>		IDIOSYNCRATIC_RISK <sub>t+1</sub>		IDIOSYNCRATIC/ TOTAL_RISK <sub>t+1</sub>	
	Mahalanobis Matched Sample	Propensity Score Matched Sample	Mahalanobis Matched Sample	Propensity Score Matched Sample	Mahalanobis Matched Sample	Propensity Score Matched Sample
	1	2	3	4	5	6
RPE_INDICATOR	-0.0267** (-1.99)	-0.0310*** (-3.03)	0.0154*** (3.62)	0.0154*** (3.77)	0.0365* (1.90)	0.0379** (2.01)
PLAN_CONVEXITY_INDICATOR	-0.0004 (-0.05)	-0.0035 (-0.42)	-0.0036 (-0.86)	-0.0039 (-0.93)	-0.0049 (-0.44)	-0.0041 (-0.38)
ln(PLAN_DURATION)	0.0364** (2.26)	0.0335*** (2.58)	-0.0172*** (-2.57)	-0.0174*** (-2.61)	-0.0393** (-2.24)	-0.0447*** (-2.60)
STOCK_AWARD_INDICATOR	-0.0041 (-1.25)	-0.0062** (-2.23)	0.0003 (0.23)	0.0005 (0.37)	-0.0026 (-0.72)	0.0025 (0.69)
STOCK_METRIC_INDICATOR	-0.0018 (-0.22)	-0.0005 (-0.07)	0.0002 (0.06)	0.0005 (0.14)	-0.0044 (-0.45)	0.0018 (0.19)
R <sup>2</sup>	0.7604	0.7565	0.9145	0.9147	0.6364	0.6378

Supplementary Material Appendix F, Table F1) and the propensity to choose RPE versus APE (presented in Supplementary Material Appendix F, Table F2). It is worth noting that in these models, the coefficients for lagged idiosyncratic risk measures are the opposite of those that would suggest a problem of reverse causality problem. This implies that ex ante differences in idiosyncratic risk measures do not explain our findings.

Our matched samples are comprised of firm-year pairs with similar plan choice propensities ex ante, but different plan choices ex post. A total of six matched pair control samples are formed based on Mahalanobis distance covariate matching and nearest-neighbor propensity score matching (Imbens (2000)). Supplementary Material Appendix F, Tables F3 and F4, shows that mean and median values of our matching variables are similar across matched pairs. Importantly, ex ante IND\_INDEX\_CORRELATION and IDIOSYNCRATIC\_RISK are comparable across matched pairs.

Panels B–D of Table 3 present models estimated using our matched pairs. As discussed above, matched pairs have comparable pre-switching characteristics. Thus, we do not include firm-year observations for the pre-switching period and do not use the DID methodology. Accordingly, the DID INTERACTION is replaced with SWITCH\_INDICATOR, which equals 1 if the firm changes performance plan type in that year, and zero otherwise, in Panels B and C of Table 3. In Panel D of Table 3, the DID INTERACTION is replaced with RPE\_INDICATOR, which equals 1 for RPE firm-years, and 0 for APE firm-years. All models include the same controls used in Panel D of Table 2 and firm and year fixed effects.

Results based on Mahalanobis distance covariate and nearest-neighbor propensity score matched pair analyses show significant differences in all three dependent variables between matched switchers and nonswitchers and between matched RPE and APE plans. The direction of the effect on subsequent idiosyncratic risk is as expected.

### 3. 2SLS/IV Model Estimation and Subsample Analyses

Supplementary Material Appendices G and H present the results of two additional robustness checks. In Supplementary Material Appendix G, we treat the potential switches from APE to RPE as endogenous and use the staggered adoption of the Inevitable Disclosure Doctrine (IDD) by U.S. states as a natural experiment that facilitates the staggered adoption of CEO RPE plans both across firms and over time. Results from 2SLS/IV models estimated using matched pairs support our finding that RPE adoption is associated with higher subsequent idiosyncratic risk. In Supplementary Material Appendix H, we examine whether our findings are driven by hidden factors that simultaneously influence both a firm's idiosyncratic risk and the type of performance plan granted to its CEO. To do so, we conduct a subsample analysis that focuses on two plausible hidden factors: i) market or industry downturns and ii) operating inflexibility. We find no evidence that either of these factors drives our findings.

## V. Additional Analyses

### A. Does the Use of RPE Versus APE Influence Corporate Policy Choices?

Our primary finding is that switches from APE to RPE (RPE to APE) are associated with relatively higher (lower) firm-level idiosyncratic risk. In this section, we test whether this higher (lower) idiosyncratic risk is reflected in corporate policy choices. We expect that it will be because corporate policy choices are an important mechanism that drives firm-level idiosyncratic risk.

Specifically, we test whether switches from APE to RPE (RPE to APE) are associated with relatively large (small) deviations in financial and investment policies from industry norms. We also test whether firms switching from APE to RPE (RPE to APE) adopt relatively more (less) idiosyncratic strategies by divesting (adding) lines of business in their primary industry and acquiring (not investing in) targets in lines of business outside their primary industry. Such decisions about corporate strategies would allow CEOs with RPE plans to distinguish their firms from the competition and outperform their peers if their more idiosyncratic strategies turn out well. CEOs with APE plans would not have such incentives.

We measure a focal firm's policy dissimilarity relative to the industry norm as the absolute value of the difference between its corporate policy variable and the median value of that variable among its industry peers. The smaller is this dissimilarity in corporate policy, the more similar the policy of the focal firm is to that which is typical in its industry. Table 4 presents results for DID models for dissimilarities in corporate financial policy (Panel A), dissimilarities in investment policy (Panel B), and dissimilarities in acquisitions and divestitures (Panel C). Explanatory variables include the same controls used in Panel D of Table 2 and firm and year fixed effects. Financial policy variables are CASH\_DISSIMILIARITY, LEVERAGE\_DISSIMILIARITY, and DEFAULT\_DISSIMILIARITY, which utilizes the estimated probability of default based on KMV-Merton's (1974) model (Bharath and Shumway (2008)). Investment policy variables are CAPEX\_

TABLE 4  
Difference in Differences Regressions: Is RPE Associated With  
More Idiosyncratic Firm Policies Relative to APE?

Panel A of Table 4 presents models for financial policy dissimilarity variables. Panel B presents models for investment policy dissimilarity variables. Panel C presents models for acquisition and divestiture policy dissimilarity variables. Variables are defined in the Appendix. Controls, firm and year fixed effects, and a constant are included in all models. *t*-values are based on robust standard errors clustered by firm and by year (2-way) and are reported in parentheses. Chow tests examine whether the coefficients for INTERACTION (Time period indicator  $\times$  Plan switch indicator) differ significantly across analogous regression models. \*, \*\*, and \*\*\* indicate significance at the 10%, 5%, and 1% levels, respectively.

Panel A. Financial Policy Mechanisms

	CASH_DISSIMILARITY <sub><i>t+1</i></sub>		LEVERAGE_DISSIMILARITY <sub><i>t+1</i></sub>		DEFAULT_DISSIMILARITY <sub><i>t+1</i></sub>	
	APE <sub><i>t-1</i></sub> $\rightarrow$ RPE <sub><i>t</i></sub>	RPE <sub><i>t-1</i></sub> $\rightarrow$ APE <sub><i>t</i></sub>	APE <sub><i>t-1</i></sub> $\rightarrow$ RPE <sub><i>t</i></sub>	RPE <sub><i>t-1</i></sub> $\rightarrow$ APE <sub><i>t</i></sub>	APE <sub><i>t-1</i></sub> $\rightarrow$ RPE <sub><i>t</i></sub>	RPE <sub><i>t-1</i></sub> $\rightarrow$ APE <sub><i>t</i></sub>
	1	2	3	4	5	6
INTERACTION (TIME $\times$ SWITCH)	0.0104** (2.43)	-0.0192* (-1.79)	0.0121** (2.30)	-0.0154*** (-2.65)	0.1239** (2.46)	-0.3170* (-1.81)
Leverage is excluded as a control variable in (3) and (4).						
<i>R</i> <sup>2</sup>	0.7964	0.5430	0.7928	0.6925	0.5387	0.4172
No. of obs.	9,307	5,092	9,307	5,092	8,865	4,868
Test of coeff. for INTERACTION	(1) vs. (2)		(3) vs. (4)		(5) vs. (6)	
[ <i>p</i> -Value]	[0.0689]		[0.0443]		[0.0883]	

Panel B. Investment Policy Mechanisms

	CAPEX_DISSIMILARITY <sub><i>t+1</i></sub>		R&D_DISSIMILARITY <sub><i>t+1</i></sub>		EFD_DISSIMILARITY <sub><i>t+1</i></sub>	
	APE <sub><i>t-1</i></sub> $\rightarrow$ RPE <sub><i>t</i></sub>	RPE <sub><i>t-1</i></sub> $\rightarrow$ APE <sub><i>t</i></sub>	APE <sub><i>t-1</i></sub> $\rightarrow$ RPE <sub><i>t</i></sub>	RPE <sub><i>t-1</i></sub> $\rightarrow$ APE <sub><i>t</i></sub>	APE <sub><i>t-1</i></sub> $\rightarrow$ RPE <sub><i>t</i></sub>	RPE <sub><i>t-1</i></sub> $\rightarrow$ APE <sub><i>t</i></sub>
	1	2	3	4	5	6
INTERACTION (TIME $\times$ SWITCH)	0.0979** (2.45)	-0.1193*** (-3.17)	1.1866*** (3.69)	-0.0537*** (-3.39)	6.6999*** (3.91)	-5.0149** (-2.05)
<i>R</i> <sup>2</sup>	0.3548	0.5030	0.8489	0.6670	0.5952	0.6145
No. of obs.	9,307	4,991	9,307	5,078	9,307	4,991
Test of coeff. for INTERACTION	(1) vs. (2)		(3) vs. (4)		(5) vs. (6)	
[ <i>p</i> -Value]	[0.0679]		[0.0244]		[0.0750]	

Panel C. Acquisition and Divestiture Policy Mechanisms

	ADD_SEGMENT_OUTSIDE <sub><i>t+1</i></sub> (%)		DIVEST_SEGMENT_OUTSIDE <sub><i>t+1</i></sub> (%)		ACQUIRE_TARGET_OUTSIDE <sub><i>t+1</i></sub> (%)	
	APE <sub><i>t-1</i></sub> $\rightarrow$ RPE <sub><i>t</i></sub>	RPE <sub><i>t-1</i></sub> $\rightarrow$ APE <sub><i>t</i></sub>	APE <sub><i>t-1</i></sub> $\rightarrow$ RPE <sub><i>t</i></sub>	RPE <sub><i>t-1</i></sub> $\rightarrow$ APE <sub><i>t</i></sub>	APE <sub><i>t-1</i></sub> $\rightarrow$ RPE <sub><i>t</i></sub>	RPE <sub><i>t-1</i></sub> $\rightarrow$ APE <sub><i>t</i></sub>
	1	2	3	4	5	6
INTERACTION (TIME $\times$ SWITCH)	13.4467*** (2.62)	-25.1125*** (-2.58)	-12.2300** (-2.29)	-5.0072 (-0.67)	7.0379*** (3.88)	-5.5318** (-2.25)
The characteristics of mergers and acquisitions are added to control variables in models (5) and (6).						
<i>R</i> <sup>2</sup>	0.8641	0.8185	0.8037	0.7806	0.7058	0.7219
No. of obs.	1,339	599	1,921	952	9,307	4,991
Test of coeff. for INTERACTION	(1) vs. (2)		(3) vs. (4)		(5) vs. (6)	
[ <i>p</i> -Value]	[0.0545]		[0.2475]		[0.0152]	

DISSIMILARITY, R&D\_DISSIMILARITY, and EFD\_DISSIMILARITY (external finance dependence), which is based on the fraction of CapEx not financed through internal cash flow (Rajan and Zingales (1998)). For acquisitions and divestitures, we measure the percentage of added business segments that have industry classifications outside the firm's primary industry classification (ADD\_SEGMENT\_OUTSIDE (%)), the percentage of divested business segments that have industry classifications outside the firm's primary industry classification (DIVEST\_SEGMENT\_OUTSIDE (%)), and the percentage of completed acquisitions that have industry



classifications outside the firm's primary industry classification (ACQUIRE\_TARGET\_OUTSIDE (%)).

Panel A of Table 4 shows that for all dissimilarity in financial policy specifications, the DID INTERACTION (TIME  $\times$  SWITCH) variable coefficients are positive for firms switching to RPE plans, indicating that after switching to RPE, the focal firm's cash ratio, market leverage, and default risk show larger deviations from industry norms than those of firms that continue to use only APE. The opposite findings hold for firms switching from RPE to APE although the results are not as strong statistically. The DID INTERACTION (TIME  $\times$  SWITCH) in Panel B shows that after switching to RPE, a focal firm's CapEx-to-PP&E, R&D-to-assets, and reliance on external financing, are more dissimilar to industry norms than those of nonswitchers. Panel C shows that after switching to RPE, firms adopt more idiosyncratic acquisition strategies; they are more likely to add business segments and acquire targets in industries outside of their primary industry and divest business segments in their primary industry. Again, opposite findings hold for switches in the opposite direction.<sup>21</sup>

## B. Does the DID Treatment Effect Vary With the Performance-Vesting Grant Schedule?

In this section, we first examine whether there are differential risk-taking incentives associated with convexity in a p-v grant schedule between RPE and APE plans. As explained earlier, convexity in the p-v grant schedule may provide stronger risk-taking incentives for RPE plans because such plans are based predominantly on stock performance metrics and the instrument to be awarded is stock.

Panel A of Table 5 estimates triple difference regressions in which the coefficient of interest is the coefficient on the triple interaction PLAN\_CONVEXITY\_INDICATOR  $\times$  TIME  $\times$  SWITCH (or PLAN\_CONVEXITY\_INDICATOR  $\times$  INTERACTION). The coefficients for the triple interaction are insignificant in five of the six specifications (except model 3), suggesting that differences in idiosyncratic risk between switchers and nonswitchers in the post-period are not due to differences in p-v grant schedule convexity for RPE versus APE plans.

The lack of statistical significance on the triple interaction could be because we use convexity at the grant date (ex ante) rather than convexity in the ex post realized value of the awards. The latter is more convex in stock price for RPE plans as they tend to use stock as a back-end instrument. Thus, a natural extension of our test is to examine if there are differential risk-taking incentives associated with using stock

<sup>21</sup>As our primary hypothesis is about how RPE plans create incentives to implement more idiosyncratic strategies relative to peers, we focus on deviations from industry norms rather than the levels of policy variables. However, much prior work finds evidence that the use of CEO stock options and firm-level idiosyncratic risk are associated with the levels of firm policy variables. For example, Coles et al. (2006) find that more intensive use of CEO stock options is associated with higher R&D expenditures, higher leverage, fewer lines of business and lower capital expenditures. In untabulated results, we show that firms switching from APE to RPE subsequently have relatively lower cash balances, higher market leverage and higher default risk than firms that continue with APE. In terms of investment policies, switchers to RPE subsequently spend relatively less on CapEx and more on R&D. In terms of acquisition and divestiture policies, switchers to RPE subsequently have relatively fewer lines of business and higher segment Herfindahl index. Across all policy categories, switches to APE yield opposite findings.

as a back-end instrument between RPE and APE plans. Panel B of Table 5 presents results from triple difference regressions in which the coefficient of interest is the coefficient on the triple interaction STOCK\_AWARD\_INDICATOR  $\times$  TIME  $\times$  SWITCH (or STOCK\_AWARD\_INDICATOR  $\times$  INTERACTION). The coefficients for the triple interaction variable are statistically insignificant in five of the six specifications (except model 4), suggesting that differences in idiosyncratic risk between switchers and nonswitchers in the post-period are independent of the

TABLE 5  
Triple Difference Regressions: Does the Performance-Vesting Grant Schedule Influence DID Treatment Effects?

Dependent variables in Table 5 are Industry index return correlation (IND\_INDEX\_CORRELATION), IDIOSYNCRATIC\_RISK, and IDIOSYNCRATIC/TOTAL\_RISK for year  $t + 1$ . We include firm and year fixed effects, which subsume TIME and SWITCH as standalone (i.e., not interacted) indicator variables. Variables are defined in the Appendix. Firm and year fixed effects are included in all models.  $t$ -values are based on robust standard errors clustered by firm and by year (2-way) and are reported in parentheses. Chow tests examine whether the coefficients for triple difference estimate differ significantly across analogous regression models. \*, \*\*, and \*\*\* indicate significance at the 10%, 5%, and 1% levels, respectively.

	IND_INDEX_CORRELATION <sub><math>t+1</math></sub>		IDIOSYNCRATIC_RISK <sub><math>t+1</math></sub>		IDIOSYNCRATIC/ TOTAL_RISK <sub><math>t+1</math></sub>	
	APE <sub><math>t-1</math></sub> $\rightarrow$ RPE <sub><math>t</math></sub>	RPE <sub><math>t-1</math></sub> $\rightarrow$ APE <sub><math>t</math></sub>	APE <sub><math>t-1</math></sub> $\rightarrow$ RPE <sub><math>t</math></sub>	RPE <sub><math>t-1</math></sub> $\rightarrow$ APE <sub><math>t</math></sub>	APE <sub><math>t-1</math></sub> $\rightarrow$ RPE <sub><math>t</math></sub>	RPE <sub><math>t-1</math></sub> $\rightarrow$ APE <sub><math>t</math></sub>
	1	2	3	4	5	6
<i>Panel A. Does the Convexity in the P-V Grant Schedule Affect DID Treatment Effects?</i>						
INTERACTION (TIME $\times$ SWITCH)	-0.0332** (-2.01)	0.0298 (1.39)	0.0369*** (5.42)	-0.0179** (-1.97)	0.0459*** (2.57)	-0.0519** (-2.23)
PLAN_CONVEXITY_INDICATOR	0.0449** (2.17)	0.0493*** (5.43)	-0.0121 (-1.42)	-0.0227*** (-5.35)	-0.0371* (-1.66)	-0.0728*** (-6.54)
PLAN_CONVEXITY_INDICATOR $\times$ TIME	-0.0179*** (-3.52)	-0.0302*** (-4.01)	0.0154*** (7.33)	0.0273*** (7.78)	0.0242*** (4.40)	0.0425*** (4.60)
PLAN_CONVEXITY_INDICATOR $\times$ SWITCH	-0.0180 (-1.39)	0.0206 (0.90)	0.0205*** (3.84)	-0.0084 (-0.79)	0.0246* (1.75)	-0.0073 (-0.26)
PLAN_CONVEXITY_INDICATOR $\times$ INTERACTION	0.0133 (0.43)	0.0058 (0.15)	-0.0304* (-1.83)	-0.0082 (0.46)	-0.0169 (-0.51)	0.0148 (0.32)
Constant	0.6258*** (14.10)	0.7670*** (7.66)	0.1161*** (4.95)	0.0457 (1.02)	0.5735*** (11.34)	0.4415*** (3.81)
$R^2$	0.6889	0.7389	0.7937	0.9392	0.6992	0.7541
No. of obs.	11,059	5,632	11,059	5,632	11,059	5,632
Test of coeff. for PLAN_CONVEXITY_ INDICATOR $\times$ INTERACTION		(1) vs. (2)		(3) vs. (4)		(5) vs. (6)
[ $p$ -Value]		[0.3169]		[0.0822]		[0.2073]
<i>Panel B. Do the Types of Back-End Instruments Affect DID Treatment Effects?</i>						
INTERACTION (TIME $\times$ SWITCH)	-0.0402*** (-3.18)	0.0246** (2.04)	0.0395*** (8.92)	-0.0090** (-2.35)	0.0622*** (5.34)	-0.0441*** (-3.10)
STOCK_AWARD_INDICATOR	-0.0084*** (-4.26)	-0.0104*** (-3.24)	0.0055*** (7.70)	0.0041*** (2.76)	0.0086*** (4.63)	0.0098** (2.52)
STOCK_AWARD_INDICATOR $\times$ TIME	-0.0069*** (-6.78)	-0.0148*** (-5.23)	0.0065*** (8.80)	0.0155*** (11.96)	0.0097*** (5.00)	0.0244*** (7.11)
STOCK_AWARD_INDICATOR $\times$ SWITCH	0.0014 (0.38)	0.0215** (2.39)	0.0023 (1.56)	-0.0035 (-0.84)	0.0004 (0.09)	-0.0215** (-1.98)
STOCK_AWARD_INDICATOR $\times$ INTERACTION	0.0047 (0.41)	-0.0043 (-0.38)	-0.0066 (-1.32)	-0.0127** (-2.22)	-0.0095 (-1.01)	-0.0044 (-0.33)
Constant	0.4816*** (11.98)	0.6002*** (9.69)	0.0770*** (11.06)	0.1292*** (5.07)	0.6899*** (22.73)	0.6608*** (8.73)
$R^2$	0.6860	0.7350	0.7998	0.9358	0.6965	0.7502
No. of obs.	15,391	7,276	15,391	7,276	15,391	7,276
Test of coeff. For STOCK_AWARD_ INDICATOR $\times$ INTERACTION		(1) vs. (2)		(3) vs. (4)		(5) vs. (6)
[ $p$ -Value]		[0.5683]		[0.3622]		[0.1434]

(continued on next page)

TABLE 5 (continued)  
 Triple Difference Regressions: Does the Performance-Vesting Grant Schedule Influence DID Treatment Effects?

	IND_INDEX_CORRELATION <sub>t-1</sub>		IDIOSYNCRATIC_RISK <sub>t-1</sub>		IDIOSYNCRATIC/ TOTAL_RISK <sub>t-1</sub>	
	APE <sub>t-1</sub> → RPE <sub>t</sub>	RPE <sub>t-1</sub> → APE <sub>t</sub>	APE <sub>t-1</sub> → RPE <sub>t</sub>	RPE <sub>t-1</sub> → APE <sub>t</sub>	APE <sub>t-1</sub> → RPE <sub>t</sub>	RPE <sub>t-1</sub> → APE <sub>t</sub>
	1	2	3	4	5	6
<i>Panel C. Does the Interaction Between Types of Back-End Instruments and Types of Performance Metrics Affect DID Treatment Effects?</i>						
INTERACTION (TIME × SWITCH)	-0.0429*** (-4.97)	0.0336*** (3.10)	0.0397*** (12.04)	-0.0185*** (-5.26)	0.0635*** (7.37)	-0.0568*** (-5.75)
STOCK_AWARD_INDICATOR × STOCK_METRIC_INDICATOR	-0.0045 (-0.13)	-0.0468*** (-5.65)	-0.0133 (-1.11)	0.0178*** (4.67)	-0.0290 (-0.93)	0.0418*** (4.16)
STOCK_AWARD_INDICATOR × STOCK_METRIC_INDICATOR × TIME	-0.0004 (-0.27)	-0.0013 (-1.43)	0.0005 (1.03)	0.0018*** (4.25)	0.0008 (0.60)	0.0025** (2.36)
STOCK_AWARD_INDICATOR × STOCK_METRIC_INDICATOR × SWITCH	-0.0063 (-0.99)	0.0061 (1.26)	0.0033 (1.26)	-0.0011 (-0.48)	0.0072 (1.04)	-0.0061 (-1.05)
STOCK_AWARD_INDICATOR × STOCK_METRIC_INDICATOR × INTERACTION	0.0090 (1.29)	-0.0102 (-1.22)	-0.0035 (-1.24)	0.0069 (0.86)	-0.0102 (-1.37)	0.0196* (1.89)
Constant	0.4798*** (11.96)	0.5992*** (9.64)	0.0771*** (11.11)	0.1317*** (5.10)	0.6916*** (22.84)	0.6628*** (8.72)
R <sup>2</sup>	0.6857	0.7351	0.7997	0.9358	0.6963	0.7504
No. of obs.	15,391	7,276	15,391	7,276	15,391	7,276
Test of coeff. for STOCK_AWARD_INDICATOR × STOCK_METRIC_INDICATOR × INTERACTION		(1) vs. (2)		(3) vs. (4)		(5) vs. (6)
[p-Value]		[0.4346]		[0.2531]		[0.0791]

stock-based payouts.<sup>22</sup> Convexity in the ex post realized value of the awards is more convex in stock price for RPE plans when both features are at play. Thus, Panel C of Table 5 presents results from triple difference regressions in which the coefficient of interest is the coefficient on STOCK\_AWARD\_INDICATOR × STOCK\_METRIC\_INDICATOR × INTERACTION. The coefficient is statistically insignificant in five of the six specifications (except model 6), suggesting that differences in idiosyncratic risk between switchers and nonswitchers in the post-period are independent of the interaction between the use of stock-based performance metrics and stock-based payouts.

In summary, our analyses in Table 5 help shed light on the main underlying mechanism of idiosyncratic risk-taking incentives induced by RPE plans; our analyses suggest that it is not the convexity, the type of back-end instruments,

<sup>22</sup>Supplementary Material Appendix I presents triple difference regressions that are estimated in order to examine whether the incentives to increase systematic risk that are provided by CEO Vega from option grants during pre-treatment and post-treatment years are dampened following switching to RPE plans (Armstrong and Vashishtha (2012), Park and Vrettos (2015)). As only 0.8% of the CEO RPE plans and 1.1% of the CEO APE plans use options as the back-end instrument, option grants during both the pre-treatment and post-treatment years are primarily associated with time-based vesting plans. Results are somewhat consistent with Park and Vrettos (2015). More specifically, we find that for firms switching to RPE (APE), larger CEO Vega during post-treatment period is associated with higher (lower) subsequent measures of idiosyncratic risk.

nor the type of performance metrics in RPE contracts, but the tournament-style incentives induced by RPE plans that matter.

### C. Alternative Measures of Firm-Specific Risk

In this section, we test whether the higher (lower) idiosyncratic risk associated with switches from APE to RPE (RPE to APE) is reflected in alternative measures of firm-specific risk. We also test whether the increase (decrease) in idiosyncratic risk following switches to RPE (to APE) comes about as a result of an increase (decrease) in total risk, a shift between systematic and idiosyncratic risk, or a combination of the two.

Panel A of [Table 6](#) presents DID models with TOTAL\_RETURN\_RISK, SYSTEMATIC\_RISK, NEGATIVE\_SKEWNESS, and DOWN\_TO\_UP\_VOL as dependent variables. Explanatory variables include the same controls used in Panel D of [Table 2](#) and firm and year fixed effects. Models 1 through 4 show that observed changes in total risk are mainly the result of changes in idiosyncratic risk. NEGATIVE\_SKEWNESS and the DOWN\_TO\_UP\_VOL capture a stock's vulnerability to firm-specific extreme negative price movements. NEGATIVE\_SKEWNESS is  $-1$  multiplied by the skewness of firm-specific weekly returns. The DOWN\_TO\_UP\_VOL is the log of the ratio of the standard deviation of firm-specific weekly returns in down weeks to that in up weeks (Chen, Hong, and Stein (2001), Kim, Li, and Zhang (2011)). Models 5 through 8 show that switches from APE to RPE (RPE to APE) plans are associated with higher (lower) NEGATIVE\_SKEWNESS and DOWN\_TO\_UP\_VOL.<sup>23</sup>

Panel B of [Table 6](#) presents DID models using firm-specific measures of the cost of borrowing as dependent variables. More specifically, the dependent variables are: i) JUNK\_RATING Indicator, ii) NO\_BOND\_RATING indicator, iii)  $\ln(\text{BANK\_LOAN\_SPREAD})$  defined as the natural logarithm of the average "all in spread" for new bank loans, and iv)  $\ln(\text{BOND\_ISSUE\_SPREAD})$  defined as the natural logarithm of the average yield spread at the time of bond issuance. For models using the JUNK\_RATING or NO\_BOND\_RATING indicator as the dependent variable, we run logistic regressions. Results show that switches from APE to RPE (RPE to APE) plans are followed by a higher (lower) likelihood of JUNK\_RATING and of NO\_BOND\_RATING, and a higher (lower) cost of borrowing.<sup>24</sup>

Overall, our results show that switches to RPE are followed by an increase in the vulnerability of the firm's stock to extreme negative stock price movements and higher credit risk. We are not in a position to determine the optimality (or non-optimality) of RPE contracts and whether these changes are optimal.<sup>25</sup> At a

<sup>23</sup>We also run our models using CRASH\_RISK as a dependent variable (Hutton, Marcus, and Tehrani (2009)). The definition is provided in the [Appendix](#) and results (untabulated) are qualitatively similar to those using other measures of firm-specific stock return risk.

<sup>24</sup>Lemmon and Zender (2010) argue that the presence of a rated bond indicates that a firm has access to low-cost borrowing. Our finding that switches to RPE plans are associated with a lower likelihood of having a bond rating the following year (model 3) is consistent with Lemmon and Zender (2010) who show that higher stock return risk is negatively associated with the likelihood of having a bond rating.

<sup>25</sup>The literature on the optimality (or nonoptimality) of RPE contracts is mixed (Noe and Rebello (2012), Chaigneau, Edmans, and Gottlieb (2018)). Kale, Reis, and Venkateswaran (2009) find that RPE is associated with improved performance. In contrast, experimental and empirical evidence shows a

TABLE 6  
 Are Changes in Idiosyncratic Risk for RPE Versus APE Firms Reflected in  
 Alternative Measures of Firms-Specific Risk?

Panel A of Table 6 presents DID regression results based on alternative measures of firm-specific stock return risk. Dependent variables are TOTAL\_RETURN\_RISK, SYSTEMATIC\_RISK, NEGATIVE\_SKEWNESS, and DOWN\_TO\_UP\_VOLATILITY for year  $t + 1$ . Panel B presents DID regression results based on measures of credit risk and the cost of borrowing. Dependent variables are JUNK\_RATING, NO\_BOND\_RATING,  $\ln(\text{BANK\_LOAN\_SPREAD})$ , which is the natural logarithm of bank loan spread at loan initiation, and  $\ln(\text{BOND\_ISSUE\_SPREAD})$ , which is the natural logarithm of bond offering yield spread at bond issuance. Variables are defined in the Appendix. All models include controls, firm and year fixed effects and a constant.  $t$ -values are based on robust standard errors clustered by firm and by year (2-way) and are reported in parentheses. Chow tests examine whether the coefficients for INTERACTION (Time period indicator  $\times$  Plan switch indicator) differ significantly across analogous regression models. \*, \*\*, and \*\*\* indicate significance at the 10%, 5%, and 1% levels, respectively.

Panel A. Measures of Firm-Specific Stock Return Risk

	TOTAL_RETURN_RISK <sub>t+1</sub>		SYSTEMATIC_RISK <sub>t+1</sub>		NEGATIVE_SKEWNESS <sub>t+1</sub>		DOWN_TO_UP_VOL <sub>t+1</sub>	
	APE <sub>t-1</sub> → RPE <sub>t</sub>	RPE <sub>t-1</sub> → APE <sub>t</sub>	APE <sub>t-1</sub> → RPE <sub>t</sub>	RPE <sub>t-1</sub> → APE <sub>t</sub>	APE <sub>t-1</sub> → RPE <sub>t</sub>	RPE <sub>t-1</sub> → APE <sub>t</sub>	APE <sub>t-1</sub> → RPE <sub>t</sub>	RPE <sub>t-1</sub> → APE <sub>t</sub>
	1	2	3	4	5	6	7	8
INTERACTION (TIME $\times$ SWITCH)	0.0230*** (5.69)	-0.0068* (-1.90)	0.0128 (1.31)	0.0041 (0.44)	0.1437** (2.52)	-0.3961** (-2.33)	0.0768*** (4.15)	-0.0639** (-2.38)
PLAN_CONVEXITY_ INDICATOR	0.0008 (0.12)	-0.0081** (-2.26)	0.0066 (0.49)	0.0007 (0.11)	0.3991*** (2.15)	-0.0372 (-0.32)	0.0569* (1.90)	-0.0130 (-0.68)
$\ln(\text{PLAN\_DURATION})$	-0.0103*** (-3.70)	0.0148*** (3.00)	-0.0179*** (-3.19)	0.0238*** (2.96)	0.0656 (0.84)	-0.0084 (-0.05)	0.0084 (0.67)	0.0026 (0.10)
STOCK_AWARD_ INDICATOR	0.0036*** (5.34)	0.0071*** (5.13)	0.0032** (2.45)	0.0033 (1.51)	0.0295 (1.55)	0.1935*** (3.18)	0.0066** (2.00)	0.0341*** (3.40)
STOCK_METRIC_ INDICATOR	-0.0013 (-0.52)	0.0043* (1.88)	-0.0060 (-1.25)	0.0044 (1.22)	-0.0171 (-0.25)	0.0787 (0.84)	-0.0002 (-0.01)	0.0104 (0.66)
$R^2$	0.8698	0.9492	0.7265	0.7330	0.7387	0.7991	0.7091	0.7652
No. of obs.	9,307	5,092	9,307	5,092	9,307	5,092	9,307	5,092
Test of coeff. for INTERACTION	(1) vs. (2)		(3) vs. (4)		(5) vs. (6)		(7) vs. (8)	
[ $p$ -Value]	[0.000]		[0.516]		[0.000]		[0.000]	

Panel B. Measures of Credit Risk and the Cost of Borrowing

	JUNK_RATING <sub>t+1</sub> Logit Reg.		NO_BOND_RATING <sub>t+1</sub> Logit Reg.		$\ln(\text{BANK\_LOAN\_SPREAD})_{t+1}$		$\ln(\text{BOND\_ISSUE\_SPREAD})_{t+1}$	
	APE <sub>t-1</sub> → RPE <sub>t</sub>	RPE <sub>t-1</sub> → APE <sub>t</sub>	APE <sub>t-1</sub> → RPE <sub>t</sub>	RPE <sub>t-1</sub> → APE <sub>t</sub>	APE <sub>t-1</sub> → RPE <sub>t</sub>	RPE <sub>t-1</sub> → APE <sub>t</sub>	APE <sub>t-1</sub> → RPE <sub>t</sub>	RPE <sub>t-1</sub> → APE <sub>t</sub>
	1	2	3	4	5	6	7	8
INTERACTION (TIME $\times$ SWITCH)	1.8356** (2.13)	-0.6122** (-2.16)	1.8328*** (5.01)	-0.4489* (-1.91)	0.1955*** (2.77)	0.1111 (1.27)	0.1802*** (2.87)	-0.1495* (-1.85)
PLAN_CONVEXITY_ INDICATOR	-1.0951 (-0.93)	-0.8308 (-0.64)	-0.5806 (-0.92)	-0.3487 (-0.97)	-0.1266 (-1.44)	0.0597 (1.16)	0.0060 (0.07)	0.0614* (1.75)
$\ln(\text{PLAN\_DURATION})$	-0.2317 (-0.51)	-0.4266 (-0.37)	0.1603 (0.59)	0.4850 (1.00)	-0.1579*** (-4.29)	0.0662 (0.92)	-0.0840 (-0.44)	0.0197 (0.45)
STOCK_AWARD_ INDICATOR	0.4448*** (3.30)	0.2918 (0.34)	0.0914 (1.53)	0.1312 (1.27)	0.0234*** (2.80)	0.1476*** (4.37)	0.0816*** (2.88)	0.0426 (1.63)
STOCK_METRIC_ INDICATOR	-0.3352 (-1.29)	0.7314 (0.93)	0.0022 (0.01)	-0.0749 (-0.40)	-0.0357 (-1.23)	0.0056 (0.29)	-0.0101 (-1.15)	-0.0084 (-0.61)
$R^2$ (or Pseudo $R^2$ )	0.5100	0.7989	0.4145	0.4335	0.8039	0.7851	0.7642	0.7066
No. of obs.	6,337	3,564	9,307	5,092	7,229	4,110	4,331	2,779
Test of coeff. for INTERACTION	(1) vs. (2)		(3) vs. (4)		(5) vs. (6)		(7) vs. (8)	
[ $p$ -Value]	[0.086]		[0.049]		[0.176]		[0.031]	

minimum, however, our findings suggest that credit rating agencies and lenders incorporate CEO risk-taking incentives induced by performance-based compensation plans into their assessment of credit risk (see also, Kuang and Qin (2013)).

higher likelihood of unethical activities, financial misconduct, or sabotage in firms with strong tournament incentives (Harbring and Irlenbusch (2011), Charness, Masclet, and Villevall (2014), and Haß, Müller, and Vergauwe (2015)). From the creditor perspective, Moody's identifies tournament-style incentives as a "red flag" in assessing credit risk (Bertsch, Smith, and Watson (2006)).

## VI. Conclusions

Utilizing a DID design, we provide new evidence on how performance-based compensation plans affect CEO corporate policy decision-making and risk-taking. Our main finding is that after a firm makes a switch from an APE to an RPE plan, the firm's industry index return correlation is lower, while both idiosyncratic risk and the idiosyncratic component of total risk are higher relative to firms that continue with an APE plan. Our main finding is consistent with the idea that RPE-driven tournament incentives provide incentives to take on idiosyncratic risk. Our findings are not driven by other performance plan features, CEO or firm characteristics, ex ante differences in industry index return correlation or idiosyncratic risk, or hidden factors. In addition, our results are robust to a battery of analyses designed to address endogeneity concerns.

Consistent with our findings regarding idiosyncratic risk, we find that firms switching to RPE plans subsequently have larger deviations in financial, investment, and acquisition policies from industry norms (i.e., more idiosyncratic strategies). This supports the idea of CEO corporate policy decision-making as a mechanism through which the RPE plans influence the nature of firm's risk. We also find that the higher idiosyncratic risk associated with switches from APE to RPE is reflected in alternative measures of firm-specific risk.

Overall, our findings are consistent with the idea that Boards of Directors find RPE plans feasible when they want to motivate the CEO to undertake more idiosyncratic strategies and distinguish the firm from its competitors. While our study does not address the optimality of RPE contracts, our empirical evidence regarding the effect of CEO RPE plans on risk-taking and firm policies may prove helpful in assessing when RPE incentives create value and when they do not.

## Appendix. Variable Definitions in Order of Use

**APE Plan:** A firm-year is classified as an APE firm-year if the CEO's performance-based compensation plan in that year relies exclusively on a target or targets defined in absolute terms.

**RPE Plan:** A firm-year is classified as an RPE firm-year if at least one of the CEO's performance-based compensation plans relies on performance benchmarks set relative to a specified group of firms or a published index.

**IND\_INDEX\_CORRELATION:** Industry index return correlation gauges the firm's exposure to sector performance. It is measured as the correlation between the firm's daily stock returns and returns to the relevant Fama–French (1997) value-weighted daily industry index.

**IDIOSYNCRATIC\_RISK:** The square root of the residual variance from an expanded index model regressing a firm's returns on the CRSP value-weighted daily market index returns and the relevant Fama–French (1997) value-weighted daily industry index returns.

**IDIOSYNCRATIC/TOTAL\_RISK:** Idiosyncratic stock return risk as a proportion of TSR risk.

- TIME:** A binary variable that equals 0 for firm-years prior to the possible switch in the type of performance-based compensation plan (the pre-treatment period) and equals 1 for firm-years of the possible switch (post-treatment period).
- SWITCH:** A binary variable that equals 0 for firms that do not switch their type of performance-based compensation plan in the post-treatment period and equals 1 for firms that do switch.
- INTERACTION (TIME  $\times$  SWITCH):** A binary variable equal to the Time period indicator multiplied by the Plan switch indicator.
- PLAN\_CONVEXITY\_INDICATOR:** A binary variable that equals 1 if the slope to the left of the performance target scaled by the slope to the right of the performance target is less than 1, and 0 otherwise. The payout is denominated in the grant date fair value of the back-end instrument (stock, options, or cash).
- ln(PLAN\_DURATION):** The natural log of the number of months between start date and end date of the performance period for a performance-based compensation plan. When the grant date of the plan is missing, we assume that it is the beginning of the fiscal year.
- STOCK\_AWARD\_INDICATOR:** A binary variable that equals 1 if the firm's performance-based compensation plan pays out in stock or stock options, and 0 otherwise.
- STOCK\_METRIC\_INDICATOR:** A binary variable that equals 1 if a firm uses only stock-based performance metric in its performance-based compensation plan.
- TARGET>ACTUAL\_INDICATOR:** A binary variable that equals 1 for observations where the compensation plan performance target is greater than actual performance in the compensation plan grant year, and 0 otherwise.
- ln(1 + PRIOR\_CEO\_VEGA):** The natural logarithm of 1 plus the change in the Black–Scholes value of a CEO's total portfolio of outstanding option grants prior to the pre-treatment year  $t - 1$  (post-treatment year  $t$ ) for prior plans (new plans) for a 1% change in standard deviation of the return. We follow the existing literature (e.g., Hayes, Lemmon, and Qiu (2012)) and use the ExecuComp database as our source to calculate vega. Following FASB ASC Topic 718 in 2006, we include the grant date fair value of performance-based option awards based on the firm's assessment of the probable outcome of the performance condition (typically the "target" award value) as of the award's grant date regardless of whether the performance metric is stock-based or accounting-based (as reported in the ExecuComp database). If the grant date fair value of performance-based option awards is missing in ExecuComp, we calculate the grant date Black–Scholes option value based on the details of plan-based awards in the Incentive Lab database. We do not include vega from option grants made during the pre-treatment year (in place in year  $t - 1$ , Time = 0) and during the post-treatment year (in place in year  $t$ , Time = 1). Nor do we consider the vega effect arising from nonlinearities in the p-v grant schedules or vega in accounting performance metrics (see Bettis, Bizjak, Coles, and Kalpathy (2018)).
- ln(1 + PRIOR\_CEO\_DELTA):** The natural logarithm of 1 plus the change in the Black–Scholes value of a CEOs' total portfolio of outstanding grants of shares and options prior to the pre-treatment year  $t - 1$  (post-treatment year  $t$ ) for prior plans (new plans) for a 1% change in the price of the underlying stock. We follow the existing literature (e.g., Hayes, Lemmon, and Qiu (2012)) and use the

ExecuComp database as our source to calculate delta. Following FASB ASC Topic 718 in 2006, we include the grant date fair value of the performance-based stock and option awards based on the firm's assessment of the probable outcome of the performance condition (typically the "target" award value) as of the award's grant date regardless of whether the performance metric is stock-based or accounting-based (as reported in the ExecuComp database). If the grant date fair value of the performance-based stock and option awards is missing in ExecuComp, we calculate the grant date stock and option value based on the details of plan-based awards in the Incentive Lab database. We do not include delta from stock and option grants made during pre-treatment year (in place in year  $t - 1$ , Time = 0) and during the post-treatment year (in place in year  $t$ , Time = 1). Nor do we consider the delta effect arising from the p-v grant schedules or delta in accounting performance metrics (see Bettis, Bizjak, Coles, and Kalpathy (2018)).

CEO\_SALARY\_COMP: The ratio of the CEO's salary to total compensation.

$\ln(1 + \text{CEO\_TENURE})$ : The natural logarithm of 1 plus the number of years the current CEO has held her position.

NEW\_AND\_OUTSIDE\_CEO: A binary variable that equals 1 if the current CEO has been in her position and has joined the firm no more than 2 years prior and 0 otherwise (Gopalan et al. (2014)).

CEO\_EMPL\_CONTRACT: A binary variable that equals 1 if the CEO has an explicit employment contract and 0 otherwise. CEO employment agreement data are obtained from Equilar Consultants.

FOUNDER: A binary variable that equals 1 if the current CEO founded the firm and 0 otherwise. The CEO's founder status is obtained from Equilar Consultants.

CEO\_DUALITY: A binary variable that equals 1 if the CEO also holds the title of chairman of the board of directors and 0 otherwise. CEO duality data are obtained from Risk Metrics.

INST\_OWNERSHIP: Total institutional ownership based on data from the Thomson-Reuters Institutional Holdings (I3F) database.

$\ln(\text{SALES})$ : The natural logarithm of the firm's annual sales.

$\ln(\text{FIRM\_AGE})$ : The natural logarithm of the number of years since the year of listing.

TOBIN'S\_Q: The ratio of market-to-book value of assets.

PP&E: The firm's net property, plant and equipment scaled by total assets.

IND\_ADJ\_ROA: Operating income before depreciation scaled by total assets adjusted for the equally weighted ROA of the Fama-French (1997) 48 industry to which the firm belongs.

IND\_ADJ\_STOCK\_RETURN: Firm stock return adjusted for the equally weighted return on the Fama-French (1997) 48 industry to which the firm belongs.

LEVERAGE: Leverage is the book value of long-term debt scaled by total assets.

$\text{INTERACTION}^{-1} (\text{TIME}^{-1} \times \text{SWITCH})$ : A binary variable that equals 1 for firms that will actually switch to a different type of performance-based compensation plan in the following year (year 0) and 0 otherwise.

SWITCH\_INDICATOR: Equals 1 if the firm changes performance plan type in that year and 0 otherwise.



- RPE\_INDICATOR:** A binary variable that equals 1 for RPE firm-years and 0 for APE firm-years.
- CASH\_DISSIMILIARITY:** Absolute value of the difference in the ratio of cash to lagged total assets between a focal firm and the median value for its Fama–French (1997) 48 industry peers.
- LEVERAGE\_DISSIMILIARITY:** Absolute value of the difference in the ratio of the book value of total debt to the book value of total debt plus the market value of equity between a focal firm and the median value for its Fama–French (1997) 48 industry peers.
- DEFAULT\_DISSIMILARITY:** Absolute value of the difference in the estimated probability of default based on KMV–Merton’s (1974) model between a focal firm and the median value for its Fama–French (1997) 48 industry peers. The SAS program provided by Bharath and Shumway (2008) is used for this estimation.
- CAPEX\_DISSIMILARITY:** Absolute value of the difference in the ratio of capital expenditures to lagged net plant property and equipment between a focal firm and the median value for its Fama–French (1997) 48 industry peers.
- R&D\_DISSIMILIARITY:** Absolute value of the difference in the ratio of research and development expenditures to lagged total assets between a focal firm and the median value for its Fama–French (1997) 48 industry peers.
- EFD\_DISSIMILARITY:** Absolute value of the difference in the firm’s need for external finance which is measured as the fraction of capital expenditures not financed through internal cash flows (Rajan and Zingales (1998)) between a focal firm and the median value for its Fama–French (1997) 48 industry peers.
- ADD\_SEGMENT\_OUTSIDE (%)**: Percentage of business segments added by a focal firm outside its primary industry.
- DIVEST\_SEGMENT\_OUTSIDE (%)**: Percentage of business segments divested by a focal firm outside its primary industry.
- ACQUIRE\_TARGET\_OUTSIDE (%)**: Percentage of completed acquisitions by a focal firm of a target outside its primary industry.
- TOTAL\_RETURN\_RISK:** The standard deviation of a firm’s daily stock returns.
- SYSTEMATIC\_RISK:** The square root of explained variance from an expanded index model in which a firm’s daily stock returns are regressed on CRSP value-weighted daily market index returns and its Fama–French (1997) value-weighted daily industry index returns.
- NEGATIVE\_SKEWNESS:**  $-1$  multiplied by the skewness (the third standardized moment) of firm-specific weekly returns for each firm-year with sufficient data (Chen, Hong, and Stein (2001)).
- DOWN\_TO\_UP\_VOL:** The log of the ratio of the standard deviation of firm-specific weekly returns in down weeks to the standard deviation of firm-specific weekly returns in up weeks. Down (up) weeks are weeks with firm-specific weekly returns below (equal or above) the annual mean (Chen, Hong, and Stein (2001)).
- CRASH\_RISK:** Used in robustness checks only. Crash weeks is defined as the frequency with which the firm-specific weekly returns fall 3.09 standard deviations (probability 0.001 events for a normal distribution) below its mean firm-specific

weekly returns during a specific firm-year (Hutton, Marcus, and Tehranian (2009)). Crash risk equals 1 for a firm-year that experiences at least one crash week during the fiscal-year, and 0 otherwise.

**JUNK\_RATING:** A binary variable that equals 1 if the firm has an S&P domestic long-term credit rating lower than BBB– in a given year, and 0 otherwise.

**NO\_BOND\_RATING:** A binary variable that equals 1 if the firm does not have a bond rating assigned by S&P in a specific year as recorded by Compustat, and 0 otherwise.

**ln(BANK\_LOAN\_SPREAD):** The natural logarithm of the average “all in spread” from bank loan-level data at the time of loan initiation from DealScan. Spread is measured in basis points over LIBOR.

**ln(BOND\_ISSUE\_SPREAD):** The natural logarithm of the average yield spread (spread between a newly issued bond’s yield-to-maturity and the yield on a U.S. Treasury of equivalent maturity) at the time of bond issuance from the Mergent Fixed Income Securities Database (FISD).

## Supplementary Material

To view supplementary material for this article, please visit <http://doi.org/10.1017/S0022109022000060>.

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