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CEO Compensation Incentives and Playing It Safe: Evidence from FAS 123R

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Abstract

This article uses FAS 123R regulation to examine how reduction in CEO compensation incentives affects managerial "playing it safe" behavior. Using proxies reflecting deliberate managerial efforts to change firm risk, difference-in-difference tests show that affected firms drastically reduce both systematic and idiosyncratic risks, leading to an 8% decline in total firm risk. These reductions in risk are achieved by shifting to safer, but low-Q, segments while closing the riskier ones, without significant changes in investment levels. Our findings suggest that decrease in risk-taking incentives provided by option compensation, when not compensated for by alternative incentives or governance mechanisms, exacerbates risk-related agency problem.

I. Introduction

In this article, we provide causal empirical evidence on the negative impact of reduced risk-taking incentives from option compensation on managerial risk-taking behavior. Using FAS 123R regulation as a negative exogenous shock to option pay and convexity in managerial compensation contracts (vega), we show that firms most affected by this reform decrease total risk by 8% on average. Crucially, we provide evidence that risk reductions due to lower compensation convexity are facilitated through shifting to investments with lower growth opportunities, thus hurting firm value in the long run. We also show how exactly firms achieve decreases in risk. Managers of affected firms invest into new safer lines of business and disinvest the existing riskier ones, thus attaining a less risky business portfolio. These reductions in risk are accomplished without significant changes in investment levels suggesting that they are driven by managerial "playing it safe" motives

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(Gormley and Matsa (2016)) rather than by their desire for a “quiet life” (Bertrand and Mullainathan (2003)).

Our study is important for three reasons. First, the effectiveness of stock option compensation in mitigating risk-related agency conflict remains theoretically ambiguous. This conflict arises when risk-averse managers, for reasons such as undiversified personal portfolios and employment risk, have incentives to forgo risk-increasing projects that are value-enhancing or to undertake risk-reducing projects that are value-destroying (Jensen and Meckling (1976), Holmström (1999)). Hence, these risk-reducing or “playing it safe” efforts create an agency cost and a welfare loss to shareholders, while representing a form of perquisite for the managers (Amihud and Lev (1981)). A large strand of literature recognizes stock option compensation as an important governance mechanism to curb managerial risk-avoidance incentives (see, e.g., Agrawal and Mandelker (1987)).[1] Because the value of a stock option increases with the volatility of the underlying stock, option portfolio values that are more sensitive to stock return volatility provide managers with higher risk-taking incentives (Haugen and Senbet (1981)). This feature, known as “convexity” and measured by managers’ portfolio vega, is specific to stock options as other equity-based compensation, for example, time-vesting stock grants, have weak sensitivity of their values to stock return volatility (Guay (1999)). It is therefore optimal to compensate self-interested risk-averse managers with stock options and increase convexity in their compensation contracts to induce them to invest in risky projects (Hirshleifer and Suh (1992), Feltham and Wu (2001)). However, another strand of literature argues that, due to a lower value that risk-averse and undiversified managers place on stock options, compensating them with stock options may magnify their risk aversion and induce them to decrease, rather than to increase, firm risk (see, e.g., Carpenter (2000), Ross (2004)).

Second, studies document mixed evidence on whether stock option compensation promotes incentive effort and value-creating risk-taking. On one hand, DeFusco, Johnson, and Zorn (1990), Guay (1999), and Shue and Townsend (2017) show that increases in stock options and compensation vega are positively associated with stock return volatility. Likewise, Low (2009) finds that CEOs of firms with low vega reduce risk in response to an exogenous increase in takeover protection. In the same vein, studies that examine risk-inducing firm policies find that managerial option compensation and vega are positively related to variance- and leverage-increasing acquisitions (Agrawal and Mandelker (1987)), debt levels, and investments in capital expenditures, research and development, and innovation activities (see, e.g., Shue and Townsend (2017)), and they are negative to cash holdings (Gormley, Matsa, and Milbourn (2013)), debt maturity (Chava and Purnanandam (2010)), diversifying acquisitions (Gormley et al. (2013)), and hedging activities (Rajgopal and Shevlin (2002), Rogers (2002)).

On the other hand, evidence in some studies refutes the ability of stock options to elicit risk-taking behaviors to the benefit of shareholders. Armstrong and Vashishtha (2012) find that option vega encourages managers to increase only

[1]See also Smith and Stulz (1985), Lewellen, Loderer, and Martin (1987), Jensen and Murphy (1990), Rajgopal and Shevlin (2002), Core, Guay, and Verrecchia (2003), and Hall and Murphy (2003).

systematic, but not idiosyncratic, risk. Based on the premise that firm growth is driven by idiosyncratic risk (Cao, Simin, and Zhao (2006), Pástor and Veronesi (2009)), they interpret it as a failure of vega to align manager-shareholder interests and to create value. Lewellen (2006) shows that managers decrease stock return volatility and debt levels when rewarded with options. Similarly, Brick, Palmon, and Wald (2012) find that managers lower equity risk when option vega increases, thus exacerbating managerial risk avoidance. Liu and Mauer (2011) document that firms with higher vega hoard cash, and hence, contrary to showing risk-increasing behaviors, prefer safer policies.

Yet other studies find no evidence that option compensation affects stock return volatility or induces risky financing and investment policies, such as lower cash holdings or higher R&D expenditures (Hayes, Lemmon, and Qiu (2012), Biggerstaff, Blank, and Goldie (2019)), thus questioning the risk-incentivizing property of options. Finally, some studies argue that option compensation induces excessive risk-taking and undue focus on driving stock prices up (Hall and Murphy (2003), Madrick (2003)) or choosing inefficient policies, leading, for example, to debt overhang (Dong, Wang, and Xie (2010)) or overinvestment in R&D (Shen and Zhang (2013)).

Third, the endogenous nature of the relationship between compensation incentives and managerial risk-taking makes it difficult to establish causality. One reason for endogeneity is that executive compensation and managerial risk-taking may be simultaneously determined. For example, firms with riskier investment profile may award compensation contracts with higher convexity to better align the interests of managers and shareholders (Stulz (1996), Prendergast (2002)). Another possibility is that causation may run in both directions, for example, when managers self-select into firms that suit their risk-taking preferences (Lazear (2000), Milidonis and Stathopoulos (2014)). A related concern is that some other omitted variables, for example, managerial overconfidence or their degree of risk-aversion, drive both vega and risk-taking or mediate the relationship between them (Athanasakou, Ferreira, and Goh (2017)). The difficulty in measuring the main endogenous variable, managerial risk-taking, further complicates the identification of the relationship between vega and risk-taking behavior.

Early empirical studies do not address endogeneity directly, focusing instead on association, rather than on causation, between compensation convexity and managerial risk-taking. Later studies deal with the endogeneity more explicitly, by using simultaneous equations (Rajgopal and Shevlin (2002), Coles, Daniel, and Naveen (2006)), instrumental variables approach (Armstrong and Vashishtha (2012)), staggered nature of multi-year option plans (Shue and Townsend (2017)), or quasi-exogenous shocks to managerial incentives, such as increases in takeover protection (Low (2009)) or FAS 123R regulation (see, e.g., Hayes et al. (2012), Mao and Zhang (2018)). However, most of these studies infer about the impact of option convexity on managerial risk-taking behavior indirectly, by studying the changes in financing policy, investment input and output (Hayes et al. (2012), Mao and Zhang (2018)), hedging policy (Bakke, Mahmudi, Fernando, and Salas (2016)), and debt maturity (Hong (2019)). A small number of studies that examine firm risk itself use stock return volatility as a risk proxy (Coles et al. (2006), Low (2009), Hayes et al. (2012), and Shue and Townsend (2017)). This proxy, however, is problematic as it is heavily influenced by the overall market and industry volatility as well as by firm-specific environment, such as financial reporting and disclosure requirements (Roll (1988), Ross (1989), and Bushee and Noe (2000)), which are often beyond managerial control. Moreover, and crucially, this proxy is likely to be mechanically related to the option vega as it is itself an input in the Black–Scholes option pricing model used to estimate vega (Guay (1999)).

In this study, we offer evidence that managers reduce their firm's risk and destroy firm value in response to an exogenous decrease to option vega, suggesting that these managers "play it safe." We overcome the endogeneity problem by exploiting the adoption of FAS 123R in 2005 as a negative shock to the usage of stock options and to option vega. This regulation required public firms to expense options at their fair value and hence drastically reduced their attractiveness in compensation plans, while leaving other equity-based pay components largely unaffected (Hayes et al. (2012)). We focus on the impact of FAS 123R on managerial risk-taking directly. To do so, we view a firm as a portfolio of business segments, which managers can change at their discretion through their investment and disinvestment decisions, hence altering the risk of the portfolio in the process. Following Aretz, Banerjee, and Pryshchepa (2019), we estimate the risk of a firm's business portfolio using Markowitz's (1952) portfolio variance formula. We compute the weights in this formula using the asset book values of business segments and use the returns of the single-segment firm industry portfolios to estimate the variance–covariance terms. The idea behind this risk proxy is that by changing the weights in the firm's business portfolio, managers can initiate deliberate changes in firm's risk profile. We also decompose the total risk proxy into idiosyncratic and systematic risk components to assess the impact of FAS 123R on different types of risk. Importantly, we also evaluate the firm-value consequences of managerial actions to alter firm's risk by examining the changes in long-term investment efficiency computed as the average Tobin's Q of its operating segments.

We follow the approach of Hayes et al. (2012) and identify firms as treated if their average pre-FAS 123R option expense was greater than the sample median, while the remaining firms act as controls. The basis for this identification is that firms, which previously heavily relied on stock option compensation and used an intrinsic method to value them, would have incurred a substantial option expense if they continued favoring options under the new regulation. Therefore, these firms were more sensitive to the FAS 123R reform.

Our main tests are based on a difference-in-differences (DiD) analysis (Atanasov and Black (2016)) that compares the change in managerial risk-taking from the prereform to the postreform period for treated firms to that of control firms. Our main hypotheses are that FAS 123R-induced reductions in risk-taking incentives (vega) cause significant declines in firm risk and value for treated firms relative to those for control firms. If true, these hypotheses would suggest that the reform had negative effects on the provision of monetary managerial incentives and exacerbated "playing it safe" behavior by managers.

Our evidence indicates that reductions in vega due to the passage of FAS 123R induce managers of firms with higher prereform option expense (treated) to change their firm's asset mixes toward lower-risk segments. For example, in our DiD tests, we find that treated firms significantly decrease the total, systematic, and idiosyncratic risks of their business portfolio by about 8.3%, 4.7%, and 7.0%, respectively, relative to the control firms in response to FAS 123R. These results are also economically meaningful as they represent declines of 19%–28% from the average prereform values of different risk types.

We recognize that this behavior would create agency costs only if it is harmful to shareholders. Alternatively, if prior to FAS 123R the proliferation of options due to their low perceived costs encouraged firms to take excessive and value-destroying risks, reductions in option usage and subsequently in managerial risk-taking, could translate into value enhancements for shareholders, and hence, will not create a risk-related agency cost. To differentiate between these hypotheses, we examine whether the declines in risk after FAS 123R were the result of investments into segments with good or poor investment opportunities. We show that reductions in managerial risk-taking are associated with inefficient investment allocations into segments with lower growth opportunities, indicating aggravation of the risk-related agency problem in these firms and the ensuing value destruction.

In further tests, we uncover that the changes in managerial risk-taking are facilitated through the restructuring of their firm's business portfolio. While the treated firms do not change their investments into mergers and acquisitions (M&As), research and development (R&D), and capital expenditures (Capex), they tend to change their business orientation by opening new and closing existing segments. Importantly, the treated firms do not reduce their risk by piling up cash (safe assets). Contrary to this presumption, they run down their cash reserves, consistent with their need to fund restructuring. Overall, these results highlight the importance of examining firm risk directly when evaluating the degree of risk-related agency problems, rather than inferring it indirectly from other corporate policies, for example, investment and cash policies. While studying the other policies can shed light on whether managers engage in "quiet life," it may be less revealing whether they choose to "play it safe." Consistent with this conjecture, we find evidence of "playing it safe," but not "quiet life," behaviors by managers in response to FAS 123R-induced reductions in vega.

Our study contributes to the literature on the role of executive compensation in incentivizing managers, specifically on the impact of stock options on managerial risk-taking behavior. Recent work exploiting the exogenous changes to the usage of stock options and the provision of risk-taking incentives finds positive (Low (2009), Shue and Townsend (2017)), negative (Brick et al. (2012)) or no (Hayes et al. (2012)) impact on firm risk. The mixed evidence could be attributed to the mechanical relationship between option vega and the commonly used proxy for firm risk, equity volatility, which is itself an input to the option pricing model. Other studies offer evidence on the impact of option compensation on financing and investment policies, rather than on firm risk directly (see, e.g., Gormley et al. (2013), Bakke et al. (2016), and Mao and Zhang (2018)). We reconcile the inconclusive evidence in the current literature by showing that a negative exogenous shock to compensation vega causes managers to shift their business portfolio to lower-risk segments. Crucially, none of the prior studies explores whether the changes in managerial risk-taking behaviors are value-enhancing or reducing. To our knowledge, we are the first study to document that exogenous decreases in option convexity lead to higher investments into lower Q segments, thus hurting shareholders' value in the long run, rather than merely representing an optimal reduction in previously excessive risk-taking.

Our study also contributes more generally to the literature on managerial "playing it safe" behavior and risk-related agency problem. Gormley and Matsa (2016) provide the most conclusive evidence to-date of the existence of this agency conflict by demonstrating that managers undertake acquisitions that reduce risk and firm value following the adoption of anti-takeover laws. Our findings advance this evidence by indicating that this conflict intensifies as extrinsic monetary incentives fall and managers choose to invest into lower risk, value-destroying projects. Finally, we contribute to the literature on the impact of accounting regulation FAS 123R on corporate policies by showing that it had unintended and undesirable consequences, leading to a decline in managerial risk-taking and subsequently firm value.

Our article is structured as follows: Section II provides an overview of the FAS 123R regulation and our methodology. Section III describes the data. Section IV reports our main empirical results, as well as those from robustness tests. Section V concludes.

II. Empirical Framework

A. FAS 123R as a Shock to Compensation Incentives

U.S. firms were always required to expense the value of stock option compensation. However, prior to 2005, firms had discretion over the method for valuing option compensation, with most firms choosing the intrinsic value method (the excess of the current stock market price over the option exercise price). Because a typical employee stock option had exercise price at or above the current market price, the reported intrinsic value was 0, and hence, no option expense was recognized for most companies under this method (Hall and Murphy (2002)).

This reporting approach was heavily criticized for not reflecting the true cost of option compensation for the firm (Murphy (2013)). In response to these criticisms and in an attempt to make reporting of option compensation consistent with that for other forms of compensation, the Financial Accounting Standards Board (FASB) issued FAS 123R in Dec. 2004 (Lyke and Shorter (2005)). This ruling became effective for fiscal years beginning after June 15, 2005, and required companies to expense the fair value of employee stock options estimated from either Black and Scholes (1973) or binomial option pricing models. Using a fair value method most likely results in a positive compensation expense, thus introducing an accounting cost to compensating with stock options. For companies that heavily awarded option grants and expensed them using the intrinsic value method before FAS 123R, continuing option issuance after the reform could result in a substantial decline in reported earnings. For example, Apostolou and Crumbley (2005) estimate that the drop in earnings could range between 5% and 86%, turning a profit into a loss for some companies.

Unsurprisingly, companies responded to this reform by significantly reducing their option compensation, causing a sharp decline in option vega and therefore, risk-taking incentives. This response to FAS 123R is extensively documented in the literature (see, e.g., Carter, Lynch, and Tuna (2007), Brown and Lee (2011), Hayes et al. (2012), Bakke et al. (2016), and Mao and Zhang (2018)). Notwithstanding the prior evidence, we corroborate the validity of FAS 123R as a negative shock to option compensation and vega by examining its impact on firms that had high expensing impact from stock options prior to the reform relative to those with low expensing impact. We describe these tests in detail and report their results in Appendix IB.1 of the Supplementary Material. Overall, consistent with prior studies, these tests confirm that the adoption of FAS 123R can be used as a valid shock to managerial risk-taking incentives, and hence, for establishing causality in the relationship between them and risk-taking behavior.

B. Difference-in-Difference Analysis

To test our main hypothesis, we adopt a DiD-continuous design (Atanasov and Black (2016)). We presume that, although all firms in the U.S. were subject to FAS 123R regulation, firms with higher perceived accounting costs of option expensing are expected to be more severely affected by the reform. Specifically, firms that are expected to experience larger declines in reported earnings following the mandatory requirement to expense them at fair value would reduce their stock option usage and, hence, risk-taking incentives most.

We begin with identifying treatment and control firms based on the intensity of the impact of FAS 123R on firms with different levels of perceived accounting costs of option expensing. We follow Hayes et al. (2012) and define OPTION_EXPENSING_IMPACT as the average pro-forma option expense deflated by fully diluted shares that a given firm reports in the pre-FAS 123R period. This variable represents the intensity of the treatment effect as it captures the extent to which earnings per share are expected to be reduced once the firm recognizes stock options at fair value. We assign firms with OPTION_EXPENSING_IMPACT greater than the sample median to the treatment group, and the remaining firms are assigned to the control group.

Our next step is to estimate the following baseline model to test our main hypothesis that the reduction in compensation vega has a negative impact on CEO's risk-taking behavior:

$$(1)\quad Y_{i,t} = \beta_0 + \beta_1 \text{POST}_t \times \text{TREATED}_i + \beta_2 \text{TREATED}_i + \theta X_{i,t-1} + \lambda_j + \lambda_t + \varepsilon_{i,t},$$

where $Y_{i,t}$ is a proxy for managerial risk-taking behavior. POST_t is an indicator for the post-FAS 123R period. It equals 0 and 1 for years before and after 2005, respectively. TREATED_i is an indicator for treatment defined above. $X_{i,t-1}$ is a vector of firm- and CEO-specific controls, and λ_j and λ_t are industry or firm and year fixed effects, respectively, and $\varepsilon_{i,t}$ is the error term. The specification does not include indicators for postreform period because they are subsumed by year-fixed effects. Standard errors are clustered at the firm level. Our main hypothesis predicts that $\beta_1 < 0$ in risk-taking equation (1) suggesting that reduction in compensation vega due to FAS 123R exacerbates managerial risk-avoidance problem.

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III. Data and Variables

A. Sample Construction and Data Sources

Data on company fundamentals are from Compustat and market data are from CRSP. Data to compute CEO risk-taking incentives, compensation, and other CEO-specific variables are from ExecuComp. Data on operating segments to construct risk proxies are from Compustat business segment data set.

We examine a 12-year period around the adoption of FAS 123R. We exclude 2005 when the reform was implemented to avoid a likely ambiguous effect in this year. Hence, our pre- and post-FAS 123R periods are 1999–2004 and 2006–2011, respectively. The choice of the 6-year period around the shock strikes a balance between being not too short to allow for a meaningful examination of firm risk-taking and investment and not too long since long pre and postperiods can bias inferences from the DiD tests (Bertrand and Mullainathan (2003)).

Our initial sample consists of 89,185 firm-year observations with nonmissing investment variables from Compustat, excluding financial firms and utilities (SIC codes 6000–6999 and 4900–4999). After merging this sample with CEO compensation data from ExecuComp and the data from CRSP and Compustat business segment necessary to construct risk-taking proxies and the main analysis variables, we are left with the final sample of 8,191 firm-year observations, representing 1,327 unique firms during our sample period.

B. Analysis Variables

1. CEO Compensation and Risk-Taking Incentives

One complication with constructing compensation and risk-taking incentive proxies is the change in the presentation format of ExecuComp tables due to new reporting requirements for executive compensation from fiscal years ending after Dec. 15, 2006. We follow Hayes et al. (2012) to merge the old and new formats and construct compensation variables.

We value stock option grants using the Black and Scholes (1973) model for valuing European call options and adjust for continuously paid dividends as in Merton (1974). Following the methodology in Core and Guay (1999), we proxy for CEO's risk-taking incentives by TOTAL_VEGA defined as the change in the value of the CEO's portfolio of current and outstanding prior grants of stock options for a 1% change in stock return volatility. We also compute another common proxy for equity incentives, TOTAL_DELTA, defined as the change in the value of the CEO's portfolio of current and outstanding prior grants of stocks and stock options for a 1% change in the stock price. Additionally, we compute CURRENT_VEGA and CURRENT_DELTA using only current grants of stock options and stocks. All compensation variables are stated in thousands and are winsorized at the top 1%. Appendix IA of the Supplementary Material provides further details on the computation of vega and delta for stock options.

To measure the level of different compensation components, we use five variables: OPTION, RESTRICTED_STOCK, LTIAS, SALARY, and BONUS, defined as the CEO's dollar value of, respectively, option rewards, restricted stock, long-term incentive awards, basic salary, and bonus. We define TOTAL_COMPENSATION as the sum of these five compensation components. We also compute the percentage that different compensation components represent in total compensation.

2. Managerial Risk-Taking Proxies

There are several problems with using a common risk proxy – the volatility of firm's stock returns. First, this measure is criticized by prior studies for reflecting information that is largely beyond managerial risk-taking choices, for example, relating to the market-wide and firm-specific environment (Ross (1989), Bushee and Noe (2000), and Armstrong and Vashishtha (2012)). Moreover, the disclosure by managers is likely to be biased and influenced by managerial preferences and characteristics.[2] Second, compensation vega is by construction mechanically related to stock return volatility. Hence, using this firm risk proxy can result in detecting a spurious relationship between risk-taking incentives and firm risk and lead to biased inferences.

To overcome these problems, we follow Aretz et al. (2019) and construct an imputed managerial risk-taking proxy as the standard deviation of the portfolio stock returns based on the industries in which a firm operates. As industry volatility is less influenced by firm-specific information and disclosure practices, the imputed proxy better reflects managerial decisions to alter firm risks through changing its operating portfolio. This proxy is also free from the mechanical association between compensation vega and risk-taking behavior.[3]

We start with viewing a firm as a portfolio of operating segments, which a firm can choose to add, remove, or change their weighting, thus altering the overall structure and risk of the portfolio. We combine firms operating in the same single industry into pure-play industry portfolios and compute value-weighted weekly pure-play industry portfolio returns, which we then use to mimic the returns of a firm's operating segments. We define industries at the level of 4-digit SIC codes and require a minimum of three single-segment firms to

[2]For example, young managers tend to withhold unfavorable information and reveal only positive information, which can lead to better performance in the early stages of managerial career and to stock price crashes later on (Andreou, Louca, and Petrou (2016)). Similarly, talented CEOs may have incentives to conceal information to extract rents (Malmendier and Tate (2009)), while lower-ability CEOs tend to issue less accurate information (Baik, Farber, and Lee (2011)). These managerial behavioral biases and selective disclosure increases the volatility of stock returns (see, e.g., Jiang, Xu, and Yao (2009), Rajgopal and Venkatachalam (2011)).

[3]The approach of Aretz et al. (2019) builds on Armstrong and Vashishtha (2012), with several important differences which influenced our choice in favor of the former method. First, Aretz et al. (2019) use a finer definition of industries at the 4-, rather than 2-digit SIC level used in Armstrong and Vashishtha (2012). Second, firm portfolio volatilities are computed based on weekly returns over the past year in Aretz et al. (2019), while they are based on monthly returns over the past 5 years in Armstrong and Vashishtha (2012). Thus, the former approach captures the most recent managerial decisions to adjust its operating structure and hence, risk. Moreover, using volatility measure computed over a year also relieves the concern of a high skewness of risk measures computed over long periods. Hence, the risk proxy in Aretz et al. (2019) is likely to capture the underlying firm risk more timely and accurately. Nonetheless, we later verify that our results are robust to using alternative definitions of risk-taking proxies.

construct an industry portfolio.[4] We compute the imputed weekly return for firm i in week t, $r_{i,t}$, as a weighted average of its mimicking industry portfolio returns, where the weights are the fraction of the asset book values of operating segments in total firm's asset value:

$$r_{i,t} = \sum_{S=1}^{S} \frac{A_i^S}{A_i} r_t^S, \tag{2}$$

where r_t^S is the imputed weekly return of pure-play industry portfolio s in week t. A_i^S is the asset book value of segment s of firm i, and A_i is the asset book value of firm i at fiscal year-end. TOTAL_RISK, is the annualized volatility of weekly imputed returns, $r_{i,t}$.

We compute systematic and idiosyncratic risk by regressing the weekly imputed returns from equation (2) for each firm at each year-end on Fama and French (1993) 3 factors:

$$r_{i,t} = \beta_{0,i} + \beta_{1,i} r_{\text{MKTRF},t} + \beta_{2,i} r_{\text{SMB},t} + \beta_{3,i} r_{\text{HML},t} + \varepsilon_{i,t}, \tag{3}$$

where $r_{\text{MKTRF},t}$ is the excess return on market portfolio, $r_{\text{SMB},t}$ is the size premium, and $r_{\text{HML},t}$ is the value premium from Kenneth French's website, and $\varepsilon_{i,t}$ is the error term. The proxies for systematic and idiosyncratic risks are defined as square roots of explained and unexplained variances, respectively, from equation (3).

3. Other Variables

To examine the value consequences of changes in risk-taking, we analyze whether the changes in firm's risk profile are achieved through investments with high or low Tobin's Q. We follow Aretz et al. (2019) to construct IMPUTED_Q as a value-weighted average of Qs of all segments of the firm. A segment's Q is computed as the value-weighted average of the Qs of all pure-play firms operating in the segment's industry, hence following the same approach as for the construction of the risk measures. A firm's Q is the ratio of total assets minus the book value of equity plus the market value of equity minus deferred taxes to total assets.

To explore how firms alter risks of its business portfolio, we use M&A, R&D, CAPEX, CASH, ln(SEGMENTS), ln(NEW_SEGMENTS), ln(CLOSED_SEGMENTS), and CHANGE_IN_FOCUS. M&A is the total annual transaction value of M&A deals made by a firm, R&D is research and development expenditure, CAPEX is capital expenditures, and CASH is cash and short-term investments, all scaled by total assets. We follow a conventional approach in the existing literature and replace missing values of R&D with zeros (see, e.g., Brown and Petersen (2011), Hirschey, Skiba, and Wintoki (2012)). ln(SEGMENTS), ln(NEW_SEGMENTS), and ln(CLOSED_SEGMENTS) are the natural logarithms of the number of, respectively, operating segments, new segments opened by a firm in a given year plus one, and existing segments closed plus one. CHANGE_IN_FOCUS is a dummy equal to

[4]We prefer using finer 4-digit SIC industry classification because Kahle and Walkling (1996) show that it results in more powerful matches compared to a coarser 2-digit SIC industry classification. However, we later check that our results remain unaffected when using risk proxies based on 2-digit industry classifications.

1 if a firm's main operating segment, defined as the 1 with the highest sales, changes its 4-digit SIC industry code over the fiscal year, and else 0.

We control for standard determinants of risk-taking, such as ln(ASSETS), ln(FIRM_AGE), ROA, MARKET_TO_BOOK_ASSETS, LEVERAGE, CASH, PP&E, ln(CEO_AGE) and ln(CEO_TENURE).[5] In imputed Q regressions, we further include CAPEX, R&D, and SALES_GROWTH (Cremers and Ferrell (2014), Chang and Zhang (2015)). In regressions examining M&A deal values as outcomes variables, we additionally control for M&A_LIQUIDITY (Schlingemann, Stulz, and Walkling (2002), Uysal (2011)). All of the variables are winsorized at the top and bottom 1%, apart from CEO age and tenure, that are winsorized only at the top 1%. Detailed definitions of variables are in the Appendix, and summary statistics are provided in Appendix IB.2 of the Supplementary Material.

IV. Empirical Results

A. Univariate Results

We begin with examining the mean differences in CEO stock option pay and managerial risk-taking between firms with high (treated) and low (controls) OPTION_EXPENSING_IMPACT across the pre-and post-FAS 123R periods. Columns 1–3 of Table 1 report mean values and mean differences for outcome variables during the pre-FAS 123R period. Perhaps unsurprisingly, prior to the

TABLE 1

Univariate Difference-in-Difference Tests: Treated and Control Firms

Table 1 presents the univariate results for the difference-in-difference analysis. Mean value for each variable in the pre- and post-FAS 123R period of the treated and control group are reported. Firms with higher than median OPTION_EXPENSING_IMPACT are defined as treated, and firms with below-median OPTION_EXPENSING_IMPACT are defined as control. Variable definitions can be found in the Appendix. The difference in means is tested by *t*-test. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Pre-FAS 123R (1999–2004)			Post-FAS 123R (2006–2011)			
	OPTION_EXPENSING_IMPACT			OPTION_EXPENSING_IMPACT			
	High	Low		High	Low		
	Treated	Control	Diff.	Treated	Control	Diff.	Diff-in-Diff
	1	2	3	4	5	6	7
OPTION ($000)	3,782.366	1,865.099	1,917.267***	1,416.770	1,125.087	291.682***	−1,625.667***
%_OPTION	0.503	0.326	0.177***	0.224	0.187	0.038***	−0.139***
CURRENT_VEGA ($000)	37.281	25.305	11.976***	23.152	19.209	3.943**	−8.033***
TOTAL_VEGA ($000)	166.507	107.343	59.164***	137.511	97.458	40.053***	−19.111***
TOTAL_RISK (%)	40.991	35.833	5.158***	29.905	33.755	−3.850***	−9.008***
SYSTEMATIC_ RISK (%)	16.548	12.676	3.872***	12.586	13.906	−1.320***	−5.192***
IDIOSYNCRATIC_ RISK (%)	37.132	33.178	3.954***	26.704	30.241	−3.537***	−7.491***
IMPUTED_Q	2.997	2.358	0.639***	2.224	2.025	0.199***	−0.440***

[5]See, for example, Guay (1999), Coles et al. (2006), Low (2009), Kini and Williams (2012), and Serfling (2014).

reform CEOs of firms with high OPTION_EXPENSING_IMPACT are rewarded with significantly higher dollar values of stock option compensation, have greater fraction of their total pay in the form of stock options, and consequently, have higher total and current vega. Greater risk-taking incentives provided to CEOs of treated firms prior to FAS 123R are associated with total (systematic) (idiosyncratic) risk higher by 5.2% (3.9%) (4.0%) relative to control firms (significant at 1%).

Columns 4–6 present the same difference statistics for the post-FAS 123R period. Although CEOs of the treated firms continue earning higher dollar value and fraction of stock option grants, and higher compensation vega, the difference compared to control firms becomes noticeably smaller. For example, the within-group difference in stock option value falls by 85% to a much smaller value of $291,682 and the difference in current vega falls by almost 70% to a mere $3,943. In stark contrast to the pre-FAS 123R period, total, systematic, and idiosyncratic risks are significantly lower for the treated group relative to control group (by 3.9%, 1.3%, and 3.5%, respectively).

The last column presents the DiD estimates for the two groups across the pre- and post-FAS 123R periods. They are negative and highly significant for all variables (p-value < 0.001). Specifically, the univariate DiD estimates for stock option compensation and its fraction in total pay are, -1.6 mln and -14%, respectively, and they are $-8{,}033$ and $-19{,}111$ for current and total vega, respectively. Thus, in response to the adoption of FAS 123R, firms with previously high option expensing impact reduced the use of option grants and vega when compensating their CEOs, relative to firms with pre-FAS 123R low option expensing impact. Importantly, DiD estimates for total, systematic and idiosyncratic risk are all significantly negative -9.0%, -5.2%, and -7.5%. Collectively, the univariate DiD results are broadly consistent with our main hypothesis that following the drop in risk-taking incentives due to the adoption of FAS 123R, managerial risk-taking significantly reduced.

B. The Impact of FAS 123R on Risk-Taking: DID Results

In this section, we apply the DiD model (1) to test the implication that decline in option vega due to FAS 123R leads managers "to play it safe" and, hence, aggravates the risk-related agency issue.

Columns 1–3 of Table 2 report the results for models of total, systematic and idiosyncratic risks controlling for industry fixed effects. TREATED attracts a positive and significant coefficient for all risk measures, indicating that treated firms took greater risks relative to control firms prior to FAS 123R. This behavior, however, reverses following the reform as suggested by significantly negative coefficients on DiD term, POST $\times$ TREATED. Specifically, total (systematic) (idiosyncratic) risks in treated firms reduced by 8.3% (4.7%) (7.0%) relative to that of prereform control firms. Economically, these values are significant as they represent a drop of 20.3% (28.1%) (18.8%) from the average prereform total (systematic) (idiosyncratic) risk value of treated firms.

Results in columns 4–6 that replace industry with firm-fixed effects are almost identical. In additional tests, we control for compensation delta to exclude the possibility that changes in pay-for-performance sensitivity due to changes in overall pay structure may be driving the results. These tests are reported in

TABLE 2

The Effect of FAS 123R on Managerial Risk-Taking

Table 2 presents the difference-in-difference results for the impact of FAS 123R on managerial risk-taking. The sample period is between 1999 and 2011, excluding 2005 (the year of FAS 123R adoption). POST is a dummy variable that indicates the period after FAS 123R (2006–2011). TREATED is a dummy variable set to 1 for the treated firms, and 0 for the control firms. Firms with above (below) median OPTION_EXPENSING_IMPACT are defined as treated (control) firms. Managerial risk-taking is measured as imputed total, systematic, and idiosyncratic risks. Firm- and CEO-level independent variables are lagged one period. Variable definitions can be found in the Appendix. Industry fixed effect is based on the 2-digit SIC codes. Standard errors are corrected for heteroscedasticity and clustering at the firm level and presented in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	RISK					
	TOTAL	SYSTEMATIC	IDIOSYNCRATIC	TOTAL	SYSTEMATIC	IDIOSYNCRATIC
	1	2	3	4	5	6
POST × TREATED	−8.337***	−4.650***	−6.971***	−8.420***	−4.691***	−7.022***
	(0.880)	(0.421)	(0.795)	(1.050)	(0.513)	(0.940)
TREATED	4.499***	2.689***	3.710***			
	(0.704)	(0.318)	(0.649)			
ln(ASSETS)	−0.430**	−0.100	−0.415**	1.396**	0.934***	1.14**
	(0.174)	(0.076)	(0.162)	(0.600)	(0.300)	(0.533)
ln(FIRM_AGE)	−0.323	−0.013	−0.346	−4.572***	−1.563**	−4.189***
	(0.366)	(0.164)	(0.339)	(1.686)	(0.790)	(1.540)
ROA	−3.022***	−1.670***	−2.506***	−1.702*	−0.830*	−1.436*
	(0.774)	(0.414)	(0.682)	(0.899)	(0.459)	(0.794)
MARKET_TO_BOOK_ASSETS	0.464***	0.203***	0.422***	0.703***	0.359***	0.618***
	(0.086)	(0.048)	(0.076)	(0.099)	(0.057)	(0.087)
LEVERAGE	8.049***	3.144***	7.249***	5.115	0.505	5.296*
	(2.194)	(0.905)	(2.036)	(3.259)	(1.461)	(2.975)
CASH	2.076***	1.369***	1.741***	1.447**	0.399	1.451**
	(0.660)	(0.333)	(0.607)	(0.647)	(0.344)	(0.615)
PP&E	−0.251	0.333	−0.449	2.326	0.872	2.110
	(1.222)	(0.558)	(1.123)	(1.611)	(0.826)	(1.453)
ln(CEO_AGE)	−1.842	−1.154	−1.540	−2.384	−0.681	−2.309
	(1.567)	(0.726)	(1.432)	(2.659)	(1.253)	(2.439)
ln(CEO_TENURE)	0.286	0.206*	0.212	0.386	0.121	0.353
	(0.237)	(0.111)	(0.216)	(0.289)	(0.153)	(0.261)
Industry-fixed effect	Yes	Yes	Yes	No	No	No
Year-fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Firm-fixed effect	No	No	No	Yes	Yes	Yes
Constant	54.566***	19.673***	50.479***	43.440***	11.827**	41.463***
	(6.903)	(3.105)	(6.295)	(11.275)	(5.349)	(10.296)
No. of obs.	8,191	8,191	8,191	8,191	8,191	8,191
Adj. R^2	0.442	0.458	0.427	0.463	0.460	0.442

Appendix IB.3 of the Supplementary Material and, consistent with Low (2009), reveal a negative relationship between delta and our risk proxies, without changing the main DiD effects.

These results confirm that firms that are more affected by the FAS 123R regulation reduce risk-taking significantly more than less affected firms and, therefore, present a convincing causal evidence of a positive relationship between compensation vega and managerial risk-taking. It appears that the regulation that aimed at improving accounting transparency (Lyke and Shorter (2005)) may have inadvertently aggravated the risk-related agency problem.

C. Did Reduction in Risk Affect Firm Value?

We next examine the value consequences of the risk-reducing behavior following FAS 123R. We show that decreases in option convexity shift managers'

TABLE 3

The Effect of Risk Reduction due to FAS 123R on Firm Value

Table 3 presents the difference-in-difference results for the impact of FAS 123R on firm value, measured by IMPUTED_Q, after the adoption of FAS 123R. The sample period is between 1999 and 2011, excluding 2005 – the year of FAS 123R adoption. POST is a dummy variable that indicates the period after FAS 123R (2006–2011). TREATED is a dummy variable set to 1 for the treated firms, and 0 for the control firms. Firms with above (below) median OPTION_EXPENSING_IMPACT are defined as treated (control) firms. Variable definitions can be found in the Appendix. Industry fixed effect is based on the 2-digit SIC code. Standard errors are corrected for heteroscedasticity and clustering at the firm level and presented in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	IMPUTED_Q	
	1	2
POST × TREATED	−0.316***	−0.296***
	(0.037)	(0.067)
TREATED	0.212***	
	(0.035)	
ln(ASSETS)	0.005	−0.161***
	(0.008)	(0.041)
ln(FIRM_AGE)	−0.016	−0.023
	(0.018)	(0.130)
CURRENT_ROA	0.310***	0.314***
	(0.066)	(0.092)
LAGGED_ROA	0.273***	0.253***
	(0.048)	(0.075)
CAPEX	−0.059	−0.385*
	(0.179)	(0.229)
R&D	1.825***	0.688**
	(0.200)	(0.318)
SALES_GROWTH	−0.009	0.026
	(0.027)	(0.029)
LEVERAGE	−0.527***	−0.196
	(0.074)	(0.136)
CASH	0.147***	0.139**
	(0.053)	(0.069)
PP&E	−0.184***	0.060
	(0.069)	(0.117)
ln(CEO_AGE)	−0.058	0.181
	(0.076)	(0.187)
ln(CEO_TENURE)	0.021*	0.007
	(0.012)	(0.021)
Industry-fixed effect	Yes	No
Year-fixed effect	Yes	Yes
Firm-fixed effect	No	Yes
Constant	2.424***	3.571***
	(0.327)	(0.792)
No. of obs.	8,191	8,191
Adj. R^2	0.437	0.285

preference toward projects not merely with lower risk, but, importantly, those with lower NPVs, thus, destroying firm value.

Table 3 offers the results from reestimating DiD regression (1) using firm's IMPUTED_Q as a new dependent variable. Following prior literature, we include additional controls in these regressions, such as current year's return on assets (CURRENT_ROA), capital expenditure (CAPEX), research and development spending (R&D), and growth in sales (SALES_GROWTH) (Bebchuk and Cohen (2005), Cremers and Ferrell (2014), and Chang and Zhang (2015)). Column 1 shows that after FAS 123R treated firms rebalance their asset mixes toward segments with lower Tobin's Qs, and hence, worse investment opportunities. Specifically, IMPUTED_Q of treated firms decreases by 0.316 ($p < 0.000$). This decrease is also economically meaningful as it represents 12% of pre-FAS 123R average IMPUTED_Q for treated firms. Results are similar when we replace industry with firm-fixed effects in column 2 or when we control for CEO total and current compensation delta as shown in Appendix IB.3 of the Supplementary Material.

Overall, our findings not only suggest that treated firms lower their risk after a decline in CEO's risk-taking incentives, but that they do so through making value-reducing investments.

D. Robustness Tests

1. Parallel Trends

We perform several tests to assess whether treated and control firms have parallel trends in the main outcome variables prior to FAS 123R. First, we follow Mao and Zhang (2018) and compute the growth rates of the analysis variables as annual changes from previous year to the current year. Panel A of Table 4 shows similar mean growth rates of managerial risk-taking, imputed Q, and key firm and CEO characteristics between treated and control groups.[6]

Second, we follow Deng, Mao, and Xia (2021) and perform a dynamic specification of model (1) by replacing the DiD term with 4 interactions of TREATED and years before and after the reform. We define Before^{1} and After^{1} equal to 1 for years 2004 and 2006, respectively, and Before^{2+} and After^{2+} equal to 1 for years before 2004 and after 2006, respectively. We set 2000 as the reference year since Atanasov and Black (2016) advise selecting a year several periods before the reform. If there are no preexisting trends, the coefficients on the prereform dummies interacted with TREATED should be small and insignificant.

Panel B of Table 4 reports the results from reestimating our main regressions using the dynamic specification. The coefficient estimates of Before^{1} and Before^{2+}, interacted with TREATED, in all risk-taking and imputed Q regressions are insignificant suggesting no overall differences in pre-FAS 123R trends between treated and control firms. The coefficient estimates on After^{1} and After^{2+}, interacted with TREATED, are negative and significant, consistent with our main findings. Additionally, we follow Deng et al. (2021), Gopalan, Gormley, and Kalda (2021) and plot the coefficients on interactions of TREATED with year-specific dummies around the reform. Appendix IB.4 of the Supplementary Material presents this figure that confirms insignificant preexisting trends and maps out the treatment effect over the postreform period. Overall, these tests suggest that, absent the reform, the two groups of firms would have continued to behave similarly, satisfying the parallel trends assumption.

2. Falsification Tests

We perform two sets of falsifications tests. In the first test, we run placebo regressions of our main risk and investment efficiency specifications to rule out spurious correlation between the treated group and risk-taking behavior. Specifically, we run these specifications using randomly drawn, instead of actual,

[6]The only exception is a significantly different pre-FAS 123R growth rates in CASH for the two groups.

TABLE 4
Pre-FAS 123R Parallel Trend

Table 4 presents the results from various tests of the parallel trends assumption. Panel A presents the average of annual changes in our main variables in the pre-FAS 123R period for the treated and control groups, as well as the differences in these average annual changes between the two groups. Panel B presents the ordinary least squares regression results on the dynamic effects of the adoption of FAS 123R. $\text{Before}^1 \times$ TREATED ($\text{After}^1 \times$ TREATED) is the interaction term between a dummy variable that equals 1 for the year before (after) the adoption of FAS 123R and the TREATED dummy. $\text{Before}^{2+} \times$ TREATED ($\text{After}^{2+} \times$ TREATED) is the interaction term between a dummy variable that equals 1 for the years equal to or further than 2-year before (after) the adoption of FAS 123R and the TREATED dummy. Variable definitions can be found in the Appendix. Standard errors are corrected for heteroscedasticity and clustering at the firm level and presented in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Panel A. Pre-FAS 123R Growth Rates in Analysis Variables

	OPTION_EXPENSING_IMPACT		Diff.	
	High	Low		
	Treated	Control	Treated − Control	*p*-Value
	1	2	3	4
ΔTOTAL_RISK (%)	2.542	2.372	0.170	0.688
ΔSYSTEMATIC_ RISK (%)	1.324	1.547	−0.222	0.345
ΔIDIOSYNCRATIC_RISK (%)	2.127	1.852	0.275	0.500
ΔIMPUTED_Q	0.029	0.017	0.012	0.712
ΔASSETS ($ MLN)	−169.456	−265.036	95.580	0.357
ΔMARKET_TO_BOOK_ASSETS	0.212	0.172	0.040	0.652
ΔLEVERAGE	0.003	0.006	−0.003	0.191
ΔCASH	0.028	−0.003	0.031	0.006
ΔROA	−0.010	0.002	−0.012	0.209
ΔPP&E	0.017	0.015	0.002	0.599
ΔCEO_AGE	−0.306	−0.098	−0.208	0.127
ΔCEO_TENURE	−0.201	−0.047	−0.155	0.204

Panel B. Dynamic Effects of Risk Reduction due to FAS 123R on Risk-Taking and Firm Value

	RISK			IMPUTED_Q
	TOTAL	SYSTEMATIC	IDIOSYNCRATIC	
	1	2	3	4
$\text{Before}^{2+} \times$ TREATED	1.147	0.561	1.043	0.108
	(0.736)	(0.346)	(0.674)	(0.066)
$\text{Before}^1 \times$ TREATED	−0.242	0.385	−0.167	0.076
	(0.624)	(0.452)	(0.576)	(0.063)
$\text{After}^1 \times$ TREATED	−3.752***	−2.234***	−3.074***	−0.120*
	(0.762)	(0.376)	(0.707)	(0.063)
$\text{After}^{2+} \times$ TREATED	−3.994***	−1.981***	−3.435***	−0.146***
	(0.693)	(0.327)	(0.628)	(0.044)
TREATED	2.703***	2.017***	2.067**	0.924***
	(0.996)	(0.392)	(0.966)	(0.125)
No. of obs.	8,191	8,191	8,191	8,191
Adj. R^2	0.460	0.449	0.448	0.418

treated, and control firms. If significant reduction in risk-taking and long-term investment efficiency that we document in Tables 2 and 3 were happening in treated firms following FAS 123R, but were not specific to these firms, we would expect to find a similarly significant DiD coefficient in regressions with falsely assigned treated firms (PSEUDO_TREATED). We present the results of this test in Panel A of Table 5 and find insignificant DiD estimates in all specifications, indicating no differences in the effect of FAS 123R on pseudo treated and control firms and confirming that the effects we find are specific to the actual treated firms.

In the second falsification test, we shift the shock year to 1995, a “placebo” year without major changes in compensation policies that could affect managerial

TABLE 5

Placebo Tests

Table 5 presents the difference-in-difference results of the placebo tests for the impact of FAS 123R on managerial risk-taking and firm value. Panel A keeps the sample period from 1999 to 2011 (excluding 2005) but randomly assigns firms into the treated and control groups. PSEUDO_TREATED is a dummy variable that indicates randomly treated firms, and 0 otherwise. Panel B keeps the identification of treated and control firms but utilizes a false shock in 1995 to replace the shock of FAS 123R in 2005. The prepseudo shock period is from 1992 to 1994, and the postpseudo shock period is from 1996 to 1998. PSEUDO_POST is a dummy variable set to 1 to indicate the postpseudo shock period. Each column includes year and 2-digit SIC code dummies and the same set of control variables as in Tables 2 and 3. Firm- and CEO-level independent variables are lagged one period. Variable definitions can be found in the Appendix. Standard errors are corrected for heteroscedasticity and clustering at the firm level and presented in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	RISK			IMPUTED_Q
	TOTAL	SYSTEMATIC	IDIOSYNCRATIC	
	1	2	3	4
Panel A. Placebo Treated				
POST × PSEUDO TREATED	0.173	−0.100	0.188	−0.021
	(0.497)	(0.256)	(0.453)	(0.038)
PSEUDO_TREATED	−0.278	−0.047	−0.262	−0.002
	(0.384)	(0.189)	(0.353)	(0.030)
No. of obs.	8,191	8,191	8,191	8,191
Adj. R^2	0.455	0.472	0.444	0.432
Panel B. Placebo Shock Year				
PSEUDO_POST × TREATED	0.680	−0.117	0.897	−0.032
	(0.585)	(0.320)	(0.584)	(0.067)
TREATED	0.501	0.777**	0.119	0.099**
	(0.588)	(0.320)	(0.569)	(0.063)
No. of obs.	3,454	3,454	3,454	3,454
Adj. R^2	0.542	0.613	0.478	0.520

risk-taking incentives. Hence, we define 1992–1994 and 1996–1998 as pseudo pre and postreform periods, respectively.[7] Panel B of Table 5 reports the results of this placebo definition for PSEUDO_POST and shows insignificant DiD coefficients in all risk and investment efficiency regressions, suggesting that a false reform in 1995 cannot replicate the actual effect of FAS 123R in 2005.

These tests confirm two important aspects of our empirical design. First, they verify that the treated and control firms are likely to exhibit similar risk-taking and investment efficiency prior to FAS 123R, thus, strengthening the validity of the parallel trends assumption. Second, they corroborate the shock strength and add further credibility to our identification strategy.

3. Propensity Score Matching

Despite the parallel-trends and falsification test results, there could still be concerns that treated and control firms differ along dimensions other than pretreatment option expensing impact. To mitigate this concern, we show that our conclusions remain unchanged when we repeat the main analysis on a matched sample of treated and control firms using propensity score matching (PSM). The advantages

[7]Consistent with the main tests, we exclude the pseudo-shock year and use symmetrical pre and postperiods. Because the first year with available compensation data in ExecuComp is 1992, we use 3 years surrounding 1995 as pseudo pre and postperiods. In unreported tests, we verify that our conclusions remain unchanged when we change a "placebo" to alternative years, for example, 1996, 1997, or 1998.

of the PSM analysis are that it attenuates potential differences between treated and control firms and the possibility of nonparallel trends between the 2 groups prior to the reform. We use pre-FAS 123R sample and estimate a logit model that regresses a treatment indicator on firm size, age, ROA, market-to-book ratio of assets, leverage, cash, PP&E, CEO age, and tenure. Using the fitted probability from this model (propensity score), we match each treated firm to a control firm from the same industry that has the closest propensity score within a 5% radius prior to FAS 123R (year 2004).[8]

Results are reported in Table 6 and are consistent with our main DiD analyses. All coefficient estimates on DiD terms in risk and imputed Q regressions are significantly negative, further supporting our hypotheses of reduced managerial risk-taking and long-term investment efficiency following reductions in option convexity after FAS 123R.

4. Alternative Proxies of Managerial Risk-Taking

Since the measurement of managerial risk-taking is at the core of our article, we check that our results are robust to alternative versions of this proxy. The first variation mitigates a concern that SIC codes may be more effective in classifying firms into coarse industrial groups rather than into finer 4-digit segments (Clarke (1989)). To this end, we recompute risk proxies using segments and pure-play portfolios defined at the 2-digit SIC level. The second variation uses monthly mimicking industry portfolio returns over the past 60 months, combined with either 2-digit or 4-digit SIC industry classifications. The third variation addresses a concern that our main proxies determine the segment's weight in a firm's business portfolio using a segment's book value of assets, changes in which may not only be driven by managerial decisions, but also by accounting rules. Hence, we recompute risk proxies using segment's sales as weights in a firm's business portfolio as they will be less affected by accounting rules. Alternatively, we use segments' investments proxies by capital expenditures as weights since they will more directly reflect managerial investment decisions.

Our final variation addresses a concern that the volatility of a firm's segment holdings may be higher than that of a well-diversified portfolio of single-segment firms since a firm's operations in a segment are unlikely to benefit from the same diversification as an investment in an industry portfolio. To mitigate this concern, we assume that stock returns of all pure-play firms in a mimicking industry portfolio are perfectly positively correlated. Following Aretz et al. (2019), we recompute the volatilities of the industry portfolios as value-weighted averages of the volatilities of pure-play firms, thus removing the benefits of diversification.

Table 7 reports the results. For ease of comparison, Panel A repeats the results from the baseline DiD regression (1) that uses risk proxies based on 4-digit SIC codes and weekly returns of pure-play portfolios over the past 52 weeks. Panels B–G report the results of the reestimation of model (1) using four alternative risk proxies and show that the results remain unchanged regardless of the variation in the

[8]In unreported tests, we employ different matching approaches by altering the 5% radius, the set of matching variables, and relaxing the no-replacement restriction. Our results are not affected by the choice of matching method.

TABLE 6
Propensity Score Matching

Table 6 presents the difference-in-difference results for the impact of FAS 123R on managerial risk-taking and firm value using the matched sample. Firms with above (below) median OPTION_EXPENSING_IMPACT are defined as treated (control) firms. Each treated firm is matched with a control firm based on the propensity score estimated using ln(ASSETS), ln(FIRM_AGE), ROA, MARKET_TO_BOOK_ASSETS, LEVERAGE, CASH, PP&E, ln(CEO_AGE), and ln(CEO_TENURE) for the pre-FAS 123R period. The matched firms must operate in the same industry and have the closest propensity score (with 5% radius) in 2004, the year before the adoption of FAS 123R. Firm- and CEO-level independent variables are lagged one period. Variable definitions can be found in the Appendix. Each column includes year and 2-digit SIC code dummies. Standard errors are corrected for heteroscedasticity and clustering at the firm level and are presented in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	RISK			IMPUTED_Q
	TOTAL	SYSTEMATIC	IDIOSYNCRATIC	
	1	2	3	4
POST × TREATED	−7.874***	−4.341***	−6.552***	−0.139**
	(1.335)	(0.657)	(1.205)	(0.058)
TREATED	3.803***	2.502***	3.052***	0.107**
	(0.952)	(0.455)	(0.870)	(0.053)
ln(ASSETS)	−0.442	−0.130	−0.415	0.024*
	(0.273)	(0.117)	(0.254)	(0.012)
ln(FIRM_AGE)	−0.392	0.144	−0.472	−0.064**
	(0.599)	(0.284)	(0.552)	(0.031)
CURRENT_ROA				0.370***
				(0.078)
LAGGED_ROA	−0.902	−1.170**	−0.433	0.202***
	(0.890)	(0.499)	(0.793)	(0.061)
MARKET_TO_BOOK_ASSETS	0.419***	0.224***	0.364***	
	(0.107)	(0.054)	(0.097)	
CAPEX				0.062
				(0.240)
R&D				1.874***
				(0.295)
SALES_GROWTH				−0.060
				(0.050)
LEVERAGE	10.332***	3.026**	9.820***	−0.356***
	(3.431)	(1.430)	(3.229)	(0.127)
CASH	3.304***	1.985***	2.788***	0.175***
	(0.843)	(0.471)	(0.745)	(0.054)
PP&E	1.613	0.352	1.539	0.067
	(2.055)	(0.955)	(1.860)	(0.107)
ln(CEO_AGE)	−0.513	−1.380	−0.095	−0.010
	(2.430)	(1.093)	(2.238)	(0.125)
ln(CEO_TENURE)	−0.235	0.007	−0.274	0.024
	(0.321)	(0.162)	(0.290)	(0.019)
Constant	34.543***	17.810***	30.105***	2.009***
	(10.167)	(4.533)	(9.365)	(0.601)
No. of obs.	3,495	3,495	3,495	3,495
Adj. R^2	0.528	0.496	0.521	0.436

risk construction. Coefficients on the DiD term, POST × TREATED are negative and significant ($p < 0.000$) in all regressions.

5. Other Sources of Convexity in Executive Compensation

One potential criticism of our current results could be that there could be other sources of convexity in executive compensation, apart from stock options, which remain unaccounted for in our tests. If this is the case, we could be under- or overestimating the implied extent to which the negative option-expensing impact

TABLE 7

Alternative Risk Proxies

Table 7 presents the difference-in-difference results for the impact of FAS 123R on managerial risk-taking using several variations of risk proxies. Firms with above (below) median OPTION_EXPENSING_IMPACT are defined as treated (control) firms. The risk proxy in Panel A is constructed by using segments identified at 4-digit SIC level and weekly mimicking industry portfolio returns over the past 52 weeks, as used in baseline estimations. The risk proxy in Panel B is constructed by using segments identified at 2-digit SIC level and weekly mimicking industry portfolio returns over the past 52 weeks. The risk proxy in Panel C is constructed by using segments identified at 4-digit SIC level and monthly mimicking industry portfolio returns over the past 60 months. The risk proxy in Panel D is constructed by using segments identified at 2-digit SIC level and monthly mimicking industry portfolio returns over the past 60 months. The risk proxy in Panels E and F is constructed as the baseline case but using segment's sales and capital expenditures as weights, respectively. The risk proxy in Panel G is constructed as the baseline case but assuming the stock returns of all pure-play firms in a mimicking industry portfolio are perfectly positively correlated. Each column includes year and 2-digit SIC code dummies and the same set of control variables as in Table 2. Firm- and CEO-level independent variables are lagged one period. Variable definitions can be found in the Appendix. Standard errors are corrected for heteroscedasticity and clustering at the firm level and presented in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	RISK		
	TOTAL	SYSTEMATIC	IDIOSYNCRATIC
	1	2	3
Panel A. Base Case – Segments Identified at 4-Digit SIC Level; Weekly Mimicking Industry Portfolio Returns over the Past 52 Weeks			
POST × TREATED	−8.337***	−4.650***	−6.971***
	(0.880)	(0.421)	(0.795)
TREATED	4.499***	2.689***	3.710***
	(0.704)	(0.318)	(0.649)
Panel B. Segments Identified at 2-Digit SIC Level; Weekly Mimicking Industry Portfolio Returns over the Past 52 Weeks			
POST × TREATED	−5.436***	−1.566***	−4.689***
	(0.581)	(0.176)	(0.514)
TREATED	2.631***	0.778***	2.282***
	(0.376)	(0.115)	(0.332)
Panel C. Segments Identified at 4-Digit SIC Level; Monthly Mimicking Industry Portfolio Returns over the Past 60 Months			
POST × TREATED	−8.813***	−6.160***	−3.178***
	(0.988)	(0.601)	(0.671)
TREATED	5.424***	5.384***	0.962*
	(0.820)	(0.584)	(0.580)
Panel D. Segments Identified at 2-Digit SIC Level; Monthly Mimicking Industry Portfolio Returns over the Past 60 Months			
POST × TREATED	−5.276***	−4.133***	−0.547**
	(0.571)	(0.417)	(0.248)
TREATED	2.741***	2.312***	0.154
	(0.371)	(0.279)	(0.190)
Panel E. Base Case; Segment Sales are Used for Weighting Segment Returns in Firm Portfolio			
POST × TREATED	−8.642***	−2.566***	−7.512***
	(0.833)	(0.245)	(0.764)
TREATED	4.333***	1.393***	3.813***
	(0.630)	(0.185)	(0.575)
Panel F. Base Case; Segment Investments are Used for Weighting Segment Returns in Firm Portfolio			
POST × TREATED	−8.661***	−2.601***	−7.762***
	(0.833)	(0.244)	(0.756)
TREATED	4.324***	1.388***	3.831***
	(0.628)	(0.185)	(0.573)
Panel G. Base Case; Mimicking Industry Returns are Computed Assuming No Diversification Within Industry Portfolio			
POST × TREATED	−9.106***	−3.015***	−8.586***
	(0.746)	(0.238)	(0.713)
TREATED	5.805***	2.002***	5.453***
	(0.602)	(0.189)	(0.577)

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of FAS 123R causes managers of treated firms to reduce managerial risk-taking and firm value relative to firms less affected by the reform.

Of particular concern are performance-vesting grants of actual stock, as distinct from options on a stock.[9] Unlike traditional, time-vesting, stock grants, performance-vesting grants specify a vesting schedule whereby stock vests based not on time but on attainment of one or more performance conditions. Therefore, performance-vesting grants create another source of convexity in executive compensation since managers receive a larger increment in pay when performance is high as opposed to moderate, compared to when it is moderate as opposed to low. Importantly, FAS 123R removes preferential accounting treatment for stock options vis-à-vis performance-vesting grants, making these sources of convexity in executive compensation more substitutable after the reform. Indeed, Bettis et al. (2018) document that rates of performance-vesting grants increased from 17% during our pre-FAS 123R period to 49% during our post-FAS 123R period.

On the one hand, by not excluding firm-year observations with performance-vesting stock grants, we could be understating the importance of convexity in executive compensation attributable to stock options per se. On the other hand, by including but not controlling for these observations, we could be overstating the importance of convexity in executive compensation attributable to stock options versus performance-vesting grants.

To address these concerns, we repeat our baseline risk-taking and value regressions by alternatively excluding and controlling for firm-year observations with performance-vesting stock grants. For consistency with recent literature (see, e.g., Bettis et al. (2018), Mao and Zhang (2018)), we rely on INCENTIVE_LAB for identifying these observations.[10] We present the results for key coefficients in Table 8 and the full regression results in Appendix IB.5 of the Supplementary Material. The regressions in Panel A exclude relevant observations, whilst those in Panel B control for them by including a performance-vesting dummy. No matter how we account for performance-vesting grants, the negative DiD terms hardly alter in comparison to when not accounting for this other source of convexity in compensation. This evidence further suggests that stock options are vital for creating incentives for value-enhancing managerial risk-taking behavior.

In additional tests reported in Appendix IB.6 of the Supplementary Material, we interact a dummy variable alternatively capturing changes in other potential sources of convexity in overall pay (LTIAs, which are closely related to performance-vesting grants; see Hayes et al. (2012)) and bonus pay (with the key variables, TREATED and POST × TREATED). In doing so, we are also able to rule out cross-sectional variation in other sources of convexity in CEO compensation that runs counter to the negative DiD terms. We find that the negative DiD coefficients in these tests hardly alter from the main tests.

[9]Grants of stock options can also have performance-based vesting schedules. However, Bettis, Bizjak, Coles, and Kalpathy (2018) document that performance-vesting grants of stock options are infrequent compared to performance-vesting grants of actual stock.

[10]Mao and Zhang (2018) exclude firms, as distinct from firm-year observations, with performance-vesting grants. Our inferences are unaffected by also implementing this blanket approach (unreported).

TABLE 8

The Effect of Other Convexity-Inducing Compensation

Table 8 presents the difference-in-difference results for the impact of FAS 123R on managerial risk-taking and firm value when considering performance-vesting equity awards. The sample period is between 1999 and 2011, excluding 2005 – the year of FAS 123R adoption. POST is a dummy variable that indicates the period after FAS 123R (2006–2011). TREATED is a dummy variable set to 1 for the treated firms, and 0 firm the control firms. Firms with above (below) median OPTION_EXPENSING_IMPACT are defined as treated (control) firms. Managerial risk-taking is measured by the imputed total risk, systematic risk, and idiosyncratic risk. Panel A excludes firm-years in which compensation includes a grant of performance-vesting equity (according to INCENTIVE_LAB). Panel B controls for the dummy variable PERFORMANCE_VESTING that equals 1 for firms that grant any compensation in the form of performance-vesting equity in a given year, and 0 otherwise. Each column includes year and 2-digit SIC code dummies and the same set of control variables as in Tables 2 and 3. Firm- and CEO-level independent variables are lagged one period. Variable definitions can be found in the Appendix. Standard errors are corrected for heteroscedasticity and clustering at the firm level and presented in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Panel A. Excluding Firm-Years with Performance-Vesting Grants

	RISK			IMPUTED_Q
	TOTAL	SYSTEMATIC	IDIOSYNCRATIC	
	1	2	3	4
POST × TREATED	−7.845***	−4.507***	−6.527***	−0.393***
	(0.962)	(0.455)	(0.864)	(0.065)
TREATED	3.874***	2.392***	3.188***	0.251***
	(0.727)	(0.328)	(0.663)	(0.061)
No. of obs.	6,052	6,052	6,052	6,052
Adj. R^2	0.476	0.484	0.468	0.487

Panel B. Controlling for Firm-Years with Performance-Vesting Grants

	RISK			IMPUTED_Q
	TOTAL	SYSTEMATIC	IDIOSYNCRATIC	
	1	2	3	4
POST × TREATED	−8.029***	−4.357***	−6.764***	−0.317***
	(0.833)	(0.391)	(0.750)	(0.059)
TREATED	4.262***	2.474***	3.569***	0.213***
	(0.665)	(0.302)	(0.605)	(0.059)
PERFORMANCE_VESTING	−1.420***	−0.773***	−1.172***	0.044
	(0.485)	(0.217)	(0.444)	(0.039)
No. of obs.	8,191	8,191	8,191	8,191
Adj. R^2	0.470	0.491	0.457	0.437

6. Unobservables in CEO Compensation

Another concern could be that our tests do not account for the variation in CEO compensation along unobservable dimensions, potentially biasing the extent to which the negative option-expensing impact of FAS 123R causes managers of treated firms to reduce risk-taking and investment efficiency relative to firms less affected by the reform. Unobservable variation in CEO compensation could stem from differences in CEOs' risk aversion, possibly because of differences in outside wealth or innate and acquired traits, and from differences in attributes of their firms' production technology. To address this issue, we rerun our baseline regressions by controlling for unexplained compensation.

Since CEO compensation comprises a wider set of components that are aggregated in our measure of TOTAL_COMPENSATION, and since omitted components (e.g., severance pay, deferred pay, perquisites, and other personal benefits) could also vary along unexplained dimensions, we follow Denis, Jochem, and Rajamani (2020) and add ExecuComp data item ALL_OTHER_COMPENSATION to construct our alternative measure of total compensation (TOTAL_COMPENSATION2).[11]

We then model CEO compensation based on the controls and industry and year-fixed effects in the relevant baseline regression, all of which are also salient for modeling compensation, so as not to induce bias via the inclusion of variables not in the baseline regression. However, we also add an exclusion restriction that takes the form of state-by-year fixed effects, allowing for annual trends in geographic determinants of CEOs' compensation, such as nonmonetary benefits associated with quality of life in their firms' headquarter states (see Deng and Gao (2013)), but not for a plausible channel directly determining firm risk and value.

We present the results of these first stages in columns 1 and 5 of Table 9 for risk-taking and firm value, respectively. The highest adjusted R^2 is 27%, leaving substantial unexplained variation in CEO compensation. The residual from these first stages then becomes our measure of unobservable CEO compensation (UNOBSERVABLE_COMPENSATION) that we include in the relevant baseline regression (duly correcting standard errors). In the second-stage, the coefficient estimate on UNOBSERVABLE_COMPENSATION is positive and significant only in firm value regression in column 6 ($p < 0.05$), suggesting that CEO compensation varies along unexplained dimensions that create incentives for value-enhancing but not risk-taking behavior. Notwithstanding this finding, the negative DiD terms hardly alter in comparison to when not accounting for unobservables in CEO compensation. Therefore, our main DiD results continue to imply that stock options create convexity in executive compensation and thus incentives for value-enhancing risk-taking behavior.

7. Further Robustness

We perform several additional tests to address other concerns about the robustness and interpretation of our main results. First, we verify that our results are robust to different threshold values of option expense used to identify treated firms, while also examining the impact of shock intensity on our main specifications. Specifically, we alter the identification threshold for treated firms from the prereform sample median to the 60th, 70th, 80th, and 90th percentile values. We report these results in Appendix IB.7 of the Supplementary Material and find that a negative impact of FAS 123R on risk-taking and firm value of treated firms becomes even stronger as the identification threshold increases. Second, we exclude firms that started voluntarily recognizing option expense at fair value prior

[11]Unexplained variation in ALL_OTHER_COMPENSATION could stem from nuances associated with contracted severance pay (see Cadman, Campbell, and Klasa (2016)), deferred versus expedited pay (see Feng (2021)), and internal tournament-based incentives (see Kini and Williams (2012)). It only became mandatory for firms to disclose contracted severance pay, as distinct from vested severance pay, after the FAS 123R reform. However, Mao and Zhang (2018), whose sample closely accords with ours, examine a subsample of contracts for voluntary disclosers in the pre-FAS 123R period and compare them against contracts for the same firms in the post-FAS 123R period. They conclude that most of these contracts remain the same or similar and that their results are therefore unlikely to be affected by changes in contracted severance pay.

TABLE 9
The Effect of Unobservable CEO Compensation

Table 9 presents the difference-in-difference results for the impact of FAS 123R on managerial risk-taking and firm value when controlling for unobservable (residual) compensation. Firms with above (below) median OPTION_EXPENSING_IMPACT are defined as treated (control) firms. ln(TOTAL_COMPENSATION2) is the natural logarithm of TOTAL_COMPENSATION plus all other compensation reported in ExecuComp (othcomp). The first-stage regressions reported in columns 1 and 5 compute the residual compensation for risk-taking and firm long-term investment efficiency, respectively. UNOBSERVABLE_COMPENSATION is the residual compensation computed from the first stage. Variable definitions can be found in the Appendix. Each column includes year and 2-digit SIC code dummies. Columns 1 and 5 additionally control for the firm's headquarter state interacted with year dummies. Standard errors are corrected for heteroscedasticity and clustering at the firm level and presented in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Panel A. The Effect on Managerial Risk-Taking				*Panel B. The Effect on Firm Value*	
	First-Stage	Second-Stage			First-Stage	Second-Stage
	ln(TOTAL_ COMPENSATION2)	TOTAL_ RISK	SYSTEMATIC_ RISK	IDIOSYNCRATIC_ RISK	ln(TOTAL_ COMPENSATION2)	IMPUTED_Q
	1	2	3	4	5	6
POST × TREATED		−8.338***	−4.649***	−6.972***		−0.317***
		(0.880)	(0.421)	(0.796)		(0.063)
TREATED		4.504***	2.683***	3.716***		0.196***
		(0.705)	(0.319)	(0.650)		(0.066)
UNOBSERVABLE_ COMPENSATION		−0.151	0.188	−0.206		0.068**
		(0.528)	(0.245)	(0.482)		(0.034)
ln(ASSETS)	0.498***	−0.356	−0.192	−0.314	0.507***	−0.028
	(0.023)	(0.316)	(0.140)	(0.291)	(0.021)	(0.022)
ln(FIRM_AGE)	0.093**	−0.309	−0.031	−0.326	0.076*	−0.012
	(0.042)	(0.370)	(0.166)	(0.344)	(0.042)	(0.034)
CURRENT_ROA					0.128	0.279***
					(0.115)	(0.084)
LAGGED_ROA	0.203	−2.990***	−1.710***	−2.462***	0.345*	0.206***
	(0.187)	(0.773)	(0.410)	(0.684)	(0.177)	(0.068)
MARKET_TO_ BOOK_ASSETS	0.047***	0.470***	0.195***	0.431***		
	(0.010)	(0.090)	(0.050)	(0.079)		
CAPEX					−0.267	−0.241
					(0.498)	(0.238)
R&D					1.948***	1.863***
					(0.450)	(0.349)
SALES_GROWTH					−0.128**	−0.005
					(0.065)	(0.034)
LEVERAGE	−0.485***	7.973***	3.239***	7.145***	−0.535***	−0.748***
	(0.168)	(2.185)	(0.907)	(2.029)	(0.150)	(0.099)
CASH	−0.103	2.072***	1.374***	1.736***	−0.153	0.103
	(0.105)	(0.660)	(0.333)	(0.607)	(0.108)	(0.075)
PP&E	−0.365***	−0.312	0.409	−0.531	−0.227	−0.156
	(0.140)	(1.250)	(0.568)	(1.148)	(0.172)	(0.109)
ln(CEO_AGE)	−0.089	−1.853	−1.141	−1.554	−0.065	−0.009
	(0.184)	(1.565)	(0.724)	(1.431)	(0.181)	(0.136)
ln(CEO_TENURE)	0.022	0.286	0.205*	0.212	0.015	0.010
	(0.026)	(0.237)	(0.111)	(0.216)	(0.026)	(0.020)
Constant	2.613	55.167***	18.925***	51.298***	2.745	2.337***
	(1.679)	(7.073)	(3.179)	(6.451)	(1.689)	(0.568)
No. of obs.	8,191	8,191	8,191	8,191	8,191	8,191
Adj. R^2	0.209	0.442	0.458	0.427	0.267	0.423

to FAS 123R. We find similar results and present them in Appendix IB.8 of the Supplementary Material. Finally, we also perform the main tests on a shorter period around the reform, 2002–2008. We again find similar results and present them in Appendix IB.9 of the Supplementary Material. All of these tests are discussed in detail in the relevant items of the Supplementary Material.

E. Cross-Sectional Effects

Providing risk-taking incentives is more important in certain types of firms characterized by riskier internal and external environments, such as those with greater investment and growth opportunities (Fama and French (1992), Guay (1999)), innovation activities (Aboody and Lev (2000), Coles et al. (2006), and Custódio and Metzger (2013)), and poorer corporate governance (John, Litov, and Yeung (2008)). Consequently, the reduction in compensation convexity due to FAS 123R is expected to have a larger negative effect on risk-taking and firm value in these firms. To test this hypothesis, we partition our sample firms into those with high and low market-to-book ratio of assets (a proxy for investment and growth opportunities), R&D expenditure (a proxy for innovation activities), and E-index (a proxy for the quality of corporate governance).[12] "High" group includes firms with the median prereform period value of the partitioning variable greater than the prereform sample median.

Table 10 presents the differences in the effect of FAS 123R on firm risk and value across "High" and "Low" groups based on the market-to-book assets (Panel A), R&D (Panel B), and E-index (Panel C) partitions. For brevity, we only report the coefficients on the DiD terms and the p-value for the Wald chi-squared test of the difference in DiD estimates between the 2 groups. Although all treated firms experience reductions in risk following a decline in option vega after FAS 123R, these reductions are greater in firms that face higher uncertainty and need to provide greater risk-taking incentives to managers, and they are associated with larger declines in firm value in these firms. For example, postreform total risk reduces by 8.5%, 10.5%, and 9.0% in firms with high market-to-book ratio of assets, R&D expenditure, and E-index values, respectively. Corresponding values for "Low" group are 6.2%, 4.0%, and 6.9%, with all the differences between high and low groups significant at 10% level or better, based on the chi-squared test. Importantly, for all partitions, IMPUTED_Q of "High" group decreased significantly more than that for "Low" group.

F. Channels of Reduction in Managerial Risk-Taking

Finally, we explore how exactly the downward risk adjustment is facilitated in affected firms. We replace the dependent variable in DiD model (1) with several proxies for changes in firm's investment policy and business portfolio, M&A, R&D, CAPEX, ln(SEGMENTS), ln(NEW_SEGMENTS), ln(CLOSED_SEGMENTS), CHANGE_IN_FOCUS, and CASH.

Table 11 presents the results of ordinary least squares (OLS) estimates of these tests.[13] We begin with examining investments in M&A, R&D, and Capex. The DiD estimates in columns 1–3 are all small and statistically insignificant, suggesting no

[12]We construct E-index following Bebchuk, Cohen, and Ferrell (2009) and using *Risk Metrics* database. Higher values of E-index indicate more anti-takeover provisions, and hence, proxy for poorer corporate governance.

[13]We repeat the channels regressions from Table 11 using alternative econometric specifications. We apply Tobit models for regressions with M&A, R&D, and CAPEX as dependent variables since they are continuous with a zero lower bound. For regressions with SEGMENTS, NEW_SEGMENTS, and CLOSED_SEGMENTS, we use Poisson and negative binomial models that are intended to deal with nonnegative integer dependent variables. For the binary dependent variable, CHANGE_IN_FOCUS, we alternatively use probit and logit specifications. The results of these tests are reported

TABLE 10

Cross-Sectional Tests

Table 10 presents the difference-in-difference estimators for the cross-sectional tests for the impact of FAS 123R on managerial risk-taking and firm value. Panels A, B, and C partition the sample into High and Low subsamples based on the pre-FAS 123R period median level of MARKET_TO_BOOK_ASSETS, R&D, and E_INDEX. Each column includes year and 2-digit SIC code dummies and the same set of control variables as in Tables 2 and 3. Firm- and CEO-level independent variables are lagged one period. Variable definitions can be found in the Appendix. Difference in coefficients is tested using Wald chi-squared test and *p*-value for the difference test is presented. Standard errors are corrected for heteroscedasticity and clustering at the firm level and presented in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	RISK			IMPUTED_Q
	TOTAL	SYSTEMATIC	IDIOSYNCRATIC	
	1	2	3	4
Panel A. Partitions Based on Market-to-Book Assets				
High	−8.484***	−4.756***	−7.055***	−0.200**
	(0.700)	(0.358)	(0.649)	(0.087)
Low	−6.206***	−2.878***	−5.468***	−0.124
	(0.780)	(0.389)	(0.715)	(0.079)
p-Value (Diff.)	0.032	0.000	0.100	0.513
Panel B. Partitions Based on R&D				
High	−10.514***	−5.639***	−8.805***	−0.319***
	(1.360)	(0.647)	(1.230)	(0.095)
Low	−4.042***	−1.746***	−3.558***	0.015
	(1.143)	(0.487)	(1.051)	(0.068)
p-Value (Diff.)	0.000	0.000	0.001	0.004
Panel C. Partitions Based on E-Index				
High	−9.002***	−4.171***	−7.479***	−0.408***
	(0.947)	(0.448)	(0.803)	(0.095)
Low	−6.873***	−3.967***	−5.573***	−0.189**
	(0.822)	(0.378)	(0.696)	(0.087)
p-Value (Diff.)	0.062	0.722	0.064	0.086

change in the volume of these investments undertaken by treated firms following FAS 123R. These results are broadly in line with Hayes et al. (2012), who show that decreases in compensation vega do not significantly affect investment policies, such as R&D and capital expenditures. However, Hayes et al. (2012) interpret these results as evidence of the failure of option convexity to provide managers with risk-taking incentives. In contrast, we interpret them merely as evidence that the *level*, rather than the riskiness, of different investment types has not been affected by the reduction in compensation vega. Changes in risk may not be facilitated through changes in M&A, R&D, and Capex levels, and it may therefore not be possible to infer the changes in risk by examining investment changes. Similarly, Mao and Zhang (2018), who study the impact of FAS 123R on firm innovation, find that reduction in compensation convexity brought on by the reform does not affect R&D input, but, nonetheless, R&D output becomes less risky. By the same token, we find that post-FAS 123R firms maintain similar *levels* of different investments, but opt for safer ones. Using conventional stock return volatility measure to proxy for risk as in Hayes et al. (2012) does not allow to uncover changes in the riskiness of the underlying firm's business portfolio, while our segment-based risk proxy allows us to capture such changes.

in Appendix IB.10 of the Supplementary Material and are qualitatively similar to those in the main models using OLS specifications.

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TABLE 11

Channels of Managerial Risk-Taking

Table 11 presents the difference-in-difference ordinary least squares results for the impact of FAS 123R on firm investment activities and business composition. The sample period is between 1999 and 2011, excluding 2005 – the year of FAS 123R adoption. POST is a dummy variable that indicates the period after FAS 123R (2006–2011). TREATED is a dummy variable set to 1 for the treated firms, and 0 for the control firms. Firms with above (below) median OPTION_EXPENSING_IMPACT are defined as treated (control) firms. Firm- and CEO-level independent variables are lagged one period. Variable definitions can be found in the Appendix. Each column includes year and 2-digit SIC code dummies. Standard errors are corrected for heteroscedasticity and clustering at the firm level and presented in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	M&A	R&D	CAPEX	ln(SEGMENTS)	ln(NEW_ SEGMENTS)	ln (CLOSED_ SEGMENTS)	CHANGE_ IN_FOCUS	CASH
	1	2	3	4	5	6	7	8
POST × TREATED	0.002	0.002	−0.004	−0.021	0.015**	0.017**	0.015*	−0.021*
	(0.005)	(0.004)	(0.003)	(0.023)	(0.007)	(0.009)	(0.008)	(0.013)
TREATED	0.000	0.026***	0.009***	−0.026	−0.012*	−0.006	−0.011	0.076***
	(0.005)	(0.004)	(0.003)	(0.026)	(0.007)	(0.007)	(0.007)	(0.012)
ln(ASSETS)	0.001	−0.009***	−0.004***	0.050***	0.009***	0.010***	0.003	−0.038***
	(0.001)	(0.002)	(0.001)	(0.009)	(0.002)	(0.002)	(0.002)	(0.004)
ln(FIRM_AGE)	−0.006**	0.002	−0.005***	0.113***	0.010***	0.022***	0.009**	−0.029***
	(0.003)	(0.002)	(0.001)	(0.017)	(0.004)	(0.004)	(0.004)	(0.007)
ROA	0.008	−0.058***	0.015***	−0.030**	−0.020**	−0.037***	−0.300***	−0.048
	(0.008)	(0.020)	(0.002)	(0.015)	(0.010)	(0.013)	(0.015)	(0.038)
MARKET_TO_BOOK_ ASSETS	0.004***	0.006***	0.005***	−0.001	−0.000	−0.001	−0.002*	0.038***
	(0.001)	(0.001)	(0.001)	(0.003)	(0.001)	(0.001)	(0.001)	(0.005)
LEVERAGE	−0.020**	−0.027***	−0.073***	−0.021	−0.020	−0.016	−0.029*	−0.246***
	(0.009)	(0.010)	(0.007)	(0.071)	(0.017)	(0.018)	(0.017)	(0.033)
CASH	0.022***	0.034***	−0.012***	−0.073***	−0.014**	−0.015**	−0.009	
	(0.007)	(0.006)	(0.003)	(0.020)	(0.006)	(0.007)	(0.008)	
PP&E	−0.000	−0.034***	0.152***	−0.084	−0.023*	−0.034***	−0.025*	−0.197***
	(0.008)	(0.008)	(0.008)	(0.052)	(0.012)	(0.013)	(0.014)	(0.023)
ln(CEO_AGE)	−0.034***	−0.026**	−0.019***	0.102	0.026	0.022	0.016	−0.078***
	(0.011)	(0.011)	(0.007)	(0.063)	(0.016)	(0.017)	(0.017)	(0.034)
ln(CEO_TENURE)	0.000	0.001	0.002**	−0.005	−0.005**	−0.004	−0.006**	0.01**
	(0.002)	(0.002)	(0.001)	(0.009)	(0.002)	(0.003)	(0.003)	(0.005)
M&A_LIQUIDITY	0.443***							
	(0.071)							
Constant	0.204***	0.152***	0.133***	−0.599**	−0.087	−0.150**	0.008	0.746***
	(0.047)	(0.043)	(0.029)	(0.290)	(0.066)	(0.071)	(0.084)	(0.133)
No. of obs.	8,191	8,191	8,191	8,191	7,566	7,566	6,815	8,191
Adj. R^2	0.061	0.454	0.573	0.207	0.057	0.033	0.030	0.404

To understand further the channels of the reduction in firm's risk, we examine changes in the structure of a firm's business portfolio. When a firm is viewed as a portfolio of operating segments, as we do to compute the imputed measures of firm risk, it can adjust risk by changing the weights of the segments in the total portfolio or by adding and removing segments altogether, thus rebalancing the entire business portfolio. Column 4 of Table 11 shows that the reduction in compensation vega due to FAS 123R does not affect the total number of segments that the firm operates in. However, positive DiD estimates in columns 5–7 indicate that treated firms open new segments and close the existing ones more frequently and are more likely to change the focus of their principal business segment. We also examine the effect on cash holdings in column 8 to rule out the possibility that lower risk after FAS 123R can be attributed to increased cash balances. Contrary to this conjecture, our evidence suggests that treated firms start running down their cash balances when option convexity decreases, likely to support their restructuring activities.

Overall, our conclusion is that decreases in risk of the treated firms found in Section IV.D.2 are likely caused by CEOs of these firms spending their efforts on actively adjusting firms' business structure in response to reduced risk-taking incentives after FAS 123R and, hence, "playing it safe." Although treated firms do not expand or shrink their firm's business portfolio, they are more likely to restructure themselves by investing into new lines of business, divesting the old ones, or by refocusing themselves toward segments with lower risk.

V. Conclusion

In this article, we examine the impact of an exogenously-induced reduction in option compensation and convexity on managerial risk-taking behavior and long-term firm investment efficiency. We use a segment-based measure of risk that better captures changes in risk induced by managers and a DiD design based on FAS 123R regulation as a negative shock to managerial risk-taking incentives from compensation. Following FAS 123R, which led to cuts in CEO option pay and compensation convexity, we find a significant decline in firm risk for firms ex ante more likely to be affected by the reform. Our evidence also shows that the decline in risk is facilitated by active rebalancing of a firm's business portfolio toward less risky, but lower-Q, segments, while the overall levels of investment remain unchanged. We conclude that reduction in managerial risk-taking incentives caused by FAS 123R exacerbated managerial risk-avoidance problem and was harmful to shareholders' value. Our findings provide empirical support for the importance of managerial extrinsic motivation derived from option compensation and cast doubt on the arguments that stock options fail to incite managerial risk-taking and can be effectively substituted by other forms of pay (Hayes et al. (2012)).

While our results highlight the importance of option convexity in mitigating risk-related agency problem, we do not speak to whether expensing options at intrinsic or fair value is the right accounting choice. What our results do suggest is that firms appear to view pro-forma cost savings from reduced option expense after FAS 123R as taking priority over providing managers with appropriate risk-taking incentives. When designing compensation regulations, policy-makers need to bear in mind this undue focus of firms on the accounting cost of options rather than on their effectiveness as incentive mechanisms.

Appendix

This Appendix includes our analysis variables' names, how they are constructed, and the details of the CRSP/Compustat/ExecuComp mnemonics of the data items used to calculate the variables.

Compensation Measures

SALARY: Dollar value of CEO basic salary (salary).

BONUS: Dollar value of CEO bonus (bonus and nobus + non_eq_tarq using old and new ExecuComp tables format).

OPTION: Dollar value of CEO option rewards. The calculation of CEO option rewards follows Hayes et al. (2012) and is defined consistently following the change in reporting format in ExecuComp.

RESTRICTED_STOCK: Dollar value of CEO-restricted stock. The calculation of CEO-restricted stock follows Hayes et al. (2012) and is defined consistently following the change in reporting format in ExecuComp.

LTIAS: Dollar value of CEO long-term incentive awards. The calculation of CEO long-term incentive awards follows Hayes et al. (2012) and is defined consistently following the change in reporting format in ExecuComp.

TOTAL_COMPENSATION: Sum of SALARY, BONUS, OPTION, RESTRICTED_STOCK, and LTIAs

TOTAL_COMPENSATION2: TOTAL_COMPENSATION plus all other compensation (othcomp).

%_SALARY: Dollar value of SALARY scaled by TOTAL_COMPENSATION.

%_BONUS: Dollar value of BONUS scaled by TOTAL_COMPENSATION.

%_OPTIONS: Dollar value of OPTIONS scaled by TOTAL_COMPENSATION.

%_RESTRICTED_STOCK: Dollar value of RESTRICTED_STOCK scaled by TOTAL_COMPENSATION.

%_LTIAS: Dollar value of LTIAs scaled by TOTAL_COMPENSATION.

CURRENT_VEGA: Dollar change in the value of the CEO's option holdings granted in the current year for a 0.01 unit change in annualized stock return volatility of the company stock, constructed following Core and Guay (1999) and Hayes et al. (2012).

TOTAL_VEGA: Dollar change in the value of the CEO's total option holdings for a 0.01 unit change in annualized stock return volatility of the company stock, constructed following Core and Guay (1999) and Hayes et al. (2012).

CURRENT_DELTA: Dollar change in the value of the CEO's equity holdings granted in the current year for a 1% increase in stock price. The definition of current delta follows Hayes et al. (2012) as (Black–Scholes delta of all current option grants + number of shares of current restricted stock grants + number of targeted shares granted under LTIA) × (fiscal year-end price × 0.01). In thousands of U.S. dollars.

TOTAL_DELTA: Dollar change in the value of the CEO's total equity holdings for a 1% increase in stock price. The definition of total delta follows Hayes et al. (2012) as (CURRENT_DELTA + Black–Scholes delta of all prior option grants + number of prior shares of restricted stock + number of prior shares granted under LTIA) × (fiscal year-end price × 0.01). In thousands of U.S. dollars.

PERFORMANCE_VESTING: Dummy variable equal to 1 for firms that grant any compensation in the form of performance-vesting equity in a given year according to INCENTIVE_LAB, and 0 otherwise.

UNOBSERVABLE_COMPENSATION: Residual compensation computed from the first-stage regressions in columns 1 and 5 of Table 9.

OPTION_EXPENSING_IMPACT: Implied option expense (XINTOPT) divided by the number of common shares used by the company to calculate diluted earnings per share (CSHFD), computed as an average over the pre-FAS 123R period (1999–2004).

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TREATED: Dummy variable equal to 1 if the firm's average OPTION_EXPENSING_IMPACT in the pre-FAS 123R period is above the median OPTION_EXPENSING_IMPACT of all sample firms in the pre-FAS 123R period, and 0 otherwise.

Risk and Tobin Q Measures

TOTAL_RISK: Imputed measure of risk as in Aretz et al. (2019). Standard deviation of returns of a portfolio that mimics firm's industry composition.

SYSTEMATIC_RISK: Imputed measure of systematic risk as in Aretz et al. (2019). The square root of the explained variance in the regression of a firm's imputed returns at the end of each year on the Fama and French (1993) factors.

IDIOSYNCRATIC_RISK: Imputed measure of idiosyncratic risk as in Aretz et al. (2019). The square root of the unexplained variance in the regression of a firm's imputed returns at the end of each year on the Fama and French (1993) factors.

IMPUTED_Q: Imputed Tobin's Q as in Aretz et al. (2019). Value-weighted average Tobin's Q across a firm's business segments. Segment weights are computed using the current fiscal-year-end book values of assets and a segment's Q is computed as the value-weighted average of Tobin's Q of all single-segment firms operating in a segment's industry. Tobin's Q is total assets (AT) minus book value of equity (CEQ) plus the market value of equity (CSHO × PRCC_F) minus deferred taxes (TXDC) scaled by book value of total assets (AT).

Investment and Business Composition Measures

M&A: Sum of M&A deal transaction value paid by a given firm in a given year divided by the previous year book value of total assets (AT).

R&D: Maximum of zero or research and development expenditure (XRD) scaled by previous year book value of total assets (AT).

CAPEX: Capital expenditure (CAPX) scaled by previous year book value of total assets (AT).

ln(SEGMENTS): Natural logarithm of the number of business segments the firm owns at fiscal year-end.

ln(NEW_SEGMENTS): Natural logarithm of the number of new segments opened in the current fiscal year plus one.

ln(CLOSED_SEGMENTS): Natural logarithm of the number of segments closed in the current fiscal year plus one.

CHANGE_IN_FOCUS: Dummy variable equal to 1 if the largest segment by sales changes its 4-digit SIC code over the fiscal year, and 0 otherwise.

Other Firm and CEO Characteristics

ln(ASSETS): Natural logarithm of book value of total assets (AT).

ln(FIRM_AGE): Natural logarithm of the number of years the firm has records in Compustat plus one.

ROA: Net income (NI) scaled by previous year book value of total asset (AT).

MARKET_TO_BOOK_ASSETS: Ratio of market value of assets scaled by book value of total assets (AT), where market value of assets is liabilities (LT) minus deferred taxes (TXDC) and investment tax credit (TXDITC) plus preferred stock (PSTKL/PSTKRV/PSTK) plus common shares outstanding (CSHO) times fiscal year-end price (PRCC_F).

SALES_GROWTH: The year-on-year change in sales (SALE).

LEVERAGE: Book value of debt (DLTT + DLC) scaled by market value of assets.

CASH: Value of cash and short-term investments (CHE) scaled by book value of total assets (AT).

PP&E: Net property, plant, and equipment (PPENT) to previous year book value of total assets (AT).

ln(CEO_AGE): Natural logarithm of age of CEO documented in ExecuComp.

ln(CEO_TENURE): Natural logarithm of the number of years CEO has worked in the company plus one.

M&A_LIQUIDITY: Sum of M&A deal transaction value made by all firms in the same 2-digit SIC code industry each year scaled by the sum of total book value of assets (AT) each year by all firms in the same industry.

E_INDEX: Entrenchment index. Constructed using 6 anti-takeover provisions: staggered boards, limits to shareholder bylaw amendments, poison pills, golden parachutes, and supermajority requirements for mergers and charter amendment as in Bebchuk, Cohen, and Derrel (2009).

Supplementary Material

To view supplementary material for this article, please visit http://doi.org/10.1017/S0022109023000017.

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