The Differential Impact of Executive Stock Options on Systematic and Idiosyncratic Risk: Evidence From Quasi-Experiment

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I investigate whether CEO stock options differentially affect the firm's systematic and idiosyncratic risk. To examine a causal effect of option compensation on the firm's systematic and idiosyncratic risk, I exploit the passage of Financial Accounting Standard no. 123R as an exogenous shock to CEO option compensation. According to the Capital Asset Pricing Model (CAPM), only systematic risk is priced since investors can eliminate idiosyncratic risk through diversification. Unlike risk-neutral shareholders, risk-averse CEOs have limited ability to eliminate idiosyncratic (or firm-specific) risk because since they usually hold large positions in their firms and are often prohibited from hedging the firm-specific risk associated with their compensation. Thus, idiosyncratic risk is unwanted by under-diversified CEOs. Consistent with this idea, I find that, although CEO option compensation is positively associated with the total risk, it is negatively associated with the ratio of idiosyncratic to total risk.

Keywords: executive compensation, executive stock options, equity incentives, risk-taking incentives, systematic and idiosyncratic risk

INTRODUCTION

This paper exploits the passage of Financial Accounting Standard no 123R (hereafter FAS 123R) to provide evidence on how executive stock options differentially affect a firm's systematic and idiosyncratic risk. The impact of executive stock options on risk-taking has been extensively studied. Early studies generally find a positive relation between stock options and risk-taking (e.g., Agrawal and Mandelker 1987, Guay 1999; Coles, Daniel, and Naveen 2006; Chava and Purnanandam 2010). The prediction that stock options induce risk-taking flows from the value of an option increasing with the underlying stock's volatility. However, because managers are under-diversified, the relationship between managerial stock options and risk preferences is not straightforward. Lambert, Larcker, and Verrecchia (1991), among others (e.g., Carpenter 2000; Ross 2004), show that a *risk-averse* manager who *cannot* diversify the risk associated with the options' payoff may not prefer an increase in the firm's total risk. If risk-aversion dominates the risk-taking incentives, stock options will lead to decreased risk-taking. Supporting this argument, subsequent studies (e.g., Bettis, Bizjak, and Lemmon 2005; Lewellen 2006; Milidonis and Stathopoulos 2014) find a negative relation between stock options and risk-taking.

These studies focus on the firm's *total* risk. However, managers may perceive *systematic* and *idiosyncratic* risk differently than diversified shareholders. According to the Capital Asset Pricing Model (hereafter CAPM), only systematic risk is priced by the market since investors can diversify away idiosyncratic risk. However, managers have limited ability to eliminate idiosyncratic (or firm-specific) risk since they hold large shares of stock in their firms and are often prohibited from hedging firm-specific risk. Bettis, Bizjak, and Kalpathy (2015) identified just 2,042 hedging transactions by executives over year 1996 to 2006. Consistent with infrequent use of derivatives, Jin (2002), Tian (2004), Henderson (2005), and Archarya and Bisin (2009) assume in their theoretical models that executives are allowed to hedge systematic risk, but not firm-specific risk.Thus, idiosyncratic risk, which goes "unrewarded", is unwanted by under-diversified managers. In contrast, systematic risk (beta) is rewarded via higher expected returns. Further, managers' can hedge any unwanted portion of systematic risk by trading the market portfolio. A potential explanation for the mixed evidence in the above literature on the relationship between option-based compensation and the manager's risk-taking behavior is that the literature focuses on total risk, when stock options have differential effects on systematic and idiosyncratic risk.

Tian (2004) numerically demonstrates that stock options provide incentives to increase (decrease) systematic (unsystematic) risk. In contrast, Armstrong and Vashishtha (2012) show that vega – a widely used measure of risk-taking incentives – provides managers with incentives to increase the *level* of both systematic and idiosyncratic risk, and thus total risk. However, Armstrong and Vashishtha (2012) show that the increase in total risk will be primarily achieved by the increase in systematic risk. These mixed predictions about the relationship between stock options and idiosyncratic risk are due to the differing assumptions these paper make about unobservable factors, e.g., utility functions, outside wealth.

For example, Tian (2004) sets the level of total risk fixed, whereas Armstrong and Vashishtha (2012) allow it to vary. In addition, the parameters used in Tian (2004) are: the market portfolio's volatility (σ_{sys}) is 20%, the firm's idiosyncratic volatility is 22%, and its beta (β) is 1. In contrast, in Armstrong and Vashishtha (2012), the market portfolio's volatility (σ_{sys}) is 20%, the firm's idiosyncratic volatility is 30%, and its beta (β) is 1.5. In addition, Tian (2004) takes the partial derivative of the subjective value of the CEO's portfolio with respect to either the systematic or idiosyncratic volatility, whereas Armstrong and Vashishtha (2012) calculate the percentage change in the subjective value for a 5% point change in either the systematic or idiosyncratic volatility. Moreover, Tian (2004) does not incorporate restricted stock in the manager's portfolio, but Armstrong and Vashishtha (2012) do.

Another issue is that some studies (e.g., Goyal and Santa-Clara 2003; Ang, Hodrick, Xing, and Zhang 2006; Ang, Hodrick, Xing, and Zhang 2009; Fu 2009) provide empirical evidence that idiosyncratic risk is priced. While idiosyncratic risk should not be priced in a complete market, in the presence of market frictions amid incomplete information, idiosyncratic risk may be priced (e.g., Merton 1987). These findings will make the predicted relationship between executive stock options and the two components of total risk unclear, suggesting that providing empirical evidence is important.

In addition to the mixed theoretical predictions, Armstrong and Vashishtha (2012) find a divergence between their theoretical predictions and empirical observations. While they predict that vega creates incentives to increase idiosyncratic risk, empirically they do not find a relation between vega and idiosyncratic risk. This disagreement between their theoretical prediction and empirical finding may be due to executive compensation and executive risk-taking being endogenously determined. First, executive compensation and risk-taking decisions are likely to be made simultaneously. That is, the risk environment of the firm affects the compensation contract, and the manager's compensation contract affects his or her risk-taking behavior. Second, there exist unobservable determinants for both executive compensation and risk-taking. For example, a CEO's risk aversion affects his/her risk-taking AND the firm s/he chooses to join (Oyer and Schaefer 2005). A risk-averse CEO may self-select into a less risky firm and, at the same time, choose to receive fewer stock options. In this case, I will find a positive relation between stock option compensation and firm risk, one which does not suggest causality, but merely but reflects the CEO's attitudes towards risk. This potential endogeneity problem makes it difficult to establish causality.

To address endogeneity, I exploit the mandated change in accounting for Share-based Payments, i.e., FAS 123R, as an exogenous shock. This will allow us to provide evidence on the causal effect of option-based pay on systematic and idiosyncratic risk. Prior to the mandated adoption of FAS 123R, almost all firms expensed stock options at their *intrinsic* value as allowed under predecessor accounting standards, e.g., Financial Accounting Standard No. 123. Given most firms granted stock options at-the-money, which meant that at grant date the options had zero intrinsic value, firms generally reported no expense associated with the grants prior to FAS 123R. FAS 123R required firms expense stock options using their grant date *fair value*. As shown by prior studies, e.g., Brown and Lee 2011; Hayes, Lemmon, and Qui 2012, FAS 123R caused firm to reduce their use of option compensation, replacing it with share grants. This shock to CEO option compensation creates an opportunity to investigate the *causal* effects of executive stock options on risk-taking.

I employ a difference-in-differences (hereafter DiD) design that compares the changes in systematic risk and idiosyncratic risk of firms that were, *ex ante*, more likely to decrease option compensation after the adoption of FAS 123R (treatment group) to those of firms that were, *ex ante*, less likely to decrease option compensation (control group). I show that the *levels* of total, systematic, and idiosyncratic risk of firms that were, *ex ante*, more likely to reduce option-based compensation decreased after the implementation of FAS 123R. This indicates a positive relationship between stock options and the *levels* of total, systematic, and idiosyncratic risk. However, for those firms, the *level* of systematic risk decreased more than the *level* of idiosyncratic risk. As a result, the *proportion* of systematic risk over total risk for firms that were expected to reduce relatively more option-based compensation decreased more (i.e., positive relationship between option-based compensation and the proportion of systematic risk). My findings suggest that, although stock options create incentives to increase the *levels* of both systematic and idiosyncratic risk (and thus total risk), stock options have a greater positive impact on systematic than on idiosyncratic risk. This is consistent with the idea that options incentivizes CEOs to pursue projects that increase systematic risk relative to idiosyncratic risk (Acharya and Bisin 2009; Armstrong and Vashishtha 2012).

This paper continues with Section 2, in which I develop hypotheses. Section 3 describes data and variable measurement. Section 4 discuss empirical analysis and Section 5 concludes.

HYPOTHESES DEVELOPMENT

Tian (2004) numerically demonstrates that stock options create incentives to reduce idiosyncratic risk. Because unrestricted investors can eliminate idiosyncratic risk through diversification, idiosyncratic risk is not priced. Thus, any increase in idiosyncratic risk will increase the risk of executives' portfolio without increasing the expected return. In contrast, increases in systematic risk increase the firm's expected return. Furthermore, a CEO can hedge any unwanted portion of the firm's systematic risk by trading the market portfolio. Tian (2004) shows that his result holds for the most range of the parameters.

Armstrong and Vashishtha (2012) not only *numerically*, but also *empirically* investigate the effects of vega on systematic and idiosyncratic risk. Their numerical analysis shows that vega is positively associated with systematic risk, consistent with Tian (2004). In contrast to Tian (2004), they predict that vega positively affects not only systematic risk but also idiosyncratic risk. However, they predict that a *larger portion* of the increase in total risk caused by vega will come from an increase in systematic risk rather than idiosyncratic risk. In their *empirical* analysis, they document the positive relation between vega and the level of systematic risk, consistent with their predictions, but do not find a relation between vega and the level of idiosyncratic risk, in contrast to their prediction.

To summarize, Tian (2004) and Armstrong and Vashishtha (2012) both support the idea that vega provides managers incentive to increase the level of systematic risk. Thus, my first hypothesis is:

H1: *Executive stock options create incentives to increase systematic risk.*

Tian (2004) and Armstrong and Vashishtha (2012) provide mixed predictions about the relationship between vega and idiosyncratic risk, a difference that is potentially due to differences in model and parameter choices. Further, confounding the issue, contradicting the argument that only systematic risk is priced, recent studies (e.g., Goyal and Santa-Clara 2003; Ang, Hodrick, Xing, and Zhang 2006; Ang, Hodrick, Xing, and Zhang 2009; Fu 2009) provide empirical evidence that idiosyncratic risk is also priced. Thus, the relation between stock options and idiosyncratic risk remains an empirical question. I state my second hypothesis in null form rather than make a directional prediction.

H2: *Executive stock options do not create incentives to increase idiosyncratic risk.*

DATA AND VARIABLE MEASUREMENT

Sample

I obtain data on executive compensation from Standard & Poor's (S&P's) Execucomp, financial statement information from S&P's Compustat Fundamental Annual, and stock market-related data from the Center for Research in Security Prices (CRSP). Following prior literature, I exclude regulated firms, i.e., finance (SIC codes 6000-6999) and utilities (SIC codes 4400-5000). My sample covers the period 2003 to 2007. I define the fiscal year 2006 as the beginning of the post-FAS123R period and exclude fiscal 2005 as it is a transitory year for FAS 123R, i.e., post promulgation but pre mandatory adoption date. FAS 123R was passed in March of 2004 and effective for fiscal years beginning after June 15, 2005.Since I employ a DiD research design, I require that all sample firms have at least one year of data in both the pre- and post-FAS 123R periods. My main sample consists of 2,623 CEO-years.

Systematic and Idiosyncratic Risk

I decompose total risk into systematic and idiosyncratic using the market model (Eq. (1)). $r_{i,d}$ is the daily stock return for firm *i*, and $r_{mkt,d}$ is the daily CRSP equal-weighted market return for day *d*. Systematic risk is calculated as the market beta multiplied by the annualized standard deviation of market returns, and idiosyncratic risk is the annualized standard deviation of the error term.

$$r_{i,d} = \alpha_i + \beta_i \, r_{mkt,d} + \varepsilon_i \qquad (1)$$

EMPIRICAL ANALYSIS

Descriptive Statistics

I define the expected cost, i.e., increase in expense recognized, associated with adoption of FAS 123R as the average of the pro forma per share option expense the company reported in 2003-2004 (following Hayes, Lemmon, and Qiu 2012). FAS 123 recommended that firms recognize the cost of their option grants using grant date fair values, which few firms did, AND mandated footnote disclosure of the impact of using grant date fair value on option expense and income, i.e., pro-forma disclosures.This variable measures the amount by which earnings per share would be reduced if the expense associated with option compensation was determined using grant date fair value. I define *H_ACCT_Impact* as one if the firm's average pro forma option expense is above the sample median in the pre-FAS 123R period (treatment group), and zero otherwise (control group). *H_ACCT_Impact* firms are expected to have a greater accounting impact post-FAS 123R and consequently, are expected to reduce option compensation relatively more than the control group.

TABLE 1
DESCRIPTIVE STATISTICS BY *H_ACCT_IMPACT* IN THE PRE-FAS 123R PERIOD

	L_Acct_Impact (a) Mean	H_Acct_Impact (b) Mean	Difference (b) - (a)	
Total_risk	0.021	0.025	0.004	***
Idiosync_risk	0.019	0.022	0.003	***
System_risk	0.009	0.012	0.002	***
Idiosync/Total_risk	0.880	0.869	-0.010	
σNI	0.039	0.065	0.026	***
MVE	7.595	7.638	0.044	*

Annret	0.336	0.338	0.002	
ROA	0.051	0.048	-0.004	
dNI	1.696	2.294	0.597	
BTM	0.463	0.388	-0.075	***
Lev	0.545	0.432	-0.113	***
BigN	0.968	0.972	0.003	
Instown	0.688	0.763	0.075	***
HHI	0.074	0.060	-0.014	**
Free_CF	0.051	0.032	-0.019	***
R&D	0.014	0.050	0.036	***
PP&E	0.283	0.218	-0.066	***
CEO_Age	4.023	4.002	-0.021	
CEO_Tenure	1.710	1.833	0.124	***
CEO_Shrown	0.025	0.022	-0.003	**
Duality	0.608	0.596	-0.011	
Male	0.986	0.984	-0.003	
N	663	669		

I define *H_ACCT_Impact* as one if the firm's average pro forma option expense is above the sample median in the pre-FAS 123R period (treatment group), and zero otherwise (control group). *H_ACCT_Impact* firms are expected to have a greater accounting impact in the post-FAS 123R period and, thus, reduce option-based compensation more than the control group. My sample is constructed from the intersection of Execucomp (compensation), Compustat (accounting data), CRSP (stock price data), and Thomson Reuters Institutional (13f) Holdings (institutional ownership). ***, **, and * denote statistical significance for the two-sample t-test at the 0.01, 0.05, and 0.10 levels (two-tail), respectively.

Table 1 presents descriptive statistics for the treatment and control groups pre-FAS 123R. The descriptive statistics show that *H_ACCT_Impact* firms differ from *L_ACCT_Impact* firms along many dimensions, in particular risk. *H_ACCT_Impact* firms' total risk, idiosyncratic risk, and systematic risk are higher. This is consistent with, but not casual evidence of, stock options leading to greater risk-taking. Additionally, *H_ACCT_Impact* firms have a lower book-to-market ratio and higher R&D expenditures. This is consistent with the idea that firms with greater growth opportunities and R&D intensive firms encouraging CEOs to take greater risk by providing more option-based compensation. *H_ACCT_Impact* firms have a higher level of institutional ownership, consistent with institutional investors playing a monitoring role to mitigate the agency problem between shareholders and managers by providing more equity compensation (Hartzell and Starks 2003). *H_ACCT_Impact* firms also have lower free cash flows. Yermack (1995), Matsunaga (1995), and Dechow, Huttion, and Sloan (1996) find that the use of stock options is greater when firms have lower free cash flow.

Difference-in-Differences Analysis

I employ a DiD design that compares the changes in systematic risk and idiosyncratic risk of firms that were, ex ante, more likely to reduce option-based compensation after the adoption of FAS 123R (treatment group) to those of firms that were, ex ante, less likely to reduce option-based compensation (control group). Importantly, this shock to CEO option-based compensation is not likely to directly influence the firm's risk-taking environment other than via risk-taking incentives. Thus, the adoption of FAS 123R provides a quasi-natural experiment setting for testing the causal effect of option compensation on CEO risk-taking.

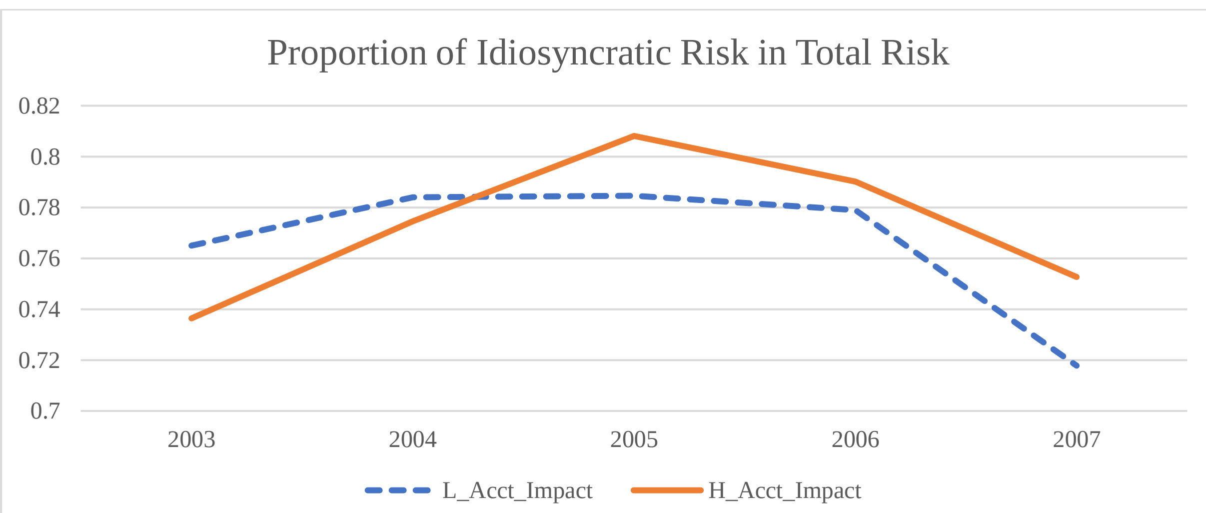
The regression models take the following form:

$$Risk_{i,t+1} = \alpha_{\mathbf{0}} + \alpha_1 H\_Acct\_Impact * Post + \alpha_2 Post + \boldsymbol{\beta Controls}_{i,t} + FirmFE + Time\ FE + \varepsilon_{it} \qquad (2)$$

Risk is alternatively total risk, idiosyncratic risk, systematic risk, or idiosyncratic risk divided by the total risk. *POST* is one if *Year* is in (2006, 2007), and zero if *Year* is in (2003, 2004). As noted above, I exclude fiscal 2005 as it is a transitory year for FAS 123R. Since I include firm-fixed effects, I omit *H_Acct_Impact* main effect to avoid model overspecification. *Controls* is a vector of control variables that have been used by prior literature to explain firm risk (e.g., Guay 1999; Lewellen 2006; Coles et al. 2006; Armstrong and Vashishtha 2012): standard deviation of net income (σNI), firm size (*MVE*), past stock performance (*Annret*), past accounting performance (*ROA*), change in net income (ΔNI), growth opportunities (*BM*), financial leverage (*Leverage*), big N (*BigN*), institutional investor ownership (*Instown*), Herfindahl-Hirschman Index (*HHI*), free cashflows (*Free_cf*), R&D expenditures (*R&D*), *PP&E*, CEO age (*Age*), CEO tenure (Tenure), CEO share ownership (*Shrown*), CEO duality (*Dual*), CEO gender (*Male*). All independent variables are lagged by one year, and winsorized at the 1 and 99 percent levels. I also include firm and year fixed effects to capture time variation and to control for unobserved time-invariant firm-level heterogeneity. My inferences are based on firm-level clustered standard errors.

An important assumption when using DiD is parallel trends, i.e., the validity of the DiD estimator requires that the trends in the outcome variable are the same for the treatment group and the control groups prior to the shock. I conduct two diagnostic checks on the parallel trend of the outcome variable as suggested by Roberts and Whited (2012). First, I compare the trends of *Idiosync/Total_risk* my risk-taking measures for *H_Acct_Impact* firms (treatment group) and *L_Acct_Impact* firms (control group). I find that the two trends almost overlap and move in parallel before FAS 123R (see Figure 1). The insignificant difference in the two-sample t-test for *Idiosync/Total_risk* variable between *H_Acct_Impact* group and *L_Acct_Impact* group in Table 1 confirms these parallel trends. Second, I conduct placebo tests by creating placebo events, which I will discuss in Section 4.3.

FIGURE 1
TREND OF THE PROPORTION OF IDIOSYNCRATIC RISK IN TOTAL FIRM RISK BY *H_ACCT_IMPACT*



This figure presents the trend of the proportion of idiosyncratic risk in total firm risk by *H_Acct_Impact* in the pre-FAS 123R period. I define *H_ACCT_Impact* as one if the firm's average pro forma option expense is above the sample median in the pre-FAS 123R period (treatment group), and zero otherwise (control group). *H_ACCT_Impact* firms are expected to have a greater accounting impact in the post-FAS 123R period and, thus, to reduce option-based compensation more than the control group.

TABLE 2
DIFFERENCE-IN-DIFFERENCES (DID) ANALYSIS

	(1) *Total_risk*	(2) *Idiosync_risk*	(3) *System_risk*	(4) *Idiosync/Total_risk*
*H Acct Impact*Post*	-0.00450***	-0.00310***	-0.00301***	0.0171***
Post	0.0219***	0.0141***	0.0168***	-0.133***
σNI	0.0256***	0.0214***	0.0130**	-0.0365
MVE	-0.00198*	-0.00280***	0.000352	-0.0190***
Annret	0.00183***	0.00171***	0.000828**	-0.00261
ROA	-0.0113**	-0.00863**	-0.00581	0.0204
ΔNI	-0.0000296	-0.0000170	-0.0000210	-0.0000263
BTM	0.00693***	0.00533**	0.00339**	0.00531
Lev	0.000865	0.00226	-0.00263	0.0369*
BigN	0.00227	0.00118	0.00238*	-0.0410***
Instown	-0.000660	0.00152	-0.00132	0.0571***
HHI	0.0357**	0.0233*	0.0219*	-0.0817
Free_CF	-0.00796*	-0.00737*	-0.00342	-0.0139
R&D	-0.0342**	-0.0301**	-0.0107	-0.0186
PP&E	0.00192	0.00267	0.00126	0.0152
CEO_Age	0.00128	0.000284	0.00219	-0.00581
CEO_Tenure	-0.0000146	-0.0000205	0.000127	-0.00131
CEO_Shrown	-0.00317	-0.00120	-0.00474	0.0541
Duality	0.000826	0.000547	0.000384	-0.00462
Male	-0.000431	-0.00138	0.000421	-0.0113
Intercept	0.0225	0.0315**	-0.00634	1.047***
Firm Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
N	2,623	2,623	2,623	2,623
Adj. R-sq	0.728	0.702	0.724	0.644

This table presents results from difference-in-differences (DiD) analysis that estimates the effects of FAS 123R on total risk, idiosyncratic risk, systematic risk, and the proportion of idiosyncratic risk in total risk. I define *H_ACCT_Impact* as one if the firm's average pro forma option expense is above the sample median in the pre-FAS 123R period (treatment group), and zero otherwise (control group). *H_ACCT_Impact* firms are expected to have a greater accounting impact in the post-FAS 123R period and, thus, reduce option-based compensation more than the control group. *Post* is one if year is in (2006, 2007) and zero if year is in (2003, 2004). I require that all sample firms have at least one year of data in both the pre- and post-FAS 123R periods. All dependent variables are measured in year *t+1* and all independent variables are measured in year *t*. All variables are winsorized at the 1 and 99 percent levels. All variables are as defined in Appendix A. All models include firm and year fixed effects and firm-level clustered standard errors are used. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively. t-values are reported in parentheses.

Since I employ DiD, the variable of interest in models (1) – (4) in Table 2 is the interaction term of *H_Acct_Impact* * *Post*. The negative coefficients on the interaction term in models (1) – (3) suggest that the *levels* of total, systematic, and idiosyncratic risk of firms that were, *ex ante*, more likely to reduce option-based compensation decreased relatively more than the control group after the implementation of FAS

123R. This indicates a *positive* relationship between stock options and the levels of total, systematic, and idiosyncratic risk. This is consistent with the prediction that vega is positively related to both systematic and idiosyncratic risk, as in Armstrong and Vashishtha (2012). However, the positive coefficient on the interaction term in model (4) indicates that the proportion of idiosyncratic risk in total risk of firms that were, *ex ante*, more likely to reduce option-based compensation increased relatively more than the control group after the implementation of FAS 123R. This suggests *negative* impact of option-based compensation on the proportion of idiosyncratic risk in total risk.

Combined together, my findings suggest that, although stock options create incentives to increase the levels of both systematic and idiosyncratic risk (and thus total risk), stock options have a greater positive impact on systematic than on idiosyncratic risk. This is consistent with the idea that option-based compensation incentivizes CEOs to pursue projects that increase systematic risk relative to idiosyncratic risk (Acharya and Bisin 2009; Armstrong and Vashishtha 2012).

Difference-in-differences Analysis: Placebo Tests

As I discussed in Section 4.2., another way to validify the parallel trend assumption suggested by Roberts and Whited (2012) is to conduct placebo tests by creating placebo events *before* and *after* the actual event. I examine whether each placebo event has similar effects on firm risk-taking as FAS 123R. Finding no effects of the placebo events on CEO risk-taking would validate my baseline results. I randomly chose 1999 as my placebo event *before* the actual event (Table 3) and 2011 as my placebo event *after* the actual event (Table 4). Similar to the baseline research design, I define the pre-event period as the prior two years before the event and the post-event period as the following two years after the event.

Table 3 reports the results for the placebo event of 1999, and Table 4 reports the results for the placebo event of 2011. In Table 3, the coefficient of the interaction term of *H_Acct_Impact* * *Post_placebo1* is significant only in model (3). The insignificant coefficients of the interaction term in models (1), (2), and (4) indicate this placebo event has no effects on the firms' other risk measures.

TABLE 3
DIFFERENCE-IN-DIFFERENCES (DID) ANALYSIS:
PLACEBO TEST – 1997-1998 VS. 2000-2001

	(1) *Total_risk*	(2) *Idiosync_risk*	(3) *System_risk*	(4) *Idiosync/Total_risk*
H_Acct_Impact Placebo1*	0.00123	0.000668	0.00125**	-0.00253
Placebo1	-0.000171	-0.00138**	0.00200***	-0.0533***
σNI	0.0308***	0.0248**	0.0155**	-0.0302
MVE	0.00146	0.000590	0.00176***	-0.0129***
Annret	0.00118**	0.00142***	-0.0000383	0.00598**
ROA	-0.0189***	-0.0166***	-0.00710**	-0.0125
ΔNI	-0.0000274	-0.0000210	-0.00000762	0.000141
BTM	0.00607***	0.00593***	0.00139	0.00932
Lev	0.00504	0.00500	-0.000178	0.0123
BigN	0.00227	0.00214	0.000460	-0.00389
Instown	-0.00384	-0.00329	-0.000229	0.0169
HHI	0.0236	0.0318*	-0.00542	0.153
Free_CF	-0.00320	-0.00330	0.000380	-0.00855
R&D	-0.0127	-0.00973	-0.00655	0.0452
PP&E	-0.0106**	-0.00755	-0.00808***	0.0130

CEO_Age	-0.00196	-0.00160	-0.00142	0.00736
CEO_Tenure	0.000756*	0.000651*	0.000492**	-0.000430
CEO_Shrown	-0.0120	-0.0115	-0.000362	-0.0372
Duality	-0.000649	-0.000581	-0.000270	-0.00319
Male	-0.00303	-0.00354	-0.0000322	-0.0289
Intercept	0.0261	0.0275*	0.00574	0.981***
Firm Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
N	2,389	2,389	2,389	2,389
Adj. R-sq	0.721	0.718	0.665	0.591

I define *H_ACCT_Impact* as one if the firm's average pro forma option expense is above the sample median in the placebo pre-FAS 123R period (treatment group), and zero otherwise (control group). *Post_placebo1* is one if year is in (2000, 2001) and zero if year is in (1997, 1998). I require that all sample firms have at least one year of data in both the placebo pre- and post-FAS 123R periods. All dependent variables are measured in year *t+1* and all independent variables are measured in year *t*. All variables are winsorized at the 1 and 99 percent levels. All variables are as defined in Appendix A. All models include firm and year fixed effects and firm-level clustered standard errors are used. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively. t-values are reported in parentheses.

In Table 4, the coefficient of the interaction term of *H_Acct_Impact* * *Post_placebo2* is positive in models (1), (2) and (3), suggesting that the *levels* of total, idiosyncratic and systematic risk of firms that were, ex ante, more likely to reduce option-based compensation increased relatively more than the control group after the placebo event. In other words, CEO option compensation has a negative impact on the *levels* of total, idiosyncratic and systematic risk. However, the insignificant coefficient of the interaction term in model (4) indicates this placebo event has no effects on the proportion of idiosyncratic risk in total risk.

TABLE 4
DIFFERENCE-IN-DIFFERENCES (DID) ANALYSIS:
PLACEBO TEST – 2009-2010 VS. 2012-2013

	(1) *Total_risk*	(2) *Idiosync_risk*	(3) *System_risk*	(4) *Idiosync/Total_risk*
H_Acct_Impact Placebo2*	0.00121***	0.000901***	0.000857***	0.00120
Placebo2	-0.00533***	-0.00221***	-0.00594***	0.0943***
σ*NI*	0.00228	0.00341	-0.00103	0.0721
MVE	-0.000239	-0.000443	0.000309	-0.00373
Annret	0.000939***	0.000373	0.00127***	-0.0137***
ROA	-0.0115***	-0.00902***	-0.00564***	0.00459
Δ*NI*	0.00000126	0.00000152	-0.00000215	0.0000375
BTM	0.00194**	0.00191**	0.000536	0.0118
Lev	0.00895***	0.00791***	0.00348**	0.0370
BigN	-0.00187	-0.00148	-0.00134	-0.000416
Instown	-0.000719	-0.00154	0.000864	-0.0345
HHI	0.00183	-0.00946	0.0148*	-0.344**
Free_CF	0.00130	-0.0000104	0.00320**	-0.0234
R&D	0.01000	0.0126	-0.00542	0.121

PP&E	0.00989***	0.00776***	0.00604**	0.0482
CEO_Age	0.000931	-0.000639	0.00169	-0.0443
CEO_Tenure	0.000196	0.000202	0.0000537	0.000179
CEO_Shrown	-0.00731	-0.00319	-0.00138	0.171*
Duality	-0.000483	-0.000407	-0.000259	0.00453
Male	-0.000667	-0.000178	-0.00105	0.0120
Intercept	0.0155	0.0196**	0.00193	0.962***
Firm Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
N	3,282	3,282	3,282	3,282
Adj. R-sq	0.783	0.776	0.767	0.747

I define *H_ACCT_Impact* as one if the firm's average vega is above the sample median in the placebo pre-FAS 123R period (treatment group), and zero otherwise (control group). *Post_placebo2* is one if year is in (2012, 2013) and zero if year is in (2009, 2010). I require that all sample firms have at least one year of data in both the placebo pre- and post-FAS 123R periods. All dependent variables are measured in year *t+1* and all independent variables are measured in year *t*. All variables are winsorized at the 1 and 99 percent levels. All variables are as defined in Appendix A. All models include firm and year fixed effects and firm-level clustered standard errors are used. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively. t-values are reported in parentheses.

Combined together, the results from both placebo tests suggest that the critical assumption on the parallel trend of the outcome variables, especially *Idiosync/Total risk*, is likely to hold. This provides validation on my baseline results that FAS 123R causes differential risk-taking behavior for treated and control groups.

CONCLUSIONS

In this paper, I exploit the passage of FAS 123R to provide evidence on how executive stock options differentially affect a firm's systematic and idiosyncratic risk. I use this accounting regulation change that removed the favorable accounting treatment of option-based compensation as an exogenous shock to CEO compensation.

Although the impact of executive stock options on risk-taking has been extensively studied, prior studies focus on the firm's *total* risk. However, managers may perceive *systematic* and *idiosyncratic* risk differently than diversified shareholders do. Even the studies that investigate the relation between option-based compensation and systematic and idiosyncratic risk differ in their predictions. Tian (2004) and Armstrong and Vashishtha (2012) both support the positive impact of stock options on *systematic* risk. Regarding the relationship between option-based compensation and idiosyncratic risk, Tian (2004) predicts negative relation between stock options and *idiosyncratic* risk. In contrast, Armstrong and Vashishtha (2012) predict a positive relationship. The mixed predictions in the literature about the relationship between stock options and idiosyncratic risk are potentially due to the difficulty of modeling the manager's utility function and the difficulty of establishing a causal relationship between executive stock options and managerial risk-taking in empirical studies.

Thus, providing new evidence on the causal relationship is meaningful. I show that the *levels* of total, systematic, and idiosyncratic risk of firms that were, ex ante, more likely to reduce option-based compensation decreased relatively more than firms that were, ex ante, less likely to reduce option-based compensation after the implementation of FAS 123R. This indicates a positive relationship between stock options and the *levels* of total, systematic, and idiosyncratic risk. This is consistent with the prediction that vega is positively related to both systematic and idiosyncratic risk, as in Armstrong and Vashishtha (2012). Interestingly, however, I show that option-based compensation is negatively associated with the *proportion* of idiosyncratic risk in total risk but positively associated with the *proportion* of systematic risk in total risk.

My findings suggest that, although stock options create incentives to increase both systematic and idiosyncratic risk (and thus total risk), stock options have a greater positive impact on systematic than on idiosyncratic risk. This is consistent with the idea that CEOs prefer projects that increase systematic risk more than idiosyncratic risk when they are given risk-taking incentives (Acharya and Bisin 2009; Armstrong and Vashishtha 2012). My findings are consistent with the idea that idiosyncratic risk is unwanted by under-diversified managers and systematic risk is preferred by CEOs since systematic risk is priced and CEOs can hedge systematic risk.

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APPENDIX: VARIABLE DEFINITIONS

Risk (dependent) variables	
Total_risk	Standard deviation of daily returns over the year.
Idiosync_risk	Market beta multiplied by the annualized standard deviation of market return.
System_risk	Annualized standard deviation of the error term in the market model.
Idiosync/Total_risk	*Idiosync_risk* divided by *Total_risk*.
Test variables	
H_Acct_Impact	One if the firm's average pro forma option expense is above the sample median in the pre-FAS 123R period (treatment group), and zero otherwise (control group)
Post	One if year is in (2006, 2007), and zero if year is in (2003, 2004).
Control variables	
σNI	Standard deviation of net income before extraordinary items over the prior five years ending in year *t*. Minimum of 3 observations required.
MVE	Natural logarithm of market value of equity.
Annret	Buy-and-hold annual return.
ROA	Net income before extraordinary items scaled by total assets.
ΔNI	Change in net income before extraordinary items divided by fiscal year-end stock price.
BTM	Book-to-market value of equity.
Leverage	Total liabilities divided by total assets.
BigN	An indicator for big N auditor.
Instown	The percentage of total intuitional ownership over common shares outstanding.
HHI	Herfindahl-Hirschman Index. Sum of the squares of the net sales of each firm in an industry.
Free_CF	Operating cash flow minus capital expenditures divided by market value of equity
R&D	Research and development expenses scaled by total assets.
PP&E	Net property, plant, and equipment scaled by total assets.
CEO_Age	Natural logarithm of one plus CEO age.
CEO_Tenure	Natural logarithm of one plus CEO tenure.

CEO_Shrown	The number of shares of the firm owned by the CEO divided by the total number of shares of the firm.
Duality	An indicator for CEO-Chairman duality.
Male	One if the CEO is male, zero otherwise.