Journal of Financial Economics 105 (2012) 174–190

Contents lists available at SciVerse ScienceDirect

Journal of Financial Economics

journal homepage: www.elsevier.com/locate/jfec

Stock options and managerial incentives for risk taking: Evidence from FAS 123R[☆]

Rachel M. Hayes, Michael Lemmon, Mingming Qiu*

University of Utah, Utah, United States

ARTICLE INFO

Article history:
Received 30 November 2010
Received in revised form
12 July 2011
Accepted 10 August 2011
Available online 30 January 2012

JEL classification:
G34
G38
M52

Keywords:
Compensation
Incentives
Risk taking
Corporate governance
FAS 123R

ABSTRACT

We provide new evidence on the relation between option-based compensation and risk-taking behavior by exploiting the change in the accounting treatment of stock options following the adoption of FAS 123R in 2005. The implementation of FAS 123R represents an exogenous change in the accounting benefits of stock options that has no effect on the economic costs and benefits of options for providing managerial incentives. Our results do not support the view that the convexity inherent in option-based compensation is used to reduce risk-related agency problems between managers and shareholders. We show that all firms dramatically reduce their usage of stock options (convexity) after the adoption of FAS 123R and that the decline in option use is strongly associated with a proxy for accounting costs. Little evidence exists that the decline in option usage following the accounting change results in less risky investment and financial policies.

1. Introduction

A significant literature examines how the incentives provided through compensation contracts affect managerial behavior. The standard principal-agent model (e.g., Holmstrom, 1979; Shavell, 1979) illustrates how shareholders must tie the manager's pay to firm performance to provide incentives for the manager to take actions that increase firm value. Using data from the 1970s and 1980s, Jensen and Murphy (1990) argue that the pay-performance sensitivity in managerial compensation contracts is too low to provide managers with significant incentives to act in the interest of shareholders. Hall and Liebman (1998) show that the pay-performance sensitivity in managerial compensation contracts increases significantly in the 1990s primarily due to a dramatic increase in the use of stock options.

Another strand of this literature examines the question of why firms use stock options as opposed to other forms of performance-based pay by focusing on the role that stock options potentially play in providing incentives for risk taking. For example, Amihud and Lev (1981) and Smith and Stulz (1985) note that because managers have significant human capital tied to the firm and are less diversified compared with outside shareholders, they could pass up risk-increasing positive net present value

[☆] We thank Hank Bessembinder, Alex Edmans, Todd Gormley, Narayan Naik, and Michael Roberts for helpful comments. We also thank participants at the 2011 European Winter Finance Conference and seminar participants at the University of Chicago, Norwegian School of Economics and Business Administration, Nanyang Technological University, Pennsylvania State University, Tulane University, Korea Business School, and the Wharton School at the University of Pennsylvania.

* Corresponding author. Tel.: +1 801 860 0968; fax: +1 801 581 3956.
E-mail addresses: rachel.hayes@business.utah.edu (R.M. Hayes), michael.lemmon@business.utah.edu (M. Lemmon), mingming.qiu@business.utah.edu (M. Qiu).

0304-405X/$ - see front matter
doi:10.1016/j.jfineco.2012.01.004

projects that would be beneficial to shareholders. Shareholders can potentially reduce this risk-related agency problem by structuring compensation to be a convex function of firm performance (e.g., through the use of stock options), which makes the manager's expected wealth an increasing function of volatility. Consistent with this view, Guay (1999) shows that the convexity of the manager's wealth-performance relation is positively related in the cross section to proxies for the demand for risk taking, such as measures of growth opportunities and research and development (R&D) expenditures. Coles, Daniel, and Naveen (2006) attempt to establish a causal relation between convexity and firm investment and financial policies, and they show that convexity in the manager's compensation contract is positively associated with R&D expenditures and firm leverage and negatively related to firm capital expenditures. Chava and Purnanandam (2010) also find that convexity is positively related to leverage and further show that convexity is negatively related to cash balances.

While the view that convexity can increase a manager's incentives to take risk is appealing, the theory is less definitive. As noted in Guay (1999), the incentives that options provide for increasing risk are positively related to the convexity of the option payoff, but they are negatively related to the risk premium required by the manager to hold the options. More formally, Lambert, Larcker, and Verrecchia (1991), Carpenter (2000), Hall and Murphy (2002), and Ross (2004) demonstrate that increasing the convexity of the manager's wealth-performance relation does not unambiguously increase the incentives for risk taking when the manager is risk-averse. Empirically, Lewellen (2006) attempts to directly account for the risk premium associated with the manager's stock and option holdings and finds results opposite to those of Coles, Daniel, and Naveen (2006), namely, that higher option ownership tends to decrease the manager's preference for debt financing.[1] In general, problems associated with controlling for the risk premium associated with the manager's compensation contract (which depends on unobservables, such as the manager's outside wealth and risk aversion) and the potential for endogeneity problems make it difficult to establish causation in the existing empirical studies.

In this paper we exploit the change in the accounting treatment of stock-based compensation under FAS 123R, which was issued by the Financial Accounting Standards Board (FASB) and took effect in December 2005, to provide new evidence on the role that convexity in compensation contracts plays in providing incentives for risk taking by managers.[2] An additional rationale that is often stated for the dramatic rise in option-based compensation over time revolves around how stock options were treated for accounting purposes. Prior to the implementation of FAS 123R, firms were allowed to expense stock options at their intrinsic value. Because nearly all firms granted stock options at-the-money, no expenses for option-based compensation were generally reported on the income statement. Hall and Murphy (2003) argue that, due to their favorable accounting treatment and the fact that there is no cash outlay at the time of the grant, firms act as though the perceived cost of options is lower than their true economic cost. If firms make decisions based on the perceived costs instead of the economic costs, they grant more options than they would otherwise, and options with their favorable accounting treatment are preferred to possibly better incentive plans with less favorable accounting treatment. Consistent with this view, Carter, Lynch, and Tuna (2007) provide evidence that the accounting treatment of stock options affected their use, showing that a comprehensive proxy for financial reporting concerns was positively related to the use of stock options prior to FAS 123R. The implementation of FAS 123R eliminated the ability to expense options at their intrinsic value and instead required firms to begin expensing stock-based compensation at its fair value, effectively eliminating any accounting advantages associated with stock options.

This change in accounting policy represents an exogenous shock to the accounting benefits of using option-based compensation with no impact on the underlying economic benefits of stock options. If firms care about the perceived accounting costs of options, we expect them to reduce their use of options post 123R. Moreover, to the extent that convexity in the wealth-performance relation has a causal effect on managers' risk-taking behavior, we expect that any significant changes in convexity associated with changes in the usage of stock options after FAS 123R will be correlated with changes in firm financial and investment policies related to risk taking and ultimately with changes in firm risk in a systematic manner.

Our findings do not generally support the view that providing incentives for risk taking is a primary rationale for the use of stock options. We show that firms dramatically decrease their usage of option-based compensation for the chief executive officer (CEO) following the implementation of FAS 123R. Based on our estimates, the value of stock options as a proportion of total compensation decreased by about 17 percentage points on average after FAS 123R became effective. More important, we find strong evidence that firms that would face higher accounting charges under FAS 123R reduced their reliance on stock options the most and that the reduction in option usage is generally unrelated to differences in firm characteristics that prior research has argued are associated with greater benefits from promoting risk-taking behavior—the market-to-book ratio, R&D expense, and new economy industry membership (Murphy, 2003; Ittner, Lambert, and Larcker, 2003).

In response to the decline in option usage, we find that firms increase their reliance on bonuses, restricted stock, and long-term incentive awards (LTIAs). These forms of compensation are useful in increasing the pay-performance sensitivity of the manager's compensation, but they do not generally share the convexity inherent in option-based

[1] Also supporting this view, Bettis, Bizjak, and Lemmon (2005) show that managers exercise their options earlier when volatility increases. They also calibrate a valuation model for options that matches the observed exercise behavior and show that incentives to increase risk from the perspective of the manager are often negative.

[2] The complete statement of FAS 123R is available at http://www.fasb.org/pdf/fas123r.pdf.

compensation, suggesting that firms appear to be concerned with maintaining incentives to increase stock price but are less concerned with maintaining convexity in the compensation contract.

To explore this issue further, we directly measure how pay-performance sensitivity (delta) and convexity (vega) in compensation change around FAS 123R. Consistent with the results above, we find that convexity decreases significantly following the adoption of FAS 123R. In contrast, changes in pay-performance sensitivity are relatively modest around the adoption of FAS 123R as firms substitute away from stock options toward other forms of performance-based pay. This latter result is consistent with Hall and Murphy (2002), who argue that restricted stock represents a more efficient (less costly) mechanism compared with stock options for providing incentives to risk-averse managers to increase the firm's stock price.

Finally, we explore whether the changes in convexity that are driven by the change in the accounting rules are accompanied by corresponding changes in investment and financing policies and firm risk that are consistent with the decline in incentives for risk taking. Our findings provide little evidence that the decline in convexity in compensation contracts after FAS 123R has been accompanied by a similar decline in risky financial and investment policies or firm risk.

Overall, our results are difficult to reconcile with the view that, at least on average, a primary motivation for the use of option-based compensation was to increase the convexity of the manager's wealth-performance relation to provide incentives for risk taking. Instead, our findings suggest that accounting benefits were an important driver of the use of stock options prior to the implementation of FAS 123R. Interestingly, our results differ from the findings of two recent papers that also exploit exogenous changes in firm's operating environments to examine the effects of option-based compensation on risk-taking behavior. Low (2009) shows that firms with low convexity decreased volatility following a court ruling that decreased the threat of takeovers. She also finds that firms appear to increase the convexity in managerial compensation contracts following the legal change. Gormley, Matsa, and Milbourn (2010) find evidence that managers whose compensation contracts have high sensitivity to stock price, low sensitivity to volatility, and options that are more in-the-money appear to reduce risk taking in response to an exogenous increase in downside risk.

In addition, although option usage declines significantly following the implementation of FAS 123R, stock options have not completely disappeared. While the conventional wisdom that convexity in compensation contracts provides incentives for risk taking appears to be too simplistic, it remains a challenge to understand the conditions under which convexity in compensation contracts affects managerial behavior and the role that options play relative to other forms of compensation as an efficient mechanism for paying managers.[3]

The remainder of the paper is organized as follows. Section 2 discusses the accounting treatment of stock options and other equity-based compensation both before and after FAS 123R. Section 3 presents our identification strategy. Section 4 describes the data and presents summary statistics, and Section 5 presents our main empirical tests. Section 6 concludes.

2. Accounting treatment of equity-based compensation before and after FAS 123R

The accounting treatment of equity-based compensation is part of the Generally Accepted Accounting Standards (GAAP) established by the Financial Accounting Standards Board and its predecessor organization, the Accounting Principles Board (APB). In 1972, the APB issued APB Opinion 25, which provided that stock-based compensation cost be recorded at its intrinsic value (the difference between the market price of the stock and the exercise price, if any) on the measurement date (the first date when both the number of shares and the exercise price are known). Between 1995 and 2005, firms accounted for equity-based compensation under FAS 123. While FAS 123 encouraged the use of fair value (e.g., the Black-Scholes value of the option on the grant date) in measuring compensation cost, the standard allowed firms to continue recording compensation expense on the income statement using the APB 25 intrinsic value method and provide pro forma footnote disclosure of the fair value compensation expense numbers. In 2004, the FASB issued a revised version of FAS 123 that required the use of fair values in the income statement. FAS 123R became effective for large public firms for the first reporting period beginning after June 15, 2005.

The most notable accounting difference resulting from the passage of FAS 123R relates to the treatment of fixed stock options, in which the number of shares and exercise price are known at the grant date. Prior to FAS 123R, most firms elected to use the intrinsic value method of APB 25. Because the exercise price of fixed stock options is commonly set to the stock price on the grant date, no compensation expense was recorded under this method. Under FAS 123R, the compensation cost of all employee stock options is measured using fair value, so fixed options now result in compensation expense on the income statement. The fair value of the option grant is measured on the grant date, and the value of the options that are expected to vest is expensed over the service period (typically the vesting period). Adjustments are made to the compensation expense for fixed options only for changes in expected vesting percentages.

The accounting for other forms of equity-based compensation was less drastically affected by FAS 123R. Restricted stock with no performance or market conditions can be viewed as a fixed option with an exercise price of zero, so the compensation cost under both the intrinsic value and fair value methods is the grant-date

[3] Dittmann and Maug (2007) also argue that it is difficult to justify stock options as part of an optimal compensation contract based on calibrations of a principal-agent model. One possible resolution is provided in Dittmann, Maug, and Spalt (2010), who show that options

(*footnote continued*)
can be an efficient way to convey incentives if managers have preferences consistent with loss aversion.

fair value. Equity awards with performance-based vesting conditions resulted in compensation expense both before and after FAS 123R, although the compensation cost is not measured in the same way. For example, performance-based equity awards received variable accounting treatment under APB 25, so the compensation cost for variable stock options was remeasured each period until the measurement date occurred or the options were exercised, forfeited, or expired unexercised. If the stock price increased, the intrinsic value also increased, and compensation expense was recorded in income. Under FAS 123R, the compensation expense recognized for equity awards (including options) with performance conditions is based on the probable outcome of that performance condition, with the total compensation expense adjusted to reflect the actual outcome of the performance condition. Because the outcome must be estimated prior to its realization, the accounting treatment for long-term equity incentive awards with performance conditions, whether they involve grants of shares or options, now allows firms some discretion in recording compensation expense.[4] This discretion is not available for fixed stock options or plain vanilla restricted stock. The tax treatment of equity-based compensation did not change as a result of FAS 123R.

3. Empirical approach

In this section we describe our identification strategy and compare our empirical approach to the approaches used by other papers in the existing literature. To fix ideas we rely on a framework similar to the one described in Himmelberg, Hubbard, and Palia (1999), which examines the effects of managerial ownership on firm value.

Consider the following setting. Shareholders determine the convexity (vega), V_{it}, of the manager's contract based on observable firm and manager characteristics, x_{it}, perceived accounting benefits, A_{it}, and some time-invariant unobservable characteristics, u_i, that are not observed by the researcher. These unobservable characteristics might include things such as the manager's risk aversion and outside wealth or unobserved attributes of the firm's production technology. The form of the contract is given by

$$V_{it} = \beta_1 x_{it} + \gamma_1 A_{it} + u_i + \nu_{it}. \tag{1}$$

In response to the contract, the manager chooses an effort level, Y_{it}, that is determined by the vega of the compensation contract and by the observable firm characteristics, x_{it}, as

$$Y_{it} = \theta V_{it} + \beta_2 x_{it} + \omega_{it}. \tag{2}$$

Finally, the firm's financing and investment policies, P_{it}, are determined by the manager's effort level and by the observable and unobservable firm characteristics as

$$\begin{aligned} P_{it} &= \delta Y_{it} + \beta_3 x_{it} + u_i + \eta_{it} = \delta(\theta V_{it} + \beta_2 x_{it} + \omega_{it}) + \beta_3 x_{it} + u_i + \eta_{it} \\ &= \delta\theta V_{it} + (\delta\beta_2 + \beta_3) x_{it} + \delta\omega_{it} + u_i + \eta_{it}. \end{aligned} \tag{3}$$

We can rewrite the coefficients to get

$$P_{it} = \alpha_0 + \alpha_1 V_{it} + \alpha_2 x_{it} + \varepsilon_{it}. \tag{4}$$

This equation corresponds closely to the regressions that are typically estimated in the literature, and it illustrates the difficulty in establishing causality in this framework. Within this framework, it is easy to see that if there are any common omitted variables, then u_i will not equal zero, and the regression will yield inconsistent estimates of the casual effect of V_{it} on P_{it}. Specifically,

$$\mathrm{E}[V_{it}\varepsilon_{it}] = \mathrm{E}[(\beta_1 x_{it} + \gamma_1 A_{it} + u_i + \nu_{it})(\delta\omega_{it} + u_i + \eta_{it})] \neq 0, \tag{5}$$

resulting in biased and inconsistent estimates of the coefficient of interest, α_1.

Standard approaches for addressing this issue are to employ a simultaneous equations framework (e.g., Coles, Daniel, and Naveen, 2006) or an instrumental variables approach that attempts to isolate exogenous variation in the contracting variable (in this case, the convexity of the manager's contract). The framework above illustrates the difficulty of implementing this approach in practice, because all of the observable variables, x_{it}, potentially affect both the choice of the manager's contract and the choice of firm policies, thus making it difficult to identify a valid instrument.

Himmelberg, Hubbard, and Palia (1999) suggest a different approach. To the extent that the unobservable characteristics of the contracting environment are largely time-invariant, consider the difference regression

$$\Delta P_{it} = b_0 + b_1 \Delta V_{it} + b_2 \Delta x_{it} + \Delta\varepsilon_{it}, \tag{6}$$

where $\Delta V_{it} = \beta_1 \Delta x_{it} + \gamma_1 \Delta A_{it} + \Delta\nu_{it}$ and $\Delta\varepsilon_{it} = \delta_1 \Delta\omega_{it} + \Delta\eta_{it}$.[5] The unobserved time-invariant omitted variables have been differenced out of the equation. In general, this regression should be well specified. However, as pointed out by Zhou (2001), the regression could lack power if the variation in ΔV_{it} comes primarily from Δx_{it}, because the difference regression already includes Δx_{it} as a control variable. In this case, the standard errors in the difference regression could be large, making it potentially difficult to reject the null hypothesis of no relation between ΔV_{it} and ΔP_{it}. In our experiment, however, we avoid some of the issues raised by Zhou (2001) by exploiting the change in the accounting treatment of options. The implementation of FAS 123R effectively eliminated the accounting advantages associated with option compensation, which, as shown Section 2, leads to large changes in vega that are generally unrelated to other firm characteristics (see Sections 4 and 5 for specific empirical evidence). In terms of the difference equation [Eq. (6)], FAS 123R represents a change to the accounting benefits (ΔA_{it}) and introduces an exogenous source of variation to ΔV_{it}. Because the variance of the coefficient of interest b_1 is inversely related to the variance in ΔV_{it} coming from any source other than

[4] The treatment of market-based and accounting-based performance conditions is slightly different. In particular, market-based performance conditions are required to be modeled and included in the grant-date fair value estimate of the compensation. In contrast, for accounting-based performance conditions, the firm is required to estimate the likely outcome at the grant date and then is allowed to "true up" the expenses based on the actual outcomes.

[5] A firm fixed effects regression is another approach for dealing with the time-invariant omitted variables.

Δx_{it}, the variation coming from the change in accounting regulations enables us to more precisely estimate the relation between ΔV_{it} and ΔP_{it}. We use this difference regression framework to provide new evidence on the causal relation between managerial incentives and firms' policies.

4. Data and summary statistics

We use the ExecuComp database as our source of CEO compensation data. Our sample includes annual compensation information from fiscal years 2002 through 2008. We define fiscal year 2005 as the beginning of the post-123R period, and we require that all sample firms have at least one year of data in both the pre- and post-FAS 123R periods.[6] In addition, we remove financial firms [firms with standard industrial classification (SIC) code between 6000 and 6999] and utility firms (firms with SIC code between 4900 and 4999). We begin by collecting data on salary, bonus, grants of stock options, grants of restricted stock, and long-term incentive awards for each CEO in the sample.

One complication with the compensation data over this time period is that the Securities and Exchange Commission changed the reporting requirements for executive compensation for fiscal years ending after December 15, 2006. Under the new requirements, firms continue to present annual components of compensation such as salary and bonus in a summary compensation table, but the details of option and equity awards now appear in two additional tables, the plan-based award and outstanding equity award tables. Previously, annual option grants were presented in a single separate table. Further, the new disclosure rules redefine certain compensation components; in particular, some bonuses have been reclassified as nonequity incentive compensation. Given our interest in whether and how compensation components have changed over this time period, it is particularly important to define the compensation variables consistently across the two disclosure regimes. We provide details about the calculation of each compensation variable under both the old and new formats in Appendix A.

We merge the ExecuComp data with the Center for Research in Security Prices (CRSP) and Compustat, and the resulting sample, presented in Table 1, contains 6,983 firm-year observations that have complete data for our main variables.[7] We calculate the Black-Scholes value of options using exercise price and option term data from ExecuComp, annual stock price volatility computed from CRSP using monthly returns over the previous three years, and annual dividend yield computed from Compustat averaged over the three previous years. We winsorize volatility at the 1st and 99th percentiles, and we winsorize dividend yield at the 99th percentile. We do not winsorize dividend yield at the 1st percentile because it is truncated at zero.

To measure incentives we follow the existing literature (e.g., Guay, 1999; Coles, Daniel, and Naveen, 2006) and compute the sensitivities of annual compensation to changes in stock price (delta) and stock price volatility (vega) as follows. *Delta_c* is measured as the change in the value of the CEO's annual equity-based compensation for a 1% change in the stock price, and *Vega_c* is the change in the value of the CEO's annual equity based compensation for a 0.01 change in stock price volatility. In addition, we compute similar sensitivities for the CEO's total portfolio of current and outstanding prior grants of shares and options (*Delta_t* and *Vega_t*) following the methodology in Core and Guay (2002). Details of the variable construction are provided in Appendix B. All measures of delta and vega are stated in thousands of dollars and are winsorized at the 99th percentile. We do not winsorize the incentive measures at the 1st percentile because these variables are truncated at zero.

Panel A of Table 1 presents summary statistics for all sample years, and Panel B presents statistics for the periods before and after adoption of FAS 123R. We first present the levels of all annual compensation variables. As seen in Panel A, total annual compensation is $6.2 million on average. In dollar terms, options are the largest component of compensation levels, on average, with long-term incentive awards the second-largest. Panel B indicates that options dominate the level of compensation before FAS 123R, but LTIAs are the largest average compensation component after FAS 123R. We also present statistics about the fraction of total compensation that comes from each pay component. On average, 38.9% of compensation comes from stock options before FAS 123R, compared with 21.8% after FAS 123R. These summary statistics indicate that the value of option grants has decreased substantially following FAS 123R, both in dollar terms and as a percentage of compensation. The decrease in option grants can also be seen in *NumOpt_share_c*, the number of options granted to the CEO in the current year deflated by shares outstanding (and multiplied by one thousand for ease of interpretation), which drops from 2.509 before FAS 123R to 1.706 in the post-FAS 123R period. In contrast, both the dollar amounts and fractions of pay coming from bonuses, restricted stock grants, and LTIAs all increase following the adoption of FAS 123R.

Table 1 also provides summary statistics for the CEO incentive measures, delta and vega. The delta of current compensation (*Delta_c*) averages 53.398 across all years, increasing significantly from an average of 46.651 before FAS 123R to an average of 58.676 after FAS 123R. The increase in *Delta_c* around the adoption of FAS 123R is consistent with firms replacing option pay with other performance-based pay. The delta of the CEO's total equity holdings (*Delta_t*) increases slightly from 726.322 prior to the implementation of FAS 123R to 750.526 afterward, but the change is not statistically significant.

[6] FAS 123R took effect for all firms with fiscal year-ends beginning in January 2006. We choose to define fiscal year 2005 as the beginning of the post-FAS 123R period to account for the possibility that firms might begin changing their compensation strategies in advance of the rule change. Our results are unaffected if we instead use fiscal year 2006 to define the post-FAS 123R period.

[7] A small number of firms voluntarily adopted the expensing of stock options prior to the implementation of FAS 123R. Nearly all of the early adopters in ExecuComp began expensing options in 2002, and we delete these firms from our sample (117 firms). The results remain similar to those reported if we instead include the early adopters.

Table 1
Summary statistics.

Panel A contains summary statistics for the variables used in the analysis over the entire sample period. Panel B contains summary statistics for the variables pre- and post-FAS 123R. The sample consists of 6,983 firm-year observations over fiscal years 2002 through 2008 surrounding the adoption of FAS 123R. FAS 123R became effective for all firms with fiscal years beginning after December 2005. The pre-FAS 123R period is defined as fiscal years from 2002 to 2004 and the post-FAS 123R period is defined as fiscal years from 2005 to 2008 to accommodate firms' early responses to FAS 123R. Variables are defined in Appendix B. * indicates that mean or median of the variable in the pre- and post-periods is significantly different at 5%.

Panel A: All sample years

Variable	*N*	Mean	Standard deviation	25th percentile	50th percentile	75th percentile
Level of chief executive officer (CEO) compensation (thousands of dollars)						
Salary	6,983	719	363	477	668	903
Bonus	6,983	956	1930	168	560	1131
Stock Option	6,983	2044	5847	0	601	2102
Restricted Stock	6,983	1087	3037	0	0	984
LTIA	6,983	1406	15025	0	0	0
Total Compensation	6,983	6212	17367	1381	2941	6193
Cash Compensation	6,983	1675	2108	725	1223	2005
Percentage of CEO compensation						
P_Salary	6,983	0.305	0.252	0.128	0.221	0.403
P_Bonus	6,983	0.204	0.178	0.066	0.173	0.296
P_Option	6,983	0.293	0.285	0.000	0.237	0.513
P_RS	6,983	0.137	0.202	0.000	0.000	0.252
P_LTIAs	6,983	0.061	0.146	0.000	0.000	0.000
Delta and Vega (thousands of dollars)						
Delta_c	6,983	53.398	91.580	4.763	21.427	60.230
Delta_t	6,983	739.903	1616.520	92.374	249.844	663.758
Vega_c	6,983	29.264	48.866	0.000	9.866	35.235
Vega_t	6,983	149.453	239.770	21.751	62.230	167.515
NumOpt_share_c (thousands)	6,983	2.058	4.281	0.000	0.984	2.438
Other variables						
MTB	6,983	1.982	1.294	1.240	1.622	2.299
R&D	6,983	0.038	0.071	0.000	0.006	0.052
CAPEX	6,975	0.051	0.052	0.020	0.035	0.063
Leverage	6,983	0.210	0.208	0.037	0.189	0.314
Cash	6,981	0.171	0.178	0.033	0.105	0.255
Firm size	6,983	7.287	1.485	6.273	7.185	8.193
Volatility	6,983	0.424	0.223	0.272	0.364	0.510
Market Volatility	6,983	0.138	0.044	0.087	0.148	0.185
Tenure	6,983	7.853	7.580	2.583	5.417	10.250

Panel B: Pre- and post-FAS 123R

	Pre-FAS 123R period			Post-FAS 123R period		
	N	Mean	Median	*N*	Mean	Median
Level of chief executive officer (CEO) compensation (thousands of dollars)						
Salary	3,065	663	602	3,918	763*	711*
Bonus	3,065	756	416	3,918	1112*	680*
Stock Option	3,065	2478	963	3,918	1705*	385*
Restricted Stock	3,065	604	0	3,918	1465*	276*
LTIAs	3,065	358	0	3,918	2225*	0*
Total Compensation	3,065	4860	2618	3,918	7270*	3272*
Cash Compensation	3,065	1420	1027	3,918	1875*	1389*
Percentage of CEO compensation						
P_Salary	3,065	0.319	0.233	3,918	0.293*	0.213*
P_Bonus	3,065	0.186	0.153	3,918	0.219*	0.191*
P_Option	3,065	0.389	0.397	3,918	0.218*	0.139*
P_RS	3,065	0.074	0.000	3,918	0.185*	0.101*
P_LTIAs	3,065	0.031	0.000	3,918	0.084*	0.000*
Delta and Vega (thousands of dollars)						
Delta_c	3,065	46.651	19.185	3,918	58.676*	23.403*
Delta_t	3,065	726.322	255.042	3,918	750.526	243.360
Vega_c	3,065	30.320	11.427	3,918	28.438	8.720*
Vega_t	3,065	154.917	65.337	3,918	145.178	59.476*
NumOpt_share_c (thousands)	3,065	2.509	1.422	3,918	1.706*	0.720*
Other variables						
MTB	3,065	2.038	1.633	3,918	1.939*	1.611*
R&D	3,065	0.038	0.006	3,918	0.037	0.006

Table 1 (*continued*)

Panel B: Pre- and post-FAS 123R	Pre-FAS 123R period			Post-FAS 123R period		
	N	Mean	Median	*N*	Mean	Median
CAPEX	3,063	0.049	0.034	3,912	0.053*	0.036*
Leverage	3,065	0.208	0.190	3,918	0.211	0.188
Cash	3,065	0.180	0.112	3,916	0.164*	0.101*
Firm size	3,065	7.128	6.969	3,918	7.411*	7.348*
Volatility	3,065	0.515	0.446	3,918	0.354*	0.320*
Market Volatility	3,065	0.178	0.185	3,918	0.107*	0.094*
Tenure	3,065	7.822	5.083	3,918	7.876	5.583

In contrast, the vega of current annual CEO compensation (*Vega_c*) decreases from an average of 30.320 prior to FAS 123R to 28.438 afterward. The decrease in the median value is larger and statistically significant, changing from 11.427 to 8.720. The vega of the CEO's total portfolio of equity and option holdings (*Vega_t*) also decreases somewhat around the adoption of FAS 123R, changing from an average (median) of 154.917 (65.337) prior to adoption to 145.178 (59.476) following adoption. The decrease in the vega of compensation provides a first indication that firms did not maintain the pre-FAS 123R convexity in CEO compensation contracts following the adoption of FAS 123R. Our regression analysis presented in Section 5 provides a more detailed examination of this issue.

The final rows of each panel in Table 1 present summary statistics for firm and CEO characteristics. We define *MTB* as the market value of equity plus the book value of total liabilities, divided by total assets, and *R&D* as research and development expense deflated by total assets. We define *CAPEX* as capital expenditures deflated by total assets, and we measure *Leverage* as the book value of long-term debt, including the current portion, divided by total assets. *Cash* is cash and short-term investments divided by total assets. *Volatility* is defined as the annualized standard deviation of stock returns measured over the previous three years. We also report *Market Volatility*, defined as the annualized volatility of the CRSP value-weighted index. We compute *Market Volatility* for each firm-year using the market returns over the three years prior to the firm's fiscal year end. *Tenure* is defined as the number of years the CEO has been in office.

In contrast to the compensation variables, the changes in firm characteristics around the adoption of FAS 123R are relatively small. For example, average *MTB* goes from 2.038 before the accounting change to 1.939 after the change. *R&D* is 0.038 before the accounting change and 0.037 after the change, while *CAPEX* increases slightly from 0.049 to 0.053. *Leverage* increases from 0.208 to 0.211, and *Cash* decreases from 0.180 to 0.164. Firm size (measured as the natural log of book assets) also increases. One feature that does stand out is the large change in *Volatility*, which decreases from 0.515 to 0.354 across the two time periods. However, the change in firm-level volatility parallels a similar decline in market volatility over this period. Given that we observe little change in firm policies, the mechanism leading to the decrease in volatility is not clear.[8] To explore this issue further, we examine a subsample of 114 firms that have zero current stock option grants throughout the pre-FAS 123R time period. Even though these firms were not granting options, we find that they experience a similar decline in average volatility in the post-FAS 123R period—from 0.484 pre-FAS 123R to 0.369 post-FAS 123R (results not tabulated). This suggests that the changes in firm-level volatility are not driven by decreased option usage leading to less risk taking but, instead, reflect a secular decline in overall market risk during this period.[9]

5. Analysis

We present our main empirical tests in this section.

5.1. Changes in CEO compensation around FAS 123R

We begin by examining how the various components of compensation were affected by the adoption of FAS 123R. In Table 2 we regress the log of total compensation, as well as the fraction of total compensation attributable to each of the five pay components, on an indicator for the post-FAS 123R period and control variables for firm size and CEO tenure. All regressions include firm fixed effects to control for any unobserved time-invariant heterogeneity across firms. The inclusion of fixed effects thus identifies the average within-firm changes in the dependent variables as a function of the independent variables in the regressions.

With respect to total compensation, the coefficient on the post-period indicator in Panel A indicates that total compensation increased by about 15.3 percentage points on average following the adoption of FAS 123R. The fourth column reports results where the value of stock options as a fraction of total compensation is used as the dependent variable. The coefficient estimate on the post-123R indicator shows that the fraction of compensation received in the form of stock options declined by 16.8 percentage

[8] We provide further analysis of the cross-sectional relation between decreases in volatility and decreases in the use of options in Section 5.3.

[9] We perform some analysis using this set of firms as a control group and the results are available in the Internet Appendix 〈http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1571991〉.

Table 2
Firm fixed effect regressions describing changes in the structure of chief executive officer (CEO) compensation around the adoption of FAS 123R.

The table contains results from firm fixed effects regressions describing changes in the structure of CEO compensation around FAS 123R. The sample consists of 6,983 firm-year observations over fiscal years 2002 to 2008 surrounding the adoption of FAS 123R. Log (Total Compensation) is the log of the dollar value of total compensation (including salary, bonus, stock option, restricted stock, and LTIA and in units of thousands of dollars) for each CEO. *P_Salary*, *P_Bonus*, *P_Option*, *P_RS*, and *P_LTIA* are the fractions of total compensation coming from those individual components of pay. The independent variables in the regressions include an indicator (*Post-123R*) equal to one for the post-FAS 123R period (which is defined as fiscal years 2005 through 2008) and zero otherwise, and other control variables that include size of the firm (log of total book assets) and CEO tenure. Variables are defined in Appendix B. The table reports *t*-statistics based on robust standard errors clustered at the firm level in parentheses. ***=significant at 1%, **=significant at 5%, *=significant at 10%.

Independent variable	Log (Total Compensation)	*P_Salary*	*P_Bonus*	*P_Option*	*P_RS*	*P_LTIAs*
Post-123R	0.153***	−0.0113*	0.0295***	−0.168***	0.102***	0.0476***
	(6.46)	(−1.68)	(5.36)	(−20.69)	(18.01)	(11.26)
Firm size	0.230***	−0.0344***	0.00116	−0.0184	0.0339***	0.0177**
	(3.51)	(−2.98)	(0.12)	(−1.36)	(3.11)	(2.52)
Tenure	−0.00963***	0.00551***	0.00140	−0.00412***	−0.00312***	0.000327
	(−2.82)	(5.17)	(1.57)	(−4.15)	(−4.18)	(0.76)
N	6,983	6,983	6,983	6,983	6,983	6,983
Adjusted R^2	0.566	0.416	0.268	0.385	0.314	0.295

points on average following the adoption of FAS 123R. The fact that total compensation increases on average following the adoption of FAS 123R, but option usage falls, suggests that firms substituted other forms of compensation for options following the adoption of the expensing rules. In Table 2, firms appear to increase bonuses, restricted stock grants and long-term incentive awards in the post-123R period. The sum of the increases in these three components, as measured by the coefficient estimates on the post-123R indicators, roughly offsets the decline in option usage. It is important to note that firms appear to substitute away from options towards other forms of performance-based pay as opposed to salary.[10]

Our strategy for identifying the effects of convexity in compensation on risk-taking behavior relies on the idea that the beneficial accounting treatment of options led firms to use more options than they would have used purely for incentive reasons. To provide evidence on this issue, we examine how the use of option compensation changed after FAS 123R as a function of both the perceived accounting costs of expensing and the demand for incentives to take risk. To perform this analysis, we use a two-way sort procedure to create four subsamples. We then repeat the regression shown in Table 2 for each subsample.

Our first sorting variable is the demand for incentives to take risk. For this sort, we use several measures identified by the prior literature as proxies for the demand for risk taking, namely, *MTB*, *R&D*, and new economy firms. To sort by *MTB*, we divide firms into two subsamples (above and below the median value of *MTB*), based on the average *MTB* of each firm in the pre-FAS 123R period. For *R&D*, we divide the firms into two subsamples, those with zero R&D expense and those with nonzero R&D based on the average level of *R&D* in the pre-FAS 123R period. New economy firms are defined as organizations competing in the computer, software, Internet, telecommunications, or networking fields; all other firms are classified as non-new economy.[11] Following prior literature, we expect that high *MTB*, high *R&D*, and new economy firms are likely to provide their executives with greater incentives for risk taking.

Our second sorting variable is based on the perceived accounting costs of option expensing. Carter, Lynch, and Tuna (2007) argue that financial reporting costs associated with accessing capital markets are an important determinant of option usage. They show that firms with high financial reporting costs used more option-based compensation in the pre-FAS 123R period, reflecting the fact that options did not need to be expensed at fair value on the income statement during this time period, which provided firms with more flexibility to report higher and more stable earnings. We define *Accounting Impact* as the average value of the pro forma option expense (deflated by fully diluted shares used to calculate earnings per share) the company reported in the pre-FAS 123R period. This variable measures the amount by which earnings per share would be reduced if the firm had to recognize compensation expense based on the fair value of its options and captures the idea that expensing options has a greater impact on the earnings of firms with greater pro forma option expense. We define firms with above-median pro forma option expense in the pre-FAS 123R period as having high accounting impact from FAS 123R.

We then reestimate the regressions in Table 2 using the fraction of option-based pay as the dependent variable for each of the four subsamples we create in the two-way sort procedure. We compare the values of the coefficient estimates on the post-FAS 123R indicator across the regressions based on robust standard errors

[10] One reason that firms might not substitute toward salary is the 1993 Internal Revenue Service ruling (162m) that disallows corporate tax deductions for non-performance-based pay exceeding $1 million.

[11] Following Murphy (2003), we define new economy firms as those with SIC codes 3570, 3571, 3572, 3576, 3577, 3661, 3674, 4812, 4813, 5045, 5961, 7370, 7371, 7372, and 7373.

Table 3
Tests across subsamples: firm fixed effects regressions describing changes in the fraction of total chief executive officer (CEO) compensation coming from options around the adoption of FAS 123R.

The table contains results from firm fixed effects regressions describing changes in the fraction of total CEO compensation coming from options around FAS 123R. The sample consists of 6,983 firm-year observations over fiscal year 2002 to 2008 surrounding the adoption of FAS 123R. The dependent variable is the fraction of total compensation coming from options. We divide the sample into subsamples on the basis of variables (*Accounting Impact* and a proxy for the firm's demand for risk taking) and run separate regressions in each subsample. Low or High *Accounting Impact* refers to below and above median of average *Accounting Impact* for the pre-FAS 123R period, which is fiscal year 2002 to 2004. The proxies for the demand for risk taking include the Market-to-Book ratio (market value of assets to book value of assets) in Panel A (low and high *MTB* refers to below and above median of Market-to-Book ratio for the pre-FAS 123R period), the ratio of research and development (R&D) spending to total book assets in Panel B (zero and nonzero *R&D* refers to average zero and nonzero *R&D* for pre-FAS 123R period), and subsamples of new and non-new economy firms as defined by Ittner, Lambert, and Larcker (2003) in Panel C. The independent variables in the regressions include an indicator (*Post-123R*) equal to one for the post-FAS 123R period (which is defined as fiscal years 2005 through 2008) and zero otherwise, and other control variables that include size of the firm (log of total book assets) and CEO tenure. We report only the coefficient on the post-FAS 123R indicator and provide *P*-values for tests that coefficients on the Post-123R indicators are equal. Variables are defined in Appendix B. The table reports *t*-statistics based on robust standard errors clustered at the firm level in parentheses. *** = significant at 1%.

	Low *Accounting Impact*	High *Accounting Impact*	*P*-value for test that coefficients on the Post-123R indicators for subsamples of different Accounting Impacts are equal
Panel A: Market-to-book subsamples			
Low *MTB*	−0.122***	−0.186***	0.0007
	(−11.50)	(−11.91)	
High *MTB*	−0.124***	−0.232***	0.0000
	(−8.15)	(−14.02)	
P-value for test that coefficients on the Post-123R indicators for subsamples of different risk taking measures are equal	0.9116	0.0426	
Panel B: R&D subsamples			
Zero *R&D*	−0.133***	−0.157***	0.2405
	(−10.95)	(−9.25)	
Nonzero *R&D*	−0.112***	−0.241***	0.0000
	(−8.90)	(−16.50)	
P-value for test that coefficients on the Post-123R indicators for subsamples of different risk taking measures are equal	0.2480	0.0002	
Panel C: New economy subsamples			
Non-new Economy	−0.123***	−0.192***	0.0000
	(−14.01)	(−14.18)	
New Economy	−0.115***	−0.258***	0.0023
	(−2.72)	(−12.18)	
P-value for test that coefficients on the Post-123R indicators for subsamples of different risk taking measures are equal	0.8430	0.0087	

clustered at the firm level.[12] The results are reported in Table 3. Panel A reports the results for *MTB* as the measure of the demand for risk taking, while Panels B and C report the results for *R&D* and new economy firms, respectively. For brevity, each panel presents only the coefficient estimate on the post-123R indicator.

In Panel A, all of the coefficient estimates are negative and statistically significant, indicating that all groups reduced the use of option-based pay following the change in accounting rules. Within both subsamples of *MTB*, firms with high *Accounting Impact* reduce their option usage following the implementation of FAS 123R by nearly twice as much as those with low *Accounting Impact*. This result complements the findings in Carter, Lynch, and Tuna (2007) that perceived financial reporting costs affect the usage of employee stock options.[13] However, within both subsamples of *Accounting Impact*, the decreases in option usage are not significantly different for high and low *MTB* firms. In Panels B and C, we divide firms into groups based on *R&D* and new economy industry membership and find similar results; the high *Accounting Impact* firms in the nonzero *R&D* group and in both the non-new and new economy groups reduce option usage significantly more than their counterparts with low *Accounting Impact*. In the zero *R&D* group firms, the reductions in option usage for high and low impact firms are not significantly different. Finally, when we examine the high and low *Accounting Impact* subsamples, we find some evidence that firms with a higher demand for risk

[12] The comparison of coefficients across regressions is done using the suest procedure in Stata.

[13] We also partition firms based on the accounting factors defined by Carter, Lynch, and Tuna (2007), who report results using two principal components of variables capturing firms' concerns associated with capital market participation. The first reflects leverage, increases in earnings, and analyst forecast variables, and the second is based on measures of debt and equity issuance. When we partition the sample based on these measures of financial reporting cost, we find no difference between the high and low accounting cost firms in our sample.

taking reduce their use of stock options more following FAS 123R. In particular, firms with high *Accounting Impact* reduce option use more when they have higher *MTB*, when R&D expense is nonzero, and when they are new economy firms.

Overall, the results indicate that all types of firms reduced their use of option-based compensation after FAS 123R. The reduction in the use of options appears to vary based on differences in perceived financial reporting costs but much less so based on differences in incentives for risk taking. The main difference between option pay and other forms of performance-based pay is the convexity inherent in option pay compared with that in restricted stock grants and bonus pay. The fact that firms tend to substitute away from options toward other performance-based pay in the post-FAS 123R period suggests that boards are primarily concerned with maintaining the pay-performance sensitivity in the manager's compensation contract but are relatively unconcerned with convexity. We explore this interpretation directly in our next set of analyses.

5.2. Changes in CEO incentives around FAS 123R

Table 4 presents the results of regressions using the incentive measures in place of the compensation components as dependent variables. The regressions include an indicator for the post-FAS 123R period and firm fixed effects, as well as controls for firm size, cash compensation, and CEO tenure (following Guay, 1999). We examine the incentives provided by both the current compensation grants and the CEO's outstanding portfolio of both current and prior grants of shares and options. While incentives are provided by all of the outstanding equity-based compensation in the CEO's portfolio, we also consider separately the incentives provided by current grants of shares and options because we are interested in how firms change their compensation practices following the adoption of FAS 123R, and current grants represent the portion of outstanding compensation that is directly under the control of the board of directors.

In the first column of Table 4, we examine how the sensitivity of current annual CEO pay to changes in firm value (*Delta_c*) is affected by FAS 123R. The coefficient estimate on the post-123R indicator is positive and statistically significant, indicating that, on average, pay-performance sensitivity increases in the post-123R period. The magnitude of the coefficient estimate indicates that the pay-performance sensitivity in current annual compensation increases by $6,804 or by 14.58% from its pre-123R period average. This result provides direct confirmation of our earlier interpretation that firms appear to be substituting away from options toward other forms of performance-based pay. The second column presents results using the sensitivity of the CEO's full portfolio of both current and prior grants of shares and options (*Delta_t*) as the dependent variable. In contrast to the results for the current delta, overall pay-performance sensitivity appears to have decreased somewhat following FAS 123R (with the coefficient significant at the 10% level). The magnitude of the coefficient estimate indicates that overall pay-performance sensitivity decreased by about 9.55% from its average level in the pre-123R period. This decrease is partly attributable to the decline in stock prices during 2007—2008; our measure of pay-performance sensitivity multiplies the option (share) delta by 0.01 times the stock price, so a decrease in stock price leads to a mechanical decrease in the delta of prior grants of stock and options. Consistent with Core and Guay (1999) and Coles, Daniel, and Naveen (2006), *Delta_t* is increasing with firm size—larger firms provide greater dollar incentives. Portfolio pay-performance sensitivity is also positively associated with CEO cash compensation and CEO tenure.

While a substitution from options to other forms of performance-based pay could leave pay-performance sensitivity relatively unchanged, the same is unlikely to be true for the convexity of the CEO's wealth-performance

Table 4
Firm fixed effect regressions describing changes in chief executive officer (CEO) incentive measures (Delta and Vega) and option grants around the adoption of FAS 123R.

The table contains results from firm fixed effects regressions describing changes in the CEO incentive measures (Delta and Vega) and the number of options granted to the CEO around FAS 123R. The sample consists of 6,983 firm-year observations over fiscal year 2002 to 2008 surrounding the adoption of FAS 123R. The dependent variables in the regressions are various incentive measures and the number of options granted to the CEO. The independent variables mainly follow Guay (1999). Variables are defined in Appendix B. The table reports *t*-statistics based on robust standard errors clustered at the firm level in parentheses. ***=significant at 1%, **=significant at 5%, *=significant at 10%.

Independent variable	*Delta_c*	*Delta_t*	*Vega_c*	*Vega_t*	*NumOpt_share_c*
Post-123R	6.804***	−69.38*	−4.592***	−26.42***	−0.602***
	(3.07)	(−1.79)	(−3.94)	(−4.07)	(−4.02)
Firm size	10.56***	199.7***	10.55***	55.33***	−0.637**
	(2.62)	(3.06)	(5.32)	(4.92)	(−2.16)
Cash Compensation	0.00384**	0.0456	−0.000901	0.00374	0.0000282
	(2.56)	(1.22)	(−0.55)	(0.67)	(0.45)
Tenure	−0.339	66.08***	−0.378**	3.235***	−0.0699***
	(−1.13)	(5.74)	(−2.37)	(3.78)	(−4.53)
N	6,983	6,983	6,983	6,983	6,983
Adjusted R^2	0.409	0.777	0.532	0.745	0.156

relation. We provide evidence on post-FAS 123R changes in convexity in the third and fourth columns of Table 4. The coefficient estimates on the post-123R indicator show that *Vega_c* and *Vega_t* both decrease significantly following the change in the accounting rules. The magnitudes of the coefficient estimates indicate that the convexity in current annual and total compensation decreased by about 15.15% and 17.05%, respectively, from their pre-FAS 123R average levels. The convexity of both current and overall compensation is positively related to firm size and unrelated to the CEO's cash compensation. The convexity of current compensation is negatively related to CEO tenure, and the convexity of the CEO's total portfolio of current and prior grants of options is positively related to CEO tenure.

The final column in Table 4 presents the results of a regression where we focus on the number of options granted to the CEO in the current period relative to shares outstanding (*NumOpt_share_c*). While this specification does not capture the value of options granted, it provides insight into whether or not the changes in convexity that we document are related to changes in the patterns of option-granting behavior around the accounting standard change. Consistent with the results on convexity, we find evidence that the number of options granted to the CEO relative to shares outstanding decreased significantly following FAS 123R.

In untabulated analyses, we perform a number of supplemental tests to assess the robustness of our results and provide additional insights. First, we repeat all of our regressions using measures of *Delta* and *Vega* scaled by total assets. Second, we repeat our analysis using a definition of *Delta* based on the dollar (as opposed to a 1%) change in stock price and with a definition of *Vega* based on a 1% (as opposed to a 0.01) change in volatility. In all cases, the inferences are similar to those reported.

Finally, given Table 4 findings that convexity decreased after FAS 123R, we follow our earlier analysis and examine how the changes in convexity vary with the demand for risk taking and perceived accounting costs. We use the two-way sort procedure described in Section 5.1 and perform a similar set of regressions to those presented in Table 3, but using the convexity of current compensation as the dependent variable in place of the fraction of options in current compensation. Our findings are similar to those in Table 3 and suggest that reductions in convexity are related to financial reporting costs. All of the coefficient estimates on the post-123R indicator in the high *Accounting Impact* subsample are significantly negative. The subsamples with high *Accounting Impact* universally show a larger decline in *Vega_c* in the post-123R period than their low *Accounting Impact* counterparts, and the difference is statistically significant for the high *MTB*, nonzero *R&D*, and non-new economy subsamples. Within each subsample of *Accounting Impact*, we find no evidence that the decrease in *Vega_c* is less in firms with a higher demand for risk taking and some evidence to the contrary: High *MTB* firms reduce *Vega_c* more than low *MTB* firms. These results further confirm that the reduction in the use of options (and consequently convexity) appears to vary based on differences in perceived financial reporting costs but much less so based on differences in incentives for risk taking. Overall, the results from Table 4 and the supplemental tests are consistent with our earlier findings showing that a shift away from options has resulted in a significant reduction in convexity following the change in the accounting rules.

5.3. *Changes in CEO incentives and changes in firm policies around FAS 123R*

Coles, Daniel, and Naveen (2006) extend the findings of Guay (1999) to examine whether the convexity in CEO incentives has a causal effect on firm investment and financing policies and firm risk. Using pooled time series cross-sectional regressions and simultaneous equations methods, they find evidence that the level of convexity is positively related to R&D expenditures, leverage, and firm risk (measured by volatility) and is negatively related to capital expenditures (which they view as low-risk investments). Chava and Purnanandam (2010) also find a positive association between convexity and leverage and further show that greater convexity is also associated with lower cash balances. These authors interpret their results as evidence that managers with greater amounts of convexity in their compensation implement riskier investment and financing choices. If the relation between convexity and firm policy choices is causal, then at a minimum we should observe less risky policy choices by managers as firms shift away from option-based compensation and decrease the convexity in compensation contracts in response to FAS 123R.

Our earlier findings demonstrate that the change in option usage (and convexity) following FAS 123R varies considerably across firms (see Table 3). In Table 5 we present a formal analysis of the relation between changes in firm policies and changes in convexity that corresponds to our identification strategy. As described in Section 3, our identification strategy allows us to exploit the cross-sectional relation between changes in firm policies and volatility and changes in convexity, while controlling for other potential determinants of firm policies and volatility that might have changed over this period. For each firm, we compute average levels of the firm policy variables, volatility, and incentive measures in the pre- and post-FAS 123R periods. We then take the within-firm difference of each variable and regress the changes in firm policies and firm risk on changes in the incentive measures of compensation structure (*Vega_t* and *Delta_t*). While the conventional wisdom predicts a positive relation between *Vega_t* and risk taking, the relation between *Delta_t* and risk taking is more ambiguous. As noted elsewhere in the literature, delta has two potential effects on risk taking. First, a higher delta more closely aligns the manager's incentives to increase stock price with those of shareholders. Second, an increase in delta exposes the manager to additional risk, which dampens the manager's incentives to increase risk. Thus the predicted relation between changes in delta and changes in firm policies is unclear. The regressions also control for changes in a number of additional firm characteristics. For *R&D*, *CAPEX*, and *Volatility*, we use the control variables from the specifications in Coles, Daniel, and Naveen (2006), and for *Leverage* and *Cash*, we follow the specifications in Chava and Purnanandam (2010).

The results in the table indicate that decreases in convexity are not generally accompanied by less risky

Table 5
Cross-sectional regressions describing changes in investment and financing policies and firm risk around the adoption of FAS 123R.

The table contains results from cross-sectional regressions describing changes in investment and financing policies and firm risk around FAS 123R. We take the average of each variable for each firm pre- and post-FAS 123R and use the difference in the regression. The sample consists of 1,153 firm observations surrounding the adoption of FAS 123R. The dependent variables in the regressions are various investment and financing policies measures and stock volatility. The independent variables in the regressions mainly follow Coles, Daniel, and Naveen (2006) and Chava and Purnanandam (2010). Variables are defined in Appendix B. The table reports *t*-statistics based on robust standard errors clustered at the firm level in parentheses. ***=significant at 1%, **=significant at 5%, *=significant at 10%.

Independent variable	Change in *R&D*	Change in *CAPEX*	Change in *Leverage*	Change in *Cash*	Change in *Volatility*
Change in *Vega_t*	0.00000689	−0.0000111***	−0.0000340*	−0.00000569	−0.0000666
	(1.32)	(−2.61)	(−1.65)	(−0.39)	(−1.16)
Change in *Delta_t*	−0.00000120*	0.000000722	−0.00000425**	−0.00000419*	−0.00000591
	(−1.75)	(0.95)	(−2.02)	(−1.72)	(−0.62)
Change in *Cash Compensation*	0.000000734**	0.00000124			−0.00000462
	(2.30)	(1.30)			(−0.94)
Change in *Log (Sale)*	−0.00486	0.00255	0.00237		0.00136
	(−1.20)	(0.76)	(0.16)		(0.05)
Change in *MTB*	0.00587**	0.00697***		0.0213***	−0.0000332
	(2.19)	(4.14)		(3.70)	(−0.00)
Change in *Surplus Cash*	−0.0314	0.0372**			
	(−0.69)	(2.04)			
Change in *Sales Growth*	−0.0405***	0.00268			
	(−3.92)	(0.36)			
Change in *Last Year's Stock Return*	0.00516*	−0.0124***			
	(1.70)	(−4.26)			
Change in *Leverage*	−0.0126	−0.0213**		−0.162***	0.212***
	(−0.94)	(−2.50)		(−5.00)	(2.90)
Change in *ROA*			0.274**		
			(2.34)		
Change in *Modzq*			−0.0786***		
			(−7.06)		
Change in *RDS*			0.0401*	0.0158	
			(1.91)	(0.87)	
Change in *PPE*			0.117		
			(1.50)		
Change in *Rated*			0.0997***		
			(4.24)		
Change in *Firm size*				−0.0231***	
				(−2.76)	
Change in *Cflow*				0.0423	
				(0.90)	
Change in *Net Working Capital*				−0.247***	
				(−5.18)	
Change in *Acquisition*				−0.162**	
				(−2.34)	
Change in *CAPEX*				−0.364***	0.690**
				(−4.03)	(2.18)
Change in *Dividend Payer Indicator*				−0.00551	
				(−0.56)	
Change in *Tenure*					−0.000183
					(−0.09)
Change in *R&D*					0.245
					(0.71)
N	1,132	1,132	1,153	1,136	1,115
Adjusted R^2	0.117	0.066	0.129	0.158	0.009

firm investment and financing policies and lower firm risk. Focusing specifically on the coefficient on the change in *Vega_t*, we find that no significant relation exists between the change in *Vega_t* and changes in R&D expense or cash balances. The table does show that the change in *Vega_t* is negatively associated with changes in capital expenditures.

Although this result goes in the correct direction to support the risk-taking explanation for convexity, the economic magnitude is small. Specifically, a 1 standard deviation increase in the change in *Vega_t* would decrease *CAPEX* by approximately 0.0027. The relation between the change in *Vega_t* and change in *Leverage* is statistically significant at the 10% level, but the sign of the coefficient is opposite to what would be expected under the risk-taking story. The regression analysis shows no significant relation between changes in *Vega_t* and changes in *Volatility*. Thus, although both *Vega_t* and *Volatility* have declined over the sample period (see Table 1, Panel B), the changes in convexity are unrelated to the changes in *Volatility* in the cross section. Further, the sign on the coefficient estimate is opposite to what one would expect if convexity increases risk-taking incentives. Finally, the table shows that changes in *Delta_t* are unrelated to changes in *CAPEX* and *Volatility* and negatively related to changes in *R&D*, *Leverage*, and *Cash* (although again the economic magnitudes are very small).

5.4. Controlling for LTIA compensation

One concern with the analysis is the possibility that firms have replaced the convexity in the option component of compensation with convexity in some other compensation component. Restricted stock generally has (near) zero convexity. However, long-term incentive awards can potentially be structured to provide a convex relation between the payoff to the manager and firm performance.[14] Typical LTIAs are structured to deliver a certain number of shares to the manager as a function of firm performance. In most cases, LTIAs define the threshold number, the target, and the maximum number of shares to be awarded to the manager for different performance levels, where performance is generally based on a variety of accounting or stock return measures. However, firms seldom disclose the exact formulas used to determine the award sizes, thus making it difficult to develop a direct measure of convexity.[15] To explore the possibility that firms replace the convexity from options with convexity in other sources of compensation, in supplemental analyses we replace the changes in *Vega_t* and *Delta_t* with changes in the fraction of total compensation coming from the sum of options and LTIAs.[16] We find that the change in the fraction of compensation coming from options and LTIAs is unrelated to the changes in *R&D* and capital expenditures. The change in the fraction of compensation from options and LTIAs is negatively related to the change in leverage and the change in cash balances. The negative association with cash balances is consistent with the view that convexity in compensation increases incentives for risk taking, while the negative coefficient on leverage is inconsistent with that view.

We also explore how LTIAs might influence our conclusions in a more direct way. We divide the sample into two subsamples according to the change in the proportion of LTIAs in compensation from pre- to post-FAS 123R. In these two subsamples, we view the firms that increase the proportion of LTIAs in compensation as having substituted LTIAs for option compensation, while those that decrease or do not change the proportion of LTIAs in compensation are seen as not substituting LTIAs for option compensation. We then reestimate our policy change regressions for these two groups and make the following conjectures based on the assumption that vega and firm policies and firm risk are related: If firms do not use LTIAs to substitute for option convexity, then we should expect that changes in firm policies and firm risk are related to changes in our calculated vega (which includes only the convexity of options). Specifically, we expect to see a positive relation between vega and risk-taking behavior for the subsample of firms in which the proportion of LTIAs in compensation does not increase. In contrast, for the group of firms that increase their use of LTIAs, the relation between changes in firm policies and firm risk and changes in our calculated vega (which does not include the convexity of LTIAs) is unclear. The results are shown in Table 6. Panel A presents the analysis of the firms for which the proportion of LTIAs does not increase. In this sample of firms, which do not appear to have substituted LTIAs for options, we do not find any evidence showing that changes in firm policies and firm risk and vega are related. Finally, while the predictions for the sample of firms that increased the proportion of LTIAs in compensation are ambiguous, we also observe no significant relations between changes in firm policies and firm risk and vega for these firms in our Panel B results.

In sum, our analyses in Tables 5 and 6 provide little evidence in support of the necessary condition (i.e., that increases in the convexity of compensation are positively correlated with changes in firm policies related to risk taking) that would be needed to support a causal relation between convexity in the compensation contract and managerial risk taking.

6. Conclusion

We provide new evidence on the relation between convexity in compensation contracts induced through the use of option-based compensation and risk-taking behavior by managers. Prior studies find that firms with characteristics that proxy for greater risk-related agency problems exhibit greater convexity in the CEO's wealth-performance relation. Other studies further argue that option-based compensation has a causal effect on firm financing and investment policies,

[14] Our previous analysis makes the assumption that LTIAs do not provide convexity.

[15] In supplemental analysis, we follow the procedure in Hall and Murphy (2002) and make numerical assumptions to approximate the convexity introduced by LTIAs. In particular, we map the LTIA payoff into stock prices using assumptions about the vesting period, the distribution of stock prices, and the relation between award payouts and stock prices. We find that the additional convexity provided by LTIAs in our sample is not enough to keep the overall convexity in compensation from decreasing following FAS 123R. However, given the number of assumptions involved in these calculations, it is difficult to draw strong conclusions from this analysis and we do not include it in the paper. The calculations are available in the Internet Appendix 〈http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1571991〉.

[16] Another way that firms could induce convexity is by inducing leverage in the CEO's personal portfolio. This is unlikely in our sample, however, because the Sarbanes-Oxley Act of 2002 banned corporate loans to executives.

Table 6
Long-term incentive award (LTIA) change subsamples: cross-sectional regressions describing changes in investment and financing policies and firm risk around the adoption of FAS 123R.

The table contains results from cross-sectional regressions describing changes in investment and financing policies and volatility around FAS 123R. We first divide the sample into subsamples that decrease or do not change and increase the proportion of LTIA in compensation from pre- to post-FAS123R. We then follow a process similar to that described in Table 5. We take the average of each variable for each firm pre- and post-FAS 123R and use the difference in the regression. The sample consists of 1,153 firm observations surrounding the adoption of FAS 123R. The dependent variables in the regressions are various investment and financing policy measures. The independent variables in the regressions mainly follow Coles, Daniel and Naveen (2006) and Chava and Purnanandam (2010). Variables are defined in Appendix B. The table reports *t*-statistics based on robust standard errors clustered at the firm level in parentheses. Asterisks denote statistical significance. *=significant at 10%.

Independent variable	Change in *R&D*	Change in *CAPEX*	Change in *Leverage*	Change in *Cash*	Change in *Volatility*
Panel A: Decrease or do not change the proportion of LTIA in compensation					
Change in *Vega_t*	0.00000479	−0.00000855	−0.0000330	0.00000340	−0.000107
	(0.55)	(−1.47)	(−1.50)	(0.15)	(−1.53)
Change in *Delta_t*	−0.00000134	0.00000103	−0.00000416*	−0.00000368	−0.00000478
	(−1.54)	(1.14)	(−1.65)	(−1.20)	(−0.42)
Panel B: Increase the proportion of LTIA in compensation					
Change in *Vega_t*	0.00000816	−0.00000887	−0.0000290	−0.00000738	−0.0000323
	(1.34)	(−1.64)	(−0.78)	(−0.40)	(−0.30)
Change in *Delta_t*	−0.00000103	0.000000580	−0.00000408	−0.00000497	−0.0000177
	(−1.07)	(0.63)	(−0.93)	(−1.34)	(−0.87)

where managers subjected to more convex compensation implement more risky firm policy choices.

We examine the relation between option-based compensation and risk taking using the revised accounting standard that changed the income statement treatment of stock options as an exogenous shock to the accounting benefits of options that had no effect on the economic costs and benefits of stock options. Our findings show that firms dramatically decrease their usage of option-based compensation following the change in the accounting standards. Moreover, the decline in option usage is larger for firms that would face higher accounting charges under FAS 123R but is generally unrelated to firm characteristics that prior literature has identified as proxies for risk-related agency problems. We further show that the reduction in option usage leads to a decrease in the convexity of compensation, but that little evidence exists that the reduction in convexity is associated with corresponding reductions in risky firm policy choices. Overall, our results are difficult to reconcile with the idea that the provision of incentives for risk taking was a primary rationale for the use of stock options in compensation contracts. Instead, our results provide new evidence that the accounting treatment of stock options was an important factor affecting firms' decisions to use stock options to compensate their executives.

Nevertheless, although option usage declines significantly following the implementation of FAS 123R, stock options have not completely disappeared. Understanding the effects of convexity in compensation on managerial behavior and the extent to which options represent an efficient mechanism for conveying compensation and incentives to managers remains an important challenge for the literature.

Appendix A. Compensation variable reference under the old and new Securities and Exchange Commission reporting requirements

If a specific Chief Executive Officer (CEO) exists in the Annual Compensation table but is missing in other tables, we treat the corresponding variables in those tables as zero.

See Table A1.

Appendix B. Variable definitions

R&D—Research and development expenditures to total assets—Max (0, *xrd*)/*at*.
MTB—($prcc\_f \times csho + lt$)/*at*.
CAPEX—*capx*/*at*.
Leverage—($dlc + dltt$)/*at*.
Cash—*che*/*at*.
Firm size—log(*at*).
Volatility—Standard deviation of past 36 months' monthly stock return × square root of 12.
Market Volatility—Standard deviation of past 36 months' monthly market return × square root of 12 (market volatility for each firm is calculated at its fiscal year-end).
Tenure—Time between fiscal year-end (datadate) and the day executive became chief executive officer (becameceo)
Cash Compensation—salary + bonus (bonus is defined in Appendix A).
Log (Sale)—log (*sale*).
Surplus Cash—(*oancf-dpc*+*xrd*)/*at*.
Sales Growth—$\log(sale_t/sale_{t-1})$.
ROA—*oibdp*/*at*.
PPE—*ppent*/*at*.
Net Working Capital—(*act-lct-che*)/*at*.
Acquisition—*aqc*/*at*.
Modzq—quartile of the following variable: $(3.3 \times ebit + 1 \times sale + 1.4 \times re)/at + 1.2 \times wc$.
RDS—Max (0, *xrd*)/*sale*.
Rated—equals one if the variable splticrm in Compustat indicates a rating.
Cflow—*ebitda*/*at*.
Dividend Payer Indicator—*dvc*.
Accounting Impact—*xintopt*/*cshfd*.

Table A1

	Data set	Table	Variable from Wharton Research Data Services	Note
Old format				
Salary	Compustat North America, Executive Compensation	Annual Compensation	SALARY	The variable is the dollar value of salary
Bonus	Compustat North America, Executive Compensation	Annual Compensation	BONUS	The variable is the dollar value of bonus
Stock options (current grant)	Compustat North America, Executive Compensation	Stock Option Grants—1992 format	EXPRIC (Exercise Price), EXDATE (Expiration Date), NUMSECUR (Number of Options Granted)	1. We assume the grant date is July 1 of that year. 2. In the calculation, we use 0.7 times the period between grant date and option expiration date as the option term. 3. Stock options are valued at fiscal year-end, so the stock price we use is the market price at fiscal year-end
Stock options (prior grant)	Compustat North America, Executive Compensation	Annual Compensation	OPT_UNEX_UNEXER_NUM, OPT_UNEX_EXER_NUM, OPT_UNEX_UNEXER_EST_VAL, OPT_UNEX_EXER_EST_VAL	We follow Core and Guay (2002) to approximately estimate delta and vega for prior grants
Restricted stock (current grant)	Compustat North America, Executive Compensation	Annual Compensation	RSTKGRNT	The variable is the dollar value of restricted stock. By dividing this number by the fiscal year end stock price, we back out the approximate number of shares of restricted stock granted
Restricted stock (prior grant)	Compustat North America, Executive Compensation	Annual Compensation	SHROWN_EXCL_OPTS	This variable also includes common stock holdings
Long-term incentive awards (LTIAs) (current grant)	Compustat North America, Executive Compensation	Long Term Incentive Awards—1992 Format	SHRTARG Num Target Future Payout (# shares), VALTARG Num Target Future Payout ($)	Firms report SHRTARG or VALTARG or both. LTIAs are settled with stock. By multiplying SHRTARG or dividing VALTARG by fiscal year end stock price, we back out the approximate value or number of shares of stock granted under LTIAs
Long-term incentive awards (prior grant)	Compustat North America, Executive Compensation	Long Term Incentive Awards—1992 Format	LT_PERIOD, SHRTARG Num Target Future Payout (# shares), VALTARG Num Target Future Payout ($)	We assume that the chief executive officer holds each year's new grant for the time period of LT_PERIOD
New format				
Salary	Compustat North America, Executive Compensation	Annual Compensation	SALARY	The variable is the dollar value of salary.
Bonus	Compustat North America, Executive Compensation	Annual Compensation, Plan-Based Awards (PBA)	BONUS+NON_EQ_TARG	When Plan-Based Awards table reports a nonzero NON_EQ_TARG number, bonus is calculated as BONUS (in Annual Compensation table) plus NON_EQ_TARG (in Plan-Based Awards).
Stock options (current grant)	Compustat North America, Executive Compensation	Plan-Based Awards, Outstanding Equity Awards (OEA)	EXPRIC (Exercise Price)—PBA, EXDATE (Expiration Date)—OEA, OPTS_GRT (Number of Options Granted)—PBA	1. Although Plan-Based Awards table reports the grant date, we assume the grant date is July 1 of that year to maintain consistency with the old table. 2. In the calculation, we use 0.7 times the period between grant date and option expiration date as the option term. 3. EXDATE is reported in OEA, and we use both Exercise Price and Number of Options Granted to match the expiration date for a specific grant. There are four ways to match the expiration date for a specific grant: (1) OPTS_GRT (PBA table)=OPTS_UNEX_UNEARN (OEA table); (2) OPTS_GRT (PBA table)=OPTS_UNEX_EXER+OPTS_UNEX_UNEXER (OEA table); (3) OPTS_GRT (PBA table)=OPTS_UNEX_EXER (OEA table); and (4) OPTS_GRT (PBA table)=OPTS_UNEX_UNEXER (OEA table) 4. Stock options are valued at fiscal year-end, so the stock price we use is the market price at fiscal year-end.

Table A1 (*continued*)

	Data set	Table	Variable from Wharton Research Data Services	Note
Stock options (prior grant)	Compustat North America, Executive Compensation	Annual Compensation	OPT_UNEX_UNEXER_NUM, OPT_UNEX_EXER_NUM, OPT_UNEX_UNEXER_EST_VAL, OPT_UNEX_EXER_EST_VAL	We follow Core and Guay (2002) to approximately estimate delta and vega for prior grants.
Restricted stock (current grant)	Compustat North America, Executive Compensation	Plan-Based Awards	STOCK_AWARDS_FV	By dividing this number by the fiscal year-end stock price, we calculate the number of shares of restricted stock granted.
Restricted stock (prior grant)	Compustat North America, Executive Compensation	Annual Compensation	SHROWN_EXCL_OPTS	This variable also includes common stock holdings.
Long-term incentive awards (current grant)	Compustat North America, Executive Compensation	Plan-Based Awards	EQ_TARG	By multiplying this number by the fiscal year-end stock price, we calculate the value of stock granted under LTIAs
Long-term incentive awards (prior grant)	Compustat North America, Executive Compensation	Annual Compensation	EIP_UNEARN_VAL	We use this number as the approximate value for prior LTIA grant. By dividing this number by the fiscal year end stock price, we back out the number of shares of stock granted under LTIAs.

*Post-123*R—equal to one for the post-FAS 123R period (which is defined as fiscal years 2005 through 2008) and zero otherwise.

New economy firms are defined as organizations competing in the computer, software, internet, telecommunications, or networking fields. Correspondingly, we classify a firm as new economy if standard industrial classification code is 3570, 3571, 3572, 3576, 3577, 3661, 3674, 4812, 4813, 5045, 5961, 7370, 7371, 7372, or 7373.

P_Salary—Dollar value of salary/dollar value of total compensation including salary, bonus, stock options, restricted stock, and long-term incentive awards.

P_Bonus—Dollar value of bonus/dollar value of total compensation including salary, bonus, stock options, restricted stock, and long-term incentive awards.

P_Option—Dollar value of stock options/dollar value of total compensation including salary, bonus, stock options, restricted stock, and long-term incentive awards.

P_RS—Dollar value of restricted stock/dollar value of total compensation including salary, bonus, stock options, restricted stock, and long-term incentive awards.

P_LTIA—Dollar value of long-term incentive awards/ dollar value of total compensation including salary, bonus, stock options, restricted stock, and long-term incentive awards.

Delta_c—(Black-Scholes Delta of all current option grants + number of shares of current restricted stock grants + number of targeted shares granted under LTIA) $\times$ (fiscal year-end price $\times$ 0.01).

Delta_t—(Black-Scholes Delta of all current option grants + number of shares of current restricted stock grants + number of targeted shares granted under LTIA + Black-Scholes Delta of all prior option grants + number of prior shares of restricted stock + number of prior shares granted under LTIA) $\times$ (fiscal year-end price $\times$ 0.01).

Vega_c—(Black-Scholes Vega of all current option grants $\times$ 0.01).

Vega_t—(Black-Scholes Vega of all current option grants + Black-Scholes Vega of all prior option grants) $\times$ 0.01.

NumOpt_share_c—Number of options granted in current year $\times$ 1,000/csho.

Black-Scholes Delta (Vega) of options is defined as first partial derivative of value of option with respect to stock price (stock volatility).

References

Amihud, Y., Lev, B., 1981. Risk reduction as a managerial motive for conglomerate mergers. Bell Journal of Economics 12, 605–617.

Bettis, C., Bizjak, J., Lemmon, L., 2005. Exercise behavior, valuation, and the incentive effects of employee stock options. Journal of Financial Economics 76, 445–470.

Carpenter, J., 2000. Does option compensation increase managerial risk appetite? Journal of Finance 55, 2311–2331.

Carter, M., Lynch, L., Tuna, I., 2007. The role of accounting in the design of CEO equity compensation. The Accounting Review 82, 327–357.

Chava, S., Purnanandam, A., 2010. CEOs vs. CFOs: incentives and corporate policies. Journal of Financial Economics 97, 263–278.

Coles, J., Daniel, N., Naveen, L., 2006. Managerial incentives and risk taking. Journal of Financial Economics 79, 431–468.

Core, J., Guay, W., 1999. The use of equity grants to manage optimal equity incentive levels. Journal of Accounting and Economics 28, 151–184.

Core, J., Guay, W., 2002. Estimating the value of employee stock option portfolios and their sensitivities to price and volatility. Journal of Accounting and Research 40, 613–630.

Dittmann, I., Maug, E., 2007. Lower salaries and no options? On the optimal structure of executive pay. Journal of Finance 62, 303–343.

Dittmann, I., Maug, E., Spalt, O., 2010. Sticks or carrots? Optimal CEO compensation when managers are loss-averse. Journal of Finance 65, 2015–2050.

Gormley, T., Matsa, D., Milbourn, T., 2010. CEO Compensation and Corporate Risk Taking: Evidence from a Natural Experiment. Unpublished Working Paper. Northwestern University and Washington University in St. Louis.

Guay, W., 1999. The sensitivity of CEO wealth to equity risk: an analysis of the magnitude and determinants. Journal of Financial Economics 53, 43–71.

Hall, B., Liebman, J., 1998. Are CEOs really paid like bureaucrats? Quarterly Journal of Economics 113, 653–691.

Hall, B., Murphy, K., 2002. Stock options for undiversified executives. Journal of Accounting and Economics 33, 3–42.

Hall, B., Murphy, K., 2003. The trouble with stock options. Journal of Economic Perspectives 17, 49–70.
Himmelberg, C.P., Hubbard, R.G., Palia, D., 1999. Understanding the determinants of managerial ownership and the link between ownership and performance. Journal of Financial Economics 53, 353–384.
Holmstrom, B., 1979. Moral hazard and observability. Bell Journal of Economics 10, 74–91.
Ittner, C., Lambert, R., Larcker, D., 2003. The structure and performance consequences of equity grants to employees of new economy firms. Journal of Accounting and Economics 34, 89–127.
Jensen, M., Murphy, K., 1990. Performance pay and top-management incentives. Journal of Political Economy 98, 225–264.
Lambert, R., Larcker, D., Verrecchia, R., 1991. Portfolio considerations in valuing executive compensation. Journal of Accounting Research 29, 129–149.
Lewellen, K., 2006. Financing decisions when managers are risk-averse. Journal of Financial Economics 82, 551–590.
Low, A., 2009. Managerial risk taking behavior and equity-based compensation. Journal of Financial Economics 92, 470–490.
Murphy, K., 2003. Stock-based pay in new economy firms. Journal of Accounting and Economics 34, 129–147.
Ross, S.A., 2004. Compensation, incentives, and the duality of risk aversion and riskiness. Journal of Finance 59, 207–225.
Shavell, S., 1979. Risk sharing and incentives in the principal and agent relationship. Bell Journal of Economics 10, 55–73.
Smith, C., Stulz, R., 1985. The determinants of firms' hedging policies. Journal of Financial and Quantitative Analysis 20, 391–405.
Zhou, X., 2001. Understanding the determinants of managerial ownership and the link between ownership and performance: comment. Journal of Financial Economics 62, 559–571.