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Optimal compensation contracts when managers can hedge ☆

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ABSTRACT

This paper examines optimal compensation contracts when executives can hedge their personal portfolios. In a simple principal-agent framework, I predict that the Chief Executive Officer's (CEO's) pay-performance sensitivity decreases with the executive-hedging cost. Empirically, I find evidence supporting the model's prediction. Providing further support for the theory, I show that shareholders also impose a high sensitivity of CEO wealth to stock volatility and increase financial leverage to resolve the executive-hedging problem. Moreover, executives with lower hedging costs hold more exercisable in-the-money options, have weaker incentives to cut dividends, and pursue fewer corporate diversification initiatives. Overall, the manager's ability to hedge the firm's risk affects governance mechanisms and managerial actions.

> An executive who hedges is a little bit like the captain of a ship who sees an iceberg up ahead and heads for his lifeboat without waking the sleeping passengers (Louis Lavelle, 2001, p. 70).

1. Introduction

Equity-based compensation is widely regarded as an effective way to align managers' interests with those of their shareholders. Most of the literature on executive compensation is built on an essential assumption that managers cannot hedge their incentive portfolios. However, executives can certainly employ a number of financial instruments to hedge the risk in their compensation packages. Bettis, Bizjak, and Lemmon (2001) show that there has been a huge increase in the development and use of financial derivatives to enable corporate insiders to hedge stock ownership in their firms. These hedging transactions cover about 30% of executives'

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firm-specific wealth (Jagolinzer, Matsunaga, and Yeung, 2007). Stulz (1984, p. 139) explicitly states, "It would be interesting to show how the choice of the management compensation schemes depends on the opportunities managers have to hedge."

This paper analyzes the impact of managerial hedging on executive compensation from both a theoretical and empirical perspective. First, I extend Holmstrom and Milgrom's (1987) principal-agent model by allowing a manager to costly hedge her incentive portfolio. The access to the hedging market increases the manager's ability to bear risk, and it decreases her incentive to exert effort. In equilibrium, shareholders should provide a higher-power contract so that the manager's after-hedging incentive is closer to the optimal level. The central empirical prediction of the model is that the pay-performance sensitivity in compensation contracts decreases alongside the manager's hedging cost.

In the empirical tests, I use two variables to measure the executive hedging cost. The first one is a dummy indicating whether the firm has listed options on the option exchanges or not. When the firm has publicly tradable options, it is easier and less costly for managers to unwind their incentive pay through derivative markets (e.g., buying put options, or short selling call options). Regarding my second proxy, for firms with traded options I measure the hedging cost using the average daily trading volume of the firms' options. Intuitively, a high volume indicates high liquidity and active trading of the firm's derivatives, which lowers the cost of making derivative transactions. These two proxies capture the opportunity that managers have to hedge through the public option market. Using a large set of compensation data, I then provide empirical evidence supporting the model's prediction.

To further my understanding of how managerial hedging influences compensation contracts, I examine the sensitivity of Chief Executive Officer (CEO) wealth to stock return volatility, which captures the convexity of the relation between CEO wealth and stock price. As suggested by prior literature (e.g., Smith and Stulz, 1985), the optimal convexity in CEO pay is determined by the benefit of inducing the CEO to take risky value-increasing projects and the cost of compensating her to bear risk. When managers can hedge more easily, the disutility imposed by the risk in their incentive pay becomes smaller; thus, the optimal convexity should be higher. Consistent with this view, I find that a CEO with lower hedging costs receives an incentive pay of greater sensitivity to stock return volatility.

Given that stock-based pay is one of a few mechanisms that can be used to discipline managers, another related question is whether shareholders use other governance policies to resolve managerial agency problems in response to executive hedging. Specifically, I deal with this question by investigating corporate capital structure. As a substitute for incentive contracts, existing studies (e.g., Jensen, 1986; Stulz, 1990) suggest that debt can be used as a powerful tool to discipline managers. Shareholders should use more debt when it is easier for their managers to unwind incentive pay, because the incentive contract is less effective in this situation (Garvey, 1997). Consistent with this view, firms are found to have higher debt levels when their managers have better hedging opportunities, and this relation is stronger for better-governed companies. This evidence also supports the implication that shareholders use other mechanisms (besides offering higher-power contracts), such as alterations to the capital structure, to overcome the executive hedging problem.

Whether or not a manager can hedge clearly influences the way she deals with her personal portfolio. To understand this issue, I examine how executives rebalance their personal portfolios when hedging transactions are possible. Given the fact that a big portion of managers' wealth is tied to their own firms, these under-diversified and risk-averse managers have strong incentives to diversify their portfolios by unwinding their equity holdings. Therefore, they should be eager to exercise their stock options when available and in-the-money (Hall and Murphy, 2002; Malmendier and Tate, 2005). However, when managers can hedge their compensation portfolios to some extent, they will suffer less disutility from bearing risk, and will be less eager to exercise their vested options (Bettis, Bizjak, and Lemmon, 2005; Carpenter, 1998; Hemmer, Matsunaga, and Shevlin, 1996). In other words, managers are supposed to hold more exercisable in-the-money options when they have a low hedging cost. The empirical analysis supports this view.

A natural extension of my study is to examine how executive hedging influences managers' decisions on corporate policies. The basic idea is quite intuitive: Managers who can hedge are less influenced by their incentive pay. In particular, I examine the corporate dividend payout in the presence of managerial hedging. Executive stock options induce managers to reduce corporate dividends because the payment of dividends, ceteris paribus, reduces the value of call options (Lambert, Lanen, and Larcker, 1989; Fenn and Liang, 2001). However, if managers have hedged their incentive portfolios, they will not have that strong motivation to avoid dividends, simply because paying dividends has less of a negative effect on their personal wealth. Empirically, I provide evidence that executive hedging weakens the negative relation between stock option compensation and dividend payout. This result also supports a broader view that managerial hedging undermines the influence of incentive pay on management decision-making.

In addition, this paper examines the impacts of executive hedging on corporate diversification. To the extent that firm diversification is another way for managers to reduce risk, I argue that hedging a personal portfolio and making corporate diversification are substitutes for executives to decrease the idiosyncratic firm risk they face. Consistent with this argument, I find that managers diversify their companies less when it is less costly to hedge their incentive pay.

I implement an extensive additional investigation to understand better the relationship between executive hedging and compensation contracts. I argue that CEOs working within the financial industry may have better chances to implement over-the-counter (OTC) hedging transactions and thus, shareholders should impose higher-power incentive contracts. Supporting this idea, CEOs in the financial industry are found to have higher pay-performance sensitivity than CEOs in other industries. I then collect a sample of CEOs who actually hedged and find that a CEO is more likely to engage in the explicit hedging activities when her hedging cost is smaller and when she holds a bigger incentive portfolio.

This paper makes several contributions to the literature. First, it identifies the executive hedging cost as an important determinant to executive compensation structure. To the best of my knowledge, this is the first paper that empirically examines how management compensation schemes depend on managers' opportunities to hedge. In addition, my research also furthers our understanding of capital structure as a substitute mechanism for compensation contracts in resolving managerial agency problems.

Second, this article provides insight into managers' personal financial decision-making. The exercise behavior of executive stock options is quite an important topic for compensation research because it is crucial to the valuation of employee stock options (Huddart and Lang, 1996). My paper contributes to this literature by showing the important impact of managerial hedging on the managers' option-exercising decisions.

Third, beyond the implications for CEO pay, this study also improves the understanding of managerial incentive in making corporate policies. Stock-based compensation is an often-cited factor that influences corporate decisions. This influence clearly depends on whether or not managers can hedge. Therefore, this research sheds more light on dividend policy and corporate diversification through the lens of executive hedging.

Lastly, this paper reveals indirect evidence that executives tend to use public derivative markets to unwind their incentive portfolios and that shareholders consider those publicly tradable derivatives when designing compensation contracts.

The article proceeds as follows. Section 2 introduces some background and related literature. Section 3 presents the model and provides the empirical prediction. Section 4 describes the data source and sample construction. Section 5 reports the empirical results. An additional investigation is conducted in Section 6 and Section 7 concludes.

2. Background on executive hedging

Current legal system and managerial contracts play a very limited role in governing executive hedging transactions. While it is illegal for managers to short sell their own firms' stock, it is legal for them to buy put options as long as the amount of securities underlying the put equivalent position does not exceed the amount of underlying securities otherwise owned.[1] It is also illegal for insiders to trade derivatives based on material value-relevant information (insider trading). Although some hedging transactions of executives could be correlated with insider trading (Bettis, Bizjak, and Lemmon, 2001), this paper concentrates on the pure hedging purpose. As summarized by Schizer (2000), although existing executive contracts and security law have put some barriers up to managerial hedging, their gaps are still significant. Bebchuk, Fried, and Walker (2002) suggest that executives have freedom to access the financial market to hedge. As pointed out by Garvey (1997), the direct bans on management hedging are costly to enforce because the securities market is sufficiently rich and liquid that the manager's participation in hedging cannot be perfectly controlled.

Business practice has long witnessed the prevalence of executive hedging activities. Puri (1997) reports that a growing number of banks are marketing derivatives to help executives hedge. In the *Wall Street Journal*, Simon (2000, p. C1) states, "It is impossible to precisely gauge the popularity of these hedges, but derivatives specialists suggest that hundreds, perhaps even a couple of thousand, are executed each year." Schizer (2000) points out that the growing importance of equity-based compensation is accompanied by the simultaneous increase in the derivative instruments, which managers can use to hedge.

Existing studies find three forms of OTC derivatives used by executives to hedge: zero-cost collars (collar), equity swaps, and prepaid variable forward contracts (PVFs). A collar involves the simultaneous purchase of a put option and sale of a call option covering the firm's stock. The holders are protected from the downward movement in the stock price below the strike price of the put, while they forgo the profit from the stock price appreciation above the strike price of the call. An equity swap agreement enables managers to exchange the future returns on their stock for the cash flows of another financial instrument, such as LIBOR and the S&P500 index. Based on 89 transactions on collars and equity swaps during 1996–1998, Bettis, Bizjak, Lemmon (2001) show that these transactions involve high-ranking executives and effectively reduce their ownership by 25% on average.

In a PVF agreement, the executive promises to sell the firm's shares, usually to an investment bank, at some future date in exchange for an up-front cash advance. Similar to zero-cost collars, a PVF provides holders protection against depreciation of the underlying stock price. However, the holders can still benefit from the price appreciation up to a predetermined level. Jagolinzer, Matsunaga, and Yeung (2007) show that an average PVF covers about 30% of the executive's personal holdings, corresponding to around $22 million.

Both the academic and the practitioner have expressed great concern over the managerial hedging issue. The Economist (1999, p. 64) states, "Such hedging is wholly against the spirit of the massive awards of shares and share options." Ofek and Yermack (2000) and Antle and Smith (1986) argue that the optimal contracting model should take the managers' freedom to hedge away the risk in their compensation into account.

Despite the significant literature on executive compensation, the understanding of managerial hedging is

[1] See Section 16 (c) of the Securities and Exchange Act of 1934 and Rule 16c-4.

quite limited. Jin (2002) and Garvey and Milbourn (2003) study the case in which executives can trade market indexes. Jin (2002) mainly addresses the effects of firm idiosyncratic and systematic risk on compensation contracts; the latter one focuses on justifying the rare use of relative performance evaluation. My paper complements their research by examining the case when managers can diversify their firm-specific risk exposure. More importantly, this article provides an extensive empirical analysis on the influence of managerial hedging on compensation contracts and corporate policies.[2]

3. The model

This section presents a standard principal-agent model in which the manager can hedge her equity holdings at a certain hedging cost. The structure of the model follows Holmstrom and Milgrom (1987).

One risk-averse manager works in a firm owned by risk-neutral investors. The manager's utility function is given by

$$U(w,a) = -\exp\left[-\eta\left(w - \frac{c}{2}a^2\right)\right], \tag{1}$$

where w is the manager's total wage, a is her effort level, η is the coefficient of risk aversion, and $c>0$ is a constant reflecting the manager's aversion to effort. The firm's cash flow, p, equals the manager's effort plus noise:

$$p = a + \varepsilon, \tag{2}$$

where ε is normally distributed with zero mean and variance σ^2. The manager gets a compensation package in the form:

$$t + sp, \tag{3}$$

where t is the fixed pay level and s is the performance-based component of her compensation. Equivalently, t is the manager's fixed salary and s is her share of the firm.

Similar to the classical papers of Holmstrom and Milgrom (1987, 1991), I restrict my attention to a linear contract for algebra simplification. The optimality of the linear contract is based on the critical assumption of a constant absolute risk aversion utility function. Although a linear sharing rule might not be optimal with more general preference, it is still a good approximation to the practice of executive compensation. Jin (2002, footnote 6) states, "In practice, however, the sharing rule is often close to linear because the convexity induced by CEO option holdings is negligible to the first order." It is also worth noting that although the shares granted in the model are shares of firm assets p, and not the equity $p-t-sp$, the affine relation between assets and equity means that the contract also provides cash and $s/(1-s)$ shares of stock, a number which is increasing in s.

The manager has the access to the hedging market, and can trade her shares at the hedging cost of $(\phi/2)x^2$, where x stands for the number of shares traded and $\phi>0$ is a constant capturing her cost of hedging. This model allows a very general form of hedging without being limited to one particular hedging instrument. Similar to Garvey and Milbourn (2003), I am assuming a strict convex function for the hedging cost, reflecting the reasonable assumption that it is costly for managers to take additional steps to either augment or offset their exposure to their own firms' equity. If one interprets the hedging cost as the transaction expense during the asset trading, this convexity is also consistent with the evidence that the transaction cost in financial markets is a convex function of trading size (see, e.g., Breen, Hodrick, and Korajczyk, 2002; Korajczyk and Sadka, 2004). Another interpretation on this hedging cost can be the probability for the manager to be caught in the hedging transactions. As the manager hedges more, there is more likelihood that she will be detected by shareholders and suffer some corresponding penalty.

This hedging cost function incorporates a less reasonable assumption that long positions are as costly as short positions. This is primarily for notational convenience, as we shall see that the actual choices of x are alway negative in equilibrium (i.e., managers always take a short position in the hedging transactions). Assuming symmetric costs for purchasing and selling follows Garvey and Milbourn (2003).[3]

The sequence of the game is described as follows:

Stage 1. The shareholders optimally set the compensation rule (t, s) to maximize the net-of-wage firm value, taking into account the subsequent hedging behavior and the effort of the manager.
Stage 2. The manager trades her shares in the hedging market, where the share price reflects the rational expectation about her subsequent effort level.
Stage 3. The manager chooses her effort. Both the hedging transaction and effort level are chosen to maximize the manager's own utility.
Stage 4. The firm's cash flow is realized and the manager consumes her wealth.

The manager's wealth after hedging is

$$w = t + (s+x)p - xE[p^0] - \frac{\phi}{2}x^2, \tag{4}$$

where $E[p^0]$ is the expected firm value at the hedging market. Since the hedging occurs before the effort is made, $E[p^0]$ reflects the expected managerial effort level $a^0(x)$; in particular, $E[p^0]=a^0(x)$. The notation $a^0(x)$ indicates that the hedging market rationally infers the manager's subsequent effort based on the number of shares hedged. By rewriting the manager's objective in terms of her certainty-equivalent wealth, the following reformulation is obtained:

$$Max_{a,x}\, t + (s+x)a - \frac{c}{2}a^2 - \frac{\eta}{2}(s+x)^2\sigma^2 - \frac{\phi}{2}x^2 - xa^0(x). \tag{5}$$

[2] Other related theoretical work includes Acharya and Bisin (2009), Bisin, Gottardi, and Rampini (2008), and Ozerturk (2006).

[3] Alternatively, the hedging cost can be modeled as $(\phi_1/2)x^2$ when x is the sales, and $(\phi_2/2)x^2$ when x is the purchase $(\phi_1 \neq \phi_2)$. The equilibrium results will be the same; but the algebra is more complicated.

First-order conditions with respect to a and x, respectively, lead to

$$ca* = s+x*, \tag{6}$$

$$a* - \eta(s+x*)\sigma^2 - \phi x* - a^0(x) - x\frac{da^0(x)}{dx} = 0. \tag{7}$$

The rational expectation condition implies

$$a^0(x) = a* = \frac{s+x*}{c}. \tag{8}$$

Eqs. (6)–(8) result in the following solutions to the manager's optimization problem:

$$a* = \frac{\phi+1/c}{c(\phi+\eta\sigma^2+1/c)}s, \tag{9}$$

$$x* = \frac{-\eta\sigma^2}{\phi+\eta\sigma^2+1/c}s. \tag{10}$$

Based on Eq. (9), the effort-compensation sensitivity is $(da*/ds) = (\phi+1/c)/(c(\phi+\eta\sigma^2+1/c))$ and it is increasing in ϕ, implying that managerial effort is more sensitive to her stock-based pay when the hedging is more costly. Eq. (10) shows the intuitive result that the manager hedges more when the hedging cost ϕ is smaller, for a given level of s. When $\phi \to +\infty$, I obtain $x^*=0$, suggesting that the manager will not hedge when it is too costly.

When $\phi=0$, I obtain $x* = -((\eta\sigma^2)/(\eta\sigma^2+1/c))s$. This result means that, even in the case of zero hedging cost, the manager will not hedge all her exposure to the firm-specific risk. Instead, she will still hold a certain number of shares, which are proportional to the initial equity given by the shareholders, because she can exert effort to increase her payoff. To be more specific, the reason that the manager does not fully hedge, even when costless, is to preserve the incentive to exert effort and add value to the shares granted by the firm. Without these "free" shares, it would not be worth taking a positive position, even to capitalize on effort, because the value of effort would immediately be built into the purchase price.[4] This result also implies that stock-based compensation can still provide managers incentive even when managers can freely hedge.

The shareholders maximize the net-of-wage firm value, which is

$$Max_{a,t,s,x} E[p-t-sp]$$
subject to
$$a,x \in \arg\max_{a,x} E\left\{-\exp\left[-\eta\left(w-\frac{c}{2}a^2\right)\right]\right. \quad \text{(IC)}$$

$$E\left\{-\exp\left[-\eta\left(w-\frac{c}{2}a^2\right)\right]\right\} \geq -\exp(-\eta\overline{w})\left.\right\} \quad \text{(IR)}$$

where $\overline{w}$ denotes the manager's reservation wage.

[4] I thank the anonymous referee for providing this explanation.

Based on Eqs. (9) and (10), the principal problem can be rewritten as

$$Max_{a,x,t,s}(1-s)a-t$$
subject to
$$a = \frac{\phi+1/c}{c(\phi+\eta\sigma^2+1/c)}s, \quad x = \frac{-\eta\sigma^2}{\phi+\eta\sigma^2+1/c}s$$
$$t+(s+x)a-\frac{c}{2}a^2-\frac{\eta}{2}(s+x)^2\sigma^2-\frac{\phi}{2}x^2-xa^0(x) = \overline{w} \tag{11}$$
$$a^0(x) = \frac{x+s}{c}.$$

Substituting for the value of t in the individual-rationality constraint and maximizing with respect to s and t, I obtain the following solutions for managerial effort, the manager's after-hedging equity holding, and the optimal compensation policy:

$$a* = \frac{1}{c}\frac{\phi+1/c}{(1+c\eta\sigma^2)(\phi+1/c)+c\eta^2\sigma^4}, \tag{12}$$

$$s* + x* = \frac{\phi+1/c}{(1+c\eta\sigma^2)(\phi+1/c)+c\eta^2\sigma^4}, \tag{13}$$

$$s* = \frac{\phi+\eta\sigma^2+1/c}{(1+c\eta\sigma^2)(\phi+1/c)+c\eta^2\sigma^4}. \tag{14}$$

Notably, when $\phi \to +\infty$, $s* = (1/1+c\eta\sigma^2)$. This is Holmstrom and Milgrom's (1987) solution with no executive hedging. The analysis above yields the following result:

Proposition. *The optimal pay-performance sensitivity s^* is decreasing in the managerial hedging cost.*

The derivation of this proposition is straightforward. It is easy to show from Eq. (14), that $(ds*/d\phi) = -(\eta\sigma^2/[(1+c\eta\sigma^2)(\phi+1/c)+c\eta^2\sigma^4]^2) < 0$. The economic intuition is as follows. A decrease in the hedging cost reduces the manager's disutility of bearing risk since she is able to hold less after-hedging stock shares (Eq. (13)). In other words, managerial hedging enhances the manager's ability to bear risk. Given the fact that an optimal contract is always about the trade-off between incentive and risk, managers with high risk-bearing ability should be given a high-power contract. Another simple interpretation is that if managers can costly undo the incentive of a compensation contract, the contract will be made to provide more incentive to start with so that it is closer to what is optimal once managers undo part of the incentive.

As we see, hedging transactions undermine the effectiveness of incentive contracting. This problem is therefore interesting only if direct bans on management hedging are difficult to enforce. The model effectively assumes that managers' participation in the hedging market cannot be perfectly controlled by shareholders. The assumption is valid because managers' trades in their own firms' securities are verifiable only by testimony from parties who know the managers personally (Muelbroek, 1992). In practice, the manager's personal portfolio is not publicly disclosed; it is difficult and costly for shareholders to monitor. Current studies, such as Garvey (1997) and Ofek and Yermack (2000), also provide evidence in favor of this assumption.

4. Data construction and sample selection

4.1. Measures of CEO incentive

I use two complementary variables to measure the CEO's incentive pay.

Jensen and Murphy's (1990) pay-performance sensitivity (PPS): Following Jensen and Murphy (1990), *PPS* is the dollar value of a CEO's wealth change relative to $1,000 change of shareholders' value. Although managers can receive pay-performance incentives from a variety of sources, the vast majority of these are ownership of stock and stock options. Similar to Core and Guay (1999), I compute this sensitivity as the dollar-value change of stock and options held by a CEO relative to $1,000 shareholder return.

For stock, the *PPS* is simply the fraction of the firm that the executive owns. The *PPS* for options is the fraction of the firm's stock on which the options are written multiplied by the options' delta. I use the method developed by Core and Guay (2002) to estimate option deltas. They use the Black–Scholes option valuation model as modified by Merton (1973) to adjust dividend payouts. Their method can avoid the cost and difficulty of collecting option data from various proxy statements, since it requires information from only the most recent proxy statements. More important, they show that their estimates are effectively unbiased and 99% correlated with the measures that would be obtained if the parameters of a CEO's option portfolio were completely known.

Core and Guay's (1999) portfolio equity incentive (*PEI*): Following Core and Guay (1999), *PEI* is defined as the change in the dollar value of the CEO's stock and option holding for a 1% change in the stock price. As pointed out by them, the *PEI* is actually equal to the *PPS* multiplied by the firm's market value of equity, and divided by $100,000.

Although both variables measure how closely the CEO's pay is related to shareholder wealth, they differ in the underlying assumptions about what drives managerial incentives. *PPS* measures the CEO's wealth change relative to the dollar-value change of shareholder wealth, under the assumption that incentives increase with a manager's fractional ownership of the firm. *PEI* captures the CEO's wealth change compared to the percentage change of shareholder wealth, by assuming that incentives increase with a manager's dollar ownership of the firm (Core and Guay, 1999).

As argued by Baker and Hall (2004), the more appropriate measure depends on how CEO actions are assumed to influence shareholder value. When CEO actions primarily affect firm dollar return (such as purchasing a corporate jet), the appropriate incentive measure is *PPS*. In contrast, when CEO actions primarily affect firm percentage returns (such as corporate reorganization and strategic redirection), *PEI* is the appropriate measure for executive incentives. This paper is not intended to contribute to the debate about measuring executive incentives; for robustness purposes, I use both measures.

4.2. Measures of executive hedging cost

The key explanatory variable is the cost of managerial hedging, which can be equivalently interpreted as the hedging opportunities managers have. I propose two proxies to measure these opportunities. The first is an *Option* dummy, which equals one if the firm's option is traded in at least one of the six US option exchanges, and zero otherwise.[5] The economic intuition behind this variable is as follows. When the firm's option is publicly tradable, managers will have better opportunities to undo their equity holding in the derivatives market, which decreases the managerial hedging cost. In other words, the managerial hedging cost will be high when *Option*=0, and relatively low otherwise. Moreover, this *Option* dummy can be largely regarded as an exogenous variable to the company itself, to the extent that the decision to list a firm's option is made by the option exchanges and not by the firm (Mayhew and Mihov, 2004).[6]

The second proxy is the firm's option trading volume, which reflects the liquidity, activeness, and development of the firm's option in the derivatives market. Intuitively, a high volume indicates that it is relatively easy and convenient to trade the firm's options.[7]

Managers may have a number of ways to hedge their firm-specific risk, such as using customized derivatives or trading the competitors' stock. This paper mainly focuses on the possibility that managers hedge through the public option market.

4.3. Control variables

In addition to the hedging cost, I also include a set of control variables that influence compensation policies as suggested by existing literature. These controls are as follows.

CEO age: Career concern is another factor influencing managerial behavior and firms' compensation policies. Gibbons and Murphy (1992) provide theory and evidence showing that firms will use more equity-based compensation for older CEOs. Like them, CEO age is controlled to take account of the manager's horizon problem. Moreover, a CEO's age may also be associated with her reputation, personal wealth, and risk aversion.

Firm risk: Optimal contracting involves the trade-off between providing incentives and risk sharing between managers and shareholders, such that incentive level should decrease with firm risk. As a common approach, I measure the firm's risk by using the stock return variance based on the firm's monthly returns of the past 5 years.

[5] The six exchanges are the American Stock Exchange, Boston Options Exchange, Chicago Board Options Exchange, International Securities Exchange, Pacific Exchange, and Philadelphia Stock Exchange.

[6] Unlike the stock market, where firms apply to be listed, decisions to list options are made within the exchanges. Generally, stocks are selected for option listing by committees composed of members of the exchange after soliciting feedback from the general membership.

[7] As a robustness check, I also normalized this trading volume by the firm's shares outstanding. The results are qualitatively similar.

Firm size: The cross-sectional level of a CEO's incentive compensation changes predictably with firm size (see, e.g., Baker and Hall, 2004). To control for this size effect, I compute firm size as the natural logarithm of the firm's market value of equity.

Leverage ratio: If managers have strong incentives to maximize shareholders' value, debt holders will demand higher risk premiums for providing capital considering the problems of risk shifting. Based on this intuition, John and John's (1993) model predicts a negative relation between leverage and pay-performance sensitivity. Therefore, the book-value ratio of long-term debt over total assets is included in the empirical study.

Market-to-book ratio (*M/B*): As suggested by numerous studies (see, e.g., Yermack, 1995), when companies have large growth opportunities, shareholders have greater difficulty evaluating managers' decisions, and thus, should provide managers with more stock-based compensation. I use *M/B* to control for the firm's growth opportunity.

Cash: Hall and Liebman (1998) suggest that scarcity of cash may lead firms to substitute cash payment with equity compensation. Therefore, availability of cash holding may be an important determinant in setting executive compensation. I measure *Cash* as the ratio of cash and short-term investment over the firm's total assets.

Moreover, companies tend to use more equity-based compensation when the firm performance is high (e.g., Core and Guay, 1999). To account for firm performance, I include return on equity (*ROE*) and the firm's annual stock return as additional controls.

4.4. Data source

I collect stock returns from CRSP, compensation data from ExecuComp, accounting information from Compustat, and option trading data from OptionMetrics. OptionMetrics is a comprehensive source of historical price and implied volatility data for all US exchange-listed equity options, starting from January 1996. All of the monetary variables are measured in 2000-constant dollars. To mitigate the effect of outliers, I winsorize all the continuous variables at the 1% level in both tails of the distribution.

The final sample consists of 13,691 CEO-year observations from 1996 to 2005, 74% of which have options traded on the US option exchanges (10,123 CEO-year observations). This big proportional number is not surprising since the companies in ExecuComp are usually the 1,500 largest US public firms.

5. Empirical results

5.1. Summary statistics

Panel A of Table 1 reports the firm's characteristics. The median firm is quite large; its market capitalization of equity is $1,339 million. The sample firms are performing well, with a median *M/B* ratio of 2.14, *ROE* of 12%, and annual stock return of 10.5%. Moreover, those firms are moderately levered with a median leverage ratio of 17%, and have sizeable cash holdings with a median *Cash* ratio of 5%. For the firms with publicly tradable options, the mean and median daily option trading volumes are 990 and 139 contracts, respectively, indicating that this variable is highly skewed. The median CEO is 56 years old.

The variable *PPS* has a mean of $26 per $1,000 shareholder return and a median of $7; this number is similar to that reported by Hall and Liebman (1998).[8] The median *PEI* is $112,000 change in CEO wealth for a 1% change in stock price, and this variable is substantially skewed with an average value of $389,000. The *PEI* value in my sample is a little smaller than that in Core and Guay (1999). The difference is consistent with the decreasing role of options in compensation after the downturn of the stock market in the early 2000s.[9] As complementing measures for managerial incentives, *PPS* and *PEI* are positively correlated; their correlation coefficient is 0.46.

The correlations between the explanatory variables are reported in Panel B. With the exception of the large positive correlations among Ln(*Volume*), *Firmsize*, and $Firmsize^2$, all of the correlations are below 0.4 in magnitude. Both *Option* and Ln(*Volume*) are positively correlated with firm size, which is consistent with the finding that large firms are more likely to have listed options and large option trading volumes (Mayhew and Mihov, 2004). This fact also suggests that it is important to control for the size effect in the regressions.

5.2. Managerial hedging cost and incentive pay

Existing literature on CEO compensation proposes the use of ordinary least squares (OLS), median, and fixed-effects regressions. I perform all of the three types and find qualitatively similar results. In particular, tests on the relation between the hedging cost and incentive pay are based on the following equation:

$$\begin{aligned} Incentive_{it} &= a_0 + a_1 Option_{it} \text{ or } \mathrm{Ln}(Volume)_{it} \\ &+ a_2 Firmsize_{it-1} + a_3 Firmsize^2_{it-1} + a_4 CDF(Variance)_{it-1} \\ &+ a_5 M/B_{it-1} + a_6 ROE_{it-1} + a_7 Leverage_{it-1} + a_8 Age_{it} \\ &+ a_9 Cash_{it-1} + a_{10} Stockreturn_{it-1} \\ &+ IndustryDummy \text{ or } Firm\ Fixed\ Effects + YearDummy + \varepsilon_{it}, \end{aligned}$$

where i indexes firms and t indexes year. The dependent variable is the pay-performance sensitivity in a CEO's compensation package, measured by *PPS* and *PEI*. Fama and French's (1997) 48 industry dummies and year dummies are included to control for industry and time variation in executive pay schemes. Throughout the entire empirical test, p-values for the OLS regressions are computed based on robust standard errors clustered at the firm level. Estimating positive coefficients for a_1 would be consistent with the prediction that the managerial hedging cost is negatively associated with incentive pay.

Table 2 reports the regression results, using the *Option* dummy as the proxy for the hedging cost. The coefficients on *Option* are both economically and statistically significant

[8] The *PPS* reported in Hall and Liebman (1998) is $25 at the mean and $5.29 at the median.

[9] Core and Guay's (1999) sample is from 1992 to 1996.

Table 1
Descriptive statistics of sample firms.

The sample consists of 13,691 firm-year observations from 1996 to 2005. In the sample, 10,123 firm-year observations have their options traded on US option exchanges. I obtain stock price data in CRSP, accounting data in Compustat, CEO compensation data in ExecuComp, and option trading data in OptionMetrics. In Panel A, MV Equity ($million) refers to the market capitalization of the equity. ROE is the accounting return of equity, obtained as the ratio of earnings before interest and taxes to the book value of common equity. Leverage is the ratio of long-term debt (book value) over total assets. M/B is the ratio of market value of equity over book value of equity. Variance is the stock return variance based on the monthly return of the past 5 years. Cash is the ratio of cash plus short-term investment over total assets. Stockreturn is the firm's annual stock return. Option is a dummy variable, which equals one if the firm's option is traded on US option exchanges, and zero otherwise. Volume is the average number of daily option contracts traded. *PPS* is calculated as the dollar value change of the stock and options held by a CEO per $1,000 shareholder return. *PEI* ($thousand) is the sensitivity of the total value of stock and options held by a CEO to a 1% change in stock price. Ln() denotes the natural logarithm transform. All the dollar-value variables are measured in 2000-constant dollars. In Panel B, firmsize is the natural logarithm of the firm's market value of equity; other variables used in this matrix are defined as for Panel A. Correlations with an absolute value greater than 0.03 are significant at the 5% level.

Panel A: Descriptive statistics of firm characteristics

	Mean	Std.	5th Pct	Median	95th Pct
MV equity	4,814	10,424	153	1,339	20,796
ROE	10%	20%	−17%	12%	31%
Leverage	19%	18%	0	17%	49%
M/B	2.93	2.62	0.73	2.14	7.95
Variance*100	1.77	1.67	0.34	1.17	5.35
Age	55.76	6.9	44	56	67
Cash	12%	16%	0	5%	49%
Stockreturn	6.5%	47%	−78%	10.5%	76%
Option	0.74	0.44	0	1	1
Volume	990	2,554	7	139	5,153
Ln(*Volume*)	5.09	1.93	2.12	4.94	8.55
PPS	26.08	51.56	0.73	6.96	138.7
PEI	388.9	978.37	5.87	112.2	1569.7

Panel B: Correlation matrix of explanatory variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Option	1										
(2) Ln(*Volume*)	–	1									
(3) Firmsize	0.34	0.58	1								
(4) Firmsize^2	0.30	0.59	0.89	1							
(5) Variance	0.09	0.18	−0.38	−0.28	1						
(6) M/B	0.15	0.26	0.24	0.27	0.18	1					
(7) ROE	0.06	0.02	0.26	0.24	−0.39	0.12	1				
(8) Leverage	−0.02	0.00	0.12	0.08	−0.19	−0.11	−0.05	1			
(9) Age	−0.03	−0.04	0.10	0.07	−0.23	−0.10	0.08	0.06	1		
(10) Cash	0.11	0.19	−0.18	−0.10	0.52	0.29	−0.14	−0.43	−0.16	1	
(11) Stockreturn	−0.02	0.00	−0.06	−0.06	−0.14	−0.08	0.06	−0.02	0.02	−0.03	1

in all six regressions. In column 1, the dependent variable in this OLS model is *PPS*. The coefficient of *Option* is about 3.2 and is significant at the 1% level. This result indicates that a change of *Option* from zero to one is associated with an increase in *PPS* by $3.2 per $1,000 shareholder wealth change, compared to the median *PPS* of $7. The coefficients of other control variables are generally consistent with existing empirical studies. In particular, *PPS* tends to be higher for firms of smaller size, higher growth potential, better accounting performance, lower leverage ratio, older CEOs, and less liquidity constraints.

Table 1 shows clearly the right skewness of the compensation data. For this reason, the median as a measure of the center of a distribution is more robust than the mean. Therefore, following Aggarwal and Samwick (1999) and Jin (2002), I use median regression to estimate *PPS* in column 2. Median regression minimizes the sum of absolute deviations rather than the sum of squared deviations, and can thus increase the precision of estimating executive incentives (Aggarwal and Samwick, 1999). The corresponding *p*-values are computed according to bootstrapped standard errors based on 20 replications.

In column 2, all the independent variables have qualitatively similar coefficients to those in column 1. The variable *Option* has a coefficient of 0.76 and it is significant at the 1% level. Not surprisingly, all the median regression estimates are well below the magnitude of the OLS estimates of *PPS*, because of the right skewness of the compensation data.[10]

Although plenty of controls are included in the regression, it is still possible that the proxy for hedging costs, *Option*, is correlated with some unobserved firm characteristics that affect CEO compensation. To address this issue, I add firm fixed effects in column 3. It is

[10] Aggarwal and Samwick (1999) and Jin (2002) also find that the estimates in OLS are bigger in magnitude than those in the median regression. For example, Aggarwal and Samwick (1999) report that OLS estimates of *PPS* are more than twice those obtained from the median regression.

Table 2
Managerial hedging cost and pay-performance sensitivity.

Panels A and B consist of 13,691 firm-year observations from 1996 to 2005. For Panel A, 10,123 firm-year observations have their options traded on US option exchanges. Pay-performance sensitivity (*PPS*) is calculated as the dollar-value change of the stock and options held by a CEO per $1,000 shareholder return. Portfolio equity incentive (*PEI*) is the sensitivity of the total value of stock and options held by a CEO to a 1% change in stock price, and *PEI* is measured in $thousand. For Panel A, Option is a dummy variable, which equals one if the firm's option is traded on US option exchanges, and zero otherwise. For Panel B, Volume is the average number of daily option contracts traded. Ln() denotes the natural logarithm transform. Industry dummies are constructed based on Fama and French's (1997) 48 industries. Corresponding *p*-values are reported in brackets. The *p*-values for OLS regressions are based on robust standard errors clustered at the firm level. The *p*-values for median regressions are according to bootstrapped standard errors based on 20 replications. The notations ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively. All other variables are the same as in Table 1.

Panel A: Using option dummy as the proxy for hedging cost

	(1) *PPS* *OLS*	(2) *PPS* *Median*	(3) *PPS* *Fixed effect*	(4) Ln(*PEI*) *OLS*	(5) Ln(*PEI*) *Median*	(6) Ln(*PEI*) *Fixed effect*
Option	3.21***	0.76***	4.07**	0.35***	0.11***	0.1***
	[0.000]	[0.005]	[0.013]	[0.000]	[0.000]	[0.000]
Firmsize	−26.46***	−5.65***	−51.33***	1.15***	1.11***	0.78***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Firmsize^2	1.11**	0.16***	2.36***	−0.04***	−0.04***	−0.02***
	[0.017]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
CDF of Variance	42.88***	9.91***	27.94***	0.76***	0.75***	0.21***
	[0.002]	[0.000]	[0.000]	[0.000]	[0.000]	[0.002]
M/B	2.01***	0.57***	2.35***	0.06***	0.08***	0.07***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
ROE	19.92***	4.39***	16.49***	0.54***	0.53***	0.34***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Leverage	−33.92***	−1.59**	−17.69***	−0.34**	−0.21***	−0.64***
	[0.000]	[0.04]	[0.000]	[0.04]	[0.01]	[0.000]
Age	1.77***	0.37***	1.14***	0.042***	0.044***	0.05***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Cash	33.76**	7.16***	4.76	0.55***	0.76***	0.25***
	[0.014]	[0.000]	[0.41]	[0.000]	[0.000]	[0.006]
Stockreturn	51.66***	10.91***	45.01***	1.26***	1.29***	1.14***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	No	Yes	Yes	No
Firm fixed effects	No	No	Yes	No	No	Yes
Intercept	59.44**	19.01***	208.35***	−3.89***	−3.97***	−2.87***
	[0.037]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
N	13,314	13,314	13,314	13,314	13,314	13,314
Adjusted-R^2/pseudo-R^2	18.5%	5.8%	22.6%	47%	29%	39%

Panel B: Using Ln(Volume) as the proxy for hedging cost

	(1) *PPS* *OLS*	(2) *PPS* *Median*	(3) *PPS* *Fixed effect*	(4) Ln(*PEI*) *OLS*	(5) Ln(*PEI*) *Median*	(6) Ln(*PEI*) *Fixed effect*
Ln(*Volume*)	3.57***	1.14***	6.77***	0.11***	0.12***	0.13***
	[0.004]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Firmsize	−30.71***	−8.21***	−63.76***	1.15***	1.01***	0.68***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Firmsize^2	1.03**	0.23***	2.69***	−0.05***	−0.04***	−0.02***
	[0.026]	[0.000]	[0.000]	[0.000]	[0.000]	[0.001]
CDF of variance	42.36***	5.36***	4.41	0.58***	0.45***	−0.25***
	[0.000]	[0.000]	[0.41]	[0.001]	[0.000]	[0.007]
M/B	2.21***	0.57***	2.38***	0.06***	0.07***	0.07***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
ROE	14.21***	4.05***	15.71***	0.48***	0.48***	0.34***
	[0.003]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Leverage	−35.52***	−3.13***	−23.17***	−0.47**	−0.32***	−0.67***
	[0.000]	[0.000]	[0.000]	[0.012]	[0.001]	[0.001]
Age	1.76***	0.35***	1.29***	0.04***	0.05***	0.05***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Cash	19.08	6.13***	1.97	0.44**	0.75***	0.35***
	[0.12]	[0.000]	[0.75]	[0.034]	[0.000]	[0.001]
Stockreturn	47.62***	9.78***	41.59***	1.21***	1.24***	1.09***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	No	Yes	Yes	No

Table 2 (*continued*)

Panel B: Using Ln(Volume) as the proxy for hedging cost

	(1) *PPS* *OLS*	(2) *PPS* *Median*	(3) *PPS* *Fixed effect*	(4) Ln(*PEI*) *OLS*	(5) Ln(*PEI*) *Median*	(6) Ln(*PEI*) *Fixed effect*
Firm fixed effects	No	No	Yes	No	No	Yes
Intercept	96.00***	34.19***	256.29***	−3.61***	−3.35***	−2.64***
	[0.006]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
N	9,837	9,837	9,837	9,837	9,837	9,837
Adjusted-R^2/Pseudo-R^2	19.5%	6.3%	25.3%	43.5%	27%	41.5%

important to note that the inclusion of firm fixed effects can control for any other aspects of the firm that influence the managerial compensation scheme.

The results from the firm fixed effects regression further demonstrate the strong positive association between *Option* and *PPS*. The coefficient on *Option* is around 4.0 and the corresponding *p*-value is 0.013. The economic implication of this coefficient is that, for the same firm, an increase of the *Option* dummy from zero to one is associated with an increase of the *PPS* by about $4 per $1,000 shareholder return, relative to the median *PPS* of $7.

In columns 4–6, I replace *PPS* with Ln(*PEI*) as an alternative measure of the executive incentive and re-do the previous three regressions.[11] The main results are unchanged: *Option* dummy has a strong positive relation with executive incentives measured by *PEI*. For example, in the fixed-effects regression reported in column 6, the coefficient of *Option* is 0.1 and is significant at the 1% level. This coefficient is also economically remarkable since an increase in *Option* from zero to one is associated with an approximate 10% increase in *PEI*. The coefficients on those controls are qualitatively consistent with the findings of Core and Guay (1999). The regression results also indicate that the levels of *PEI* are well-explained by the regression model outlined earlier. Taking column 4, for example, the adjusted R^2 is 47%, implying that the model explains a substantial proportion of the cross-sectional variation in *PEI*.

Overall, the results in Panel A support the prediction that the pay-performance sensitivity of CEO compensation is negatively correlated with the managerial hedging cost.

In Panel B, I use Ln(*Volume*) as an alternative proxy for the executive hedging cost, and repeat the earlier regression analysis in Panel A. The sample used in this panel is a subsample, in which the firms have available listed options in the option exchanges. Consistent with the previous panel, Panel B further supports the prediction that the hedging cost is negatively associated with pay-performance sensitivity.

The regression result in column 1 highlights that the coefficient of Ln(*Volume*) is 3.57 and is significant at the 1% level. This coefficient is also economically meaningful: When Ln(*Volume*) increases by one standard deviation (1.93), the executive is awarded an increased *PPS* of $6.9 ($3.57\times1.93$) per $1,000 shareholder return. Therefore, this result is consistent with the prediction that a lower managerial hedging cost leads to higher stock-based pay sensitivities of CEOs. In the median regression (column 2) and fixed-effects regression (column 3), the coefficients of *Option* are 1.14 and 6.77, respectively; both of them are significant at the 1% level.

Columns 4–6 in Panel B show that Ln(*Volume*) also has a significant positive relation with *PEI*. The coefficients on Ln(*Volume*) are 0.11, 0.12, and 0.13, respectively, implying that a one-standard-deviation increase in Ln(*Volume*) predicts an increase in *PEI* of about 23% ($12\%\times1.93$). Other controls have very similar coefficients to those in Panel A.

Since the firms listed in the option exchanges and the ones with large option trading volumes are usually large, the *Option* and Ln(*Volume*) variables might just capture the firm size effect rather than the hedging cost effect. This concern can be ruled out for two reasons. First, *Firmsize* and $Firmsize^2$ are controlled in the regressions. Therefore, the positive coefficients on *Option* and Ln(*Volume*) indicate that firms with publicly tradable options or large option trading volumes provide higher CEO incentive than other firms of similar size. I have also used sales volume and total assets to measure firm size instead of market value of equity; the coefficients on the two hedging cost proxies are quite robust. Since *Firmsize* and $Firmsize^2$ are highly correlated, I have also tried to just include either of them in the regressions, and the results on *Option* and Ln(*Volume*) are largely unchanged.

Second, the relation between firm size and CEO incentives depends on the measures of incentive pay. I find that firm size is negatively related to *PPS* but positively related to *PEI*; this relation is consistent with prior literature, such as Core and Guay (1999) and Baker and Hall (2004). However, the coefficients on *Option* and Ln(*Volume*) are always significantly positive regardless of whether incentive pay is measured by *PPS* or *PEI*. This fact further supports the notion that the hedging cost proxies are not capturing firm size effects.

Another concern with my hedging cost proxies is that they might primarily reflect firm risk, as riskier firms are more likely to be listed in option exchanges and to have larger option trading volumes (Mayhew and Mihov,

[11] The reason that natural logarithm transform is not taken for *PPS* is to make the results easier to compare with those in prior literature.

2004). This concern is not valid for the following reasons. First, the regressions have accounted for stock return volatility; that is, the effect of firm risk on incentive pay has been controlled. Second, standard principal-agent theory predicts a negative relation between firm risk and managerial incentive levels (Holmstrom and Milgrom, 1987), which implies that the coefficients on *Option* and Ln(*Volume*) would be negative if they captured firm risk. Third, as summarized by Prendergast (2002), empirical studies have failed to find any robust association between risk and executive incentive, further indicating that the positive relation between hedging cost proxies and incentive compensation is not due to the risk effect on compensation.

The conclusion from Table 2 is clear: CEOs are receiving higher-power compensation contracts when it is less costly for them to hedge their incentive portfolios. This evidence supports the proposed theoretical model.

5.3. Managerial hedging cost and convexity in incentive pay

My earlier analysis on *PPS* and *PEI* is concerned with the slope of the relation between the CEO's wealth and stock price. Although managing slope is important in setting CEO pay, another important aspect is the convexity in the compensation package. As shown in existing literature (Jensen and Meckling, 1976; Smith and Stulz, 1985), the convexity of the relation between stock price and CEO wealth, in addition to the slope, has to be properly designed to induce executives to make optimal corporate decisions. This convexity refers to the sensitivity of executives' wealth to the volatility of stock return.

As shown by Smith and Stulz (1985), risk-averse managers are likely to forgo risk-increasing but positive net-present-value (NPV) projects, and this risk-related agency problem can be resolved by using stock options to construct a convex relation between executive wealth and firm performance.

Following the framework of Holmstrom and Milgrom (1987) and Guay (1999), the optimal convexity in CEO incentive pay is determined by the benefits of risky positive NPV projects and the cost of compensating the manager for bearing the risk. When shareholders increase the sensitivity of CEO wealth to firm risk, CEOs are less likely to pass up those risky but value-increasing investments. However, shareholders also need to increase the level of total pay to compensate those risk-averse managers for taking the risk. In equilibrium, the optimal convexity in CEO pay should decrease in the managerial aversion to risk (Coles, Daniel, and Naveen, 2006; Guay, 1999). This risk-aversion effect depends on the degree of diversification of the manager's wealth portfolio and her utility function. All else being equal, good hedging opportunities enable managers to diversify risk and to be less vulnerable to stock price volatility. For this reason, the optimal sensitivity of CEO wealth to firm risk should be higher when managers can hedge more easily.

Similar to Guay (1999), I define *Vega* as the change in dollar value of the executive's wealth for a 0.01 change in the annualized standard deviation of stock return. Following Coles, Daniel, and Naveen (2006), *Vega* of the option portfolio is used to measure the total *Vega* of executives' total equity portfolios because option *Vega* is many times higher than stock *Vega*. In my sample, the mean and median *Vega* are $112.9 thousand and $44.5 thousand, respectively. I regress Ln(*Vega*) on the hedging cost proxies, controlling for potential confounding variables. The regression model is specified below:

$$\begin{aligned}\text{Ln}(Vega)_{it} = {} & b_0 + b_1 Option_{it} \text{ or } \text{Ln}(Volume)_{it} \\ & + b_2 Firmsize_{it-1} + b_3 Firmsize^2_{it-1} \\ & + b_4 CDF(Variance)_{it-1} + b_5 M/B_{it-1} + b_6 ROE_{it-1} \\ & + b_7 Leverage_{it-1} + b_8 Age_{it} + b_9 Cash_{it-1} \\ & + b_{10} Stockreturn_{it-1} + IndustryDummy \text{ or } \\ & Firm\ Fixed\ Effects + YearDummy + \varepsilon_{it}.\end{aligned}$$

Estimating positive coefficients of b_1 would be consistent with the prediction that the sensitivity of CEO wealth to firm risk is higher when the CEO has better opportunities to hedge her personal portfolio.

Table 3 reports a positive relation between Ln(*Vega*) and the hedging cost proxies; the relation is both statistically and economically significant. Taking column 1 for example, I use the *Option* variable as the proxy for the hedging cost and run a pooled OLS regression. The coefficient on *Option* is 0.17 and is significant at the 1% level. This result indicates that a zero-to-one increase in *Option* is associated with an approximate 17% increase in *Vega*. Taking column 6 as another example, I use Ln(*Volume*) to proxy for the hedging costs in the firm-fixed effects regression; the coefficient on Ln(*Volume*) is 0.07 and is statistically significant at the 1% level. The result is quite economically important; *Vega* will increase by about 13.5% when Ln(*Volume*) increases by one standard deviation.

As suggested by Coles, Daniel, and Naveen (2006), the slope and convexity in the CEO's compensation contract are jointly determined. In other words, shareholders choose a combination of the slope and the convexity to solve the compensation problem optimally. In this case, using simultaneous equations to estimate *PPS*/*PEI* and *Vega* jointly could be a more appropriate approach than estimating them separately. Following Coles, Daniel, and Naveen (2006), I use three-stage least squares (3SLS) to estimate the following simultaneous equations:

$$\begin{aligned}\text{Ln}(Vega)_{it} = {} & \gamma_0 + \gamma_1 \text{Ln}(PEI)_{it} + \gamma_2 Option_{it} \text{ or } \text{Ln}(Volume)_{it} \\ & + \gamma_3 Firmsize_{it-1} + \gamma_4 Firmsize^2_{it-1} \\ & + \gamma_5 CDF(Variance)_{it-1} + \gamma_6 M/B_{it-1} + \gamma_7 ROE_{it-1} \\ & + \gamma_8 Leverage_{it-1} + \gamma_9 Cash_{it-1} \\ & + \gamma_{10} Stockreturn_{it-1} + \gamma_{11} \text{Ln}(Cash \\ & Compensation)_{it} + IndustryDummy \\ & + YearDummy + \varepsilon_{it} \end{aligned} \quad (a)$$

$$\begin{aligned}\text{Ln}(PEI)_{it} = {} & \delta_0 + \delta_1 Ln(Vega)_{it} + \delta_2 Option_{it} \text{ or } \text{Ln}(Volume)_{it} \\ & + \delta_3 Firmsize_{it-1} + \delta_4 Firmsize^2_{it-1} \\ & + \delta_5 CDF(Variance)_{it-1} + \delta_6 M/B_{it-1} + \delta_7 ROE_{it-1} \\ & + \delta_8 Leverage_{it-1} + \delta_9 Age_{it} + \delta_{10} Cash_{it-1} \\ & + \delta_{11} Stockreturn_{it-1} + IndustryDummy \\ & + YearDummy + \varepsilon_{it}. \end{aligned} \quad (b)$$

Table 3
Managerial hedging cost and sensitivity of CEO wealth to stock volatility.
The sample consists of 13,691 firm-year observations from 1996 to 2005. In the sample, 10,123 firm-year observations have their options traded on US option exchanges. The dependent variable is Ln(*Vega*) and Vega (in $thousand) is calculated as the dollar-value change of the stock and options held by a CEO for 0.01 change in standard deviation of stock return. Option is a dummy variable, which equals one if the firm's option is traded on US option exchanges, and zero otherwise. Volume is the average number of daily option contracts traded. Ln() denotes the natural logarithm transform. Industry dummies are constructed based on Fama and French's (1997) 48 industries. Corresponding *p*-values are reported in brackets. The *p*-values for OLS regressions are based on robust standard errors clustered at the firm level. The *p*-values for median regressions are according to bootstrapped standard errors based on 20 replications. The notations ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

	(1) OLS	(2) Median	(3) Fixed effect	(4) *OLS*	(5) *Median*	(6) Fixed effect
Option	0.17***	0.09***	0.09***			
	[0.005]	[0.000]	[0.001]			
Ln(*Volume*)				0.12***	0.11***	0.07***
				[0.000]	[0.000]	[0.000]
Firmsize	0.52***	0.71***	0.26***	0.44***	0.65***	0.08
	[0.000]	[0.000]	[0.000]	[0.008]	[0.000]	[0.359]
Firmsize^2	0.005	−0.006*	0.016***	0.001	−0.01**	0.02***
	[0.618]	[0.095]	[0.000]	[0.912]	[0.041]	[0.000]
CDF of variance	0.28**	0.29***	0.09	−0.43**	−0.23***	−0.16*
	[0.04]	[0.000]	[0.18]	[0.011]	[0.001]	[0.08]
M/B	−0.04***	−0.02***	−0.03***	−0.04***	−0.03***	−0.03***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
ROE	0.07	−0.05	0.03	0.11	0.02	0.04
	[0.336]	[0.310]	[0.480]	[0.211]	[0.814]	[0.414]
Leverage	0.97***	0.85***	0.33***	0.94***	0.79***	0.39***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Age	−0.02***	−0.01***	−0.01***	−0.02***	−0.01***	−0.01***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Cash	−0.02	0.42***	0.21**	0.06	0.38***	0.18*
	[0.941]	[0.000]	[0.026]	[0.801]	[0.000]	[0.077]
Stockreturn	0.34***	0.36***	0.29***	0.28***	0.31***	0.25***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	No	Yes	Yes	No
Firm fixed effects	No	No	Yes	No	No	Yes
Intercept	−0.32	−1.56***	0.83***	0.24	−1.08***	1.68***
	[0.554]	[0.000]	[0.002]	[0.732]	[0.001]	[0.000]
N	13,314	13,314	13,314	9,919	9,919	9,919
Adjusted-R^2/pseudo-R^2	37%	29%	22%	35%	27%	22%

Table 4 contains the system's specifications using two hedging cost proxies. In each case, the jointly determined variables are *Vega* and *PEI*. The independent variables are generally drawn from the prior literature (Coles, Daniel, and Naveen, 2006; Guay, 1999). The variable *Cash compensation* is the dollar value of the CEO's cash pay.

The coefficients on *Option* and Ln(*Volume*) are positive and both economically and statistically significant. This result supports the prediction that shareholders increase both the slope and convexity in the CEO's incentive pay when the CEO has good hedging opportunities. In columns 1 and 2, the coefficients on *Option* are 0.16 and 0.06, respectively, and both are significant at the 5% level. Controlling for other factors, a firm with publicly tradable options provides about 16% higher *Vega* and 6% higher *PEI* than a company without such options. I use Ln(*Volume*) as an alternative proxy for hedging costs in columns 3 and 4. The corresponding coefficients are 0.16 and 0.12, respectively, and both are significant at the 1% level. A one-standard-deviation increase in Ln(*Volume*) is associated with a 31% increase in *Vega* and a 23% increase in *PEI*.

Other control variables are generally consistent with the results in Coles, Daniel, and Naveen (2006). I also replace Ln(*PEI*) with *PPS* in the systems and find that the coefficients on *Option* and Ln(*Volume*) do not change qualitatively. The simultaneous equations results for *PPS* are omitted here for brevity.

In summary, the evidence in Tables 3 and 4 supports the view that higher executive hedging costs are associated with not only lower pay-performance sensitivity but also lower sensitivity of CEO wealth to equity volatility.

5.4. *Managerial hedging cost and capital structure*

Given the fact that managerial hedging undermines the efficacy of incentive contracts, how will shareholders use other mechanisms to resolve the executive incentive problem? This section addresses this problem by examining firms' capital structure decisions.

Agency theory suggests that debt mitigates the shareholder-manager agency problem by inducing lenders to monitor, reducing the free cash flow available to managers, and forcing them to maximize value when facing the threat of bankruptcy (Jensen, 1986; Stulz, 1990). For this reason, Ortiz-Molina (2007) suggests that high leverage and high-power incentive contracts can be

Table 4
Simultaneous equations (3SLS): Managerial hedging cost, pay-performance sensitivity, and sensitivity of CEO wealth to stock volatility.

The sample consists of 13,691 firm-year observations from 1996 to 2005. In the sample, 10,123 firm-year observations have their options traded on US option exchanges. The jointly determined variables are Ln(*Vega*) and Ln(*PEI*). The variable *Option* is a dummy variable, which equals one if the firm's option is traded on US option exchanges, and zero otherwise. *Volume* is the average number of daily option contracts traded. Ln() denotes the natural logarithm transform. Industry dummies are constructed based on Fama and French's (1997) 48 industries. Corresponding *p*-values are reported in brackets. The notations ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

	(1) Ln(*Vega*)	(2) Ln(*PEI*)	(3) Ln(*Vega*)	(4) Ln(*PEI*)
Ln(*PEI*)	−0.61***		−0.58***	
	[0.000]		[0.000]	
Ln(*Vega*)		−0.03		−0.14***
		[0.336]		[0.000]
Option	0.16***	0.06**		
	[0.000]	[0.039]		
Ln(*Volume*)			0.16***	0.12***
			[0.000]	[0.000]
Firmsize	1.11***	1.16***	1.03***	1.21***
	[0.000]	[0.000]	[0.000]	[0.000]
Firmsize^2	−0.022***	−0.038***	−0.028***	−0.046***
	[0.000]	[0.000]	[0.000]	[0.000]
Variance	0.81***	0.76***	0.14	0.53***
	[0.000]	[0.001]	[0.18]	[0.000]
M/B	0.018***	0.061***	0.012**	0.057***
	[0.001]	[0.000]	[0.044]	[0.000]
ROE	0.35***	0.54***	0.32***	0.50***
	[0.000]	[0.000]	[0.000]	[0.000]
Leverage	0.42***	−0.31***	0.41***	−0.32***
	[0.000]	[0.001]	[0.000]	[0.001]
Age		0.04***		0.04***
		[0.000]		[0.000]
Cash	0.41***	0.55***	0.41***	0.44***
	[0.000]	[0.000]	[0.001]	[0.000]
Stockreturn	0.92***	1.26***	0.84***	1.24***
	[0.000]	[0.000]	[0.000]	[0.000]
Ln(*Cash compensation*)	0.56***		0.47***	
	[0.000]		[0.000]	
Year & industry dummies	Yes	Yes	Yes	Yes
Intercept	−5.24***	−3.84***	−4.18***	−3.51***
	[0.000]	[0.000]	[0.000]	[0.000]
N	13,314	13,314	9,837	9,837
R^2	19%	46%	18%	43%

substitutes. In a theoretical model, in which shareholders set both capital structure and compensation policy to discipline managers, Garvey (1997) shows that debt is important in aligning shareholder-manager interests, especially when managers can unload their incentive contracts in a liquid secondary market. In one word, the literature on capital structure and agency problems implies that firms should experience higher debt level when their managers have better opportunities to hedge incentive pay.[12] To examine this prediction empirically, I run pooled OLS regressions using the model below:

$$\begin{aligned} Leverage_{it} = {} & c_0 + c_1 Option_{it} \text{ or } \mathrm{Ln}(Volume)_{it} \\ & + c_2 Democracy_{it} + c_3 Democracy_{it} \\ & \times (Option_{it} \text{ or } \mathrm{Ln}(Volume)_{it}) + c_4 Firmsize_{it-1} \\ & + c_5 Stockreturn_{it-1} + c_6 CDF(Variance)_{it-1} \\ & + c_7 M/B_{it-1} + c_8 ROE_{it-1} + c_9 Tangibility_{it-1} \\ & + c_{10} R\&D_{it-1} + c_{11} Advertising_{it-1} \\ & + IndustryDummy + YearDummy + \varepsilon_{it}. \end{aligned}$$

Here, the dependent variable is the firm's leverage ratio, following the same definition as *Leverage* defined in Section 4.3. *Democracy* takes the value of one if the firm's Gompers, Ishii, and Metrick's (2003) *G*-index value is less than or equal to five, and zero otherwise. Gompers, Ishii, and Metrick (2003) construct the G-index to measure governance from the perspective of firm-level anti-takeover protection. They show that better-governed firms (which they call firms with "Democracy") have a higher firm value and better performance. The variable *Tangibility* is the ratio of the firm's fixed assets over total assets; *R&D* is the ratio of research and development (R&D) expenses to sales; *Advertising* is the ratio of advertising expenses over sales. Since I no longer require data availability in ExecuComp, the sample size for analyzing capital structure increases to 59,381 firm-year observations from 1996 to 2005. Among them, 17,638 observations have traded options. Available studies agree that capital structures are influenced by factors, such as firm size, asset tangibility, growth opportunities, advertising expenditure, R&D expenditure, volatility, and profitability (Harris and Raviv, 1991). Estimating positive coefficients of c_1 would support the prediction that financial leverage is negatively associated with the executive hedging cost.

Table 5 highlights the hedging cost as a strong determinant for capital structure decisions. In column 1, I regress book leverage on the *Option* dummy, as well as control variables. The coefficient on *Option* is 2.19 and is significant at the 1% level. The zero-to-one increase in *Option* is associated with an increase in book leverage by about 2.2 percentage points, relative to the sample median of 9%. *Option* is then replaced with Ln(*Volume*) in column 2. The coefficient of Ln(*Volume*) is 0.43 and is significant at the 1% level. Again, the economic impact is sizeable; book leverage will increase by about 0.81 percentage points when Ln(*Volume*) increases by one standard deviation.

Next, I interact *Democracy* with *Option* and Ln(*Volume*) in columns 3 and 4. Both interaction terms have positive and significant coefficients, indicating that better-governed firms are more likely to increase financial leverage in response to managerial hedging.

Among the control variables, the coefficients of *M/B* are persistently negative across all of the four regressions, indicating high-growth firms use less debt. The variable *Tangibility* is significantly positively associated with the leverage level.

The regression analysis in Table 5 supports the prediction that shareholders tend to use more debt when managers have better opportunities to hedge. This result also implies that, besides providing higher-power contracts, shareholders simultaneously use other mechanisms, such as

[12] Although it could be the managers who make the capital structure decisions, the board and shareholders do have strong influence on the financing decision (see, e.g., Klein, 1998; Guner, Tate, and Malmendier, 2008).

Table 5
Regression analysis on capital structure.

The sample consists of 59,381 firm-year observations from 1996 to 2005. I obtain stock price data in CRSP, accounting data in Compustat, and option trading data in OptionMetrics. In the sample, 17,638 firm-year observations have their options traded on US option exchanges. The dependent variable is the book leverage ratio (in percentage), defined as the book value of long-term debt/total assets. *Option* is a dummy variable, which equals one if the firm's option is traded on US option exchanges, and zero otherwise. *Volume* is the average number of daily option contracts traded. *Tangibility* is computed as the ratio of the firm's fixed assets over total assets. *R&D* is the ratio of the firm's R&D expenses to sales. *Advertising* is the ratio of the firm's advertising expenses to sales. Ln() denotes the natural logarithm transform. Industry dummies are constructed based on Fama and French's (1997) 48 industries. Corresponding *p*-values from robust standard errors clustered at the firm level are reported in brackets. The notations ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)
Option	2.19***		0.83**	
	[0.000]		[0.023]	
Ln(*Volume*)		0.43***		0.56***
		[0.000]		[0.000]
Democracy			−2.92***	−13.56***
			[0.008]	[0.000]
Democracy × Option			1.23*	
			[0.1]	
Democracy × Ln(*Volume*)				2.31***
				[0.000]
Firmsize	0.51***	−0.09	0.34	−1.04***
	[0.002]	[0.65]	[0.78]	[0.000]
Stockreturn	−0.93***	−0.79***	−1.47***	−0.65
	[0.001]	[0.000]	[0.001]	[0.18]
CDF of variance	1.65**	−0.37	4.28***	−1.79
	[0.035]	[0.71]	[0.000]	[0.19]
M/B	−0.27***	−0.26***	−0.24***	−0.29***
	[0.000]	[0.000]	[0.001]	[0.000]
ROE	−0.21	0.07	0.34	0.27
	[0.18]	[0.85]	[0.51]	[0.62]
Tangibility	24.75***	22.44***	17.34***	17.72***
	[0.000]	[0.000]	[0.000]	[0.000]
R&D	0.02	0.65***	3.77***	4.75***
	[0.84]	[0.000]	[0.000]	[0.000]
Advertising	−3.73	5.41	−10.89	−5.69
	[0.26]	[0.41]	[0.12]	[0.47]
Year & industry dummies	Yes	Yes	Yes	Yes
Intercept	11.73***	22.97***	21.41***	32.99***
	[0.000]	[0.000]	[0.000]	[0.000]
N	59,371	17,637	12,124	9,214
Adjusted-R^2	18.3%	20%	20.6%	22%

capital structure, to resolve the shareholder-manager agency problem as responding to executive hedging.

5.5. Managerial hedging cost and option exercising/holding behavior

To further support that the two hedging cost proxies do influence CEOs' hedging behavior, I investigate executive option exercising/holding behavior in this section.

CEOs usually receive large grants of stock and options of their own firms as compensation, and in the mean time, their human capital is also intimately linked to the firm performance. As they are usually prevented from unwinding their equity ownership, these under-diversified and risk-averse CEOs should be eager to exercise their in-the-money options when the vesting period expires (Hall and Murphy, 2002). As argued by Malmendier and Tate (2005), those CEOs should minimize their holdings of company equity to divest themselves of idiosyncratic risk. However, ceteris paribus, when CEOs can hedge their equity positions to a certain extent, they will be less eager to exercise their vested options, and will hold more exercisable in-the-money options, simply because the firm-specific risk can be diversified away through the hedging instruments. Consistent with this argument, Hemmer, Matsunaga, and Shevlin (1996, p. 49) state, "Hedged managers do not bear the risk of holding employee stock options (ESOs) and therefore have no incentive to exercise their ESOs early to diversify their portfolio." Other studies, such as Bettis, Bizjak, and Lemmon (2005) and Carpenter (1998), also suggest a positive relation between the strength of the hedging and the holding of exercisable in-the-money options.[13]

To test this prediction, I use three variables to measure a CEO's ownership of exercisable in-the-money options. They are: (1) dollar value of the CEO's exercisable in-the-money options (*Opt*1); (2) *Opt*1 as a percentage of the CEO's total annual compensation (*Opt*2); and (3) the number of common shares underlying the CEO's exercisable in-the-money options as a percentage of the firm's shares already owned by the CEO (*Opt*3). Pooled OLS regressions are run using the following model:

$$\begin{aligned} &Exercisable\ In\!-\!the\!-\!Money\ Option_{it} \\ &\quad = d_0 + d_1 Option_{it} \text{ or } \mathrm{Ln}(Volume)_{it} + d_2 Firmsize_{it-1} \\ &\qquad + d_3 CDF(Variance)_{it-1} + d_4 Ownership_{it-1} + d_5 M/B_{it-1} \\ &\qquad + d_6 Age_{it} + d_7 Stockreturn_{it} \\ &\qquad + IndustryDummy + YearDummy + \varepsilon_{it}. \end{aligned}$$

Existing studies suggest a few variables that influence managers' option-exercising behavior, including firm size, managerial ownership, stock volatility, growth opportunities, managerial risk-aversion, and recent stock movement (Huddart and Lang, 1996; Ofek and Yermack, 2000). The *Ownership* variable measures the percentage of the firm's shares owned by the CEO. Based on the implication that a manager with lower hedging costs will hold more vested in-the-money options, the coefficient d_1 is expected to be positive.

Columns 1–3 of Table 6 highlight a positive relationship between the *Option* dummy and CEOs' exercisable in-the-money options. The dependent variable in Model 1 is Ln(1+*Opt*1), and the coefficient on *Option* is 0.4 with the *p*-value less than 0.001. The economic magnitude is quite large; as *Option* increases from zero to one, the dollar value of CEOs' vested in-the-money options will increase by 40%. I then normalize the dollar value of options by the CEOs' total annual compensation, and use Ln(1+*Opt*2) as the left-hand

[13] There are two reasons why CEOs should hedge and keep exercisable options instead of exercising them directly. First, direct option exercising would send negative signals to investors. If managers fear this signal, they may retain their options while taking some hedging positions. Second, the market value of a "live" option usually exceeds the proceeds from exercise; managers face the trade-off between diversification benefits and cost of early exercise. When managers can use hedging instruments, such as put options, to protect themselves from stock price downturn, they will keep their exercisable options alive.

Table 6
Regression analysis on executive option holding.

The sample consists of 13,691 firm-year observations from 1996 to 2005. In the sample, 10,123 firm-year observations have their options traded on US option exchanges. *Opt*1 is the dollar value of the exercisable in-the-money options held by the CEO. *Opt*2 is calculated as *Opt*1 over the CEO's total annual income. *Opt*3 is defined as the number of shares underlying the CEO's vested in-the-money option as the percentage of the firm's stock shares owned by the CEO. *Option* is a dummy variable, which equals one if the firm's option is traded on US option exchanges, and zero otherwise. *Volume* is the average number of daily option contracts traded. Ln() denotes the natural logarithm transform. *Ownership* is the percentage of the firm's shares owned by the CEO. Industry dummies are constructed based on Fama and French's (1997) 48 industries. Corresponding *p*-values from robust standard errors clustered at the firm level are reported in brackets. The notations ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

	(1) Ln(1+*Opt*1)	(2) Ln(1+*Opt*2)	(3) Ln(1+*Opt*3)	(4) Ln(1+*Opt*1)	(5) Ln(1+*Opt*2)	(6) Ln(1+*Opt*3)
Option	0.41***	0.22***	0.09**			
	[0.000]	[0.000]	[0.033]			
Ln(*Volume*)				0.098***	0.028	0.092***
				[0.000]	[0.126]	[0.000]
Firmsize	0.61***	0.21***	0.05***	0.46***	0.13***	−0.088*
	[0.000]	[0.000]	[0.000]	[0.000]	[0.005]	[0.060]
CDF of variance	0.19	−0.09	0.19***	−0.45	−0.32	−0.38*
	[0.41]	[0.59]	[0.000]	[0.162]	[0.139]	[0.064]
Ownership	−7.69***	−3.33***	−19.35***	−9.32***	−4.59***	−17.84***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
M/B	0.17***	0.14***	0.001	0.11***	0.085***	−0.013
	[0.000]	[0.000]	[0.925]	[0.000]	[0.000]	[0.201]
Age	0.004	0.005*	−0.023***	0.008	0.007	−0.033***
	[0.318]	[0.087]	[0.000]	[0.343]	[0.225]	[0.000]
Stockreturn	2.52***	1.66***	−0.057	2.61***	1.69***	−0.12**
	[0.000]	[0.000]	[0.175]	[0.000]	[0.000]	[0.016]
Year & industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Intercept	−0.38	0.45	4.56***	1.94***	2.11***	6.27***
	[0.595]	[0.343]	[0.000]	[0.004]	[0.000]	[0.000]
N	13,689	13,689	13,682	10,121	10,121	10,114
Adjusted-R^2	30.6%	30.6%	28%	27.6%	21.8%	29.1%

variable in column 2. The variable *Option* has a coefficient of 0.22, which is significant at the 1% level. To examine the robustness of the results further, I employ the shares of vested in-the-money options instead of dollar values. The predicted variable in Model 3 is Ln(1+*Opt*3); the coefficient on *Option* is 0.09 and is significant at the 5% level, indicating that a zero-to-one increase of *Option* is associated with a 9.5% increase of *Opt*3.

Models 4–6 provide further results supporting the expected relation between executive option holding and the hedging cost, using Ln(*Volume*) as the proxy. All of the three regressions (except Model 5) highlight a significantly positive relation between Ln(*Volume*) and executives' holding of exercisable in-the-money options. The conclusion from Table 6 is quite clear. Managers are less eager to unwind their equity portfolios when they can use hedging instruments more easily. The finding also supports the claim that the two variables, *Option* and Ln(*Volume*), capture the effect of managerial hedging cost and influence managers' hedging behavior.

5.6. Managerial hedging cost and corporate dividend policy

In an earlier analysis in this paper, I mainly focus on how shareholders design compensation in response to executive hedging. A natural question for extension is how the hedging influences managers' decisions on corporate policies. In this section, I address this question by examining the effect of executive hedging on corporate dividend payments.[14]

Executive stock options furnish management with the incentive to reduce dividends because the value of executive stock options, like all call options, is negatively related to future dividend payments. Consistent with this hypothesis, Lambert, Lanen, and Larcker (1989) and Fenn and Liang (2001) find a strong negative relationship between dividends and management stock options. However, in the presence of managerial hedging, managers will not have such a strong incentive to cut dividends, because a drop in the stock price from a dividend payment will increase the value of short call and long put positions being held to hedge option compensation.[15] To test this view, I run pooled OLS regressions using the following model:

$$\begin{aligned} Dividend_{it+1} = e_0 + e_1 Option_{it} \text{ or } \mathrm{Ln}(Volume)_{it} \\ + e_2 Optionpay_{it} \text{ or } \mathrm{Ln}(Optionwealth)_{it} \\ + e_3 (Option_{it} \text{ or } \mathrm{Ln}(Volume)_{it})(Optionpay_{it} \\ \text{or } \mathrm{Ln}(Optionwealth)_{it}) + e_4 Firmsize_{it} \end{aligned}$$

[14] The influence of managerial hedging on other corporate decisions, such as investment and financing decisions could be an interesting topic for future research.

[15] It is worth noting that if the hedging is with equity swaps or with correlated assets in private portfolios, the hedged position could not be affected by the dividend policy. In these situations, the incentive to cut dividends remains. This concern is mitigated since the form of hedging the paper analyzes with its *Option* and *Volume* variables is indeed option-based hedging.

$$+e_5 CDF(Variance)_{it} + e_6 M/B_{it} + e_7 ROE_{it} + e_8 Leverage_{it} + e_9 Cash_{it} + IndustryDummy + YearDummy + \varepsilon_{it+1}.$$

Here, the dependent variable is the firm's dividend payment (Compustat Item 21) normalized by stock market capitalization. The variable *Optionpay* is the value of the CEO's annual option grants as a proportion of her total annual compensation; *Optionwealth* is the Black–Scholes value of the CEO's total stock options. Obviously, *Optionpay* is a flow variable, and *Optionwealth* is a level variable. I use these two variables to measure the relative importance of stock options for a CEO's wealth. I expect the e_2 coefficient to be negative, and the e_3 coefficient to be positive. Since my compensation data are from 1996 to 2005, the corresponding dividend data are from 1997 to 2006. The sample in this regression consists of 17,036 firm-year observations; 11,247 observations have publicly traded options.

Table 7 reports the results of estimating the above equation, in which I regress corporate dividend payments on the control variables plus CEOs' option holding, as well as the latter's interaction with the hedging cost proxies. In column 1, I use the *Option* dummy to measure the hedging cost and *Optionpay* for the CEO's option pay. The coefficient of *Optionpay* is significantly negative. The interaction term *Option* × *Optionpay* has a significantly positive coefficient.

I replace *Optionpay* with Ln(*Optionwealth*) in column 2. Similar to column 1, I find a negative coefficient on Ln(*Optionwealth*), and a positive coefficient on *Option* × Ln(*Optionwealth*). Both of the coefficients are significant at the 1% level. Furthermore, I substitute *Option* with Ln(*Volume*) in columns 3 and 4, repeat the previous two regressions, and find qualitatively similar results. The interactions, Ln(*Volume*) × *Optionpay* and Ln(*Volume*) × Ln(*Optionwealth*), are positive; both *Optionpay* and Ln(*Optionwealth*) have significantly negative coefficients.

Those coefficients of the interaction terms are also economically significant. Taking Model 1, for example, *Optionpay* and *Option* × *Optionpay* have the coefficients of −1.22 and 0.71, respectively. The interpretation of this

Table 7
Regression analysis on corporate dividend policy.

The sample consists of 17,036 firm-year observations from 1997 to 2006. In the sample, 11,247 firm-year observations have their options traded on US option exchanges. The dependent variable is the firm-level dividend payment (Compustat Item 21) normalized by the firm's stock market capitalization. *Option* is a dummy variable, which equals one if the firm's option is traded on US option exchanges, and zero otherwise. *Volume* is the average number of daily option contracts traded. *Optionpay* is the Black–Scholes value of the CEO's annual option grant normalized by her total annual compensation. *Optionwealth* is the Black–Scholes value of the CEO's total option holding. Ln() denotes the natural logarithm transform. Industry dummies are constructed based on Fama and French's (1997) 48 industries. Corresponding *p*-values from robust standard errors clustered at the firm level are reported in brackets. The notations ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)
Optionpay	−1.22***		−0.76***	
	[0.000]		[0.000]	
Ln(*Optionwealth*)		−0.053***		−0.041***
		[0.000]		[0.000]
Option × Optionpay	0.71***			
	[0.000]			
Option × Ln(*Optionwealth*)		0.02***		
		[0.005]		
Ln(*Volume*) × Optionpay			0.05***	
			[0.004]	
Ln(*Volume*) × Ln(*Optionwealth*)				0.001
				[0.487]
Option	−0.54***	−0.55***		
	[0.000]	[0.000]		
Ln(*Volume*)			−0.20***	−0.21***
			[0.000]	[0.000]
Firmsize	0.13***	0.15***	0.33***	0.37***
	[0.000]	[0.000]	[0.000]	[0.000]
CDF of variance	−3.02***	−3.12***	−2.59***	−2.63***
	[0.000]	[0.000]	[0.000]	[0.000]
M/B	−0.05***	−0.04***	−0.05***	−0.04***
	[0.000]	[0.000]	[0.000]	[0.000]
ROE	0.02	0.09***	0.06*	0.12***
	[0.429]	[0.002]	[0.066]	[0.001]
Leverage	0.23***	0.22***	0.49***	0.48***
	[0.000]	[0.000]	[0.000]	[0.000]
Cash	−0.43***	−0.53***	−0.38***	−0.42***
	[0.000]	[0.000]	[0.000]	[0.000]
Year & industry dummies	Yes	Yes	Yes	Yes
Intercept	0.59***	0.62***	−0.57***	−0.54***
	[0.000]	[0.000]	[0.002]	[0.009]
N	16,991	17,036	11,247	11,246
Adjusted-R^2	35.9%	36.2%	36.4%	37.3%

result is as follows. When *Option*=0, the partial effect of *Optionpay* on dividend payment is −1.22; when *Option*=1, the partial effect of *Optionpay* is reduced to −0.51 (−1.22+0.71=−0.51).

Table 7 supports the prediction that managerial hedging weakens the negative relation between management option pay and corporate dividends. The result is also consistent with a broader idea that managers who can hedge are less influenced by their incentive pay.

5.7. Managerial hedging cost and corporate diversification

In addition to hedging personal incentive portfolios, another way for managers to hedge risk is to diversify their companies. This section addresses the natural question of how managerial hedging costs influence corporate diversification decisions.

Existing literature finds risk reduction as a strong motive for corporate diversification (Amihud and Lev, 1981; May, 1995). To the extent that diversification decreases firm risk, managers facing higher idiosyncratic risk tend to diversify the companies more. Given that managerial hedging enables the managers to unwind their wealth from firm risk, I expect that hedging personal portfolios and diversifying the firms are substitutes for managers to reduce risk. In other words, when executives can hedge more easily, they will execute fewer corporate diversification initiatives. To test this prediction, I run pooled OLS regressions estimating the following model:

$$\begin{aligned} &Corporate\ diversification_{it} \\ &= f_0 + f_1 Option_{it} \text{ or } \mathrm{Ln}(Volume)_{it} + f_2 Firmsize_{it-1} \\ &\quad + f_3 Stockreturn_{it-1} + f_4 CDF(Variance)_{it-1} + f_5 M/B_{it-1} \\ &\quad + f_6 ROE_{it-1} + f_7 Cash_{it-1} + IndustryDummy \\ &\quad + YearDummy + \varepsilon_{it}. \end{aligned}$$

I use two measures of corporate diversification: the Herfindahl Index of the concentration of sales across the various business segments, and the number of reported business segments. A more diversified firm is represented by a lower value of Herfindahl Index and more segments. The regression sample consists of 52,472 firm-year observations from 1996 to 2005; 16,369 observations have options traded in the option exchanges. The means of Herfindahl Index and segment number are 0.83 and 2.01, respectively. To support the prediction that corporate diversification is positively associated with managerial hedging costs, I expect positive (negative) coefficients for f_1 when the Herfindahl Index (segment number) is the dependent variable.

Table 8 highlights the significantly positive relation between the degree of corporate diversification and executive hedging costs. In columns 1 and 2, the dependent variable is the Herfindahl Index. The coefficients on *Option* and Ln(*Volume*) are 0.017 and 0.004, respectively; both are significant at the 10% level. These positive coefficients indicate that lower hedging costs are associated with a higher Herfindahl Index

Table 8
Regression analysis on corporate diversification.
The sample consists of 52,472 firm-year observations from 1996 to 2005. I obtain stock price data in CRSP, accounting data in Compustat, and option trading data in OptionMetrics. In the sample, 16,369 firm-year observations have their options traded on US option exchanges. The dependent variables are the Herfindahl Index and the natural logarithm of number of business segments. The Herfindahl Index is calculated as the sum of the square of segment sales divided by the square of firm sales. *Option* is a dummy variable, which equals one if the firm's option is traded on US option exchanges, and zero otherwise. *Volume* is the average number of daily option contracts traded. Ln() denotes the natural logarithm transform. Industry dummies are constructed based on Fama and French's (1997) 48 industries. Corresponding *p*-values from robust standard errors clustered at the firm level are reported in brackets. The notations ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

	(1) Herfindahl index	(2) Herfindahl index	(3) Ln(segments)	(4) Ln(segments)
Option	0.017***		−0.041***	
	[0.001]		[0.002]	
Ln(*Volume*)		0.004*		0.003
		[0.066]		[0.644]
Firmsize	−0.027***	−0.028***	0.073***	0.058***
	[0.000]	[0.000]	[0.000]	[0.000]
Stockreturn/100	0.27***	0.20**	−0.61***	−0.56**
	[0.000]	[0.042]	[0.000]	[0.023]
CDF of variance	0.08***	0.13***	−0.21***	−0.39***
	[0.000]	[0.000]	[0.000]	[0.000]
M/B/100	0.41***	0.42***	−1.12***	−1.13***
	[0.000]	[0.000]	[0.000]	[0.000]
ROE/100	0.91***	1.16***	−2.59***	−3.48***
	[0.001]	[0.002]	[0.000]	[0.000]
Cash	0.13***	0.15***	−0.35***	−0.41***
	[0.000]	[0.000]	[0.000]	[0.000]
Leverage	−0.057***	−0.043**	0.147***	0.094*
	[0.000]	[0.029]	[0.000]	[0.058]
Year & industry dummies	Yes	Yes	Yes	Yes
Intercept	0.97***	0.98***	0.072	0.012
	[0.000]	[0.000]	[0.152]	[0.925]
N	51,532	16,220	52,472	16,369
Adjusted-R^2	20%	26%	24%	31%

(less firm diversification). I then replace the Herfindahl Index with the natural logarithm of segment number as the dependent variable in columns 3 and 4. The results are qualitatively similar. Other controls are generally consistent with those in Coles, Daniel, and Naveen (2006). In summary, the regression analysis supports the prediction that when managers can hedge their incentive pay more easily, they initiate fewer diversification projects with their companies.

6. Additional investigation

6.1. *Proxy for the ease of OTC hedging transactions*

Hedging through the OTC market is also an important channel for managers to diversify firms' risk. While existing literature has identified few variables indicating the ease of implementing OTC transactions (to my knowledge), CEOs in the financial industry probably have better access to these OTC derivatives. Hedging by OTC transactions usually involves private negotiation between corporate executives and some financial institutions (Bettis, Bizjak, and Lemmon, 2001; Jagolinzer, Matsunaga, and Yeung, 2007). Therefore, a good ongoing relationship and strong social network with these financial organizations should facilitate the executives during the negotiation process. A CEO working within the financial industry presumably has a better personal relation with financial companies than CEOs outside the industry, which gives her better opportunities to implement the OTC hedging operations. Moreover, the CEO in the financial industry may understand the OTC derivatives better than CEOs working in other sectors; this can also increase her comfort in the OTC market.

Based on this idea, I define an indicator variable, *Financial industry*, equaling one if the firm is in banking, insurance, or trading industries,[16] and zero otherwise. In my sample of 13,691 firm-year observations used in Panel A of Table 2, 1,780 (13%) of them are in the financial industry. I then re-do the regressions in Panel A of Table 2 by replacing *Option* with *Financial industry* (industry dummies and firm fixed effects are also excluded). Given that the *Financial industry* dummy is supposed to indicate the ease of implementing OTC hedging transactions, its coefficients are expected to be positive.

Table 9 reports that CEOs in the financial industry have greater pay-performance sensitivity than other CEOs, after controlling for the CEO and firm characteristics. The coefficients of *Financial industry* are all positive and significant (except Model 1). Taking Model 3 for example, *Financial industry* has a significantly positive coefficient of 0.41, indicating that CEOs in the financial industry have 41% higher *PEI* than other CEOs. The result supports the argument that it is easier for CEOs in the financial industry to conduct the OTC hedging transactions; therefore, shareholders impose higher-power contracts.

[16] The corresponding classifications of Fama and French's (1997) 48 industries are 44, 45, and 47, respectively.

Table 9
Financial industry and incentive pay.
The sample and regression specifications are the same as those in Panel A of Table 2, except that I replace *Option* with the *Financial industry* dummy (industry dummies and firm fixed effects are also excluded). The *Financial industry* dummy takes the value of one if the firm is in banking, insurance, or trading industries, and zero otherwise. The coefficients of controls (unreported) are similar to those in Panel A of Table 2. Corresponding *p*-values are reported in brackets. The *p*-values for OLS regressions are based on robust standard errors clustered at the firm level. The *p*-values for median regressions are according to bootstrapped standard errors based on 20 replications. The notations ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

	(1) *PPS* *OLS*	(2) *PPS* *Median*	(3) Ln(*PEI*) *OLS*	(4) Ln(*PEI*) *Median*
Financial industry	1.11	2.91***	0.41***	0.49***
	[0.76]	[0.000]	[0.000]	[0.000]

6.2. *Direct executive hedging transactions*

To further support the model and validate the hedge cost proxies, this section examines the explicit hedging transactions of CEOs. My model predicts that the manager will hedge more when the hedging cost is smaller, and that higher pay-performance sensitivity is associated with more hedging transactions (see Eq. (10)). In this section, I empirically examine the following three questions: Do lower hedging costs predict more explicit hedging transactions made by the CEOs? Are CEOs with higher-power contracts more likely to trade the hedging instruments? What is the relation between CEOs' option holding behavior and explicit hedging activities?

Starting in 1996, Primark/Disclosure (now part of Thomson Reuters) began to collect all the hedging transactions recorded in Table 2 of Forms 3, 4, and 5. Similar to Bettis, Bizjak, and Lemmon (2001) and Jagolinzer, Matsunaga, and Yeung (2007), I search in the insider trading database of Thomson Reuters for the security codes "EQSWP," "FWD," and "PUT," which correspond to the executive transactions of equity swaps, forward sales, and put options, respectively. During 1996–2005, I identify 75 ExecuComp CEO-year observations that are involved in the above transactions. Similar to Bettis, Bizjak, and Lemmon (2001), for each of the 75 hedging observations, I identify a comparison firm in the same Fama and French (1997) 48 industries with the closest market value of equity in the preceding year of the transaction. Using a matched-pairs sample produces more efficient parameter estimates than using the full ExecuComp population would, given the very small fraction of hedged CEOs in the population (Manski and Lerman, 1977). To examine the direct hedging behavior of CEOs, I estimate the following logit regression:

$$\Pr(Hedged) = F(X, Firmsize, CDF(Variance), M/B, ROE, \\ Leverage, Age, Cash, Stockreturn, YearDummy, IndustryDummy).$$

The dependent variable, *Hedged*, equals one if the CEO-year observation is one of those 75 hedging observations, and zero otherwise. The function *F* denotes the logit cumulative distribution function. The contemporaneous variable *X* denotes a set of key independent variables, including *Option*, Ln(*Volume*), *Financial industry*, *PPS*, Ln(*PEI*), and Ln(1+*Opt*1). I also control for a set of the firm characteristics measured at the fiscal year prior to the transactions. The coefficients reported are estimates of the marginal effect on the probability when all of the other independent variables are at their mean value.

It is worth noting that some CEOs could have used hedging instruments but did not report them (Bettis, Bizjak, and Lemmon, 2001). This possibility will cause biases against me to detect differences in *X* between hedged CEOs and other CEOs. In other words, the detected differences will become more evident if I analyze a complete sample of CEOs who used hedging instruments.

Columns 1–3 of Table 10 show that the CEO is more likely to conduct the hedging transaction when her hedging cost is lower. I use *Option* as the proxy for hedging costs in column 1; the coefficient of *Option* is 0.31 and is significant at the 5% level. This coefficient implies that an increase of *Option* from zero to one will increase the probability of a CEO being hedged by about 30 percentage points. Replacing *Option* with Ln(*Volume*), column 2 also indicates that a CEO with lower hedging costs is more likely to engage in explicit hedging transactions. The variable Ln(*Volume*) has a coefficient of 0.13; it is significant at the 10% level. I then use the

Table 10
Direct executive hedging transactions.

This table reports the logit regression predicting CEOs' explicit hedging transactions. The dependent variable is the *Hedged* dummy, which equals one if the CEO-year observation is associated with purchases of equity swaps, forward sales, or put options identified in the insider trading database of Thomson Reuters (75 observations), and zero otherwise. For each of the 75 observations, I form a control firm in the same Fama and French (1997) 48 industries with the closest market value of equity in the preceding year. *Option* equals one if the firm's option is traded on US option exchanges, and zero otherwise. *Volume* is the average number of daily option contracts traded. *PPS* is the dollar value change of the stock and options held by a CEO per $1,000 shareholder return. *PEI* (in $thousand) is the sensitivity of the total value of stock and options held by a CEO to a 1% change in stock price. *Financial industry* equals one if the firm is in banking, insurance, or trading industries, and zero otherwise. *Opt*1 is the dollar value of the exercisable in-the-money options held by the CEO. The coefficients are the marginal effect on the probability when all of the independent variables are at their mean. Ln() denotes the natural logarithm transform. Industry dummies are based on Fama and French's (1997) 48 industries. The notations ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Option	0.31**					
	[0.014]					
Ln(*Volume*)		0.13*				
		[0.077]				
Financial industry			0.22			
			[0.221]			
PPS				0.003***		
				[0.003]		
Ln(*PEI*)					0.23***	
					[0.000]	
Ln(1+*Opt*1)						0.034*
						[0.063]
Firmsize	−0.025	−0.21	−0.012	0.036	−0.12	0.005
	[0.710]	[0.112]	[0.810]	[0.608]	[0.103]	[0.932]
CDF of Variance	1.07***	1.16**	0.82***	1.18***	1.18***	1.24***
	[0.002]	[0.014]	[0.001]	[0.004]	[0.006]	[0.000]
M/B	0.038	0.022	0.037	0.073*	0.057	0.027
	[0.224]	[0.595]	[0.152]	[0.072]	[0.173]	[0.388]
ROE	0.15	0.16	0.22	−0.45	−0.21	0.17
	[0.772]	[0.807]	[0.574]	[0.505]	[0.774]	[0.731]
Leverage	0.81**	0.91*	0.84**	0.88**	0.81*	0.89**
	[0.048]	[0.073]	[0.017]	[0.046]	[0.086]	[0.032]
Age	0.018**	0.034***	0.01	0.02**	0.015	0.02**
	[0.034]	[0.004]	[0.115]	[0.048]	[0.166]	[0.017]
Cash	−1.71***	−3.09***	−0.95**	−2.01***	−1.72**	−1.55***
	[0.005]	[0.000]	[0.041]	[0.006]	[0.013]	[0.010]
Stockreturn	0.26	0.22	0.16	0.001	−0.093	0.17
	[0.119]	[0.247]	[0.257]	[0.998]	[0.660]	[0.313]
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	No	Yes	Yes	Yes
N	139	112	141	125	125	139
Pseudo-R^2	19.8%	29.8%	14.1%	24.2%	28.4%	19.3%

Financial industry dummy as the proxy for the OTC hedging cost in column 3; the coefficient of *Financial industry* is 0.22 and its *p*-value is around 0.2. The positive sign suggests that CEOs in the financial industry seem more likely to use the hedging instruments, although the coefficient is not statistically significant at the 10% level. Overall, columns 1–3 broadly support the model's prediction that lower hedging costs facilitate the direct hedging transactions.

In columns 4 and 5, I examine the relation between pay-performance sensitivity and direct hedging behavior and find that both *PPS* and Ln(*PEI*) strongly predict the CEO's hedging activities. The coefficients of *PPS* and Ln(*PEI*) are 0.003 and 0.23, respectively; both the coefficients are statistically significant at the 1% level. Their economic magnitude is also sizeable. For example, given that the standard deviation of Ln(*PEI*) in this regression sample is 1.59, a one-standard-deviation increase in Ln(*PEI*) is associated with about 36 percentage points higher likelihood of a CEO being hedged. Clearly, the positive association between *PPS*/Ln(*PEI*) and *Hedged* supports the model.

Column 6 examines the relation between the explicit hedging activity and option holding behavior. As discussed in Section 5.5, a hedged CEO should be associated with more voluntary option holding. To examine this relationship, I then put Ln(1+*Opt*1), the dollar value of the CEO's exercisable in-the-money option defined in Section 5.5, as the key independent variable in column 6 and find a significantly positive coefficient.[17] This result supports the view that option holding behavior and direct hedging activities are positively correlated.

In summary, Table 10 finds that a CEO is more likely to engage in direct hedging activities when her hedging cost is smaller, when her compensation is more sensitive to performance, and when she holds more options. This result is consistent with the model.

7. Conclusion

This paper examines the optimal executive compensation with respect to managerial hedging. The driving force behind my theoretical analysis is the notion that an executive's actions are influenced by the cost for her to access hedging instruments. I extend previous research by showing that the hedging cost has important effects on the manager's effort-exerting incentive and risk-bearing ability. My model predicts a negative association between pay-performance sensitivity and the managerial hedging cost. I then provide empirical evidence to support the model's prediction.

Two variables are primarily employed to measure the hedging cost. The first measure is a dummy variable indicating the availability of the firm's options on option exchanges. I then use the firm's option trading volume as the second proxy. In a straightforward manner, these two variables capture the ease with which one can trade the firm's derivatives to hedge idiosyncratic risk. Equivalently, the two proxies reflect the opportunities that managers have to make the hedging transactions.

In addition to examining the pay-performance sensitivity, I also investigate the impact of managerial hedging on the sensitivity of CEO wealth to stock volatility. The findings support the view that shareholders increase the convexity of the relation between CEO wealth and stock return, along with increasing the slope, when managers can hedge.

To deepen the understanding of the managerial hedging problem, I then examine whether shareholders use other mechanisms to resolve this hedging issue, in addition to offering high-power contracts. Particularly, I address this question by investigating the capital structure decision. As a substitute for incentive pay, debt is widely suggested by available studies as a powerful way to align shareholder-manager interests. When executive hedging undermines the effectiveness of incentive compensation, shareholders are expected to increase financial leverage as an alternative way to restore executive incentive. Consistent with this argument, I show evidence that firms exhibit higher leverage ratios when it is easier for their managers to unwind the incentive contracts. This relation is found to be stronger for better-governed companies.

To validate that the two proxies measure the hedging cost and influence managers' personal trading, I further analyze executives' option exercising/holding behavior. Existing studies suggest that managers will hold more exercisable in-the-money options when they can diversify firm-specific risk through hedging instruments. Consistent with this prediction, my analysis reports a reverse relation between the hedging cost and holdings of options that have become vested and in-the-money.

Furthermore, I extend this study by investigating how managerial hedging influences corporate policies. In particular, I look at corporate dividend payouts. Prior research shows that option pay induces managers to cut dividend payments. Based on the idea that managers who can hedge are less influenced by their incentive portfolios, managerial hedging is expected to undermine the negative association between option compensation and dividend payments. I then provide evidence supporting this implication.

To the extent that diversifying the firm and hedging personal portfolios are substitutes for managers to reduce risk, I find evidence that managers undergo fewer corporate diversification initiatives when they have lower costs to hedge their incentive pay.

In an additional investigation, CEOs are found to receive higher-power contracts when they can implement OTC hedging transactions more easily. Finally, based on a sample of explicit hedging transactions, I find that CEOs are more likely to engage in such transactions when their hedging costs are lower and when they have more equity portfolio.

In summary, this study concludes five major implications that: (1) managerial hedging undermines managers' incentive to exert effort and increases their ability to bear risk; (2) shareholders enhance both the sensitivity and

[17] Instead of Ln(1+*Opt*1), I also use Ln(1+*Opt*2) or Ln(1+*Opt*3) as a robustness check. The results are qualitatively similar.

convexity of the relation between CEO wealth and stock return in corresponding compensation contracts; (3) shareholders adopt higher financial leverage to overcome this executive-hedging issue in addition to providing higher-power contracts; (4) managerial hedging induces managers to delay the exercise of their option grants, and weakens the negative relation between option compensation and dividend payment; and (5) managers diversify their firms less when they can hedge their incentive pay more easily. Lastly, this paper provides indirect evidence that managers tend to use public options markets to undo their incentive compensation.

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