Hedge Markets for Executives and Corporate Agency*

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Abstract

This paper analyzes the implications of executive hedge markets for firm value maximization in an optimal contracting framework. The main results are as follows: Without any hedging ability, the manager underinvests in risk at the firm level to diversify his own compensation risk. If the manager can trade a security correlated with firm specific risk, the underinvestment in risk is reduced, optimal managerial share ownership and equilibrium effort increase. If the manager can hedge by simulating the sale of his shares, however, he can completely undo any incentive scheme. The model predicts that a higher degree of financial market development implies higher managerial share ownership and more efficient risk taking at the firm level.

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1 Introduction

Stock-based compensation for corporate executives increased at drastic rates in the United States during the 1990s.[1] According to the agency theory of optimal contracting, stock-based pay induces the manager the correct incentives to maximize shareholder value by creating a correlation between the manager's wealth and firm performance. Modern portfolio theory, however, should also apply to corporate managers. Excessive stock-based compensation schemes should create a portfolio diversification incentive for the manager (Ofek and Yermack (2000)).

Almost simultaneous with the upward trend in stock based compensation, in the late 1990s a sizable market for managerial hedging emerged. Investment banks and derivatives securities dealers developed and introduced sophisticated financial instruments, like executive equity swaps, basket hedges and zero-cost collars, that enable the managers to diversify their stock ownership positions (Bettis et. al 2001). The workings of this new market and especially its implications for shareholder value maximization are very little understood. One reason is the lack of available data. Due to lax disclosure rules and the managers' own incentives not to attract too much market attention, these hedging transactions have been quite private.[2]

Despite the lack of formal analysis, the general view on managerial personal hedging practices is quite negative.[3] In the legal profession, Bank (1995), Schizer (2000) and Easterbrook (2002) argue that if a manager has unrestricted access to hedge markets to liberate his compensation from firm

[1] According to Morgenson (1998), in the late 90s, the 200 largest U.S. companies had reserved more than 13 percent of their common shares for compensation awards to managers, up from less than 7 percent in 1990.

[2] The case of Autotote CEO equity swap, studied by Bolster et. al (1995), is an example of the secretive nature of managerial hedging. This was the only transaction reported to SEC in 1994. Ip reports that the level of disclosure of such derivative transactions is far below the actual level of activity (WSJ, September 17, 1997). Lavalle (2001) reports only 31 disclosed transactions in 2000 up from 15 in 1996. Among them were some big names in the high tech sector including Microsoft co-founder Paul G. Allen.

[3] An editorial in *The Economist,* (Executive Relief' April 3, 1999, p.64) takes the following view: "Further justifying the scepticism is the current popularity of derivatives that allow managers to hedge their exposure to their own company's shares...Such hedging is wholly against the spirit of the massive awards of shares and share options."

performance, the incentive justification for managerial stock ownership would no longer hold. A quite puzzling issue is the permissive attitude of firms towards managerial hedge transactions. Schizer (2000) points out that the contractual bans on hedge transactions are uncommon. According to Bebchuk and Fried (2003) firms take surprisingly few steps to prevent or regulate the financial market access of their executives. If the manager's ability to enter into hedging transactions with third parties undermines incentives, why is it allowed? A satisfactory answer to that question should distinguish between different hedging practices and analyze whether all managerial hedging transactions are detrimental to incentives. It should also allow the shareholders to design the optimal compensation package taking into account the manager's hedging opportunities. Given the growing importance of managerial hedge markets, a formal analysis seems to be warranted.

This paper introduces managerial hedge markets into an optimal contracting framework and analyzes the implications of these markets for the manager's effort and risk choices. An agency model is developed where shareholders optimally choose their manager's ownership share to induce value maximizing policies. The risk averse manager (he) can affect the firm value in two ways: he supplies costly effort that increases expected firm value. The manager can also affect the firm level risk by choosing a risk reduction policy. In particular, I consider the possibility of inefficient risk reduction at the firm level which, if undertaken, reduces shareholder value. Before supplying effort and implementing the risk reduction policy, the manager can trade with third parties and alter the firm specific risk exposure in his compensation. The analysis distinguishes between two different types of managerial hedging: (i) a hedge transaction with a financial intermediary based on the innovation of a security correlated with the manager's firm specific risk, (ii) a hedge transaction directly contingent on the manager's company stock, commonly known as an equity swap, which allows the manager to simulate the sale of his company share ownership. The main results are as follows.

Compensating the manager with share ownership gives him incentives to supply effort and increase shareholder value. However, without any hedging opportunities, share ownership also gives the risk averse manager inefficient risk reduction incentives at the firm level. Due to the inability to diversify the firm specific risk in his compensation by a personal portfolio choice, the manager reduces the firm level risk inefficiently.[4] This result is driven by the manager's personal portfolio diversification motives first identified by Amihud and Lev (1981). The shareholders' optimal response is then to lower the incentives in the form of share ownership to mitigate the inefficient risk reduction appetite. In equilibrium, the supply of effort and hence expected firm value is adversely affected due to the manager's lack of personal hedging ability.

The third party innovation of a security correlated with the firm specific risk increases the manager's tolerance for this risk without undermining his incentives to supply effort. This hedging practice mitigate the inefficient risk reduction appetite of the manager by allowing him to diversify partially the firm specific risk in his compensation This ability hence aligns the manager's preference towards firm specific risk with that of the shareholders who can perfectly diversify that risk. The shareholders can now give steeper incentive compensation to the manager and achieve a higher supply of effort, since increasing the manager's ownership share results in less (with perfect diversification ability none) wasteful risk reduction.

The analysis also endogenizes the manager's hedging ability through costly security innovation. This endogeneity derives a testable link between the degree of financial market development, optimal managerial share ownership and level of efficient risk taking at the firm level. A novel implication of the analysis is that a higher degree of financial market development, which implies a lower cost of security innovation, gives rise to a higher managerial share ownership and promotes more efficient risk taking at the firm level.

The above results illustrate a positive role for managerial hedge markets. However, the common concern against these markets is not without substance: managerial hedging that simulates the sale of shares, like an equity

[4] More incentive compensation in the form of higher share ownership induces more wasteful risk reduction as well as more effort. Therefore, the expected firm value is not in general monotone increasing in the manager's incentive compensation. This implication differs from standard agency settings which predict a monotone positive relationship between incentives and performance. The difference arises because the manager's ability to affect firm specific risk and the wasteful risk reduction incentives are ruled out by assumption in standard settings.

swap, can potentially undermine incentives. This time, the manager again diversifies the firm specific risk and hence has less incentives for inefficient risk reduction at the firm level. However, these hedge transactions reduce the manager's effective holdings of company shares and leave him with lower incentives to supply effort. Therefore, as argued in the popular press and the legal profession, managerial hedging transactions that simulate the sale of shares can undo the link between the manager's wealth and firm performance. In particular, the manager's ability to simulate the sale of shares in a non-exclusive hedge market yields a unique equilibrium with complete lack of managerial activity: the manager synthetically sells all his holdings of company shares and ends up with no incentives for supplying effort.

Related Literature: The literature that analyzes agency problems when managers have access to hedge markets is quite recent. Jin (2002), Garvey and Milbourn (2003), Acharya and Bisin (2003) study agency settings where the managers can trade the market index and hence can diversify only *the systematic risk* in their compensation. These papers preclude the manager's ability and incentives to diversify the firm specific risk by assumption. In practice, however, most of the managerial hedging instruments grant the managers the ability to diversify the *firm specific risks*. This is especially true in case of basket hedges, executive equity swaps and zero-cost collars, the most common hedging instruments manager use (Bettis et al. (2001)). The popular business press coverage of the issue and studies in the legal profession have also expressed concern on the manager's ability to diversify the firm specific risks rather than the systematic risk.[5]

In recent independent work, Bisin et al. (2004) allow the manager to hedge the firm specific risk in a standard effort type moral hazard setting. Their assumptions and results differ than this paper in several ways: Unlike this paper, they do not distinguish between different hedging transactions

[5] Schizer (2000) argues that the concern on managerial hedging does not apply to hedges that screen out market risk: "Such a hedge is a bet that the manager will outperform the market, and if anything, would intensify an executive's motivation and incentives (page 453). The seminal principal-agent analysis by Holmstrom (1979) also predicts that the optimal compensation contracts should filter out market risk, since tying pay to factors which are not in the agent's control (luck) does not provide better incentives, but merely adds risk to the contract.

and implicitly assume that the manager can hedge only in a way that reduces his effective share ownership. Therefore, hedging is always detrimental to managerial incentives in Bisin et al (2004). The shareholders prevent the manager from hedging by monitoring his portfolio which results in an equilibrium with no hedging. Another key difference is that they analyze a setting where the firm specific risk is fixed and does not depend on the manager's policy. They therefore do not address the risk choice implications of incentive compensation and how the manager's hedging ability can mitigate inefficient risk reduction incentives at the firm level, increase equilibrium effort incentives and improve shareholder value.

The manager's access to a hedge market introduces non-exclusivity to the agency setting. This aspect relates the paper to a body of work which study common agency environments where the agent can make non-exclusive contracts with multiple principals for the same moral hazard activity (see Kahn and Mookherjee (1995, 1998) and Bisin and Guaitoli (2004) on implications for insurance and credit markets, Bisin and Rampini (2004) for taxation without commitment, Bizer and DeMarzo (1992) on implications for banking, Parlour and Rajan (2001) for loan contracts from multiple creditors, Bizer and DeMarzo (1999) for a principal-agent model with borrowing and default). In this paper, non-exclusivity does not take the form of multiple principals. The manager works only for one firm, but can trade with outside parties once his compensation contract is set. Another difference is that the manager can affect not only the expected output, but also the output risk.

Another related strand of literature is papers that link corporate risk management policies to managerial diversification motives (Amihud and Lev (1981), Stulz (1984), May (1995) and Tufano (1996)). This paper adds to that literature by introducing managerial hedge markets so that the manager can diversify at the portfolio level as well as at the firm level. Also, the manager's compensation scheme here is endogenous: it is jointly determined by the acquisition of managerial hedging instruments, the manager's equilibrium effort and risk choice incentives. [6]

[6] For example, in his conclusion, Stulz writes: "It would be interesting to show how the choice of the management compensation schemes depends on the opportunities managers have to hedge." (Stulz (1984), p. 139).

The plan of the paper is as follows. The next section lays out the basic model. Section 3 analyzes the benchmark setting with no hedging. Sections 4 and 5 analyze two different types of hedging opportunities and contain the main results. Section 6 summarizes and discusses the implications. Section 7 concludes. All proofs are collected in the Appendix.

2 The Model

Consider an all equity financed firm owned by shareholders and run by a manager. The shareholders are assumed to be risk neutral and they maximize expected firm value net of the manager's compensation. The manager is risk averse and has negative exponential preferences with a CARA (constant absolute risk aversion) coefficient $a > 0$. The manager's certainty equivalent reservation utility (outside option) is normalized to zero.

The manager can affect the distribution of firm value with two actions: he chooses costly effort $e \geq 0$ that increases expected firm value. The manager also implements a risk reduction policy $x \geq 0$. The distribution of the firm value y as a function of e and x is given by

$$y(e,x) \equiv F(e) - L(x) + \varepsilon(x) \tag{1}$$

where $F(e)$ is concave, increasing and differentiable in e with $F(0) = 0$. Furthermore,

(A1) The firm specific risk $\varepsilon(x)$ is normally distributed with

$$\varepsilon(x) \sim N(0, \Sigma - \Delta x)$$

where $\Delta > 0$ and $\Sigma > 0$ are constants. x lies in the interval $[0, \bar{x}]$ with $\bar{x} < \Sigma/\Delta$.

(A2) Risk reduction activity x reduces expected firm value by $L(x)$ where $L(.)$ is a differentiable, convex and increasing loss function with $L(0) = 0$, $L^{'}(0) = 0$, $L^{'}(x) > 0$ for $x > 0$ and $L^{''} > 0$.

Assumptions 1 and 2 model the possibility that the manager can undertake inefficient risk reduction at the firm level, which is the case for $x > 0$.

Throughout the paper, I refer to x generically as the inefficient risk reduction activity or the level of underinvestment in firm specific risk. x can measure the manager's inefficient diversification strategy where such diversification reduces shareholder value as in Aggarwal and Samwick (2003). A more straightforward interpretation is distortions in project selection: the manager may avoid undertaking risky projects with positive net present values as in Lambert (1986) or he may undertake risk reducing acquisitions with negative net present values, as in Amihud and Lev (1981).

As standard in agency models, supplying effort is costly for the manager.

(A3) *Cost of Effort*: The manager incurs a convex and increasing private cost $c(e)$ from expending effort, with $c(0) = 0$.

Given the above specification of y, the first best effort level e_{fb} equates the marginal social benefit of effort to its marginal cost and solves $F^{'}(e_{fb}) = c^{'}(e_{fb})$. Since risk reduction is wasteful, first best level is $x_{fb} = 0$. I assume that the effort choice e and the risk choice x are not contractible: the shareholders can not compensate the manager directly contingent on e and x and achieve the first best solution.[7] Following the optimal contracting literature, I consider a setting where shareholders use incentive compensation in the form of managerial share ownership to induce firm value maximizing policies.

(A4) *Linear Compensation:* The compensation contract of the manager is described by a pair (t, s) where t is a fixed wage and s is the manager's share of firm value. The manager's compensation contract (t, s) is determined endogenously by the shareholders at the start of the model.[8]

Managerial Hedging: The manager has access to hedging opportunities

[7]The model in this paper is also related to a very recent class of models where the agent/manager controls both the mean and the risk of the output technology by his actions (see Guo and Ou-Yang (2004), Cadenillas et. al (2004)). These models do not consider the implications of the manager's access to hedge markets.

[8]Linear compensation schemes are popular in the literature mostly due to their analytical tractability, but they have practical relevance as well. Following Jensen and Murphy (1990) empirical tests often convert option ownership into "equivalent" stock ownership using Black-Scholes formula. Jin (2002) points out that in practice the sharing rule is often close to linear, because the convexity induced by the manager's stock options is negligible to the first order.

to diversify his personal portfolio before supplying effort and implementing the risk reduction policy. I distinguish between two different and common types of hedging. The main body of the paper considers the case where the manager can diversify the firm specific risk ε by trading a hedge security innovated by a financial intermediary. Section 5 analyzes the case when the manager can trade claims directly contingent on his own firm value and hence simulate the sale of his shares. The description of side transactions that simulate sale of shares is left to Section 5. The description of hedging with security innovation is as follows.

After his compensation package is set by the firm, the manager approaches to a financial intermediary, like an investment bank or a derivatives securities dealer, with an expertise to innovate a hedge security. Schizer (2000, page 451) reports that corporate executives use such derivatives, based not on their own company stock but on a hybrid group of securities, designed to track their company stock.[9] The financial intermediaries that can innovate the hedge security are risk neutral and competitive. Let b denote the stochastic payoff of the innovation.

(A5) *Hedge Security Payoff:* The payoff b of the innovation is normally distributed with $b \sim N(\mu, \sigma^2)$ and it is correlated with the firm specific risk ε according to a correlation coefficient ρ.

The normality assumption on b helps to keep the model tractable. Since CARA preferences preclude any wealth effects, the expected payoff μ of the innovation is inconsequential in the analysis. The assumption that b is correlated with ε is crucial for the innovation to play a role as a hedge instrument. With $\rho = 0$, the payoff of the security is orthogonal to firm specific risk, and a manager with CARA preferences and who wants to diversify ε has no use of it.[10] For convenience, define $z \equiv \rho^2 > 0$. As the analysis illustrates shortly,

[9] See also the discussion in Bisin et. al. (2004, page 4) on the popularity of such hybrid instruments.

[10] This statement is not necessarilly true with more general preferences. Franke et. al. (1998) show that with HARA (hyberbolic absolute risk aversion) preferences, agents optimally demand call and put options on the market portfolio to diversify their background risk (i.e., risks that are not tradeable). CARA is a special case in the HARA family where this demand is zero.

z is the measure of the effectiveness of the innovation as a hedge instrument. In what follows, I refer to z as the manager's endogenously chosen hedging ability or the quality of the innovation. The cost of security innovation is assumed to be increasing in z.

(**A6**) *Cost of Security Innovation:* The financial intermediary incurs a cost $\gamma z^2/2$ from providing the manager a hedging ability z, i.e., from innovating a security with quality z.

The intermediary (or any one else including the manager) could come up at no cost with a general market index not correlated with ε. This index would be of no use to the manager to diversify his firm specific risk. The costly financial innovation assumption captures the idea that such hedging instruments are customized for the manager. The intermediary may expend costly resources to design an effective hedge instrument fine tuned for the managers' diversification needs. To keep the analysis simple, I assume that there are no moral hazard issues between the manager and the intermediary about the security quality z. The intermediary can be compensated contingent on z which is verifiable by both parties.

The following feature of the model deserves further comment. The shareholders can not tie the manager's compensation to the realization of the innovation payoff b, nor they can offer such an innovation to their manager themselves. They simply lack the expertise to develop such financial instruments which is the whole point behind the emergence of managerial hedge markets. The shareholders can not use b directly to filter out more the firm specific risk from the manager's compensation contract. However, they take into account the manager's acquisition of a hedge security and in equilibrium adjust the intensity of incentives accordingly. In that sense, the above set-up is quite different from a principal relying on other measures of effort as in the seminal paper by Holmstrom (1979), or a principal using relative performance evaluation and market indexation as in Garvey and Milbourn (2003) to filter out the systematic risk from the manager's contract.[11]

[11] Following the empirical results in Jin (2002) and Garvey and Milbourn (2003), the model excludes the systematic (aggregate) risk from the analysis by construction: the manager can always remove the systematic risk by trading a general market index.

Sequence of Events: The timing and notation of the game is as follows. After the shareholders set his ownership share s, the manager asks a financial intermediary to innovate a hedge security with quality z. The intermediary innovates at a cost $(\gamma/2)z^2$. The manager then creates a position $\alpha \in R$ in the security and makes a payment p to the intermediary. Subsequently, the manager supplies effort level e and implements the risk reduction policy x at the firm level. Finally, the firm value y and innovation payoff b are realized, and the manager consumes his final portfolio wealth.

3 Benchmark with No Hedging

This section analyzes the model with no hedging opportunities for the manager and illustrates that the inability to diversify his compensation risk induces the manager inefficient risk reduction incentives.

For an ownership share s, the manager's wealth distribution is given by

$$w(e,x) \equiv sy(e,x) + t - c(e). \tag{2}$$

The CARA preferences and the normality assumptions on y imply that the manager's certainty equivalent expected utility is equal to $E[w(e,x)] - (a/2)Var[w(e,x)]$. Therefore, the manager's problem is to choose effort e and the risk level x to maximize

$$U(e,x) \equiv s[F(e) - L(x)] + t - c(e) - (a/2)s^2(\Sigma - \Delta x) \tag{3}$$

Given the assumptions on $F(.)$ and $L(.)$, the objective function $U(e,x)$ is concave in e and x. Accordingly, the optimal $e^*_{nh}(s)$ and $x^*_{nh}(s)$ with no managerial hedging ability are described by the following first order conditions:

$$sF^{'}(e^*_{nh}) - c^{'}(e^*_{nh}) = 0 \tag{4}$$

$$-L^{'}(x^*_{nh}) + (\frac{a}{2})\Delta s = 0 \tag{5}$$

The risk averse manager ($a > 0$) engages in inefficient risk reduction and underinvests in risk, i.e., $x^*_{nh} > 0$. Furthermore, both $e^*_{nh}(s)$ and $x^*_{nh}(s)$ are increasing in s.

$$\frac{\partial e^*_{nh}}{\partial s} = \frac{F^{'}}{-(sF^{''} - c^{''})} > 0 \text{ and } \frac{\partial x^*_{nh}}{\partial s} = \frac{a\Delta}{2L^{''}} > 0 \tag{6}$$

The manager's share ownership s gives incentives to supply costly effort. This is a standard result in agency theory. However, due to the inability to diversify his portfolio, s also induces the risk averse manager an incentive for wasteful risk reduction, or underinvestment in risk, which lowers shareholder value. This negative effect of incentive compensation would be absent in a standard moral hazard setting where the manager can not affect the firm specific risk by assumption (i.e., $\Delta = 0$).

There is ample empirical evidence documenting that the manager's private portfolio diversification motives do play a role in firm level risk choices, including firm diversification strategies and corporate cash flow hedging activities. The managers can pursue mergers without any obvious benefit to shareholders to diversify their own personal portfolios (Amihud and Lev (1981)). May (1995) examines cross sectional differences in CEO motives to pursue risk reduction, and finds that CEOs with higher proportion of their personal wealth tied up to firm's equity tend to pursue equity variance reducing acquisitions more often. Tufano (1996) examines corporate risk management activity in the North American gold mining industry and confirms that firms whose managers hold more stock manage more gold price risk. He concludes that risk reduction policies may be set as if to satisfy the needs of poorly diversified risk averse managers. His study also finds that firms with larger managerial ownership blocks hedge corporate cash flow risk more and those with larger outside block ownership hedge less. An important feature distinguishing these two types of share ownership is that managers are undiversified holders, whereas blockholders are well diversified investors, less likely to act based on aversion to firm level risk.

How does the expected firm value depend on the manager's share ownership? Note that $E[y(s)] = F(e^*_{nh}(s)) - L(x^*_{nh}(s))$. Differentiating with respect to s and using (6), one obtains

$$\frac{\partial E[y(s)]}{\partial s} = \frac{(F')^2}{-(sF'' - c'')} - \frac{a\Delta L'}{2L''} \tag{7}$$

The first term describes the positive effect of increasing share ownership s through inducing higher effort. The second term captures the negative effect of s through inducing inefficient risk reduction. The expected firm value is not in general monotone increasing in s. I assume that effort is productive enough such that $\partial E[y(s)]/\partial s$ is not always negative. This ensures that incentive contracting to induce effort is desirable despite the inefficient risk reduction appetite it creates. Generally, $E[y(s)]$ is first increasing and then decreasing in s.[12] This non-monotonic relationship between expected performance and incentive compensation differs from standard agency models which predict a monotone increasing relationship.[13]

With no hedging opportunities, the optimal managerial compensation package should take into account and mitigate the manager's incentives for inefficient risk reduction. This objective calls for a lower managerial share ownership. Given $x^*_{nh}(s)$, $e^*_{nh}(s)$ and a participation constraint, the shareholders choose s to maximize expected firm value net of compensation (see the Appendix for a detailed formal analysis). The optimal managerial ownership level s^*_{nh} solves

$$(1-s)\left(F^{'}\frac{\partial e^*_{nh}}{\partial s} - L^{'}\frac{\partial x^*_{nh}}{\partial s}\right) = as[\Sigma - \Delta x^*_{nh}(s)] \tag{8}$$

The left hand side is the marginal benefit for the shareholders of increasing the manager's share s, where the adverse effect of the manager's inefficient risk reduction incentive is captured by the term $-L^{'}(\partial x^*_{nh}/\partial s)$. The right hand side is the marginal cost of exposing the risk averse manager to risk.

4 Security Innovation

I now turn to the model where the manager can acquire a hedge security by contracting with a financial intermediary. Consider first the manager's choice of effort and the risk reduction policy. Given a share ownership s and a position α in the security, the manager's wealth distribution as a function of the risk reduction policy x and effort e can be written as

$$\pi(e,x,s,\alpha) \equiv sy(e,x) + t - c(e) + \alpha b - p \tag{9}$$

[12]As an example, assume $F(e) = e$, $c(e) = e^2/2$, $L(x) = x^2/2$, $a = 2$ and $\Delta = 2$. Then the effort choice in (4) is $e^*_{nh} = s$, the risk management choice in (5) is $x^*_{nh} = 2s$, and $E[y(s)] = s - 2s^2$ which is increasing in s for $s < 0.25$ and decreasing in s for $s > 0.25$.

[13]Empirical evidence testing the relation between manager's ownership and performance, however, has been mixed. Lazear (2000) finds a positive relation, whereas Himmelberg, Hubbard and Palia (1999) find little evidence that increasing managerial ownership improves firm performance.

where p is the payment made to the intermediary.[14] In this expression, $sy(e, x)$ is the fraction of firm value that the manager is entitled to by way of his compensation contract. This is the source of the firm specific risk exposure in the manager's portfolio. The position α in the innovated security creates a claim αb which is correlated with the firm specific risk. The manager chooses x and e to maximize his expected utility

$$\begin{aligned} V(e, x; s, \alpha) \quad \equiv \quad & s[F(e) - L(x)] + t - c(e) + \alpha\mu - p \\ & -\frac{a}{2} Var[s\varepsilon(x) + \alpha b] \end{aligned} \tag{10}$$

where his total risk exposure is now given by $Var[s\varepsilon(x) + \alpha b]$. The optimal effort $e^*(s)$ again solves $sF^{'}(e^*) - c^{'}(e^*) = 0$. The risk reduction policy $x(\alpha)$ as a function of the hedge position α solves

$$-L^{'}(x(\alpha)) + \frac{a\Delta}{2}\left(s + \frac{\rho\sigma\alpha}{\sqrt{\Sigma - \Delta x(\alpha)}}\right) = 0 \tag{11}$$

For $\rho = 0$, the above expression is identical to the case with no hedging ability (see equation 5). In that case, a portfolio position in the innovation does not provide any diversification against firm specific risk and hence does not affect the manager's risk reduction policy. To characterize fully how the manager's hedging ability affects the risk reduction choice, consider the optimal position α in the innovation. The manager's choice of α takes into account the subsequent risk reduction choice $x(\alpha)$ described by (11) and effort choice $e^*(s)$. Formally, the manager chooses α to maximize

$$V(e^*(s), x(\alpha), s, \alpha)$$

where his expected utility $V(.)$ is defined by (10). Differentiating with respect to α and using the envelope theorem, one obtains the following expression that characterizes the optimal position α^* in the innovation (see the Appendix):

$$\alpha^* = \left(\frac{-\rho\sqrt{\Sigma - \Delta x(\alpha^*)}}{\sigma}\right) s \tag{12}$$

[14]The payment p is determined by the competitive intermediary's zero profit condition as will be shown in Section 4.1.

The size of the optimal position in the innovated security is increasing in the manager's exposure s to firm specific risk and the degree of correlation ρ between the innovation and ε. The sign of ρ determines whether the optimal portfolio involves a long or short position in the security with α^* and ρ having opposite signs. For a given ownership share s, the risk averse manager's disutility from ε depends both on his portfolio choice α^* and the firm level risk reduction choice $x(\alpha^*)$. Using α^* in (12), one can show that

$$Var[s\varepsilon(x(\alpha^*)) + \alpha^* b] = (1-z)Var[s\varepsilon(x(\alpha^*))]$$

where $z \equiv \rho^2$. Given a security innovation with quality z, the manager chooses α^* and $x(\alpha^*)$ such that he diversifies a fraction $z \in (0,1]$ of his exposure to firm specific risk ε. Accordingly, I refer to z as the manager's diversification ability.

Rather than rendering incentive compensation ineffective, the manager's hedging ability mitigates the inefficient risk reduction activity, and it aligns the manager's attitude toward firm specific risk with that of the shareholders'. Combining (11) and (12) yields the following result.

Proposition 1 *For a given innovation quality z and share ownership s, the inefficient risk reduction x^* and effort e^* are described by*

$$\begin{aligned} -L^{'}(x^*) + (\frac{a}{2})\Delta s(1-z) &= 0 \\ sF^{'}(e^*) - c^{'}(e^*) &= 0 \end{aligned} \tag{13}$$

x^* is decreasing in z. The manager's hedging ability reduces (for $z = 1$ it completely eliminates) the underinvestment in firm level risk.

To the extent that the risk averse manager can diversify ε by creating a position in the innovated security, he has less appetite for inefficient risk reduction to achieve personal portfolio diversification. The ability to acquire a hedge security increases the risk averse manager's tolerance for firm specific risk. With perfect diversification ability, the manager views ε exactly like the well diversified shareholders who are neutral to this risk. Therefore, acquisition of a hedge instrument corrects the manager's inefficient risk reduction incentives, while keeping intact the effort incentives induces by share ownership.

4.1 Endogenizing Innovation Quality

For ease of reference, denote the manager's optimal portfolio position with $\alpha^*(z)$ and his inefficient risk reduction activity with $x^*(z)$. In choosing hedging ability z, the manager takes into account $\alpha^*(z)$, $x^*(z)$ and the payment p to be made the risk neutral and competitive financial intermediary. This payment is determined by the zero profit condition

$$p - \alpha E[b] - (\gamma/2)z^2 = 0,$$

and is given by

$$p(z) = \alpha^*(z)\mu + (\gamma/2)z^2 \tag{14}$$

Using $p(z)$, one can write the manager's expected utility as a function of z:

$$\begin{aligned} \Omega(x^*(z); \alpha^*(z); p(z)) \equiv & -sL(x^*(z)) + \alpha^*(z)\mu - p(z) \\ & -\frac{a}{2}(1-z)s^2[\Sigma - \Delta x^*(z)] \end{aligned} \tag{15}$$

where the terms that do not depend on z are excluded for convenience. The manager chooses optimal hedging ability z to maximize $\Omega(.)$.

Proposition 2 *For $\gamma > a\Sigma/2$, the manager acquires a hedge security with quality $z^* \in (0,1)$ that solves*

$$\frac{a}{2}s^2[\Sigma - \Delta x^*(z)] = \gamma z \tag{16}$$

For $\gamma < a\Sigma/2$, $z^* = 1$. Optimal innovation quality z^* is increasing in share ownership s, risk aversion a, initial level of firm specific risk Σ. z^* is decreasing in the cost of security innovation γ.

The right hand side of (16) is the marginal cost of acquiring hedging ability z. The left hand side is the marginal benefit which is increasing in z, since the subsequent inefficient risk reduction activity $x^*(z)$ is decreasing in z.

4.2 Endogenizing Managerial Share Ownership

The shareholders set s and the fixed wage t to maximize expected firm value net of the manager's compensation. In doing so, they take into account the manager's optimal hedge transaction which is described by the pair $(z^*(s), \alpha^*(z^*(s)))$, the inefficient risk reduction policy $x^*(z^*(s))$ and effort choice $e^*(s)$.

Proposition 3 *The optimal managerial ownership s^* with endogenous security innovation solves*

$$(1-s)\left(F^{'}\frac{\partial e^*}{\partial s} - L^{'}(\frac{\partial x^*}{\partial z^*}\frac{\partial z^*}{\partial s})\right) = a(1-z^*)[\Sigma - \Delta x^*(.)]s \tag{17}$$

s^* is decreasing in the cost γ of security innovation.

Lower cost of security innovation increases optimal managerial ownership through two channels. First, better managerial hedging ability decreases the cost of exposing the agent to risk and relaxes the well-known risk incentive trade-off. A given ownership level s imposes less risk on the manager and requires less risk premium. Hence, managerial ownership becomes a less costly incentive instrument. This effect works through the term $(1-z^*)\Sigma$ in (17). The second channel works through mitigating the inefficient risk reduction activity and hence increasing the benefits of managerial share ownership. The acquisition of hedge security corrects the undesirable effect of incentive compensation in the form of underinvestment in firm level risk. The manager now has less incentives to seek inefficient risk reduction at the firm level. The marginal increase in expected firm value from increasing the manager's share ownership is given by

$$\frac{\partial E[y(s)]}{\partial s} = \frac{(F^{'})^2}{-(sF'' - c'')} - \frac{L^{'}a\Delta(1-z^*)}{2L''} \tag{18}$$

which increases as γ decreases, since z^* increases as γ decreases. With the inefficient risk reduction motive mitigated, compensation in the form of managerial share ownership becomes a more effective incentive tool. To summarize, the manager's acquisition of hedging ability (i) decreases the marginal cost of incentive compensation- since now the manager demands less risk premium for bearing risk (ii) mitigates the inefficient risk reduction activity arising from incentive compensation and hence increases the marginal benefit of incentive compensation.

5 Hedging to Simulate Sale of Shares

This section analyzes side contracts that enable the manager to simulate the sale of his shares. These transactions involve trading claims contingent on firm value y. A common financial instruments that serve this purpose is an *executive equity swap* (see Bolster et al. (1996) and Bettis et al. (2001)). In an equity swap transaction, the manager enters into a bilateral agreement, the swap, with a financial intermediary. In this agreement, the shares in his firm are *synthetically* sold by depositing them with the intermediary. For a prespecified time period, the intermediary gets the total return from the manager's shares and the manager gets the return from an alternative investment, such as a fixed income security. The net effect of this transaction is that the manager simulates the sale of ownership on the shares swapped. Such side contracts alter the sensitivity of the manager's wealth to company stock price and hence reduce effective managerial share ownership.

A contract that simulates the sale of the manager's shares is modeled in the following simple way. After the shareholders determine s, the manager contracts with an intermediary to pay ψy in exchange for receiving a fixed payment G. In effect, a hedge size ψ reduces the manager's share ownership to $s-\psi$. Subsequent to hedging, the manager chooses e and x. The financial intermediaries that can trade with the manager are again assumed to be risk neutral and competitive. An intermediary makes the manager a fixed payment equal to the expected value of the claim ψy.

5.1 Exclusive Transactions

Assume for now that the manager can commit (or he is restricted) to engage in an exclusive side contract with only one financial intermediary. This is clearly a restrictive setting. It requires that the intermediary can write an enforceable exclusivity clause in the contract so that the manager trades exclusively with that intermediary. Analyzing this case is useful to illustrate the key difference between hedging that simulates the sale of shares and hedging which involves a customized security innovation.

Suppose the manager is given a share ownership s of which he hedges ψ and reduces his effective share ownership to $s-\psi$. The subsequent effort and risk reduction choices maximize

$$(s-\psi)[F(e)-L(x)]-c(e)-(a/2)(s-\psi)^2(\Sigma-\Delta x) \tag{19}$$

Optimal effort $\hat{e}$ solves

$$(s-\psi)F^{'}(\hat{e})-c^{'}(\hat{e})=0 \tag{20}$$

and it is decreasing in the hedge size ψ. The risk reduction policy $\hat{x}$ solves

$$-L^{'}(\hat{x})+(a/2)(s-\psi)\Delta=0 \tag{21}$$

and it is also decreasing in ψ. The more ownership share the manager hedges, the less incentives he is left with to supply costly effort. He also has less appetite for inefficient risk reduction, since hedging reduces the exposure to firm specific risk.

A hedge transaction that simulates the sale of share ownership has different effort incentive implications compared to a hedging with security innovation. With simulated sale, the manager diversifies his exposure to firm specific risk by effectively reducing his share ownership. This reduction in ownership mitigates the underinvestment in risk. At the same time, it also lowers the incentives to supply effort. In contrast, a security innovation mitigates the inefficient risk reduction incentives while keeping intact the effort incentives induced by share ownership. Due to this adverse effect on subsequent effort incentives, the expected firm value $E[y]$ is also decreasing in ψ. This follows from

$$\frac{\partial E[y]}{\partial\psi}=F^{'}\frac{\partial\hat{e}}{\partial\psi}-L^{'}\frac{\partial\hat{x}}{\partial\psi}=-\left(F^{'}\frac{\partial\hat{e}}{\partial s}-L^{'}\frac{\partial\hat{x}}{\partial s}\right)<0$$

For a hedge size ψ, the intermediary's zero-profit condition implies that the payment G that the manager is to receive from the simulated sale of the claim ψy is given by

$$G(\psi) = E[\psi y] = \psi[F(\hat{e}(s-\psi)) - L(\hat{x}(s-\psi))] \tag{22}$$

where $\hat{e}$ and $\hat{x}$ are determined by the post-hedging share ownership $s-\psi$ as described by (20) and (21). While pricing the hedge transaction, the intermediary takes into account the effect of the hedge size ψ on $\hat{e}$ and $\hat{x}$, since these choices determine the expected value of the claim ψy. Suppose the manager reduces his effective share ownership to $\theta \equiv s-\psi$. Define his expected utility as a function of θ as

$$\Pi(\theta) \equiv \theta E[y(\hat{e},\hat{x})] - c(\hat{e}) - (a/2)\theta^2 Var[\varepsilon(\hat{x})] \tag{23}$$

The manager optimally chooses ψ to maximize $\Pi(s-\psi) + G(\psi)$. Using the definitions of $\Pi(.)$ and $G(\psi)$, the problem becomes choosing ψ to maximize

$$sE[y(\hat{e},\hat{x})] - c(\hat{e}) - (a/2)(s-\psi)^2 Var[\varepsilon(\hat{x})] \tag{24}$$

The optimal hedge size ψ^* is reported in the following Lemma.

Lemma 1: *In an exclusive hedge market, the manager's optimal hedge size ψ^* solves*

$$\underbrace{a(s-\psi^*)Var[\varepsilon(\hat{x}(s-\psi^*))]}_{\text{Marginal benefit of simulated sale}} = \underbrace{-\psi^*\left(\frac{\partial E[y]}{\partial \psi}\right)}_{\text{Marginal cost of simulated sale}} \tag{25}$$

The optimal hedge size is such that $0 < \psi^*(s) < s$ and $\psi^*(s)$ is increasing in s.

The left hand side of (25) is the manager's marginal expected utility gain from diversification where $Var[\varepsilon(\hat{x}(s-\psi^*))]$ is determined by the risk reduction level $\hat{x}$ which depends on the undiversified exposure $s-\psi^*$. The right hand side stands for the marginal cost of hedging with simulated sale. A larger hedge size implies less incentives to supply effort. Hence increasing ψ decreases $G(\psi)$ due to its adverse effect on $E[y]$. Due to this trade-off, the manager does not hedge completely.

The shareholders optimally choose s taking into account the manager's optimal hedge transaction $\psi^*(s)$ and the subsequent choice of $\hat{e}$ and $\hat{x}$. Formally, the shareholders choose s to maximize the net surplus

$$E[y(\hat{e},\hat{x})] - c(\hat{e}) - (a/2)(s-\psi^*(s))^2 Var[\varepsilon(\hat{x})] \tag{26}$$

subject to (25) that describes the optimal hedge $\psi^*(s)$, effort choice $\hat{e}$ and risk reduction choice $\hat{x}$ given by (20) and (21), respectively.

Note the similarity between the shareholders' problem of choosing the manager's share ownership given by (26) and the manager's problem of choosing the optimal hedge size described by (24). These problems differ only in one aspect. The shareholders problem involves maximizing $E[y(\hat{e}, \hat{x})]$ whereas the manager's problem maximizes $sE[y(\hat{e}, \hat{x})]$, minus the cost of effort and the manager's disutility from incentive compensation due to risk aversion. The trade-off in both problems are the same. The shareholders trade off between inducing the manager incentives and insuring the manager. The manager trades off between hedging more (insurance) and the cost of doing so (less incentives) which is reflected in the price of the hedge transaction. If the shareholders give the entire company ownership to the manager by setting $s = 1$, the manager completely internalizes the shareholders' trade-off between firm value maximization and insurance. Therefore, $\hat{s} = 1$ is optimal. The manager then uses the hedge market to reduce his effective share ownership to the level that is optimal without any access to hedge markets (given by s^*_{nh} in (8)). Subsequently, he chooses the same effort level and implements the same risk reduction policy that would be implemented without the hedge markets.

5.2 Non-Exclusive Transactions

Consider now a non-exclusive hedge market. The manager can trade with a different financial intermediary after each hedge transaction and these trades are unobservable to his previous trading partners. This sequential trading mechanism is similar to the ones in Bizer and De Marzo (1992) and Admati et al. (1994).

With nonexclusivity, the fixed payment $\hat{G}$ in each transaction is determined as follows: Suppose the manager starts with some initial holdings s and at the end of the trading, he ends up with a fraction θ of company shares in his portfolio. Since trading is non-exclusive, the fixed payment in each transaction depends on the market's conjecture on θ. Although the financial intermediaries do not observe the manager's future trades with other parties, they form a conjecture an allocation θ where the manager has no further demand to simulate the sale of his share ownership, and will actually stop trading. Let θ^*, $\hat{x}(\theta^*)$ and $\hat{e}(\theta^*)$ denote the market's conjecture of the manager's final share, the subsequent risk and effort choices, respectively. If the manager offers a financial intermediary a claim ϕy, then the fixed payment $\hat{G}$ that the intermediary is willing to pay is determined by the zero profit condition $\phi E[y(\hat{e}, \hat{x})] - \hat{G} = 0$. Therefore, the fee schedule for that transaction is given by

$$\hat{G}(\phi, \theta^*) = \phi E[y(\hat{e}, \hat{x})] = \phi[F(\hat{e}(\theta^*) - L(\hat{x}(\theta^*)] \tag{27}$$

The market's conjecture θ^* for the manager's final holdings enters into the fee schedule through its effect on $\hat{e}(\theta^*)$ and $\hat{x}(\theta^*)$ (given by (20) and (21) respectively) which determines the expected company firm value $E[y(\theta^*)]$. The above pricing schedule then captures the non-exclusive aspect of the hedge market. Since the manager can engage in further trades after each transaction and since such trades are unobservable, nobody except the manager knows the manager's final holdings of company shares while choosing x and e. All intermediaries, however, rationally anticipate that as long as the manager holds $\theta > \theta^*$, he will have further hedging demand.

The equilibrium concept used in this section is adopted from the globally stable allocation concept of Admati et al. (1994). One difference is that in their setting a large shareholder trades in a sequence of Walrasian markets, whereas here, consistent with the fact that hedging transactions are bilateral agreements, I adopt a sequential bilateral trading environment. The equilibrium is described by the manager's final share θ, the market's conjecture θ^* and the corresponding pricing rule $\hat{G}(\phi, \theta^*)$ such that; given θ^* and $G(\phi, \theta^*)$ the manager has no further hedge demand at $\theta = \theta^*$ and will actually end up holding a share θ^* in his portfolio.

In order to characterize the equilibrium, one can again use the manager's expected utility $\Pi(\theta)$ at some final company share θ as defined in (23). Since the manager's hedge demand must be zero at $\theta = \theta^*$, it follows that

$$0 \in \arg\max_{\phi} \Pi(\theta^* - \phi) + \hat{G}(\phi, \theta^*) \tag{28}$$

i.e., at θ^* the manager must be optimally choosing not to trade any further claims given the price schedule $\hat{G}(\phi, \theta^*)$. Differentiating with respect to ϕ

and evaluating the first order condition at $\phi = 0$ (see the Appendix), one obtains

$$a\theta^*[\Sigma - \Delta\hat{x}(.)] = 0 \tag{29}$$

which implies that the equilibrium final allocation that involves no further trading is given by $\theta^* = 0$. As long as the manager is exposed to risk (i.e., $\theta > 0$), he has an incentive to hedge more after every hedging transaction.[15]

This result is driven by the manager's lack of ability to commit not to trade any further after each hedging transaction.[16] Since the manager simulates the sale of all his shares, incentive contracting fails completely. With no stake in the firm, the manage does not supply any effort. He does not engage in any wasteful risk reduction either, since he is not exposed to any firm specific risk. In other words, there is complete lack of managerial activity. This analysis substantiates the concerns against the emergence of a managerial hedge market. It illustrates that in a non-exclusive sequential trading environment to simulate the sale of his share ownership, the manager undoes his incentive package completely and indeed cuts the whole link between his compensation and firm performance as argued by financial business press and legal practitioners.

Proposition 4 *(Complete Lack of Managerial Activity) The unique final share of the manager when he can simulate the sale of his share ownership in a nonexclusive hedge market is given by $\theta^* = 0$. The manager does not supply any effort ($\hat{e} = 0$) and does not engage in wasteful risk reduction ($\hat{x} = 0$).*

[15] The sequential Walrasian trading mechanism in Admati et. al (1994) also yields a complete unraveling equilibrium when the small investors trading with the large shareholder are risk neutral. In our analysis, hedging transactions are bilateral and therefore risk neutrality on the part of the intermediaries for complete unraveling is not required. If intermediaries were risk averse, the manager would again sell off completely.

[16] The intuition is similar to the Coase conjecture that applies to a durable goods monopolist who can not commit not to reduce price when facing infinitely patient consumers.

6 Summary and Implications

6.1 Desirability of Managerial Hedging

The analysis in this paper distinguishes between managerial hedging practices that improve incentive contracting and those which can potentially undermine it. Stock-based compensation induces the manager the incentives to supply costly effort to increase shareholder value. However, in the absence of any ability to diversify the firm specific risk, it also creates an incentive for underinvestment in firm risk or wasteful risk reduction. Hedging with a security innovation allows the manager to diversify the firm specific risk exposure without altering his effective share ownership and aligns the interests of the well-diversified shareholders and the manager in terms of the firm level risk choices, while keeping effort incentives intact. Accordingly, hedging transactions that allow the manager to diversify firm specific risks without altering the effective ownership share are beneficial for the shareholders.

On the other hand, hedging transactions that simulate the sale of manager's share ownership can undermine effort incentives, unless the hedge market is exclusive. Unlike hedging with an innovation, a simulated sale reduces the manager's effective share ownership. Such hedging transactions can potentially undo the link between firm performance and manager's wealth. Firms should impose restrictions on hedging transactions that simulate sale of shares, at least to make sure that the manager does not use hedge markets to considerably reduce his stake in the firm. Bebchuk et al. (2003) make a similar point suggesting that the firms should require that sales are carried out gradually over a specified period and the executive is to receive advance permission from the compensation committee before trading. These results also confirm the assertion of Schizer (2000) who argues that stock hedging might enhance incentives if stock ownership induces excessive managerial risk aversion, but by altering the effective ownership levels through undisclosed transactions, it might also undermine transparency. This paper shows that besides transparency issues, simulating the sale of shares in a non-exclusive hedge market can undermine incentives.

6.2 Managerial Hedging and Firm Risk

The analysis shows that in the absence of any access to hedge markets, the managers have a tendency to achieve portfolio diversification at the firm level. They may pursue risk reducing but inefficient mergers (Amihud and Lev (1981) and May (1995)) or engage in excessive corporate cash flow hedging activity (Tufano (1996)). If managers pursue inefficient risk reduction strategies due to their inability to diversify their compensation risks, their access to managerial hedge markets should induce riskier policies at the firm level. The implication below follows from Propositions 1 and 2.

Implication 1: *Access to hedge markets should promote greater risk taking by managers at the firm level.*

The emergence of a managerial hedge market might increase the volatility of individual stocks, at least consistent with the degree that managers can affect firm level volatility by their policies. The empirical work on the link between managerial hedging and firm level risk is quite nascent due to the difficulty of obtaining reliable data on managerial hedge transactions. The only study that uses direct evidence of managers' use of such derivatives products is by Bettis, Bizjak and Lemmon (2001). They examine hedging transactions by corporate insiders between January 1996 and December 1998, and find that purchases of derivatives products by corporate insiders are followed by an increase in the volatility of their stock returns. Consistent with Implication 1, the authors interpret this finding as possible evidence that the managers alter firm strategies towards riskier policies after they hedge.

6.3 Hedging Ability and Managerial Share Ownership

Better managerial hedging ability mitigates underinvestment in firm level risk, which would call for lowering the manager's share ownership in the absence of any access to hedge markets. When acquisition of hedging ability is endogenous, higher managerial share ownership induces the innovation of more effective hedge securities, which in turn allows the shareholders to grant more share ownership, since managers can now diversify the associated compensation risks.

Implication 2: *The manager's access to hedge markets increases the managerial ownership share offered by shareholders. Accordingly, managerial share ownership must be higher in economies where financial markets are more developed and hence the cost of financial innovations are lower.*

The above relationship between the manager's share ownership and cost of acquisition of hedging ability has not been tested. However, casual comparison of corporate executive pay structures in the U.S. versus continental Europe provides some support for this prediction. In the U.S., the financial markets are more developed and sophisticated derivatives securities are incomparably more widespread. A financial intermediary in the U.S. can hedge her own exposure from entering into a hedging transaction with a corporate executive at a much lower cost due to more liquid primary and secondary securities markets. In the U.S., finding a counterparty is also much easier (Schizer (2000)). Accordingly, the innovation and transactions costs of derivatives securities dealers are likely to be much lower and hence the effectiveness of hedging instruments available to managers is likely to be much higher in the U.S. This difference in managerial hedging ability might account for, at least to a certain extent, the difference in executive pay structures with the U.S. firms granting much higher share ownership compared to their European counterparts. The above prediction may also explain why higher managerial share ownership and hedging instruments have appeared almost simultaneously in the U.S. financial markets during the 1990s. For instance, Schizer (2000) argues that the increasing availability of derivative instruments for managerial hedging and the growing importance of stock-based pay in managerial compensation have occurred simultaneously.

6.4 Managerial Demand for Hedging Instruments

The analysis formalizes the idea that a manager demands personal portfolio diversification as a response to firm specific risk exposure in his compensation scheme. The optimal hedge demand in (12) and the endogenous hedging ability z^* imply that a manager with a higher ownership share s acquires better hedging ability and create a larger position in a hedge security. Similarly, with simulated sale a manager with a higher share ownership chooses a larger hedge size. These results can be interpreted in relation to the restrictions that managers face to realize gains from their stock based compensation. Insider trading restrictions on selling own company stock, restricted class of shares that can not be sold for years and lock-up provisions that ban the sale of shares for a specified period all imply that a sizable proportion of the manager's personal wealth is tied up in the company stock. The access to hedge securities should then give the managers the opportunity to protect the value of the shares that they can not liquidate. This diversification need should become even more severe, (i) after a surge in the own company stock price, since a jump in the stock price increases the value of the exposure, (ii) when the manager is subject to lock-up provisions that prevent the sale of his shares. Going public decision provides a good experiment to test the determinants of the manager's hedging demand. First, the insiders experience large increases in the value of their stock ownership positions when the firm goes public. Second, insiders of firms that have recently gone public are often subject to lock-up provisions that prohibit them from immediately selling their shares (see Brav and Gompers (2003)).

Implication 3*: Managers who (i) experience large increases in the value of their equity positions, (ii) face restrictions to sell their shares should demand hedging instruments more.*

Consistent with the above implication, Bettis et al. (2001) find that managerial hedging transactions tend to follow significant stock price runups and that the demand for hedging instruments is positively related to whether the firm recently went public. Ofek and Yermack (2000) find that when higher ownership managers are granted new options, they sell shares of stock they already own to reduce their risk exposure. Although they analyze outright sale of stock (not simulated sale by using hedging instruments), they arrive at two important conclusions potentially consistent with the analysis in this paper: First, they conclude that higher ownership managers tend to undo much of the impact of stock compensation by selling previously owned shares to diversify. This empirical conclusion supports the tension identified in this paper between incentive related stock based compensation and the manager's diversification related response to that compensation. Second, Ofek and Yermack argue that their findings cast doubt on the common theoretical assumption which ignores the managers' ability to hedge the risks associated with their compensation packages. Therefore, optimal contracting models should take into account the manager's hedging incentives. In the accounting literature, early empirical work by Antle and Smith (1986) also cautions that conventional economic analysis of optimal incentive contracts is somewhat incomplete because the models do not account for the effects of the manager's ability to hedge the risk of ownership of shares.

7 Conclusion

This paper analyzes the implications of managerial hedge markets for shareholder value maximization. In the absence of any hedge markets, the manager has a tendency to underinvestment in risk at the firm level to diversify his own compensation risk. This tendency arises because the undiversified manager and diversified shareholders view firm specific risk differently. A risk averse manager may avoid undertaking efficient risk and/or engage in risk reducing acquisitions at the shareholder's expense to achieve personal diversification. Despite the common negative view on managerial hedging transactions in the popular business press and the legal practice, the analysis illustrates that managerial hedge markets can play a positive role. When the manager can trade a security correlated with his firm specific risk, then he can diversify this risk in his compensation scheme without altering his ownership share. Such managerial hedging is actually beneficial from the point of view of the shareholders, since it aligns the manager's preference for firm specific risk with theirs: it mitigates wasteful risk reduction incentives, increases optimal managerial share ownership and results in higher supply of effort. The analysis endogenizes the manager's acquisition of such hedging instruments by introducing costly security innovations. This exercise links the degree of financial market development, which determines the cost of innovations, to optimal managerial share ownership. A testable implication is that managerial ownership must be higher in economies where financial markets are more developed and hence the cost of financial innovations are lower.

However, the concerns expressed against managerial hedge markets are not without substance. If the manager can hedge by simulating the sale of his shares, for instance by using equity swaps or collars, incentive contracting may fail completely. These transactions have adverse incentive implications, since they allow the manager to reduce his effective share ownership in the firm. If the manager can not be restricted to engage in an exclusive transaction, he can potentially undo all incentives and completely cut off the link between compensation and performance. This type of hedging ability may result in complete lack of managerial activity. This negative result suggests that firms should take measures to prevent hedging that simulates the sale of their manager's share ownership.

The model also predicts that (i) greater access to hedge markets promote greater risk taking by managers at the firm level, (ii) managers who face restrictions to sell their shares (like managers of firms which have recently gone public) and/or managers who experience large increases in the value of their equity positions should demand hedging instruments more. Greater access to reliable data on managerial hedging transactions will provide a better understanding of this new and controversial market.

8 Appendix

Derivation of s^*_{nh} in (8)

The shareholders' problem is to choose s and t to maximize

$$(1-s)[F(e^*_{nh}(s)) - L(x^*_{nh}(s))] - t \qquad \text{(A1)}$$

subject to $e^*_{nh}(s)$, $x^*_{nh}(s)$ described in (4) and (5), and the participation constraint

$$U(e^*_{nh}(s), x^*_{nh}(s)) \geq 0 \qquad \text{(A2)}$$

where the manager's expected utility $U(.)$ is defined in (3). The participation constraint holds as an equality in equilibrium. Solving for t in this constraint and substituting it in the shareholders' objective function, an equivalent formulation of the problem is to choose s to maximize the expected net surplus

$$F(e^*_{nh}(s)) - L(x^*_{nh}(s)) - c(e^*_{nh}(s)) - (a/2)s^2\left(\Sigma - \Delta x^*_{nh}(s)\right) \qquad \text{(A3)}$$

The first order condition for a maximum reads

$$\left(F' - c'\right)\frac{\partial e^*_{nh}}{\partial s} - L'\frac{\partial x^*_{nh}}{\partial s} - as\left(\Sigma - \Delta x^*_{nh}(s)\right) + (a/2)s^2\Delta\frac{\partial x^*_{nh}}{\partial s} = 0 \qquad \text{(A4)}$$

Using the optimality of e^*_{nh} and x^*_{nh} from (4) and (5) eliminates the envelope effects and (A4) becomes

$$(1-s)\left(F'\frac{\partial e^*_{nh}}{\partial s} - L'\frac{\partial x^*_{nh}}{\partial s}\right) - as\left(\Sigma - \Delta x^*_{nh}(s)\right) = 0 \qquad \text{(A5)}$$

Solving for s one arrives at (8).

Derivation of α^* in (12)

Differentiating $V(e^*(s), x(\alpha), s, \alpha)$ with respect to α, one obtains the first order condition that describes the manager's optimal hedge position:

$$\left[\frac{\partial V(.)}{\partial x}\right]\frac{\partial x(\alpha)}{\partial \alpha} - a\left[\alpha\sigma^2 + s\rho\sigma\sqrt{\Sigma - \Delta x(\alpha)}\right] = 0 \tag{A6}$$

where the first term in square brackets is zero, given (11) that describes $x(\alpha)$. Therefore, for $a > 0$ the above first order condition reduces to

$$\alpha\sigma^2 + s\rho\sigma\sqrt{\Sigma - \Delta x(\alpha)} = 0 \tag{A7}$$

which yields (12).

Proof of Proposition 1

The proposition follows from substituting α^* in (12) into (11) which describes $x(\alpha)$. This substitution yields

$$-L'(x(\alpha^*)) + \frac{a\Delta}{2}\left(s - \frac{\rho\sigma}{\sqrt{\Sigma - \Delta x(\alpha^*)}}\frac{\rho s\sqrt{\Sigma - \Delta x(\alpha^*)}}{\sigma}\right) = 0 \tag{A8}$$

Simplification and noting that $z \equiv \rho^2$, one obtains (13) that describes wasteful risk reduction x^*. Using (13), one can also show that

$$\frac{\partial x^*}{\partial z} = \frac{-L' a\Delta}{2L''} < 0 \tag{A9}$$

Proof of Proposition 2

The expression in (16) that describes the optimal z^* follows from maximizing (15) with respect to z. The parametric restriction $\gamma > a\Sigma/2$ ensures an interior solution. The comparative static results follow directly from (16).

Proof of Proposition 3

The shareholders' problem is to choose s and t to maximize

$$(1-s)E[y(e^*,x^*)]-t \tag{A10}$$

subject to the manager's optimal hedge security quality choice z^* that solves (16), the optimal hedge position α^* described by (12), the optimal effort e^* that solves $sF^{'}(e^*)-c^{'}(e^*)=0$, the wasteful risk reduction policy x^* that solves (13) and the participation participation constraint

$$sE[y(e^*,x^*)]+t-c(e^*)+\alpha^*\mu-p(\alpha^*,z^*)-(a/2)s^2(1-z^*)Var[\varepsilon(x^*)]\geq 0 \tag{30}$$

Note that the manager is only exposed to a fraction $(1-z^*)$ of firm specific risk. In equilibrium, (A11) holds as an equality. Solving for t and substituting it in (A10), an equivalent formulation is to choose s to maximize the net surplus

$$E[y(e^*,x^*)]-c(e^*)-(\gamma/2)(z^*)^2-(a/2)s^2(1-z^*)Var[\varepsilon(x^*)] \tag{A12}$$

subject to the manager's choices of z^*, e^* and x^*. Differentiating with respect to s and eliminating the envelope effects, one obtains the first order condition that describes the optimal s^*.

$$(1-s)\frac{\partial E[y]}{\partial s}-as(1-z^*(s))Var[\varepsilon(x^*(s,z^*(s)))]=0 \tag{A13}$$

Furthermore,

$$\frac{E[y]}{\partial s}=\frac{\partial E[y]}{\partial e^*}\frac{\partial e^*}{\partial s}+\frac{\partial E[y]}{\partial x^*}\frac{\partial x^*}{\partial z^*}\frac{\partial z^*}{\partial s}=F^{'}\frac{\partial e^*}{\partial s}-L^{'}\frac{\partial x^*}{\partial z^*}\frac{\partial z^*}{\partial s} \tag{A14}$$

Combining (A13) and (A14) yields (17). To prove that s^* is decreasing in γ, note that

$$\frac{\partial s^*}{\partial \gamma}=\frac{\partial s^*}{\partial z}\frac{\partial z^*}{\partial \gamma}<0 \tag{A15}$$

since

$$\frac{\partial z^*}{\partial \gamma}<0 \text{ and } \frac{\partial s^*}{\partial z}>0 \tag{A16}$$

Proof of Lemma 1

Differentiating (24) with respect to ψ, one obtains the first order condition

$$s[F'\frac{\partial \hat{e}}{\partial \psi}-L^{'}\frac{\partial \hat{x}}{\partial \psi}]-c^{'}\frac{\partial \hat{e}}{\partial \psi}+a(s-\psi^{*})Var[\varepsilon(\hat{x})]+(\frac{a}{2})(s-\psi^{*})^{2}\Delta\frac{\partial \hat{x}}{\partial \psi}=0 \quad \text{(A17)}$$

Using the optimality conditions for $\hat{e}$ and $\hat{x}$ eliminates envelope effects and the above condition becomes

$$\psi^{*}[F'\frac{\partial \hat{e}}{\partial \psi}-L^{'}\frac{\partial \hat{x}}{\partial \psi}]+a(s-\psi^{*})Var[\varepsilon(\hat{x}(s-\psi^{*})]=0 \quad \text{(A18)}$$

Note that

$$\psi^{*}[F'\frac{\partial \hat{e}}{\partial \psi}-L^{'}\frac{\partial \hat{x}}{\partial \psi}]=\psi^{*}\frac{\partial E[y]}{\partial \psi}<0 \quad \text{(A19)}$$

which implies that evaluated at $\psi^{*}=s$, the first order condition in (A18) is negative, which proves that $\psi^{*}(s)<s$. Combining (A18) and (A19) yields (25) which describes ψ^{*}.

Proof of Proposition 5

First rewrite the objective function in (28) using the definition of certainty equivalent expected utility $\Pi(\theta)$ in (23) to obtain

$$\begin{aligned}\Pi(\theta^{*}-\phi) &= (\theta^{*}-\phi)E[y(\hat{e}(.),\hat{x}(.)]-c(\hat{e}(.)) \\ &\quad -\frac{a}{2}(\theta^{*}-\phi)^{2}(\Sigma-\Delta\hat{x}(.))\end{aligned} \quad \text{(A20)}$$

Now let $\Phi\equiv\Pi(\theta^{*}-\phi)+\hat{G}(\phi,\theta^{*})$ and differentiate Φ with respect to ϕ:

$$\begin{aligned}\frac{\partial \Phi}{\partial \phi} &= -E[y(\hat{e}(\theta^{*}-\phi),\hat{x}(\theta^{*}-\phi)]-\left[(\theta^{*}-\phi)\frac{\partial E[y]}{\partial \hat{e}}-c^{'}(.)\right]\frac{\partial \hat{e}}{\partial \phi} \\ &\quad +\left[-(\theta^{*}-\phi)\frac{\partial E[y]}{\partial \hat{x}}+\frac{a}{2}(\theta^{*}-\phi)^{2}\Delta\right]\frac{\partial \hat{x}}{\partial \phi}+a(\theta^{*}-\phi)[\Sigma-\Delta\hat{x}(.)] \\ &\quad +E[y(\hat{e}(\theta^{*}),\hat{x}(\theta^{*})]+\phi\left(\frac{\partial E[y]}{\partial \hat{e}}\frac{\partial \hat{e}}{\partial \phi}+\frac{\partial E[y]}{\partial \hat{x}}\frac{\partial \hat{x}}{\partial \phi}\right)\end{aligned} \quad \text{(A21)}$$

The terms in square brackets are equal to zero by the Envelope Theorem. Evaluating the remaining terms at $\phi=0$, one arrives at

$$\frac{\partial \Phi}{\partial \phi}\mid_{\phi=0}=a\theta^{*}[\Sigma-\Delta\hat{x}(.)] \quad \text{(A22)}$$

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