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Research Article

Managerial risk reduction, incentives and firm value*

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Summary. Empirical evidence suggests that managers privately alter the risk in their compensation by trading in the financial markets. This paper analyzes the implications of the manager's hedging ability on her optimal compensation scheme, incentives and firm value. I allow the manager to reduce her systematic risk exposure by trading the market portfolio. I find that the manager's optimal hedge depends on the liquidity of the market. Due to imperfect liquidity, the manager's optimal hedge is not complete. The equilibrium pay-performance sensitivity and hence the manager's equilibrium incentives and the firm value increases in the liquidity of the market.

Keywords and Phrases: Pay-performance sensitivity, Hedging, Managerial compensation, Liquidity, Systematic risk.

JEL Classification Numbers: G30, G32.

1 Introduction

One central theme in the corporate finance literature is to align manager-shareholder interests by compensating the manager according to firm performance. The principal-agent model of executive compensation has illustrated a trade-off between providing incentives to the manager and optimal risk sharing. Tying the manager's compensation to firm performance increases the manager's incentives to maximize firm value. However, such schemes also expose the manager to some uncertainty over which she has no control. This theory produces the following empirical prediction: given the manager's effort aversion (i.e., the intensity of the moral hazard

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problem) and the manager's risk aversion (which determines the risk premium to be paid to the manager to bear risk), the compensation in riskier firms should be less sensitive to firm performance.[1]

An implicit assumption in the literature on risk and incentives is that it is prohibitively costly for managers to trade in the financial markets and privately alter their risk exposure. Restrictions that prevent the managers *to trade in their own firms* are commonplace. However, general transactions by managers in the stock market are not restricted. Recent evidence suggests that the managers do use the financial markets: An article in *The Economist* reports that the use of derivatives to hedge managerial exposure to firm risk has become a business of hundred millions of dollars.[2] By using such instruments or simply by trading in a market index, managers seem to be able to adjust the risk in their compensation.

This paper analyzes the implications of the manager's hedging ability on her optimal compensation scheme, her incentives and the firm value. To this end, I decompose the total risk into its systematic and firm-specific components. I allow the manager to trade in a market portfolio (but not in the stock of her own company) to alter the systematic risk exposure in her compensation. The manager trades as a rational but uninformed hedger in a Kyle type market setting. This market microstructure framework helps to endogenize the manager's diversification costs. In particular, it allows to relate the manager's hedging behavior and her equilibrium compensation scheme to the liquidity of the market where systematic risk is traded.

I show that due to imperfect liquidity, hedging the systematic risk is costly and the manager's optimal hedge is only partial: the manager does not diversify away all of the systematic risk in her compensation. The hedging demand is increasing in the liquidity of the market. The more systematic risk the manager hedges ex post, the more high-powered incentives she can be given ex ante. Accordingly, the optimal pay-performance sensitivity of the compensation scheme is increasing in the liquidity of the market. By combining elements of market microstructure theory and theory of managerial contracting, the paper builds a previously unexplored '*diversification link*' between market liquidity, managerial incentives and the firm value. Equilibrium incentives and hence the firm value are increasing in the liquidity of the market portfolio (or the liquidity of the systematic risk security).

Three recent papers also address the managers' ability to hedge the systematic risk exposure in their compensation. A common theme in these papers is that the optimal compensation contract should take into account the manager's ability to diversify away the systematic risk (Garvey and Milbourn, 2003; Jin, 2002) or substitute between systematic and firm-specific risk factors (Acharya and Bisin, 2003). The innovation of this paper is to endogenize the manager's optimal hedge and derive a link between the market liquidity, incentives and the firm value.

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[1] Aggarwal and Samwick (1999), Haubrich (1994) and Garen (1994) find supporting empirical evidence for this prediction. For a very recent critique of the central prediction of the principal-agent theory, see Prendergast (2002). Raith (2003) also challenges the trade-off between risk and incentives in a model of product competition.

[2] 'Executive Relief', Economist, April 3, 1999, p.64. See also the Business Week article, 'Undermining Pay for Performance', January 2001, p.70. Bettis et al. (2001) also document executives' increasing use of zero-cost collars and equity swaps for hedging purposes.

In Jin (2002), hedging is costless, therefore the manager diversifies completely. However, Jin also acknowledges that, '..although in theory CEOs could fully adjust their market risk exposure through trading, in reality constraints might be placed on doing so.' Garvey and Milbourn (2003) introduce diversification costs by an exogenously specified cost function. They motivate this diversification cost by referring to short selling and wealth constraints for the manager. Their conclusion is that market (systematic) risk might be an important determinant of the pay-performance sensitivity for younger managers, since it is those managers who face higher diversification costs. This paper makes a complementary point by endogenizing the diversification cost and relating it to market liquidity. If the hedging instrument has lower liquidity, the manager can only partially diversify her systematic risk exposure. Therefore, the liquidity of the systematic risk security affects the equilibrium pay-performance sensitivity and incentives.

This paper contributes to the theoretical literature that investigates the link between market liquidity and production efficiency. This literature has produced mixed results. On one side, researchers have emphasized that liquidity by definition requires dispersed and temporary ownership of the company's stock. Hence, higher liquidity implies less incentives to monitor the management. In other words, this literature asserts a trade-off between liquidity and control. Bhide (1993) and Admati, Pfleiderer and Zechner (1994) show how liquid markets undermine effective corporate governance by providing investors with an easy exit. Other theoretical models arrive at the opposite conclusion: liquidity can reduce agency problems. Kahn and Winton (1998) and Maug (1998) show that liquidity reduces the costs that an investor bears in taking a large position to influence the management.

Holmstrom and Tirole (1993) show how liquidity can improve incentive contracts by increasing the information content of stock prices. There are two important differences between this paper and Holmstrom and Tirole (1993). In this paper, liquidity refers to the liquidity of the market where the systematic risk factor (not the company's stock) is traded, whereas in their paper it is the liquidity of the own stock. Furthermore, in this paper the manager can trade unilaterally to adjust the systematic risk exposure in her compensation.

The paper is organized as follows. The next section describes the model and formally lays out the contract problem between the shareholder and the manager. Section 3 solves the equilibrium of the trading game and characterizes the manager's optimal hedging decision, given her compensation scheme. Section 4 describes the optimal linear incentive contract and derives empirical implications of the manager's hedging ability on her optimal incentive scheme and firm value. Section 5 concludes.

2 The model

I employ a standard principal-agent setting to analyze the trade-off between giving the manager incentives to maximize the firm value and making her bear risk. The basic ingredients of the model are as follows:

Technology. An agent (the manager) runs a firm owned by a principal (the shareholder). The principal is risk neutral and maximizes the final firm value net of the manager's compensation. The manager has exponential preferences with a constant absolute risk aversion coefficient $a > 0$. The final value of the firm, $\tilde{X}$, is determined by the following stochastic technology:

$$\tilde{X} = e + \tilde{\omega}, \tag{1}$$

where e is the costly and unobservable effort expended by the manager. For tractability, I assume that the manager's cost of effort is given by $c(e) = ke^2/2$ with $k > 0$, a constant. $\tilde{\omega}$ is the stochastic component over which the manager has no control. Note that, as in Jin (2002) and Garvey and Milbourn (2003), the moral hazard problem in this paper is the standard one where the manager can affect the expected return of the company through her choice of effort. Alternatively, Bisin and Acharya (2003) analyze a model where the total risk is fixed, but the manager chooses the composition of risk between aggregate and firm specific components and determines the covariance of the company's cash flow with the return of the market portfolio. Green (1984) and Bebchuck and Fershtman (1994) analyze models where the expected return is fixed and the manager's choice determines the risk of the company's cash flow. Finally, Lambert (1986) and Prendergast (2002) consider moral hazard settings where a risk averse agent must be motivated to first evaluate and then adopt a risky project.

Manager's compensation. Drawing on the optimality results in Holmstrom and Milgrom (1987), I restrict attention to linear compensation contracts.[3] In particular, the manager's compensation contract is described by a pair (F, s), where F is a fixed payment and s is the manager's share of the final firm value. Accordingly, the manager's compensation is given by;

$$F + s\tilde{X}. \tag{2}$$

In what follows, I refer to s as the pay-performance sensitivity of the manager's compensation scheme.

Risk factors. I assume that $\tilde{\omega}$ can be decomposed into two orthogonal risk factors

$$\tilde{\omega} = \beta(\tilde{v} - \bar{v}) + \tilde{\varepsilon}, \tag{3}$$

where $\tilde{v} \sim N(\bar{v}, \Sigma)$ is a systematic risk factor and $\tilde{\varepsilon} \sim N(0, \eta)$ is a firm-specific (non-systematic) risk factor with $E(\tilde{v}\tilde{\varepsilon}) = 0$ (for specifications along the same lines see also Acharya and Bisin, 2003; Garvey and Milbourn, 2002; Jin, 2002). Furthermore, β, the firm's beta, is defined as

$$\beta \equiv \frac{Cov(\tilde{X}, \tilde{v})}{Var(\tilde{v})}. \tag{4}$$

[3] The optimality of the linear sharing rule depends critically on the constant absolute risk aversion utility function for the manager. With more general preferences, a linear contract might not be optimal. Jin (2002) points out that in practice the sharing rule is often close to linear because the convexity induced by the manager's options is negligible to the first order.

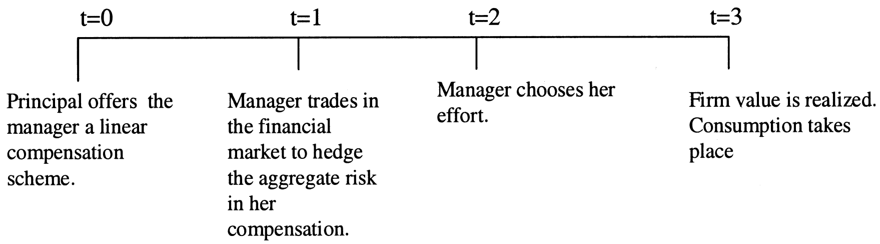

Figure 1. Sequence of events

Trading in financial markets. I depart from the standard principal-agent setting and allow the manager to trade in the financial markets to hedge the systematic risk $\tilde{v}$ in her compensation. For example, trading the market portfolio would achieve this end. I assume that the manager can not trade a security to hedge the firm-specific risk $\tilde{\varepsilon}$. This restriction is consistent with the empirical evidence documented by Bettis et al (2000). They document the extensive use of firm-specific bans and short selling restrictions on such trading practices.

I follow Kyle (1985) to model the trading game. In particular, other than the manager trading for hedging reasons, there is (i) a risk neutral informed speculator who knows v perfectly at the time of the trading, (ii) a risk neutral market maker who sets prices according a zero profit condition and (iii) noise traders who are not strategic and trade a random amount $\tilde{u}$. The noise trade $\tilde{u}$ is independent from all the other random variables and it is distributed normally with mean zero and variance ϕ. Given the pricing rule of the market maker and the trading rule of the informed speculator, the manager submits an order D^*. It is common knowledge in the market that the manager is an uninformed trader. I leave the formal description of this well-known and common framework to Section 3.1. For the reader's convenience I summarize the sequence of events with the timeline below.

2.1 The contract problem

The principal optimally sets the compensation rule (F, s) taking into account the subsequent hedging (D^*) and effort (e^*) choices of the manager. For a compensation scheme (F, s), the manager's final wealth $\tilde{W}_m^*$ is given by

$$\tilde{W}_m^*(D^*, e^*) = F + s[e^* + \beta(\tilde{v} - \bar{v}) + \tilde{\varepsilon}] + D^*(\tilde{v} - \tilde{p}) - k(e^*)^2/2. \tag{5}$$

The value of the hedge position is given by $D^*(\tilde{v} - \tilde{p})$ where $\tilde{p}$ is the equilibrium price for the systematic risk security (or market portfolio). The contract (F, s) must also satisfy the manager's participation constraint

$$E\left[\tilde{W}_m^*\right] - (a/2)Var\left[\tilde{W}_m^*\right] \geq 0, \tag{6}$$

where the manager's reservation payoff is normalized to zero. The complete formulation of the contract problem is as follows:

$$\underset{(F,s)}{Max}\; E\left[(1 - s)\tilde{X} - F\right] \qquad \text{subject to}$$

$$e^* \in \arg\max E\left[\tilde{W}_m(s, F, D^*)\right] - (a/2)Var\left[\tilde{W}_m(s, F, D^*)\right] \tag{7}$$

$$D^* \in \arg\max\ E\left[\tilde{W}_m\right] - (a/2)Var\left[\tilde{W}_m\right] \tag{8}$$

$$D_s \in \arg\max E\left[D_s(v - \tilde{p})|v\right] \tag{9}$$

$$\tilde{p} = E\left[\tilde{v}|D_T \equiv D^* + D_s + u\right] \tag{10}$$

and the participation constraint (6). Equation (7) describes the manager's optimal effort problem. Equations (8)-(10) describe the trading equilibrium. (8) is the manager's optimal hedge problem. (9) stands for the informed speculator's optimal trading strategy problem. Given the equilibrium strategies of the other market participants, informed speculator submits an order flow D_s to maximize her expected profits. Finally, (10) is the market maker's pricing rule that sets the price according to a zero profit condition, conditional on the *total* order flow $D_T \equiv D^* + D_s + u$.

3 Manager's optimal hedge and effort

3.1 Trading equilibrium

First, I solve for the trading equilibrium described by equations (8)–(10) and characterize the manager's optimal hedge. Following Kyle (1985), I derive a linear equilibrium. The speculator's optimal trading strategy is given by $D_s(v) = \delta(v - \bar{v})$ where δ is the trading intensity. The market maker's equilibrium pricing rule is given by $p(D_T) = \alpha + \lambda D_T$ where λ is the endogenous sensitivity of the equilibrium price to the total order flow D_T. Note that λ describes the extent that the market maker relies on the total order flow in setting the price. I follow the market microstructure literature and refer to the inverse of λ as the measure of market liquidity (see, for example Subrahmanyam, 1991). A highly liquid market corresponds to a low λ. Given the pricing rule $p = \alpha + \lambda D_T$, the expected trading cost of liquidity traders is given by $E[\tilde{u}(\tilde{p} - \tilde{v})] = 2\lambda\phi$. Therefore, a lower λ implies lower expected trading costs for liquidity traders, and hence a more liquid market.

In the original Kyle framework, there is no rational uninformed trader like our manager. As I show below, however, a linear equilibrium continues to exist. The market maker filters out the manager's hedge order from the total order flow as uninformative. Anticipating this, in equilibrium, the informed speculator does not respond to the manager's order flow either. The following proposition describes this equilibrium.

Proposition 1 *There is a linear equilibrium where the manager's optimal hedge is given by*

$$D^* = -\left[\frac{a}{a + (2\lambda/\Sigma)}\right] s\beta, \tag{11}$$

the market maker's pricing rule is $p = \bar{v} + \lambda(D_T - D^*)$ *and the informed speculator's optimal trading rule is* $D_s = \delta(v - \bar{v})$ *where* $\lambda = \frac{1}{2}\left(\Sigma/\phi\right)^{1/2}$*and* $\delta = (\phi/\Sigma)^{1/2}$.

Proof. Given the trading strategy $D_s(v) = \delta(v - \bar{v})$ of the informed trader and hedge order D^* by the manager, the market maker sets the price according to (10). Note that $\tilde{D}_T = \delta(\tilde{v} - \bar{v}) + \tilde{u} + D^*$ and one can define

$$\tilde{Z} \equiv \frac{\tilde{D}_T - D^* + \delta\bar{v}}{\delta} = \tilde{v} + \frac{1}{\delta}\tilde{u}. \tag{12}$$

Conditioning on Z is statistically equivalent to conditioning on $\tilde{D}_T$. We have $E\left[\tilde{v}|D_T\right] = E\left[\tilde{v}|Z\right] = (\bar{v}\phi + \delta^2\Sigma Z)/(\phi + \delta^2\Sigma)$. Substitute back Z to obtain

$$E\left[\tilde{v}|D_T\right] = \bar{v} - \left(\frac{\delta\Sigma}{\phi + \delta^2\Sigma}\right) D^* + \left(\frac{\delta\Sigma}{\phi + \delta^2\Sigma}\right) D_T. \tag{13}$$

which implies that $\lambda = (\delta\Sigma)/(\phi + \delta^2\Sigma)$. Given the pricing rule $p = \alpha + \lambda D_T$, the informed trader chooses D_s to maximize her expected profits given by $E\left[D_s(v - \tilde{p})|v\right] = D_s v - D_s\bar{v} - \lambda(D_s)^2$. The optimal informed order D_s is then given by $D_s = (v - \bar{v})/2\lambda$ which implies that $\delta = 1/(2\lambda)$. Solving this together with $\lambda = \delta\Sigma/[\phi + \delta^2\Sigma]$ yields the equilibrium coefficients δ and λ.Finally, the manager's wealth is given by

$$\tilde{W}_m = F + se - \frac{ke^2}{2} + s[\beta(\tilde{v} - \bar{v}) + \tilde{\varepsilon}] + D(\tilde{v} - \tilde{p}) \tag{14}$$

where $\tilde{p} = \alpha + \lambda[\delta(\tilde{v} - \bar{v}) + D + \tilde{u}]$. Accordingly, the first order condition that maximizes (8) is

$$\bar{v} - \alpha - 2\lambda D - a\left\{(1 - \lambda\delta)(s\beta + (1 - \lambda\delta)D)\Sigma + \lambda^2\phi D\right\} = 0 \tag{15}$$

Note that $1 - \lambda\delta = \frac{1}{2}$, $\alpha = \bar{v} - \lambda D$ and $\lambda^2\phi = \frac{1}{4}\Sigma$. Substituting these into the above first order condition and solving for D gives (11). □

The above proposition shows that the manager's hedge consists of a short position in the market portfolio to counter the systematic risk in her compensation. Examination of the optimal hedge described in (11) yields the following two key observations:

Corollary 2 *When $s = 0$, then $D^* = 0$, i.e., without any systematic risk to hedge in her compensation, the manager does not trade the market portfolio.*

The above corollary follows, since in this market microstructure framework with asymmetric information, trading the market portfolio is costly for the uninformed manager due to the volatility in price. In other words, there is a price risk for the uninformed hedger and hedging is costly. This result differs from Jin (2002) where hedging is costless. In his analysis, the market portfolio is traded in a competitive CAPM framework. In Jin's setting, even without any systematic risk to hedge the manager trades the market portfolio as long as there is a risk premium.

Corollary 3 *For any $\lambda > 0$ and $s > 0$, we have $s + D^*(s) > 0$.*

As long as the market is not perfectly liquid ($\lambda > 0$), the manager does not eliminate all the diversifiable risk in her compensation. The incomplete hedge is another implication of the asymmetric information framework and the consequent price risk. As standard in the market microstructure literature, our measure of liquidity is the inverse of the market maker's pricing response λ to the order flow. For any liquidity parameter $\lambda > 0$, the manager's hedge position does not eliminate all the diversifiable risk in her compensation. Only when $\lambda = 0$, i.e., when the market is perfectly liquid, the manager's hedge is given by $D = -s\beta$ and she hedges her systematic risk exposure completely.

How does the market liquidity affect the manager's hedging demand? The manager's order flow is identified by the market maker as uninformative. Therefore, it has no effect on the equilibrium price. However, as long as the market maker responds to the noisy total order flow in setting the price, the manager faces a price uncertainty. It is straightforward to verify that the distribution of the equilibrium price is given by $\tilde{p} \sim N(\bar{v}, \Sigma/2)$. This price uncertainty introduces a trading cost to the manager's hedge portfolio. Consequently her optimal hedge is not complete and she bears some systematic risk as long as $\lambda > 0$.

Given the compensation scheme (F, s), one can solve the effort problem in (7) and obtain

$$e^* = \frac{s}{k}. \tag{16}$$

The next section endogenizes the optimal pay-performance sensitivity s and relates it to the manager's hedging ability.

4 Optimal pay-performance sensitivity

Consider the shareholder's optimal choice of the compensation scheme (F, s). Substituting the manager's optimal hedge in (11) and optimal effort in (16) into her wealth distribution in (5), one obtains

$$\tilde{W}_m^* = F + \frac{s^2}{2k} - s\beta\bar{v} + \left[\frac{s\beta(2\lambda)}{\Sigma a + 2\lambda}\right]\tilde{v} + s\tilde{\varepsilon} + \left[\frac{s\beta\Sigma a}{\Sigma a + 2\lambda}\right]\tilde{p} \tag{17}$$

Notice that there are three sources of risk in the manager's ex ante wealth distribution: (i) the systematic risk factor $\tilde{v}$ that the manager cannot perfectly hedge due to imperfect liquidity, (ii) the firm specific risk factor $\tilde{\varepsilon}$ and (iii) the price risk. In equilibrium, the principal sets (F, s) such that the manager's participation constraint in (6) holds as an equality and hence F is given by

$$F = (a/2)Var[\tilde{W}_m^*] - \frac{s^2}{2k} \tag{18}$$

Substituting F into the shareholder's expected final wealth, the problem of optimal pay-performance sensitivity choice reduces to

$$s \in \arg max\ (1 - s)\left(\frac{s}{k}\right) + \frac{s^2}{2k} - (a/2)Var[\tilde{W}_m^*] \tag{19}$$

where

$$Var[\tilde{W}_m^*] = s^2\beta^2 \left[\frac{(a+z)^2 + z^2}{2(a+z)^2}\right] \Sigma + s^2\eta \tag{20}$$

and $z \equiv 2\lambda/\Sigma$. Our next result characterizes the optimal pay-performance sensitivity s^* and relates it to market liquidity.

Proposition 4 *(i) The optimal pay-performance sensitivity* s^* *is given by*

$$s^* = \frac{1}{1 + ak\Gamma} \tag{21}$$

where $\Gamma \equiv \beta^2 \left[\frac{(a+z)^2 + z^2}{2(a+z)^2}\right] \Sigma + \eta$ *and* $z \equiv 2\lambda/\Sigma$.

Proof. Follows from maximizing (19) with respect to s.

The mechanism that links the market liquidity to the manager's compensation scheme is as follows: The manager's ability to diversify away the systematic risk depends on the liquidity of the market. To the extent that the market is more liquid, the manager can diversify away more systematic risk. Consequently, the manager can be given more risk ex ante. Hence, the optimal pay-performance sensitivity s is increasing in the liquidity of the market where the systematic risk security is traded. The comparative static results for optimal pay-performance sensitivity are reported in the corollary below.

Corollary 5 *The optimal* s^* *is decreasing in the systematic risk* Σ*, the firm specific risk* η *and the manager's risk aversion* a*. It is increasing in the measure of market liquidity (inverse of* λ*).*

4.1 Empirical implications

The analysis has the following empirical implications.

(1) *Pay-performance sensitivity decreases in firm specific risk.* This is the central prediction of the principal-agent theory and it follows from the well known trade-off between optimal risk sharing and providing incentives. Aggarwal and Samwick (1999) find strong empirical evidence that the pay-performance sensitivity is decreasing in the volatility of the company's stock price. They conclude that pay-performance sensitivity is negatively related to company's total risk. Jin (2002) extends these empirical findings by distinguishing between systematic and firm-specific risk and finds that firm specific risk has a negative effect on pay-performance sensitivity. These studies treat pay-performance sensitivity as the dependent variable and estimate the effect of risk (the independent variable) on pay-performance sensitivity. They control for the parameters of the incentive problem; as the value of the manager's effort, the manager's disutility from effort, and the manager's risk aversion. This approach has been criticized by Prendergast (2002) who argues that

the level of risk itself determines the nature of the agency problem. In particular, the importance of manager's effort and discretion on firm value may as well depend on the level of risk. Prendergast points out that it is the high risk firms where managerial discretion and effort becomes more valuable and hence pay-performance sensitivity could actually be increasing in firm specific risk. Such considerations are important in testing the empirical relationship between risk and incentives, since the common approach seems to omit any possible effect of level of risk on the intensity and the specifics of the agency problem.

(2) *Pay-performance sensitivity is decreasing in the systematic risk.* This result follows in our model because due to imperfect liquidity, the manager does not diversify away all the systematic risk. Jin (2002) provides empirical tests by focusing on a sub-sample of CEOs who seem to be loaded with too much systematic risk. He documents that for that sub-sample, the relationship between systematic risk and pay-performance sensitivity is indeed negative. Garvey and Milbourn (2002) also provide supportive empirical results. They focus on young CEOs for whom diversification is likely to be more costly. Both studies conclude that, to the extent that the manager is constrained to diversify away the systematic risk, pay-performance sensitivity is decreasing in that risk factor.

(3) *Pay-performance sensitivity is increasing in the liquidity of the market where systematic risk is traded.* Our main empirical prediction identifies lack of liquidity as a possible constraint for diversification. This implication relates the principal-agent theory of executive compensation to a financial market fundamental which endogenously determines the extent that the manager can diversify. Note, again, that in our model the more the manager is able to diversify risk ex post, the more risk she can be given ex ante. Therefore, controlling for the intensity of the incentive problem and the level of total risk, a manager who has access to a less liquid market for diversification purposes would receive less exposure to risk in terms of stock-based compensation. An important cross-country implication of the analysis is that firms operating in countries without developed equity markets (hence with low levels of liquidity) would rely less on stock based compensation. To the best of our knowledge, this is a new empirical prediction and has not been tested. However, a casual comparison between U.S. (with its highly liquid equity markets and extensive use of own stock or own stock option grants as compensation for CEOs) and continental Europe (with much less liquid equity markets and little incentive compensation in the form of own stock or own stock option grants) seems to support the empirical validity of this prediction.

4.2 Competitive hedge market

In our market microstructure framework the manager's hedging choice takes into account a price risk and associated diversification costs. Note, however, that the case of a competitive hedge market (studied by Jin, 2002) is nested in the above analysis and it corresponds to a market with infinite liquidity. In that case, $\lambda = 0$ and the manager can hedge the systematic risk costlessly and hence completely.

Setting $\lambda = 0$ in (17), the manager's wealth distribution reduces to

$$\tilde{W}_m^* = F + \frac{s^2}{2k} - s\beta(\bar{v} - p) + s\tilde{\varepsilon} \tag{22}$$

with the firm specific risk factor $\tilde{\varepsilon}$ being the only source of risk. The following corollary summarizes the results for this case and reconciles the analysis in Jin (2002).

Corollary 6 *Suppose $\lambda = 0$ and hence the hedge market is infinitely liquid. In this case, $s^* = (1 + ak\eta)^{-1}$ and it is independent from systematic risk and the company's beta.*

4.3 Market liquidity and firm value

An interesting feature of the above analysis is the effect of the liquidity of the market portfolio on firm value. With higher liquidity, the manager can better hedge the systematic risk exposure in her compensation. This further implies that the equilibrium pay-performance sensitivity is increasing in the liquidity of the market where systematic risk is traded. Since the manager bears less of the systematic risk factor, she can be given high powered incentives. This, in turn, increases the manager's equilibrium effort and thus the firm value. This testable implication of our analysis is stated in the following proposition.

Proposition 7 *In equilibrium, the firm value is increasing in the liquidity of the market where the aggregate (systematic) risk factor is traded.*

Proof. Directly follows, since expected firm value is given by $E(\tilde{X}) = e^* = s^*/k$ and s^* is increasing in market liquidity (Corollary 5).

Holmstrom and Tirole (1993) also build a positive link between market liquidity and production efficiency. It is important to note, however, that in their theory market liquidity refers to the liquidity of the company's own stock, whereas I refer to the liquidity of the market portfolio which is completely exogenous to the firm. Furthermore, in the current setting liquidity improves incentives through a diversification channel which is not considered in agency literature on executive compensation.

4.4 Diversification and incentives

In the special environment studied in this paper, the fact that the manager can diversify risk by trading in the market does not have an adverse effect on the equilibrium effort level. The agent can only diversify the systematic part of the risk and ex ante she can always be offered more firm-specific risk that she can not diversify. This, however, is not true in general. The manager's access to financial markets and/or third parties such as financial intermediaries for diversification purposes may yield equilibria with inefficiently low levels of effort.

In order to illustrate this point, consider the following principal-agent setting analyzed by Bisin and Guaitoli (2003) where the agent can contract with outside parties. There are two possible states of the world: high and low. The high state generates a payoff H, and in the low state the payoff is L with $H > L > 0$. The agent's effort choice determines the probability distribution of the two states. If the agent undertakes high effort e_H, then the probability of the high state is p_H, whereas if low effort e_L is undertaken, the probability of the high state is p_L with $p_H > p_L > 0$. Suppose the principal can optimally offer the agent a payoff scheme $\{w_H, w_L\}$ which implements the high effort, i.e. $(p_H - p_L)[u(w_H) - u(w_L)] \geq v(e_H) - v(e_L)$ where $u(.)$ is the agent's strictly increasing concave VNM utility function and $v(.)$ is the disutility from effort with $v(e_H) > v(e_L)$. Now suppose the agent has access to a financial intermediary who offers her an insurance contract so that the agent can diversify away the risk in her compensation. Bisin and Guaitoli (2003) show that under a large set of parameter values, the unique equilibrium is the one with the intermediary offering an insurance contract that implements the low effort choice. Furthermore, if the agent were restricted from diversification the high effort would be implemented (A similar result can also be found in Garvey, 1993). This argument shows that whether diversification has an adverse effect on incentives depends on the *equilibrium* availability of full insurance contracts that sustain the low effort equilibrium.

5 Conclusion

This paper analyzes the implications of the manager's hedging ability on her optimal compensation scheme. I introduce the manager as a rational but uninformed hedger in a Kyle type market setting and allow her to privately adjust the systematic exposure in her compensation. The main results are as follows: (1) Due to imperfect liquidity the manager's optimal hedge of the systematic risk is not complete. (2) The equilibrium pay-performance sensitivity is increasing in the market liquidity. (3) Since better hedging ability increases the manager's equilibrium incentives, the firm value is increasing in the liquidity of the market where systematic risk is traded.

The analysis extends the standard principal-agent theory of executive compensation to a market microstructure setting. The main contribution of the paper is to emphasize the positive role of liquidity, a financial market fundamental, on the managerial incentives and the firm value through a previously unexplored 'diversification' channel. This feature of the analysis is in contrast to some previous research that asserts a trade-off between liquidity and control, and concludes that increased liquidity undermines effective corporate governance and managerial incentives. I argue that the liquidity of the general stock market can actually facilitate the diversification of systematic risk by managers, so that the managers can be given more high-powered incentives.

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