

CEO Incentives and Institutional Trader Monitoring are Substitutes: Theory and Evidence^{*}

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Abstract

We show that stock price signals of future value that are extraneous “noise” from the perspective of inferring managerial actions from stock price movements are ameliorated by informed trading. Managerial actions are now reflected in more informative stock price inducing higher managerial productivity and pay, even though we show that only a limited form of complementarity is possible and that substitution occurs with the sum of equity and bonus incentives falling. Our theoretical predictions are supported by empirical evidence from the top 1500 U.S. companies over the period, 1992-2007. Aggressive “swing” trades by institutional investors result in subsequent *reductions* in the use of CEO’s equity-based and bonus pay allocations but nevertheless raise total pay due to induced higher managerial effort.

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1. Introduction

In his famous paper, Holmstrom (1979) formulated the “informativeness principle” as to how sharing relationships such as agency can be improved upon: even imperfect additional information about the agent’s actions can be used to make both the principal and agent better off in a world with moral hazard. This theme is revisited in their seminal paper, Holmstrom and Tirole (1993, pp.694-95) (hereafter, HT), in which the authors show that the optimal incentive scheme will increase the equity allocation to the manager relative to non-price (i.e. bonus) allocation, when the informed trader (speculator) becomes better informed, meaning that stock price becomes a better relative measure of the manager’s hidden actions. It might also be inferred from their comparative statics that the absolute equity allocation also increases but this apparent and unintentional demonstration is simply a consequence of their redefinition of equity units. Had they translated back to their original units it would have been apparent that there was no such demonstration.

Hence their study leaves open the so far unaddressed question as to whether incentives are complementary with monitoring by informed traders or are substitutes. If they are complements this makes more severe the claim by Jensen and Murphy (1990) that equity incentives are too low but if they are substitutes then the optimal pay-for-performance sensitivity (hereafter, PPS) for managers will be lower than has been considered hitherto. This consideration is likely to be empirically significant given the prevalence of monitoring by informed traders as indicated by our literature review.

Recently, utilizing a variant on the HT model, Calcagno and Heider (2008) confirm that the agent’s pay should be more linked to the stock price if it is more informative about the future value of the firm but their proof is based only on the relative use of equity and a non-price incentive such as a bonus based on an accounting signal. They did not consider whether the use of equity actually goes up as the price signal becomes more informative.

Let us take a simple analogy: an automobile with a diesel engine is more fuel-efficient than an equivalent automobile with a gasoline engine. Naturally, we would expect the diesel vehicle to use less fuel each week because of its greater fuel efficiency, even if it is driven further each week due to its greater fuel economy (the agent works harder). That is, the technological fuel efficiency improvement

(monitoring) and the number of gallons of fuel purchased each week (equity allocation) are likely to be substitutes, not complements.¹ It would be exceedingly rare for the weekly fuel bill to go up (equity allocation to rise) as a result of replacing the gasoline engine by the more efficient diesel engine. In fact, it is clear that if an agent needs to be awarded a sizeable (and costly) share of the enterprise (stock grant) to motivate her appropriately in the absence of monitoring, then one would expect the allocation to be reduced in the event that equity becomes a more effective incentive device.

Now suppose that equity incentives are initially negligible because non-price (e.g., accounting) information provides a better signal of manager performance in the subsidiary of a conglomerate. A sufficiently large improvement to monitoring by informed traders could make it viable to hive off the subsidiary and provide the manager with equity-based incentives. In this case, while it is true that the use of equity increases with the innovation in monitoring and therefore suggests a form of complementarity, we prove that the sum of the equity (price) plus non-price incentives must still fall. Hence use of incentives falls as the result of a more informative stock price. In this sense, substitutability between monitoring and incentives always prevails.

Apart from the unaddressed substitutability-complementarity issue, there is another aspect of the HT specification that makes empirical testing of their model difficult. For the price signal to improve for contracting purposes they rely on the single informational monopolist (informed trader) to make unobservable but costly outlays in acquiring a better signal of future firm value that reduces the error of observation. By contrast, the theoretical model of Edmans and Manso (2009) (hereafter, EM) identifies an advantage arising from competition between traders with each seeing signals of future value with a common element. Each trader trades more aggressively than would be optimal for the informational monopolist modelled by HT and thus releases more information that raises the informativeness of the stock price. Hence both the number of informed traders and their trade aggressiveness play important roles in improving the stock price as an indicator of managerial performance. While we retain an imperfect signal of future firm value, we also allow there to be either one or multiple informed traders forming a Cournot oligopoly of informed traders that

¹ We thank Gerald Garvey for this analogy.

ranges from pure monopoly all the way to perfect competition with the latter generating the most informative price signal.² Each trader observes the same signal but potentially with differing error terms. Not only are the number of traders observable but the model also predicts trading patterns that are also observable in our dataset. Hence, this extension of the HT model is required for the goal of empirically testing the hypotheses of complementarity or substitutability. By construction, the HT model is a special case of ours with the number of informed traders set equal to one.

While we show that our (and hence HT's) model is consistent with substitutability in a weak form in that the use of equity could rise with a more informative stock price, we show empirically that the use of equity actually falls as the informativeness of stock price increases. Substitutability exists in a strong form. This empirical finding implies, according to our theoretical model, that the informational advantage of informed traders is high relative to the quality (precision) of the accounting signal (i.e., the error term in the accounting signal is relatively large). We also demonstrate empirically based on S&P 1500 stocks, 1992-2007, that increased informativeness due to monitoring does indeed absolutely reduce equity-based incentives and the sum of equity and bonus incentives but also raises total CEO compensation as higher managerial productivity outweighs the fall in the use of incentives. However, both our theoretical model and empirical results do confirm an important aspect of both the HT and Calcagno and Heider (2008) models: the reliance on stock price increases relative to the non-price measure as stock price informativeness improves. Our empirical result indicates that the observational error term perceived by informed traders is small relative to the informational advantage of the signal to informed traders.

There is an intuitive explanation for our findings: managerial monitoring that occurs serendipitously when informed traders buy and sell stock removes extraneous information about future firm performance from stock price leaving only managerial actions affecting stock price. Harmful actions (e.g., "managerial slack") is less likely to occur as there is a higher probability that these will be immediately reflected in stock price. Even though inside shareholders now economize on costly equity allocation by reducing it (and bonus incentives even more), we show theoretically that total compensation must rise due to higher managerial productivity more than

² Note that Edmans and Manso (2009) do not attempt to formulate an optimal contract and their manager, unlike ours, is risk neutral.

outweighing falling incentives, conditional on the error with which traders observe the informed signal not being too large relative to the value of the signal itself. Since we demonstrate empirically that managerial pay goes up even with falling incentives, it makes no sense for managers to receive a costly double-whammy benefit at the expense of shareholders – higher incentives as well as higher pay. Moreover, our results are consistent with their being only a relatively small observational error term.

To put our model and findings into context, traditional theories argue that concentrated ownership helps alleviate the agency problems embedded in the manager-shareholder relationship in a firm, because only large shareholders have incentives to monitor the manager through direct intervention, or “voice”, as termed by Hirshman (1970). For example, Shleifer and Vishny (1986), Admati, Pfleider and Zechner (1994), Maug (1998), Kahn and Winton (1998), and Mello and Repullo (2004) all explain corporate governance from the perspective of large shareholder activism. However, the assumption that a firm is owned by one large, controlling shareholder, along with many other small shareholders is in stark contrast with the trend that we observe in the U.S. data. By defining a blockholder as a shareholder with at least 5% of the firm’s equity, we find from 1992 to 2007, on average, 52% of firms in the Execucomp universe³ have multiple (i.e. at least two) blockholders as shown in Table 1. Notably, the proportion of firms having only one large blockholder decreases consistently from 32% in 1992 to 19% in 2007.⁴ As shown in Figure 1, what has been increasing is the proportion of firms with multiple blockholders over the same period of time. The proportion of such firms increases remarkably from 33% in 1992 to 74% in 2007.⁵ An increasingly severe free-rider problem now seems inevitable under such trend growth in multiple blockholders as each individual blockholder and small investor now has fewer incentives to bear the cost of monitoring or coordination to share the cost. In other words, splitting a block reduces the effectiveness of exerting “voice” in governance.⁶

Recent research shows the possibility of an alternative channel through which multiple blockholders may still exert effective governance despite the power of using

³ We examine only institutional investors’, rather than the individual holdings here.

⁴ Also interestingly, the proportion of firms with no blockholder (i.e. the ownership structure is extremely diffused) also decreases from 35% in 1992 to 8% in 2007.

⁵ Our findings are in line with Dlugosz et al. (2006) using U.S. data from 1996 to 2001.

⁶ Perhaps mitigating the growing free-rider problem, specialized advisors now recommend how institutional investors should vote on governance issues.

“voice” being reduced. By following the “Wall Street Rule”, or “taking the Wall Street walk”, informed traders can largely eliminate extraneous information about future stock price that disguises managerial actions leaving only managerial actions to affect stock price. The resulting greater sensitivity of stock price to managerial actions – stock price informativeness – makes a non-performing manager vulnerable to stock price decline and thus ensures that the manager exerts appropriate costly effort even though inside shareholders optimally economize on managerial costs by lowering share allocation and PPS.

This alternative monitoring mechanism (“threat of exit”) has been noted in many empirical works. For example, Garvey and Swan (2002) find that what they term the market delegation ratio, the proportion of stock-based pay, is positively related to trading volume. Hartzell and Starks (2003) and Almazan, Hartzell and Starks (2005) find a positive relationship between the concentration of institutional ownership and sensitivity of manager’s equity-based pay. Parrino, Sias and Starks (2003) show that some institutional investors engage in the biggest sell-off in a firm four quarters immediately before the CEO is fired. Sias, Starks and Titman (2006) provide evidence that institutional investors possess information that impacts permanently on prices. With a different focus but in a similar vein, Chen, Harford and Li (2007) show that some institutional investors will sell their stakes in a firm when they anticipate a large enough value reduction. Gopalan (2008) evidences that institutional selling is a predictor of subsequent poor performance and firm takeover. A survey conducted by McCahery, Saunter and Starks (2009), find that 80% of responding institutional investors are willing to use “exit” by selling their holdings as a governance mechanism. Yan and Zhang (2009) find that short-term trading by institutional investors forecast future returns. Ferreira, Ferreira and Raposa (2008) find that stock price informativeness is a substitute for a more demanding board structure. Gorton, Hunag and Kang (2009) find that trading on stocks with poorly performing boards is more profitable. Boehmer and Kelley (2009) show that institutional trading is associated with greater pricing efficiency. Ferreira, Laux and Markarian (2009) find that managerial equity-based incentives are a substitute for institutional trading. Gallagher, Gardner and Swan (2009) (hereafter, GGS) find using daily trades of Australian fund managers that swing trades by informed traders indeed improve the

subsequent performance of the firm and is profitable even after brokerage and transaction costs.

In terms of theory, both Admati and Pfleiderer (2009) and Edmans (2009) focus on a single blockholder that exerts the “threat of exit”. EM consider a setting with multiple blockholders who can intervene (“voice”) as well as trade (“exit”). Noe (2002) recognizes the importance of multiple blockholders but does not consider the common informational signal observed by all informed traders which forms the cornerstone of ours and EM’s approach.

In the EM model, the larger the number of informed blockholders, the greater the informed trading volume, accordingly more information unrelated to managerial performance is impounded into prices and therefore removed as a source of noise. Greater stock price informativeness means that the stock price is much more sensitive to the manager’s actions. Blockholders’ self-interested trading now works as a commitment device to the manager because it rewards (punishes) the manager who owns stock (or stock equivalent incentives) in the firm *ex post* if she makes value-enhancing (decreasing) decisions *ex ante*. Seeing that, the manager would exert more efforts to increase the firm value *ex ante*. Therefore, a larger number of blockholders should lead to an increase in managerial effort and a rise of the firm’s value.

The organization of the paper is as follows. Section 2 presents the theoretical framework that forms the basis of our empirical analysis. Section 3 discusses our data source and the construction of several institutional investor- and manager-related variables. Section 4 provides the rationale of using the “buy-sell-buy” and “sell-buy-sell” trade sequence as the proxy for “threat of exit”. We present our empirical tests in Section 5. In Section 6 we conclude.

2. Optimal Contracting With Informed Traders

2.1 Incentives and price-(and non-price-) based signals

As in EM’s model, we view a blockholder simply as a shareholder who has greater information than the market and does not require her to hold a certain proportion (e.g., 5%) of a firm; we refer to blockholders as simply informed investors or traders in our model. We introduce an optimal managerial contract for a risk-averse manager who is

rewarded for stock price performance. In the first stage of the game the manager takes actions $a \in [0, \infty)$ that affect firm value, \tilde{v} :

$$\tilde{v} = a + \tilde{\eta} \quad (1)$$

Nature determines a value v for the firm's equity from a normally distributed value $\tilde{v} \sim N(a, \sigma_\eta^2)$, i.e., mean a and variance, σ_η^2 . The mean a depends on unobservable effort taken by the firm manager. The higher the variance, the more valuable is the receipt of this signal to informed traders but the harder it is to infer managerial actions from stock price movements. Hence, the actions of the manager are garbled by the random shocks, $\tilde{\eta}$, which also raise the risk borne by the risk-averse manager. Thus, it is desirable to eliminate the impact of these shocks from a contracting perspective.

Additionally, there are N symmetric informed traders (speculators) who observe the signal, $\tilde{s}_i = \tilde{v} + \tilde{\varepsilon}_i$, $\tilde{\varepsilon}_i, i \in N$, where ε_i are independent observational error terms, of the firm's future value, where $\varepsilon_i \sim N(0, \sigma_\varepsilon^2)$. There is also a non-price (e.g., accounting) signal, $y = \tilde{v} + \tilde{\theta}$, of the firm's terminal value, where $\theta \sim N(0, \sigma_\theta^2)$ are independent observational error terms.

The manager's total income, I , consists of a fixed salary, α_0 , plus what HT call *stock appreciation rights* at the rate, α_p , with a cash reward based on the (observable) stock price, p , i.e., $\alpha_p p$, and a share allocation, α_y , paid by inside stockholders to the manager at the time of termination and based on the non-price performance measure, y , consisting of the (e.g., accounting) value of the asset measured net of the other aspects of CEO pay at the (unknown) time the manager is terminated:

$$I = \alpha_0 + \alpha_p p + \alpha_y y, \quad (2)$$

where $\alpha_y y = \alpha E[v - \alpha_0 - \alpha_p p | y, p]$. Here we follow Calcagno and Heider (2008) by adopting a more general specification of the non-price signal than HT. Our manager can depart at any time so long as there is a non-price signal whereas the HT manager must depart at a pre-specified date. The manager is paid an amount in cash, $\alpha_0 + \alpha_p p$, plus an amount $\alpha E[v - \alpha_0 - \alpha_p p | y, p]$ in the form of α shares when she leaves the

firm that we can interpret as her bonus. The term $(v - \alpha_0 - \alpha_p p)$ can be viewed as the net liquidation value of the firm.

The risk averse manager's CARA utility function depends on the manager's income less cost of effort, $U(a) = -\exp\left[-\rho\left(I - \frac{1}{2}a^2\right)\right]$, where ρ is the manager's coefficient of constant absolute risk aversion and $\frac{1}{2}a^2$ is the manager's quadratic cost of effort function.

Risk-neutral owners choose the parameters of the manager's incentive contract so as to maximize the expected value of the firm net of the manager's income,

$$\max_{\alpha_0, \alpha_p, \alpha_y} E(\tilde{v} - I). \quad (3)$$

This is maximized subject to the incentive compatibility constraint such that the manager's expected utility is maximized,

$$a^* = \arg \max_a E\left\{-\exp\left[-\rho\left(I - \frac{1}{2}a^2\right)\right]\right\}, \quad (4)$$

where the superscripted * always indicates the optimal value. In turn, given the normality of the distributions, this is equivalent to the manager's certainty equivalent wealth:

$$a^* = \arg \max_a E(I) - \frac{\rho}{2} \text{Var}(I) - \frac{1}{2}a^2, \quad (5)$$

where $\text{Var}(I)$ denotes the variance of managerial income, and subject to the manager's participation constraint

$$E(I) - \frac{\rho}{2} \text{Var}(I) - \frac{1}{2}a^2 \geq \bar{I}. \quad (6)$$

Outside opportunities are reflected in reservation income, \bar{I} , that can be set at zero.

2.2 Trading demand of informed investors and price informativeness

The total number of shares in the firm is normalized to 1 made up of κ shares retained by insiders with the residual number sold to liquidity traders. There are N symmetric risk-neutral informed traders and each trades B/N shares. In our model, free float is

fixed and plays no role as in the EM framework. In the second stage of the game, each informed trader submits a market order, $x_i(\tilde{s})$, after observing a noisy signal of the true (common) value of the firm, v . Uninformed risk-neutral (noise) traders submit market orders \tilde{u} with mean zero and variance, σ_u^2 . We normalize the price and incentive contract to place it on a gross (i.e., pre-management compensation) basis.⁷ The observed price, p , measured net of cash outlays on the manager is related to the gross price undistorted by incentive payments, \hat{p} , by $p = \hat{p} - (\alpha_0 + \alpha_p p)$. This normalization procedure, which is also initially adopted by HT, results in the definition of the gross (normalized) share price as $\hat{p} = \alpha_0 + (1 + \alpha_p)p$ and the identical normalized manager income as

$$I = \hat{\alpha}_0 + \hat{\alpha}_p \hat{p} + \hat{\alpha}_y y. \quad (7)$$

We adopt Kyle's (1984, 1985, 1989) model and follow Admati and Pfleiderer (1988), EM, HT, and Calcagno and Heider (Appendix A, 2008) for our analysis of trading demands. The normalized market-clearing price, $\hat{p}(\tilde{z})$, is set by the competitive market maker who observes only the total order flow, $\tilde{z} = \sum_i \tilde{x}_i + \tilde{u}$, made up of the informed trader demands and normally distributed noise trades, \tilde{u} .

Proposition 1: *The trading strategy of an informed trader is assumed to be a linear function of the unique signal, $\tilde{s}_i = \tilde{v} + \tilde{\varepsilon}_i$, she observes: $x_i = \gamma(\tilde{s}_i - a^*)$. Kyle's lambda is*

$$\lambda = \frac{\sigma_\eta^2 \sqrt{N} \sqrt{(\sigma_\eta^2 + \sigma_\varepsilon^2)}}{\sigma_u [(N+1)\sigma_\eta^2 + 2\sigma_\varepsilon^2]}; \quad (8)$$

*The informed trader's linear demand is characterized by the trader's individual aggressiveness parameter:*⁸

⁷ In the context of different models, both HT and Calcagno and Heider (2008) recognize the need to normalize by grossing up so as to remove the direct effects of pay from the stock price. The basic difference between our model and that of HT is that in their model there is a single information monopolist whereas in ours there are N informed traders making up a Cournot oligopolistic group ranging from pure monopoly, $N = 1$, to purely competitive, $N \rightarrow \infty$. Our specification is more in the spirit of Kyle (1984, 1985, 1989) in that noise trader volatility does not affect price volatility and in Appendix A of Calcagno and Heider (2008) but with multiple traders each in receipt of the same partially observed informed signal. In Calcagno and Heider (2008) each partially informed speculator sees part of the puzzle with each one a separate part. Collectively, if all their information was combined, they would face no uncertainty.

⁸ The trade aggressiveness parameter also corresponds to that of HT (their equation (9)) when $N=1$.

$$\gamma_i = \frac{1}{\sqrt{N}} \frac{\sigma_u}{\sqrt{\sigma_\eta^2 + \sigma_\varepsilon^2}}; \quad (9)$$

(i) *The individual informed trader's trading demand in equilibrium is:*

$$x_i = \gamma(\tilde{\eta} + \tilde{\varepsilon}); \quad (10)$$

(ii) *The transformed price is:*

$$\hat{p} = (1 - \beta)a^* + \beta(a + \tilde{\eta} + \tilde{\varepsilon}) + \lambda\tilde{u},^9 \quad (11)$$

where

$$\beta = \frac{N\sigma_\eta^2}{(N+1)\sigma_\eta^2 + 2\sigma_\varepsilon^2} = \frac{\phi\sigma_\eta^2}{\sigma_\eta^2 + 2(1-\phi)\sigma_\varepsilon^2}, \quad (12)$$

where $\phi \equiv \frac{N}{N+1}$ and $\beta = \phi = \frac{N}{N+1}$ when the signal is observed without error,

and

(iii) *Aggregate expected trading profits are:*

$$N\pi_i = \frac{\sigma_\eta^2 + 2\sigma_\varepsilon^2}{(N+1)\sigma_\eta^2 + 2\sigma_\varepsilon^2} \sigma_u \left[(\sigma_\eta^2 + \sigma_\varepsilon^2) N \right]^{\frac{1}{2}}; \quad (13)$$

(iv) *Based on equation (9), the aggregate informed trade aggressiveness can be computed as:*

$$N\gamma = \sqrt{N} \frac{\sigma_u}{\sqrt{\sigma_\eta^2 + \sigma_\varepsilon^2}} \quad (14)$$

Proof : See Appendix A.

The aggregate trade aggressiveness parameter specified in equation (14) is increasing in the number of informed traders and is higher the smaller is the magnitude of the informed trader observational error, σ_ε^2 . It is also increasing in the volatility of noise trading, σ_u , and diminishing in the magnitude of the trader informational advantage, σ_η^2 . The higher the trade aggressiveness, the greater the

⁹ Note that a^* refers to the equilibrium level of effort. The transformed stock price, equation (11), corresponds to equation (11) of HT with the proviso that the number of informed traders in HT is $N=1$.

likelihood of swing trades which we treat as being associated with “threat of exit” trading patterns in Section 4 below.

Equation (12) captures the notion of price informativeness. EM define the informativeness of stock price as the expected change in price for a given change in firm value, $E\left[\frac{d\hat{p}}{dv}\right]$, and prove that their definition is equivalent to the one used in the microstructure literature, $(Var(v) - Var(v|\hat{p}))/Var(v)$, the proportion of the variance of the asset value that is incorporated in the price. We can therefore show:¹⁰

$$\frac{Var(v) - Var(v|\hat{p})}{Var(v)} = Corr(v, \hat{p})^2 = E\left[\frac{d\hat{p}}{dv}\right] = N\gamma\lambda = \frac{\phi\sigma_\eta^2}{\sigma_\eta^2 + 2(1-\phi)\sigma_\varepsilon^2} \equiv \beta. \quad (15)$$

Informativeness captures the degree to which the informative signal is incorporated in the contemporaneous stock price, \hat{p} , as shown in equation (11). This is increasing in the number of informed traders at the rate,

$$\frac{d\beta}{d\phi} \frac{d\phi}{dN} = \frac{\sigma_\eta^2 (1-\phi)^2 \beta (\sigma_\eta^2 + 2\sigma_\varepsilon^2)}{\phi (\sigma_\eta^2 + 2(1-\phi)\sigma_\varepsilon^2)} > 0. \quad (16)$$

In other words, the higher the number of the informed traders in the market, the greater the rate at which private information is impounded into the price. Informativeness is also increasing in trader informational advantage, σ_η^2 , conditional on there being an observational error term,

$$\frac{d\beta}{d\sigma_\eta^2} = \frac{2\beta(1-\phi)\sigma_\varepsilon^2}{\sigma_\eta^2 [\sigma_\eta^2 + 2(1-\phi)\sigma_\varepsilon^2]} > 0 \text{ iff } \sigma_\varepsilon^2 > 0. \quad (17)$$

Naturally, informativeness is falling with increases in the observational error term, σ_ε^2 , itself,

¹⁰ In contrast to EM’s and our definition, Calcagno and Heider (2008) adopt a different measure of price informativeness that reflects the inverse of the volatility in future value conditional on the observed price. This is given by $Var[v|\hat{p}]^{-1} = \frac{1}{\sigma_\eta^2(1-\beta)}$. Under either definition, informativeness is

increasing in the number of informed traders and in the precision of their observation of the informed signal (i.e., lower σ_ε^2) but for Calcagno and Heider (2008) it is also diminishing in the informational advantage of informed traders, σ_η^2 .

$$\frac{\partial \beta}{\partial \sigma_\varepsilon^2} = -\frac{2\phi\sigma_\eta^2}{\left[\sigma_\eta^2 + 2(1-\phi)\sigma_\varepsilon^2\right]^2} < 0. \quad (18)$$

The second effort term in the normalized price (equation (11)) represents out-of-equilibrium effort, a . In equilibrium, $a = a^*$ and thus the terms in equation (11), $a\beta$ and $-a^*\beta$, cancel out, leaving the *equilibrium* price dependent on equilibrium effort a^* plus informativness effects.¹¹

2.3 The manager's action and incentives

Now we can explore the manager's effort level and her incentives in the first stage of the game. By incorporating the normalized stock price \hat{p} , which has the effect of eliminating terms involving managerial effort from the variance of managerial income, and on evaluating the manager's optimization program specified in equation (5), the first-order condition for maximum manager utility yields:

$$a^* = \hat{\alpha}_p E\left(\frac{d\hat{p}}{dv}\right) + \hat{\alpha}_y. \quad (19)$$

Since we now know from equation (11) and (15) that $E\left[\frac{d\hat{p}}{dv}\right] = \beta$, the expression for the manager's optimal effort becomes:

$$a^* = \beta\hat{\alpha}_p + \hat{\alpha}_y. \quad (20)$$

Before we solve for the absolute weights of equity-based pay allocation, $\hat{\alpha}_p$, and non-equity-based pay allocation, $\hat{\alpha}_y$, so that we can determine the value of the manager's optimal effort, we first consider the relative weight placed on equity-based pay allocation. In our structure with both CARA preferences and normally distributed returns, the optimal contract must minimize the total income risk faced by the risk-averse manager. Therefore, the (inside) firm owner's objective is to choose the best

¹¹ It is important to note that due to our generalized Kyle structure, the volatility of noise trading does not enter into the volatility of price itself as $Var(\hat{p}) = \frac{\beta^2}{\phi}(\sigma_\eta^2 + \sigma_\varepsilon^2)$ based on result (11). In the Kyle framework, informed trading adjusts to the rate of noise trading, hence removing noise trading as a source of price volatility. However, in the framework adopted by Calcagno and Heider, this is not the case.

combination of $\hat{\alpha}_{\hat{p}}$ and $\hat{\alpha}_y$ that minimize the variance of managerial income $Var(I)$ subject to effort level being optimal for the manager (equation (20)). We state the following result:

Proposition 2: *The ratio of equity-based to non-equity-based compensation is given by:*

$$\frac{\hat{\alpha}_{\hat{p}}}{\hat{\alpha}_y} = \frac{\beta Var[y] - Cov[\hat{p}, y]}{Var[\hat{p}] - \beta Cov[\hat{p}, y]} = \frac{\phi \sigma_{\theta}^2}{\beta [(1 - \phi) \sigma_{\eta}^2 + \sigma_{\varepsilon}^2]}, \quad (21)$$

where $\phi \equiv \frac{N}{N+1}$, as before.

Proof: See Appendix A.

The manager's normalized equity allocation increases relative to the bonus share allocation the greater is the measurement error induced by the non-price (e.g., accounting) variance, σ_{θ}^2 , the larger the number of informed traders conditional on the variance of the informed signal being large relative to the variance of the observational error term (specifically, $\frac{\sigma_{\eta}^2}{\sigma_{\varepsilon}^2} > \sqrt{2}$), the smaller is the informational advantage of informed traders, σ_{η}^2 , and the smaller the observational error term, σ_{ε}^2 , for all $N > 1$.¹²

Having examined the relative weight on equity and bonus-based pay allocation, we now solve for the absolute weights of the share and bonus allocations, $\hat{\alpha}_{\hat{p}}$ and $\hat{\alpha}_y$.

Proposition 3: *The normalized weight for equity-based pay allocation $\hat{\alpha}_{\hat{p}}$, is given by:*

$$\hat{\alpha}_{\hat{p}} = \frac{\phi \sigma_{\theta}^2}{\beta \phi} \quad (22)$$

¹² In the special case corresponding to HT's assumption of an informational monopolist we obtain

$\beta = \frac{\sigma_{\eta}^2}{2(\sigma_{\eta}^2 + \sigma_{\varepsilon}^2)}$; $\lambda = \frac{\sigma_{\eta}^2}{2\sigma_u \sqrt{\sigma_{\eta}^2 + \sigma_{\varepsilon}^2}}$; and $\frac{\hat{\alpha}_{\hat{p}}}{\hat{\alpha}_y} = \frac{\sigma_{\theta}^2}{\sigma_{\eta}^2(1 - \beta)}$. These results correspond to Appendix A of

Calcagno and Heider (2008) with both β and λ corresponding precisely to HT.

and non-equity-based pay allocation, $\hat{\alpha}_y$, is given by:

$$\hat{\alpha}_y = \frac{(1-\phi)\sigma_\eta^2 + \sigma_\varepsilon^2}{\phi}, \quad (23)$$

where the denominator,

$$\phi \equiv \left(\rho \left\{ \sigma_\eta^2 \left[\sigma_\theta^2 + (1-\phi)\sigma_\eta^2 + \sigma_\varepsilon^2 \right] + \sigma_\theta^2 \sigma_\varepsilon^2 \right\} + \phi \sigma_\theta^2 + (1-\phi)\sigma_\eta^2 + \sigma_\varepsilon^2 \right).$$

Proof: See Appendix A.

The denominator, ϕ , reflects second-best optimal contracting since the manager is risk-averse ($\rho > 0$). Under the first-best optimal contracting (when the manager is risk-neutral, i.e. $\rho = 0$), the term in the $\{\}$ brackets disappears and the overall ϕ term is reduced, i.e., incentives are higher-powered when it is less costly for shareholders to risk-share with the manager.

We are now able to examine the impact of price informativeness by way of increasing number of informed traders on $\hat{\alpha}_p$ and $\hat{\alpha}_y$. As equations (15) to (18) show, the direct impact of β on equity-(or non-equity-) based pay allocation may not be clearly revealed without considering the impact of β 's components; we first investigate the impact of the number of informed traders (N), followed by the impact of the observational error term (σ_ε^2).

Proposition 4: The impact of the number of informed traders on equity-based pay allocation is given by:

$$\text{Sign} \left[\frac{\partial \hat{\alpha}_p}{\partial N} \right] = \text{Sign} - \left\{ \frac{2\phi\sigma_\varepsilon^2}{\sigma_\eta^2 + 2(1-\phi)\sigma_\varepsilon^2} + \sigma_\theta^2 - \sigma_\eta^2 (1 + \rho\sigma_\eta^2) \right\}. \quad (24)$$

Thus, on examining the first expression in the $\{\}$ brackets in equation (24), the higher is the volatility of the observational error term (σ_ε^2), i.e., the less precise the observed signal, the more effective is a larger number of informed trading in enabling a reduction in the equity allocation. This suggests that a larger number of traders each with an observational error provide insurance against a bad draw. The combined second and third terms in the $\{\}$ brackets provides an important insight about substitutability: the greater the error in the non-price signal, i.e., the larger is σ_θ^2 ,

relative to the effective trader informational advantage term, $\sigma_\eta^2(1 + \rho\sigma_\eta^2)$, the more the manager's equity allocation is reduced with an increase in the number of informed traders. For example, if the non-price incentive is not used at all, indicating that the non-price error term is too high, the equity incentive allocation always falls with a larger number of informed traders even if there is no observational error term in the informed trader advantage signal. Q.E.D.

Thus, in general, it is not possible to unequivocally sign on theoretical grounds alone the impact of more informed traders on the equity allocation because the relative magnitudes of parameters of interest are latent. Hence, we need to rely on the empirical evidence as presented in Section 5. This empirical evidence in turn provides information on the relevant latent variables.

Proposition 5: *The impact of a more volatile observational error term on the equity allocation is given by*

$$\text{Sign} \left\{ \frac{\partial \hat{\alpha}_p}{\partial \sigma_\varepsilon^2} \right\} = \text{Sign} \left\{ \begin{array}{l} \rho\sigma_\eta^2 \left[(2(1-\phi)-1)\sigma_\theta^2 + (2(1-\phi)^2 - 1)\sigma_\eta^2 \right] \\ + 2(1-\phi)\phi\sigma_\theta^2 + (2(1-\phi)^2 - 1)\sigma_\eta^2 \end{array} \right\}. \quad (25)$$

In the HT case $N=1$ and thus $\phi = \frac{1}{2}$ with the sign condition,

$\text{Sign} \left\{ \frac{\partial \hat{\alpha}_p}{\partial \sigma_\varepsilon^2} \right\} = \sigma_\theta^2 - (1 + \rho\sigma_\eta^2)\sigma_\eta^2$, which, if positive (e.g., smaller observational error term leads to lower equity-based pay allocation), is identical to the requirement for a larger number of informed traders to reduce the equity allocation. Thus, the two kinds of informativeness, larger informed trading numbers and a smaller error term, act in a similar fashion. By contrast, when there are a large number of informed traders so that $1-\phi \rightarrow 0$ the sign condition is negative so that a larger variance of the observational error term actually reduces the equity allocation. This finding extends the results of Proposition 4 to show that with a large number of participants a more significant error term promotes higher substitutability between monitoring and the equity allocation. This proposition also illustrates that the role of the observational error term in informativeness and impact on optimal contracting is quite complex and subtle in terms of its effects.

Proposition 6: *It is also very straight forward to show that the equity allocation is falling in the informed trader informational advantage, σ_η^2 . This result is not surprising as the more valuable it is to traders to observe a signal of firm future value unrelated to the manager's actions, the harder it is to detect the effect of managerial actions when so much else is impacting on the stock price.*

Proposition 7: *The impact of a larger number of informed traders on the non-price incentive allocation is negative. It is given by evaluating the responsiveness to show that*

$$\text{Sign}\left\{\frac{\partial \hat{\alpha}_y}{\partial N}\right\} = \text{Sign}\left\{-\left\{\sigma_\theta^2(\sigma_\eta^2 + \sigma_\varepsilon^2)(1 + \rho\sigma_\eta^2)\right\}\right\} < 0. \quad (26)$$

Proposition 8: *The effect of a higher error variance on the non-price incentive allocation depends on: $\text{Sign}\left\{\frac{\partial \hat{\alpha}_y}{\partial \sigma_\varepsilon^2}\right\} = \text{Sign}\left\{\phi\sigma_\theta^2(1 + \rho\sigma_\eta^2)\right\} > 0$; hence a more informative signal due to a lower error component reduces the non-price-based incentive allocation.*

From Propositions 7 and 8 we can clearly see that non-price-based incentive allocation declines in price informativeness (either via larger number of informed traders or greater precision of their observed signal or both).

Proposition 9: *We derive the manager's optimal action in equation (20) by substituting from equations (22) and (23) as:*

$$a^* = \beta\hat{\alpha}_p + \hat{\alpha}_y = \left\{1 + \rho \frac{\left\{\sigma_\eta^2[\sigma_\theta^2 + (1-\phi)\sigma_\eta^2 + \sigma_\varepsilon^2] + \sigma_\theta^2\sigma_\varepsilon^2\right\}}{\phi\sigma_\theta^2 + (1-\phi)\sigma_\eta^2 + \sigma_\varepsilon^2}\right\}^{-1}, \quad (27)$$

with $\text{Sign}\left\{\frac{\partial a^*}{\partial N}\right\} = \text{Sign}\left\{\frac{\partial a^*}{\partial \phi}\right\} = \text{Sign}\left\{\rho\sigma_\theta^4(\sigma_\eta^2 + \sigma_\varepsilon^2)\right\} > 0$ iff $\rho > 0$. Hence the effort of the risk averse manager, and therefore firm performance, is always increasing in the number of informed traders.

Thus, increased informativeness due to more traders must always increase managerial effort except in the unrealistic case in which effort is already at first-best. This implies that firm (fundamental) value is increasing in the number of informed

traders because informed trading induces managerial effort *ex ante*. Combined with the results in Proposition 2, multiple informed traders lead to higher trading volume and more intense trade aggressiveness, causing greater price informativeness and an increase in firm value accordingly.¹³

We now obtain a general result on the substitutability of equity and bonus incentives for informed trader monitoring.

Proposition 10: *The sum of price (equity) and non-price (bonus) incentives is always diminishing in informed trader monitoring.*

Proof: See Appendix A.

Note that this result holds regardless of whether the equity-based incentive is increasing in informativeness. Hence, we obtain a strong result in terms of the general substitutability of managerial incentives for informed trader monitoring.

We now examine the impact of increased informativeness on the manager's expected income, $E[I] = \hat{\alpha}_0 + (\hat{\alpha}_p + \hat{\alpha}_y)a^*$ since the expected values of \hat{p} and y are given by equilibrium managerial productivity, a^* .

Proposition 11: *Expected managerial income is increasing in informativeness induced by a larger number of informed trader monitoring if and only if the trader informational advantage ratio, formed by deflating the trader informational advantage by the variance of the observational error term, exceeds two, i.e., $\frac{\sigma_\eta^2}{\sigma_\varepsilon^2} > 2$.*

This is a similar but slightly less demanding condition to that which was required in Proposition 2 for the relative equity allocation to rise with an increase in the number of informed traders.

Proof: See Appendix A.

This is an important result as it shows that the effect of “exit” monitoring on managerial productivity outweighs the substitution effect that results in reduced incentives so long as the observational error by informed traders is not too high.

¹³ In our setting, as in the EM and HT framework, firm value and managerial effort has no bearing on informed traders' trading profits.

To recover the weights put on equity-based and non-equity-based pay in the original managerial incentive contract (2) from the normalized ones in (7), we present the following proposition:

Proposition 12: *Following the general approach of Calcagno and Heider (2008) but with a quite different specification, the transformed components of the manager's contract can be expressed in terms of its original components:*

$$\hat{\alpha}_0 = \frac{1-\alpha}{1+\alpha_p} \alpha_0, \hat{\alpha}_p = \left[\frac{(1-\alpha)\alpha_p}{1+\alpha_p} + \frac{\alpha\phi\sigma_\eta^2\sigma_\theta^2}{\beta\omega} \right], \hat{\alpha}_y = \frac{\alpha\sigma_\eta^2[\sigma_\eta^2(1-\phi)+\sigma_\varepsilon^2]}{\omega}, \quad (28)$$

where $\omega \equiv \sigma_\eta^2[\sigma_\eta^2(1-\phi)+\sigma_\varepsilon^2] + \sigma_\theta^2(\sigma_\eta^2 + \sigma_\varepsilon^2)$.

Proof: See Appendix A.

3. Data and descriptive statistics

We merge CRSP/Compustat database with Standard & Poor's (S&P) Execucomp database (from 1992 to 2007) to calculate CEO incentives. The institutional trading and shareholdings data are sourced from Thomson's institutional ownership database. All the firm-level accounting and stock price data are from Compustat and CRSP respectively.

3.1 CEO incentives data

The Execucomp database covers the 1,500 firms in the S&P 1500, which consists of the 500 S&P 500, the 400 S&P MidCap, and the 600 S&P SmallCap index firms.¹⁴ Execucomp contains valuable compensation-related information for the top five (sometimes more) executives of each firm including total amounts of salary, bonus, long-term incentive plan, restricted stock grants and stock option grants. In our paper we focus only on the CEO because we expect the CEO alone to have the greatest power in a firm's decision-making process and also to be the focus of institutional investors.

We compute the PPS of CEO's total equity-based compensation as our proxy for equity-based pay allocation in the text. PPS as a proper proxy can be easily

¹⁴ The Execucomp database also keeps the information of the firms that were removed from the index but are still trading; hence the total number of firms included in the database can be above 1,500 in each year.

economically motivated since higher PPS indicates a closer alignment of interests between the CEO and the shareholders as posited by Jensen and Murphy (1990) and Hall and Liebman (1998). Our PPS measure consists of two parts: *PPS_Cum_Option* and *PPS_CEO_Shares*. The former is calculated as per Yermack (1995)¹⁵ and is used to measure the dollar change in value of CEO option holdings for every \$1,000 change in the value of the firm (shareholders value); the latter is used to measure the dollar change in CEO shareholdings (including restricted stock) for every \$1,000 change in the firm value. The combined PPS measure is termed *PPS_Total*. It is worth noting that *PPS_Cum_Option* comprises the value of all outstanding options as we believe the value of unexercised stock options granted in previous years also provides incentives that will influence CEOs' actions (Jensen and Murphy (1990)).

We also include CEO total compensation and other pay components (salary, bonus, and equity-based incentives) in our sample. Total compensation is the total direct compensation data derived from Execucomp, defined as the sum of salary, bonus, total value of restricted stock granted, total (Black-Scholes) value of stock options granted, long-term incentive pay, and other annual payouts (including pension and health benefits, perquisites, etc).

3.2 Institutional trading and ownership measures

We identify informed institutional investors by validating whether they engage in a specific trading pattern. To identify the trading patterns of each institution and construct the institutional trading and ownership measures we rely on SEC 13-f filings compiled by Thomson/CDA Spectrum. Institutions with more than \$100 million of securities under management are required to report to the SEC. The reports contain the aggregate shareholdings for each institution on the quarterly basis.¹⁶ To make sure that all shares in the 13-f reports are adjusted for splits and special distributions we merge the 13-f reports with CRSP monthly stock file dataset and use FDATE (file date in Thomson 13-f dataset) and CRSP cumulative adjustment factors to make the

¹⁵ In particular, *PPS_Cum_Option* is computed by dividing the share equivalent of CEO cumulative option holdings by the total number of shares outstanding at the beginning of the fiscal year, whereas the share equivalent of CEO option holdings is the product of the delta (i.e. the hedge ratio, based on the Black-Scholes formula adjusted for dividends) and the number of options granted in current and previous years. We apply the same method to compute *PPS_CEO_Shares* (note that hedge ratio of shares is 1). We then multiply PPS by 1000 to reflect the dollar change in CEO option grants for every \$1,000 change in the firm value.

¹⁶ All positions greater than 10,000 shares or \$200,000 must be disclosed.

adjustment. We also make similar adjustments for total number of shares outstanding and price sourced from CRSP. As a final step to clean up the data we remove the stocks with total institutional investors' holdings greater than total number of shares outstanding. We then carry out all the following calculation based on RDATE (quarterly report date in the 13-f dataset).

3.2.1 Institutional ownership measures

For each stock we aggregate shares held across all institutions and divide it by total number of shares outstanding at the end of each quarter to construct the institutional ownership measure (*IO*). We also construct the *Top5_shrout* measure by summing up the holdings of the five largest institutional investors for each firm and scale it by total number of shares outstanding at the end of each quarter. These concentrated ownership measures are proxies for “voice” of institutional investors as we expect direct shareholder activism to be greater the fewer are the opportunities for “free riding”, as exemplified, for example, in EM’s model.

3.2.2 Institutional trading pattern and turnover

We analyze all institutional trades in a year (four quarters). All yearly trades are split up into mutually exclusive trading patterns based on the sign of change in the quarterly holdings of a particular stock. Hence, a trading pattern represents how an institution investor has been trading a particular stock within a year. Since the report date of Thomson data for a year is fixed at every March, June, September and December, we take every December of the previous year as the starting point and calculate the quarterly change of shareholdings of an institutional investor for a particular stock for the next four quarters. We identify the following eight mutually exclusive trading patterns: (1) Buy-Sell-Buy (BSB), (2) Sell-Buy-Sell (SBS), (3) Sell-Buy (SB), (4) Buy-Sell (BS),¹⁷ (5) Hold-Hold-Hold (HHH), (6) Buy-Buy-Buy (BBB), (7) Sell-Sell-Sell (SSS), and finally (8) Others (one occurrence of either Sell or Buy in the sequence). We require an institutional investor to hold the stock for four consecutive quarters for her trade sequence to be valid.

¹⁷ Pattern (3) also includes both Sell-Buy-Hold and Hold-Sell-Buy; pattern (4) also includes Buy-Sell-Hold and Hold-Buy-Sell.

As a stock can experience different trade sequences across institutional investors in any given year, for each stock we calculate its turnover ratio by each trading pattern identified in a year. The detail goes as follows: for each stock we firstly compute the annual trading volume of an institutional investor by summing the absolute value of the quarterly change in holding within a year (i.e. four quarters). Then we aggregate the trading volume across all institutional investors engaging in a particular trading pattern, scaling it by total number of shares outstanding at the end of each September (because we start with each December of the previous year, the ending quarter is September of each year). We repeat the same process for all the trading patterns and finally arrive at a dataset containing the turnover rate of each of the seven¹⁸ trading pattern for each stock, totaling 24,679 firm-years (covering 16 years from 1992 to 2007). We also construct a measure called *InstTrade* that represents the total institutional turnover by aggregating all the trading volume annually (regardless of the trading patterns) across all institutions, scaling it by its total number of shares outstanding.

3.3 Other control variables

We carefully conduct our analyses by controlling for variables pervasively used in the literature. *Ln_MktCap* is the natural log of market value of equity, measured as the product of the number of shares outstanding and share price, both of which are sourced from CRSP. The difference of MktCap between year t and year $t-1$, ΔMktCap , and the lagged value of ΔMktCap are included as per Hartzell and Starks (2003) to control for change in shareholder value. We also include *Debt_Ratio*, computed as the ratio of Total Liabilities to Total Assets, for debt has been widely viewed as an alternative monitoring mechanism in principal-agent theory and therefore is likely to have impact on CEO incentives. *Tobin_Q*, defined as the ratio of the market value of assets¹⁹ to the book value of total assets, is included as a popular proxy for the firm's growth opportunities in the literature. The above two firm-level controls are computed based upon Compustat dataset. We also include both the yearly buy-and-hold cumulative returns (*CumRet*) and standard deviation of market

¹⁸ The trading pattern of "HHH" is excluded because there is no change in holdings, hence no turnover rate.

¹⁹ See Sung and Swan (2009) for more details on the calculation of the market values of assets.

capitalization (*Dol_Volat*) because the former deals with the potential association between the firm's performance and CEO pay whereas the latter is highly related to the talent of CEO as per Sung and Swan (2009). Both of them are computed from CRSP. All the price level-related variables are CPI deflated (2006-07=100).

In all of our analyses we also control for year and industry effects. Year dummy variables are used to allow both PPS and other CEO pay component to vary year by year. They also serve the purpose of controlling for exogenous factors that may influence PPS and other CEO pay component, such as the overall market condition. Industry dummy variables can be treated as fixed effects at the industry level.

To generate a unified dataset that merge CEO incentives-related data with institutional trading/ownership data and firm-level control variables, we avoid the potential overlapping issue due to the fact that ExceComp is fiscal-year-based annual dataset (same as Compustat) and Thomson 13-f reports are calendar-year-based quarterly dataset by selecting firms with fiscal year-end month in September, October, November, and December only.²⁰ Our final unified dataset covers more than 77% of the firms in Execucomp from 1992 to 2007, totaling 17,946 firm-years. All the continuous variables are winsorized at the 1% and 99% levels to mitigate the effect of extreme observations.

In Table 2 we report descriptive statistics on all the variables of interest. In Panel A we can see that on average, PPS of CEO total equity-based compensation is about \$35 per \$1000 change in shareholder value. Around 67% of PPS of CEO total equity-based compensation can be attributed to CEO shareholdings (including restricted shares), and the remaining part to CEO option grants. The average CEO's total compensation is \$4.9 million in 2006 dollars. Of this amount, salary averages \$760,000 and bonus \$784,000. We also aggregate all equity-based components²¹ and the sum averages \$2.97 million. All the CEO pay measures are right-skewed.

Panel B of Table 2 shows the average institutional ownership of the 13-f institutions is about 60% in the 1992-2007 year range, which is 7 percentage point higher than a decade ago reported in Hartzel and Starks (2003), using 1992-1997 data. The concentration of the top 5 institutions averages 24%, which is only slightly higher

²⁰ See Appendix C for further details.

²¹ Equity-based components include CEO's restricted stock grants, stock option grants, and long-term incentive pay (LTIP). LTIP is included because it is mostly equity-based in public listed firms.

than a decade ago. The mean of total institutional turnover is about 23.5% with a standard deviation of 13% and the mean turnover of all the trading patterns is 3.5%, varying from 0.17% (the “Sell-Buy” pattern) to 11.7% (the “Others” pattern).

As can be seen from Panel C of Table 2, the average annual stock return (buy-and-hold) is 17.7% with a standard deviation of nearly 49%. The standard deviation of market capitalization averages \$2,210 million. The debt ratio of all the firms in our sample is about one quarter and Tobin’s Q is 1.8 on average. Finally, the mean (median) firm size is about \$7.4 billion (\$1.8 billion).

<<Insert Table 2>>

4. Threat of exist—“BSB” and “SBS” as swing trades

We follow GGS to identify institutional investors aiming to make trading profits rather than to extract private benefits from acquiring control of the firm or to gain from better governance of the firm. Of all the eight trading patterns, the sequence of a “Buy”, followed by a “Sell”, then a “Buy” (“BSB” sequence) or a “Sell”, followed by a “Buy”, then a “Sell” (“SBS” sequence) in a stock fits the characteristics of an institutional investor’s “threat of exist” best as they indicate high trade aggressiveness according to equation (14) above. The justification given by GGS is briefly summarized here: the sequence of three consecutive “Buys” (“Sells”) may indicate strongly-held beliefs about the future prospect of the firm and thus the subsequent long-term outperformance (underperformance) but shows no “threat of exit”. The sequence of three consecutive “Holds” (“HHH”) in a year shows either there is no private information at all that may induce institutional investors to trade or the investors are simply holding the stock with long-term horizon. A “Buy-Sell” (including both “Hold-Buy-Sell” and “Buy-Sell-Hold”) sequence may indicate bad news. Similarly, a “Sell-Buy” (including both “Hold-Sell-Buy” and “Sell-Buy-Hold”) sequence may suggest good news. None of the above trading patterns poses an explicit and unambiguous “threat of exit” to the CEO in the form of large swings in trading consistent with high trade aggressiveness.

By contrast, the sequence of “BSB” or “SBS” best captures the notion of “threat of exit” in the EM model because it involves large swings (defined as the distance from the peak to trough in the holdings) without indicating a pure favorable or unfavorable

view of an institutional investor about the firm's future performance as in "BBB" or "SSS". We call the trade sequence of BSB or SBS "swing trades", as per GGS. Note that the major difference between our methodology and that of GGS is the latter is able to identify swing trades within a three-month time period using daily data in Australia; ours relies on the quarterly change in holdings to identify trade sequences within a year.

Although it is true that the trade sequences we identify do not capture the short-term institutional trading between quarters, the argument provided above is still valid. For example, longing (shorting) a stock for three consecutive quarters can still reasonably be viewed as a strong signal that the institutional investors believes the price of the firm will go up (down). Likewise, the swing trading sequence does encapsulate the potential "threatening" nature of some institutional investors among all the eight mutually exclusive trading patterns, although, strictly speaking, our theory does not require a threat. Also importantly and from the firm's perspective, the CEO may be more concerned about medium-long term impact of share price movement on her compensation package, rather than the extremely volatile daily effect.

Panel A of Table 3 shows that on average BSB-type (SBS-type) swing trading accounts for nearly 9% (8.5%) of total institutional trading volume per firm. Also in Panel B of Table 3, we find on average, about 7% of total institutional investors engaging in BSB and SBS trading pattern per firm. Though their trades may offset as one trader (e.g. BSB) may very likely take the other side of trade against the other (e.g. SBS), a one-sided trade of 9% of the market (in terms of trading volume) should be considered substantial compared with other trading patterns (e.g. "Sell-Buy" only accounts for 1% of total institutional trading volume). The largest amount (about 50%) comes from "Others", which registers actually no pattern at all. Similar observation can be made from the perspective of number of institutional investors as shown in Panel B.

<<Insert Table 3>>

Based on our theoretical framework, in this paper we test the following three hypotheses:

H1: The higher the trade aggressiveness induced by informed traders ("threat of exit") due to increasing number of informed traders, the *lower* the manager's equity-based

pay allocation if the quality of the non-price signal is poor relative to the informational advantage of informed traders (by *Proposition 4*);

H2: The higher the trade aggressiveness induced by informed traders (“threat of exit”), the *greater* the weight placed on equity-based pay relative to non-equity-based pay (by *Proposition 2*);

H3: The higher the trade aggressiveness induced by informed traders (“threat of exit”), the *higher* the total compensation awarded to the manager as a result of her increasing effort level, conditional on the observational error term not being too high (by *Proposition 11*);

Stock price informativeness is latent rather than directly observable, but we know from our discussion in Section 2.3 that price informativeness is increasing in the number of informed traders and in the precision of their signal (i.e., smaller σ_ε^2). We have also shown that the aggregate informed trade aggressiveness is increasing in the number of informed traders and with better precision of the informed trader’s signal (i.e., smaller σ_ε^2). This indicates that informativeness and trade aggressiveness are virtually one and the same. Hence, in order to carry out empirical analysis, we choose trade aggressiveness as our proxy for price informativeness. As explained in Section 4, we believe the institutional investors engaging in BSB-(or SBS-) type trading patterns are likely to be the informed traders required by the model. Their trade aggressiveness is measured by swing trading, i.e., the turnover rate of their trades within a year. Since turnover rate is simply the trading demand (trading volume) scaled by total number of shares outstanding, our swing trading measures serve as a good proxy for trade aggressiveness as specified in equations (10) or (14).

To test the above hypotheses, our core regression model has the following specification:

$$\begin{aligned}
 (PPS_Total)_{it} = & \beta_0 + \beta_1 (Swing)_{it-1} + \beta_2 (Top5_shrout)_{it-1} \\
 & + \beta_3 (CumRet)_{it-1} + \beta_4 (Dol_Volat)_{it-1} + \beta_5 \ln(MktCap)_{it-1} \\
 & + \beta_6 (\Delta MktCap)_{it} + \beta_7 (\Delta MktCap)_{it-1} + \beta_8 (Debt_Ratio)_{it-1} \\
 & + \beta_9 (Tobin_Q)_{it-1} + \varepsilon_{it}.
 \end{aligned}
 \tag{29}$$

5. Empirical results

5.1 Pay-for-performance sensitivity of CEO total equity-based compensation

Since the direction of change in equity-based pay allocation due to increasing stock price informativeness cannot generally be determined purely on theoretical grounds, in this section we examine whether or not the sign condition on the relationship between informed trading and equity-based allocation is satisfied, as specified in equation (24) and to examine our first hypothesis, **H1**.

As shown in our core regression model, equation (29), we use *PPS_Total* to proxy the manager's equity-based allocation. *PPS_Total* consists of two parts: *PPS_Cum_Option* and *PPS_CEO_Shares*. In our theoretical framework we do not distinguish one from the other; therefore in our first empirical test we are interested in the relationship between informed investors' swing trading and *PPS_Total*. Because *PPS_Total* is censored from below (left-censored at 0), we employ Tobit analysis instead of OLS regression.

Column (1) of Table 4 shows that *PPS_Total* is negatively associated with the turnover by institutional investors engaging in the BSB-type trading pattern at the 5% level even when we control for the ownership concentration of the five largest institutions, firm performance of past year, volatility of the market capitalization, size, change in size, debt ratio, Tobin's *Q*, and the industry and year dummy variables. This result implies that a one-standard-deviation increase in BSB-type swing trading is associated with a decrease in CEO total equity-based pay of \$1.18 per \$1000 change in firm value. This is a 3.3% (8.8%) drop for a CEO with *PPS_Total* equal to the sample mean (median) of \$35.3 (\$13.4) per \$1000 change in firm value. Column (1) also reports the result of regressing *PPS_Total* on SBS-type swing trading along with other control variables. The increase in SBS-type swing trading also leads to lower *PPS_Total* although the impact is not as big as with BSB-type swing trading.²² We hence confirm the sign of equation (24) is negative in our sample: the more intense the trade aggressiveness the lower the manager's equity-based incentive (PPS). In other words, it seems during our observation period (1992-2007), that higher price informativeness (and trade aggressiveness by informed traders) leads to a fall in the sensitivity of equity-based pay. Our first hypothesis is thus confirmed.

²² We also examine the impact of other trading patterns and total institutional turnover on *PPS_Total*. Though most of the trading patterns are significantly negatively associated with *PPS_Total*, none of them exert as big impact as BSB-type swing trading.

The concentration of the top five institutions can be viewed as a proxy for “voice”. If “voice” exerts monitoring influence to raise equity-based incentives, as is the presumption in the literature, we should expect to see a positive relationship between *Top5_shrout* and *PPS_Total*. Our result shows it is not the case. Increasing concentration of the largest five institutions actually reduces sensitivity of CEO’s total equity-based pay to shareholder value. Swing trading, however, reduces the sensitivity of the managerial equity-based pay. We therefore conclude that “threat of exit” indeed constitutes a monitoring mechanism that is consistent with our theoretical model of informed trading.

<<Insert Table 4>>

To further examine which component of CEO equity-based pay is most affected by institutional investors’ swing trading, we re-run the analysis but substitute *PPS_Total* in equation (29) with *PPS_CEO_Shares* and *PPS_Cum_Option*. Column (2) of Table 4 shows a significant negative relationship between *PPS_CEO_Shares* and BSB-type swing trading. However, Column (3) shows the relationship between *PPS_Cum_Option* and BSB-type swing trading turns positive. This positive relationship between *PPS_Cum_Option* and informed trade aggressiveness is also in line with the results presented by Smith and Swan (2008).²³ As the impact of BSB-type swing trading on sensitivity of CEO’s shareholdings is much greater than that on sensitivity of CEO’s cumulative option holdings in absolute terms, we conclude that the negative relationship between *PPS_Total* and BSB-type swing trading is mainly driven by the CEO’s shareholdings. This is possibly because the CEO’s option holdings suffer no downside when the volatility of stock price soars due to intense trade aggressiveness, but the value of her share ownership will be adversely affected. In fact, higher price volatility raises option values. Hence *PPS_CEO_Shares* is more adversely affected by CEO’s heightened cost of risk as a result of increasing volatility in stock price than *PPS_Cum_Option*. The same result also applies when BSB-type swing trading is replaced by SBS-type swing trading, though the impact of the former, again, is bigger than that of the latter.

²³ Smith and Swan (2008) use different set of measures for trading intensity.

“Voice”, proxied by *Top5_shrout*, increases the sensitivity of CEO option grants.²⁴ But overall, when we examine the impact of “voice” on PPS of CEO total equity-pay, this channel of monitoring is not at work.

In our model we show aggregate trade aggressiveness is increasing in the number of informed investors, N . Since PPS of CEO total equity-based pay (*PPS_Total*) decreases in aggregate trade aggressiveness, we expect that *PPS_Total* also decreases in the number of N informed investors. To test this conjecture, we re-estimate the equation (29) but replace swing trading with the natural log of the number of institutional investors engaging in either BSB- or SBS-type swing trading, ($\ln(\text{num_mgr})$). Table 5 reports the Tobit regression result. In Column (1) of Table 5 we find higher number of institutional investors engaging in BSB-type swing trading indeed leads to lower *PPS_Total*. A similar result is also found when we examine those who engage in SBS-type swing trading. This finding further lends support to our argument derived from results in Table 4 and confirms **H1**.

For completeness, we also use *PPS_CEO_Shares* and *PPS_Cum_Option* as the dependent variables and the results, as shown in Column (2) and (3) of Table 5, are similar to those found in Table 4. Namely, higher number of institutional investors engaging in swing trades leads to lower *PPS_CEO_Shares* but higher *PPS_Cum_Option*. Therefore, we conclude that the overall CEO equity-based allocation is indeed decreasing in the number of institutional investors engaging in swing trading and the consequent aggregate trade aggressiveness. “Voice”, again, is not a functional mechanism of monitoring.

<<Insert Table 5>>

5.2 Trading Aggressiveness and Relative Weight placed on CEO’s Equity-based Compensation

Although equity-based pay allocation is a decreasing function of trading aggressiveness, we have shown in equation (21) that the ratio of equity-based to non-equity-based pay allocation is increasing in informativeness and therefore, by

²⁴ Similar results are also documented in Hartzell and Starks (2003), though their focus is merely on PPS of CEO option grants, not the PPS of CEO total equity-based pay as a whole.

implication, trade aggressiveness. The aim of this section is hence to test the validity of this prediction—our second hypothesis, **H2**.

We again utilize *PPS_Total* as our proxy for equity-based allocation, $\hat{\alpha}_p$, in equation (29) as before. The non-equity-based pay allocation, $\hat{\alpha}_y$, is estimated by using CEO’s bonus pay and some non-price (accounting) performance measure. Particularly, we estimate $\hat{\alpha}_y$ by dividing bonus pay by a financial accounting measure of performance. We use bonus pay since it is arguably the purest non-equity-based pay component that is rewarded based on some accounting performance measure (or a mix of accounting measures) of a firm. Although standard agency theory model does not suggest a specific non-price performance measure, we defer to the accounting literature (e.g., Sloan (1993) and Core, Guay, and Verrecchia (2003)) and choose earnings per share before extraordinary items (EPS) as our non-price performance measure. We then take the natural log of the ratio of *PPS_total* to our estimated $\hat{\alpha}_y$ and run the core regression model (29). In other words, the dependent variable is

replaced with $\ln\left(\frac{PPS_Total}{\hat{\alpha}_y}\right)$, where $\hat{\alpha}_y$ is computed as $\frac{bonus_{i,t}}{EPS_{i,t} - EPS_{i,t-1}}$. We use

the incremental change of EPS as the denominator because the determination of the bonus pay is generally based on the improvement of the performance measure in use, although the exact formula varies across firms and is unknown to outside researchers.²⁵ The results are shown in Column (1) of Table 6. The relative weight placed on equity-based pay allocation is positively associated with BSB-type swing trading at the 1% level. This confirms **H2**, that the optimal CEO compensation scheme will put more weight on price-based performance measure (e.g. stock prices) relative to non-price performance measure (e.g., EPS) as more valuable information is impounded in stock prices due to increased amount of informed trading.

This also provides evidence that the aggressive trading by multiple informed traders (BSB-type swing trading in our case) indeed constitutes a credible commitment device to reward the manager for her actions by making stock price a more useful signal (than the accounting performance measures) to the firm owners. Intervention (“voice”) of the largest institutional investors, proxied by *Top5_shrout*, plays no role in determining the relative weight on equity-based pay, however.

²⁵ We also use the growth rate of EPS as the denominator, our conclusion remains the same.

To illustrate that our result is not accounting measure-specific, we also choose other popular non-price performance measures in the industry: ROE, ROIC, and Net Income. We report the results in Column (2), Column (3), and Column (4), respectively. Our conclusion does not change: the impact of swing trading dominates that of intervention in determining the mixes of equity-based and non-equity-based pay allocation.

<<Insert Table 6>>

5.3 Trading Aggressiveness and CEO's Total Compensation Components

In this section we test our third hypothesis to see whether aggressive informed trading impacts on the level of CEO's total pay and its components. The dependent variable in the core regression model (29) now becomes CEO's total compensation (*Total_Comp*). As can be seen from Column (1) of Table 7, CEO's total pay increases in the informed trade aggressiveness (for both BSB- and SBS-type swing trading). According to Proposition 10 above, our empirical result implies that the traders' informational advantage is relatively high compared to the variance in the observational error term. A one-standard-deviation increase in BSB-type swing trading is associated with an increase in CEO's total pay of \$303.5, or a 6.8% (13.2%) rise for a CEO with the average (median) total pay of \$4,909.5 (\$2,545) per year. "Voice" this time, is positively related to CEO's total pay at the 1% level, though its impact is smaller than that of aggressive trading in size. A one-standard-deviation increase in *Top5_shrout* is associated with an increase in CEO's total pay of \$280, or a 5.7% rise for a CEO with the average total pay. Note that the pay figures are in thousands and in 2006 dollars.

We further explore the impact of "exit" and "voice" on the CEO pay components. Column (2) to Column (4) of Table 7 reports the regression results of CEO's salary, bonus, and total equity-based pay (including long-term incentives), respectively. We find, except *Salary*, both *Bonus* and *Equity-based Pay* are positively associated with swing trading and ownership of the top five institutional investors. It is also true in both cases that the impact of swing trading is greater than that of "voice" (e.g., one-standard-deviation increase in BSB-type swing trading is associated with a 3% rise in average bonus for a CEO, compared with a 2.7% rise as a result with an increase in *Top5_shrout* of the same magnitude). We find neither of our swing trading measures has any significant impact on *Salary*, however.

The result supports **H3**. It implies that, despite the reduced use of equity-based pay for the CEO due to a high quality price signal relative to the accounting signal, the informed traders' trading aggressiveness, still induces a higher effort level for the CEO and consequently the CEO will be rewarded by higher total pay. The stock price becomes a better signal now to the inside shareholders. More information is impounded in the price as a result of informed traders' aggressive trading while incentives are, in general, substitutes for informed trader monitoring. We also find the more concentrated the top five institutional investors are, the higher is the level the total pay and its components. Although "voice" reduces sensitivity of CEO's equity-based pay, it is found to be critical in determining the level of CEO's compensation package.

<<Insert Table 7>>

5.4 Robustness check

5.4.1 First-difference approach

We justify implementing the first-difference method by assuming the existence of some time-invariant firm-specific variables for each firm (e.g., some CEOs are exceptionally talented and their talents are persistent). Since firm-specific characteristics are generally unobserved, by first-differencing the equation for a specific firm across the sample period we also remove the time-invariant variables from the model. In other words, the first-difference model enables us to consider all the (time-invariant) individual variables across the firms without having to estimate them. The equation we estimate is hence:

$$\begin{aligned}
 (\Delta PPS_Total)_{it} = & \delta_t + \beta_1(\Delta Turnover)_{it} + \beta_2(\Delta Top5_shroud)_{it} + \beta_3(\Delta CumRet)_{it} \\
 & + \beta_4(\Delta Dol_Volat)_{it} + \beta_6(\Delta MktCap)_{it} + \beta_7(\Delta MktCap)_{it-1} \\
 & + \beta_8(\Delta Debt_Ratio)_{it} + \beta_9(\Delta Tobin_Q)_{it} + \Delta \varepsilon_{it},
 \end{aligned} \tag{30}$$

where δ_t is the time dummy. Because we also take first difference of time dummy variables and we still keep the constant term in the model, we use $t-2$ time dummy variables.

In order to show that the significance of either the BSB-type or SBS-type swing trading is not accidental, we also consider all the other five trading patterns we

identify in Section 3, specified as *Turnover*, along with the total institutional turnover, specified as *InstTrade*, in our regression model, equation (30). Table 8 presents the result of first-difference regression using *PPS_Total* as our dependent variable.

The result confirms our first hypothesis (**H1**) that the more aggressive the BSB-type swing trading is, the less sensitive the CEO total equity-based pay becomes. Although impact size is reduced compared with the result in Column (1) of Table 4, since we are now adopting a stricter estimation approach, the coefficient is nonetheless significant at 1%. As can be seen from Column (2) to Column (7) of Table 8, all the other trading patterns, including SBS-type swing trading, have no impact on *PPS_Total*, except the “Others” trading pattern. Column (8) shows that total institutional turnover also exerts negative impact on *PPS_Total*. However, the impact of both the Others-type trading pattern and institutional turnover is smaller in size compared with that of BSB-type swing trading. It is also worth noting that *Top5_shrout* has no impact in this more strenuous regression result.²⁶ We conduct the same analysis on the two components of *PPS_Total*—*PPS_CEO_Shares* and *PPS_Cum_Option*—and find our results remain the same (unreported here).²⁷ This suggests this particular “Buy-Sell-Buy” trading sequence indeed poses an explicit “threat of exit” to the CEO as it is a proxy for trade aggressiveness.

<<Insert Table 8>>

5.4.2 The alternative “swing” measures

We have been employing the aggregate turnover rate of institutional investors engaging in the BSB or SBS trade sequence as our swing trading or “threat of exit” proxy. To further examine the robustness of our results that BSB-type institutional investors are the most likely informed traders, we develop an alternative proxy for “threat of exit”. We calculate another “swing” measure (termed *Swing2*) as per GGS by computing the difference between the peak and trough in stock holdings induced by an institutional investor trading in the BSB or SBS sequence. We then aggregate this swing measure across all BSB- or SBS-type traders, scaling it by total number of shares outstanding. We re-estimate equation (30) by using the first-difference

²⁶ We also use institutional ownership (*IO*) as the proxy for “voice”, the result are qualitatively the same.

²⁷ This result is furnished upon request.

approach but replace *Turnover* with our alternative swing measure (*Swing2*). The result is shown in Table 9.

Column (1) to Column (3) of Table 9 use different measures of PPS of CEO equity-based compensation as the dependant variables. The result is consistent with what we find from Table 8: the greater the BSB-type swing, the lower the sensitivity of CEO total equity-based compensation. Most importantly, this result suggests institutional investors engaging in this Buy-Sell-Buy trading pattern are most likely the ones who know something about the firm other investors do not know. Their self-interested trading poses a “threat of exit” to the manager, serving as an alternative monitoring mechanism other than direct intervention (“voice”).

<<Insert Table 9>>

5.4.3 The heterogeneous nature of institutional investors

We are aware that our approach to generating turnover or swing measures based on a particular trading pattern (e.g, Buy-Sell-Buy) within a year is merely one way of discerning which institutional investors are more likely to discipline the manager’s behavior. Since each institutional investor may have its own investment objective, preference, legal restrictions, and investment horizon (Gompers and Metrick (2001); Bennett, Sias, and Starks (2003); Yan and Zhang (2009)), our approach does not take into account such heterogeneity across all institutions. A possible way to examine the impact of trading by different types of institutional investors on the manager’s incentives is resort to the legal-type code of the institutional investors in the 13-f reports.²⁸ However, as noted in the database manual, the legal-type code has serious classification errors and many groups are improperly classified in 1998 and beyond.

To resolve this issue, we follow the classification as per Bushee (1998, 2001)²⁹ and calculate the annual turnover rate of each of Bushee’s group of institutions for each stock. Institutions are classified into three types: Transient institutions (TRA) have

²⁸ The institutional types listed in the manual of 13-f reports are: bank, insurance company, investment companies and their managers, investment advisors, and finally, all others (including pension funds, university endowments, foundations, etc.).

²⁹ Bushee uses principal factor analysis and cluster analysis to classify institutional investors into three groups based on their past investment behavior and portfolio characteristics. Eight variables are constructed to describe the investment behavior of institutional investors. See Bushee (1998, 2001) for details.

high portfolio turnover and diversified portfolios. Dedicated institutions (DED) have low turnover and more concentrated portfolio holdings. Quasi-indexer institutions (QIX) have low turnover and diversified portfolio holdings.³⁰ Of the three types we suspect transient institutions are more likely to pose a “threat of exit” than the other two types and therefore are closely related to our BSB-type swing investors. Indeed, we find the correlation between our original BSB-type swing measure and the turnover rate of transient investors is 0.436, compared with 0.413 and 0.188 with the turnover rate of quasi-indexer and dedicated institutions, respectively (unreported, all statistically significant at 1%).

We also perform the similar analyses as specified in Section 5.1 to 5.3, regressing *PPS_Total*, relative weight put on equity-based to non-equity-based incentives (using EPS as the accounting measure), and *Total_Comp* on the turnover rate of transient institutional investors (TRA) and other control variables. The result in Table 10 confirms that, in line with our earlier results using BSB-type swing as proxy for informed trade aggressiveness, the turnover of the arguably aggressive transient institutional investors indeed leads to lower *PPS_Total*, higher relative equity-based pay allocation, and higher total CEO pay, after controlling for all related variables.³¹ We therefore conclude our earlier result is robust to this different classification of institutional investors after taking into account their heterogeneity.

<<Insert Table 10>>

6. Conclusion

In this paper we provide a theoretical framework with multiple blockholders trading based on their own self-interest but serendipitously constituting a monitoring mechanism (“threat of exit”) in disciplining CEO’s behavior. The higher the number of these informed investors is, the more aggressive informed trading and the more information is impounded in the price. Such aggressive informed trading rewards managerial effort *ex post*, hence in turn induces it *ex ante*. Importantly, we show that such “exit” monitoring mechanism is a substitute for equity-based (e.g. restricted stocks) *and* non-equity-based incentives (e.g. bonus). This finding clarifies

³⁰ We are grateful that Brian Bushee makes his classification data public on his website.

³¹ Generally, the result is also robust to using all the dependent variables mentioned above in Section 5.1-5.3. Turnover of quasi-indexer and dedicated institutions, however, do not reveal such consistency.

Holmstrom and Tirole (1993)'s result and is confirmed empirically: the more informative price not only encourages the firm owner to place more weight on equity-based pay relative to non-equity-based pay but the use of equity-based incentive pay falls absolutely and the sum of equity and non-equity-based pay allocation also falls because “exit” monitoring leads to a substitution away from the use of incentives in general.

Our empirical evidence also shows, despite the lower use of both equity and non-equity-based incentives, that total managerial pay is increasing in swing trading, in support of our theoretical model and the HT and EM frameworks. Higher pay is consistent with both higher managerial effort and firm value. An important theoretical implication that follows from pay rising in response to greater informativeness is that the error with which informed traders view the informed signal is low relative to the informational value of the signal to informed traders.

Our findings suggest the existence of multiple blockholders pursuing trading profits can not only alleviate the free-rider problem, albeit unintentionally, by constituting an alternative form of monitoring, but also become a substitute for the use of both equity and non-equity-based compensation without discouraging managerial effort and thus impairing firm value. Both our model and theoretical results help to explain the observed and apparently low pay-for-performance sensitivity for CEOs noted by previous researchers. How such “exit” monitoring mechanism affects firm performance, pricing efficiency and corporate governance are high on the authors’ research agenda.

APPENDIX A: Proofs

Proof of Proposition 1

Following Kyle (1984), Admati and Pfleiderer (1988) and EM, the i th of N informed trader adopts a linear strategy , $x_i = \gamma(\tilde{s} - a^*)$ and a competitive market maker observing the aggregate informed plus uninformed order flow, z , also has a linear pricing rule, $p(z) = a^* + \lambda z$, with market price determined by $p(z) = E[\tilde{v}|z]$. The i th symmetric informed trader chooses x_i to maximize,

$$\left[(\tilde{v}_i - a - \lambda z) x_i \mid \tilde{s}_i = s \right] = \left\{ \frac{\sigma_\eta^2}{\sigma_\eta^2 + \sigma_\varepsilon^2} (s - a^*) - \lambda (N-1) \gamma \left[\frac{\sigma_\eta^2}{\sigma_\eta^2 + \sigma_\varepsilon^2} (s - a^*) \right] \right\} x_i - \lambda x_i^2,$$

with solution, $x_i(s_i) = \frac{1}{2} \left[\frac{1}{\lambda} - (N-1)\gamma \right] \frac{\sigma_\eta^2}{\sigma_\eta^2 + \sigma_\varepsilon^2} (s - a^*)$. The $N-1$ terms involving γ take account of the responses of the other players in the Nash equilibrium. On solving for γ ,

$$\gamma = \frac{\sigma_\eta^2}{\left[\sigma_\eta^2 (N+1) + 2\sigma_\varepsilon^2 \right] \lambda} \text{ with Kyle's } \lambda = \frac{\text{Cov}[\hat{p}, z]}{\text{Var}[z]} \text{ given by equation (8) in the text.}$$

On eliminating λ in the expression for γ , equation (9) in the text is obtained.

The total order flow is $z = \frac{N\sigma_\eta^2}{\sigma_\eta^2 (N+1) + 2\sigma_\varepsilon^2} \frac{1}{\lambda} (s - a) + u$ and the expectation of the normalized price conditional on the market maker observing the aggregate order flow, z , is $\hat{p} = \alpha_0 + (1 + \alpha_p) p = a^* + \lambda z = a^* + \frac{N\sigma_\eta^2}{\sigma_\eta^2 (N+1) + 2\sigma_\varepsilon^2} (s - a^*) + \lambda u$. On evaluating the signal, $s = a + \eta + \varepsilon$, observable to informed traders, and collecting the terms in the effort term, a^* , we obtain the normalized price expression:

$$\hat{p} = \left(1 - \frac{N\sigma_\eta^2}{(N+1)\sigma_\eta^2 + 2\sigma_\varepsilon^2} \right) a^* + \frac{N\sigma_\eta^2}{(N+1)\sigma_\eta^2 + 2\sigma_\varepsilon^2} (a + \tilde{\eta} + \tilde{\varepsilon}) + \lambda \tilde{u}, \quad (\text{A1})$$

where the superscript * on the effort-related term, a^* , indicates that it is set at its equilibrium value and is thus out of the direct control of the manager. As per EM's definition of price informativeness, $E \left[\frac{d\hat{p}}{dv} \right]$, we obtain

$$E \left[\frac{d\hat{p}}{dv} \right] = \frac{d\hat{p}}{da} = \frac{\phi \sigma_\eta^2}{\sigma_\eta^2 + 2(1-\phi)\sigma_\varepsilon^2} \equiv \beta, \quad (\text{A2})$$

so that now we can express equation (A1) as equation (11) in the text. Q.E.D.

An individual informed trader earns expected profit $E[x_i(s - \hat{p})]$

$$\pi_i = E[(\tilde{s} - \hat{p})x_i | \tilde{s} = s] = (1 - \beta)\gamma(\sigma_\eta^2 + \sigma_\varepsilon^2), \quad (\text{A3})$$

which on substitution for γ and multiplying by N becomes equation (13) in the text after evaluating $1 - \beta$. In the limiting case as informed trader observational error, σ_ε^2 , approaches zero, the aggregate trading profits earned by informed traders becomes:

$$N\pi_i = \frac{\sqrt{N}}{N+1} \sigma_\eta \sigma_u \equiv \lambda \sigma_u^2,$$

which is the same as the EM result (their equation (6)) and indicates that collective informed trader profitability is the product of market impact and noise trader volatility when the error term in the signal is small. Q.E.D.

Proof of Proposition 2

The components of $Var(I)$ are

$$\begin{aligned} Var[\hat{p}] &= \beta^2 (\sigma_\eta^2 + \sigma_\varepsilon^2) + \lambda^2 \sigma_u^2 \\ &= \frac{\beta^2}{\phi} (\sigma_\eta^2 + \sigma_\varepsilon^2), \end{aligned}$$

$$Cov[\hat{p}, y] = \sigma_\eta^2 \beta, \text{ and } Var[y] = \sigma_\eta^2 + \sigma_\theta^2.$$

Hence, the inside shareholders' (the firm's owner) objective is to choose the best combination of $\hat{\alpha}_p$ and $\hat{\alpha}_y$ that minimizes the variance of managerial income, $Var(I)$:

$$Min_{\hat{\alpha}_p, \hat{\alpha}_y} Var[I] = \hat{\alpha}_p^2 \beta^2 \phi (\sigma_\eta^2 + \sigma_\varepsilon^2) + 2\hat{\alpha}_p \hat{\alpha}_y \beta \sigma_\eta^2 + (\sigma_\eta^2 + \sigma_\theta^2) \hat{\alpha}_y^2, \text{ subject to optimal}$$

managerial effort level, $a^* = \beta \hat{\alpha}_p + \hat{\alpha}_y$, being held constant. Thus on forming the Lagrangian and minimizing, the optimum normalized equity/bonus incentive ratio is

$$\text{given by } \frac{\hat{\alpha}_p}{\hat{\alpha}_y} = \frac{\beta Var[y] - Cov[\hat{p}, y]}{Var[\hat{p}] - \beta Cov[\hat{p}, y]} = \frac{\phi \sigma_\theta^2}{\beta [(1-\phi) \sigma_\eta^2 + \sigma_\varepsilon^2]} = \frac{\sigma_\theta^2 [\sigma_\eta^2 + 2(1-\phi) \sigma_\varepsilon^2]}{\sigma_\eta^2 [(1-\phi) \sigma_\eta^2 + \sigma_\varepsilon^2]},$$

where $\beta = \frac{dE[\hat{p}]}{dv} = \frac{dE[\hat{p}]}{da}$, as given by equation (A1) and (A2). Q.E.D.

Proof of Proposition 3

The inside shareholders' problem is to maximize expected cash flows net of payments and share transfers to management, and subject to the manager's participation constraint given by equation (6), by the appropriate choice of the share allocation, $\hat{\alpha}_p$, and bonus proportion, $\hat{\alpha}_y$:

$$\begin{aligned} \max_{\hat{\alpha}_p, \hat{\alpha}_y} E(\tilde{v} - I) \\ \text{s.t. } E(I) &= \frac{1}{2} (a^*)^2 + \frac{\rho}{2} Var(I) + \bar{I}, \\ a^* &= \beta \hat{\alpha}_p + \hat{\alpha}_y. \end{aligned}$$

On eliminating $E(I)$ using the participation constraint, equation (6), the objective becomes:

$$\max_{\hat{\alpha}_p, \hat{\alpha}_y} \left\{ \begin{aligned} &a - \frac{1}{2} a^2 - \frac{\rho}{2} \left[(\hat{\alpha}_p)^2 Var[\hat{p}] + 2\hat{\alpha}_p \hat{\alpha}_y Cov[\hat{p}, y] + (\hat{\alpha}_y)^2 Var[y] \right] \\ &-\bar{I} - \lambda \left[a - (\beta \hat{\alpha}_p + \hat{\alpha}_y) \right], \end{aligned} \right\}$$

where λ denotes the Lagrangian multiplier. On evaluating the two first-order conditions and the Lagrangian multiplier and substituting for effort from equation (20), we obtain the normalized weight for equity-based pay allocation, $\hat{\alpha}_p$, which can be plugged in equation (21) to obtain $\hat{\alpha}_y$. Q.E.D.

Proof of Proposition 10

We express the sum of the manager's equity and bonus weights as:

$$\begin{aligned}\hat{\alpha}_{\hat{p}} + \hat{\alpha}_y &= \frac{\phi\sigma_\theta^2}{\beta\phi} + \frac{(1-\phi)\sigma_\eta^2 + \sigma_\varepsilon^2}{\phi} \\ &= \frac{\sigma_\eta^2(\sigma_\theta^2 + \sigma_\varepsilon^2) + (1-\phi)(2\sigma_\theta^2\sigma_\varepsilon^2 + \sigma_\eta^4)}{\sigma_\eta^2\phi},\end{aligned}\quad (\text{A4})$$

and evaluate the derivative:

$$\text{Sign}\left\{\frac{\partial(\hat{\alpha}_{\hat{p}} + \hat{\alpha}_y)}{\partial\phi}\right\} = \text{Sign}\left\{-\frac{\sigma_\theta^2(\sigma_\theta^2 + \sigma_\varepsilon^2)[2(1+\rho\sigma_\eta^2)\sigma_\varepsilon^2 + \sigma_\eta^2]}{+\rho\sigma_\theta^2\sigma_\varepsilon^2(2\sigma_\theta^2\sigma_\varepsilon^2 + \sigma_\eta^4)}\right\} < 0, \quad (\text{A5})$$

after simplifying. Q.E.D.

Proof of Proposition 11

Utilizing the slope of the effort function from equation (A5) and the responsiveness of effort to incentives, equation (27), expected managerial income is increasing in the number of informed traders if $\frac{\partial E(I)}{\partial\phi} > 0$. Now $E[I]$ can be expressed as

$\hat{\alpha}_0 + (\hat{\alpha}_{\hat{p}} + \hat{\alpha}_y)(\beta\hat{\alpha}_{\hat{p}} + \hat{\alpha}_y)$. The numerator of the first multiplicative term is given by $\sigma_\theta^2 + (1-\phi)\left[\frac{2\sigma_\theta^2\sigma_\varepsilon^2}{\sigma_\eta^2} + \sigma_\eta^2\right] + \sigma_\varepsilon^2$ while the numerator of the second term is $\phi\sigma_\theta^2 + (1-\phi)\sigma_\eta^2 + \sigma_\varepsilon^2$. The denominators are the same. The sign condition is true iff $\frac{\sigma_\eta^2}{\sigma_\varepsilon^2} > 2$. Q.E.D.

Proof of Proposition 12

We can express the manager's income as

$$\begin{aligned}I &= \alpha_0 + \alpha_p p + \alpha E[v - \alpha_0 - \alpha_p p | y, p] \\ &= (1-\alpha)\alpha_0 + (1-\alpha)\alpha_p \frac{\hat{p} - \alpha_0}{1 + \alpha_p} + \alpha E[\tilde{v} | y, \hat{p}] \\ &= \frac{1-\alpha}{1+\alpha_p}\alpha_0 + \left[\frac{(1-\alpha)\alpha_p}{1+\alpha_p} + \frac{\alpha\phi\sigma_\eta^2\sigma_\theta^2}{\beta\omega}\right]\hat{p} + \frac{\alpha\sigma_\eta^2[\sigma_\eta^2(1-\phi) + \sigma_\varepsilon^2]}{\omega}y,\end{aligned}\quad (\text{A6})$$

where, $\omega \equiv \sigma_\eta^2[\sigma_\eta^2(1-\phi) + \sigma_\varepsilon^2] + \sigma_\theta^2(\sigma_\eta^2 + \sigma_\varepsilon^2)$, since $E[\alpha_p p | y, p] = \alpha_p p$ and

$$E[\tilde{v} | y, \hat{p}] = \frac{\sigma_\eta^2[\sigma_\eta^2(1-\phi) + \sigma_\varepsilon^2]}{\omega}y + \frac{\phi\sigma_\eta^2\sigma_\theta^2}{\beta\omega}\hat{p}. \text{ This is derived as follows:}$$

$$E[\tilde{v} | y, \hat{p}] = a^* + [Cov[v, y], Cov[v, \hat{p}]] \begin{bmatrix} Var[y] & Cov[y, \hat{p}] \\ Cov[y, \hat{p}] & Var[\hat{p}] \end{bmatrix}^{-1} \begin{bmatrix} y - a^* \\ \hat{p} - a^* \end{bmatrix}$$

$$\begin{aligned}
&= a^* + [\sigma_\eta^2, \beta\sigma_\eta^2] \begin{bmatrix} \frac{\beta^2}{\phi}(\sigma_\eta^2 + \sigma_\varepsilon^2) & -\beta\sigma_\eta^2 \\ -\beta\sigma_\eta^2 & \sigma_\eta^2 + \sigma_\theta^2 \end{bmatrix} \begin{bmatrix} y - a^* \\ \hat{p} - a^* \end{bmatrix} \frac{1}{\frac{\beta^2}{\phi}[(\sigma_\eta^2 + \sigma_\varepsilon^2)(\sigma_\eta^2 + \sigma_\theta^2) - \phi\sigma_\eta^4]} \\
&= \frac{\sigma_\eta^2[\sigma_\eta^2(1-\phi) + \sigma_\varepsilon^2]}{\omega} y + \frac{\phi\sigma_\eta^2\sigma_\theta^2}{\beta\omega} \hat{p}. \quad \text{Q.E.D.}
\end{aligned}$$

APPENDIX B: Issue of merging calendar-year-based and fiscal-year-based datasets

We calculate institutional turnover rate for each stock in a year (or four quarters) by using December of the previous year as the starting point and September as the ending point. Since only quarterly holdings data available in Thomson 13-f reports, an institution's holdings in December actually represent the holdings from October to December of the previous year. In other words, the turnover is computed based on all the information from October in year $t-1$ to September in year t . To ensure consistency, we calculate all CRSP-derived variables (e.g. the buy-and-hold cumulative returns) using the same time period.

The primary concern is 13-f reports and CRSP datasets are calendar-year based, while Execucomp and Compustat datasets are fiscal-year based. As variables generated from both type of databases are on the annual basis, if we naively merge variables generated from the former datasets with those from the latter by *YEAR* without considering different fiscal year-end months (*FYR* in ExceComp and Compustat) across firms, our Execucomp (or Compustat) variables may capture only a fraction of the contemporaneous effect in that year. The issue is more egregious when we estimate a regression model with a lead-lag relationship between the dependent and independent variables.³²

In order to mitigate this issue without leaving out valuable information, we keep firms with year-end month (*FYR*) equal to September (i.e. fiscal year covering Oct/ $t-1$ to Sep/ t), October (i.e. fiscal year covering Nov/ $t-1$ to Oct/ t), November (i.e. fiscal year covering Dec/ $t-1$ to Nov/ t), and December (i.e. fiscal year covering Jan/ t to Dec/ t). Any analysis that involves the combined datasets of fiscal-year-based data and calendar-year-based data should beware of the issue of overlapping time periods among testing variables.

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³² For example, if we select firms with *FYR*=June, 2007 (which covers July, 2006 to June, 2007 as per calendar year), the subsequent period would be *FYR*=June, 2008 (which covers July, 2007 to June, 2008 as calendar year). Execucomp/Compustat variables (e.g. *PPS_Total*) in this subsequent period are not "clean" in the sense that there is a 3-month overlap between those variables and 13-f/CRSP variables (e.g. *Turnover*), computed from October, 2006 to September, 2007. For more information on *FYR* please refer to Compustat or Execucomp manuals.

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Table 1: Proportion of Firms with N Blockholders in the S&P Execucomp Database Universe from 1992 to 2007

This table reports the proportion (in percentage terms) of U.S. firms in the universe of *S&P Execucomp* database with N number of blockholders. A blockholder is defined as a institution who holds at least 5% of the firm. The institutional ownership data is sourced from *Thomson 13-f* reports.

Number of Blockholder	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	35%	31%	29%	27%	27%	25%	24%	21%	18%	19%	17%	15%	13%	12%	10%	8%
1	32%	35%	30%	30%	28%	30%	28%	26%	28%	26%	26%	27%	24%	24%	21%	19%
2	20%	20%	22%	23%	24%	22%	24%	26%	25%	26%	25%	25%	25%	25%	27%	25%
3	9%	9%	12%	13%	14%	14%	15%	16%	17%	18%	20%	18%	21%	21%	23%	20%
4	3%	4%	5%	6%	6%	7%	6%	7%	8%	8%	9%	11%	11%	12%	11%	17%
≥ 5	1%	1%	1%	2%	2%	2%	3%	3%	4%	4%	4%	5%	6%	7%	8%	12%

Figure 1: Trend of Proportion of Firms with N Blockholders

This chart plots the time-series proportion of firms specified in Table 1 with N number of blockholders from 1992 to 2007. We ignore the firms with 2 or 3 blockholders in the chart to better reflect the upward/downward trend.

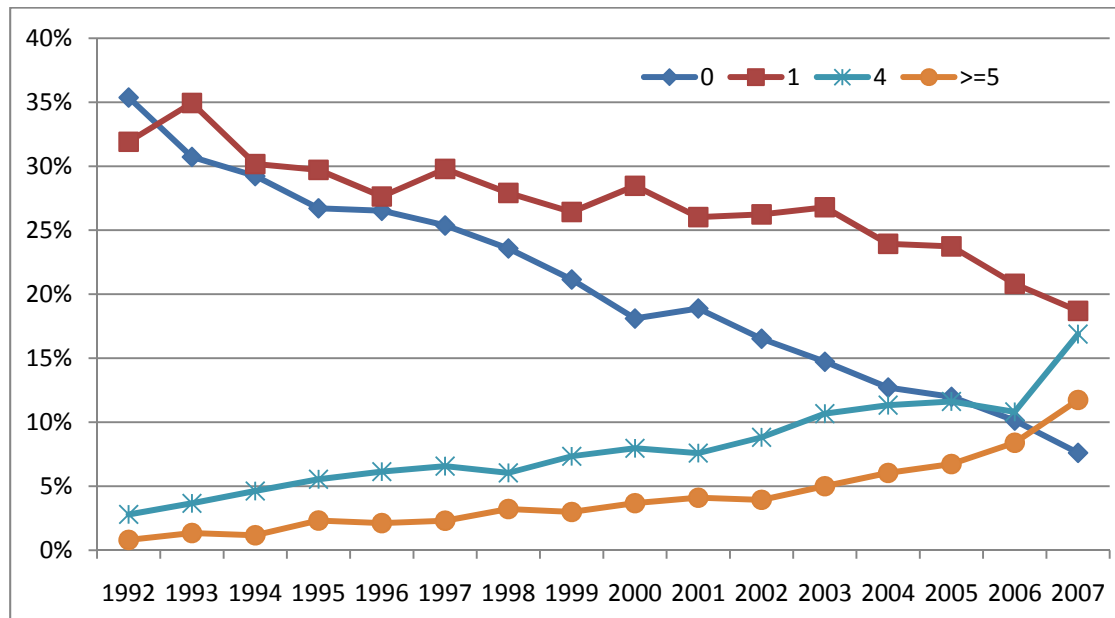


Table 2: Descriptive Statistics (1992-2007)

We merge Execucomp database with Thomson 13-f reports and the combined dataset includes 17,946 firm-year observations (2,324 unique firms) from 1992 to 2007. *PPS_cum_option* is the dollar value change in the CEO cumulative option grants per \$1000 change in shareholder value, computed based on Black-Scholes formula. *PPS_CEOshares* is the dollar value change in the CEO shareholdings (inclusive of restricted stock) per \$1000 change in shareholder value. *PPS_Total* is the sum of the above two measures. *Total_Comp* includes salary, bonus, total value of restricted stock granted, total (Black-Scholes) value of stock options granted, and long-term payouts. *Salary* and *Bonus* are simply the cash value of the CEO's annual salary and bonus, respectively. *Equity-based Pay* is the sum of CEO's restricted stock granted, stock option granted, and long-term incentive pay (LTIP). *IO (Institutional Ownership)* is calculated as the shares held by the 13-f institutional investors divided by the total number of shares outstanding. *Top5_shourt* is the five largest institutional investors' ownership of the firm. *InstTrade* is calculated as the annual sum of the absolute value of quarterly change in institutional holdings, aggregated across all institutions trading shares in the firm, scaled by total number of shares outstanding. *Turnover (Trading Pattern)* is computed as *InstTrade* but applied to the trading pattern specified in the brackets. *CumRet* is the annual buy-and-hold cumulative return for the firm. *Dol_Volat* is the dollar volatility of the firm's stock, computed as the product of the standard deviation of returns and the market capitalization at the beginning of the year. *Tobin_Q* is measured as the ratio of market value of assets to the book value of assets. *Debt_Ratio* is computed as the ratio of total liabilities to total assets. *MktCap* is defined as the product of the number of shares outstanding and the price at the beginning of the year. All prices are CPI deflated (2006=100).

Variables	Obs.	Mean	Std Dev	Min	25%ile	Median	75%ile	Max
Panel A: CEO Incentives Variables								
PPS_cum_option	17946	11.066	14.093	0.000	2.073	6.038	14.247	78.912
PPS_CEOshares	17946	23.746	56.714	0.000	0.871	3.242	13.708	337.575
PPS_total	17946	35.310	60.309	0.150	5.143	13.403	34.344	346.000
Total_Comp (real, \$000)	15266	4909.514	6710.332	230.774	1285.581	2544.919	5554.328	41365.640
Salary (real, \$000)	17946	759.972	368.331	3.176	490.478	707.547	984.571	2118.518
Bonus (real, \$000)	17946	783.992	1245.546	0.000	0.502	386.824	954.965	8011.799
Equity-based Pay (real, \$000)	15266	2976.135	5409.349	0.000	176.814	1033.651	3172.559	34366.050
Panel B: Institutional Trading and Concentration Variables								
IO	17946	60.37%	20.33%	10.68%	46.24%	62.29%	76.02%	97.10%
Top5_shrout	17946	24.39%	9.35%	6.05%	17.48%	23.76%	30.37%	51.12%
InstTrade	17946	23.486%	13.151%	1.399%	13.434%	21.877%	31.729%	60.704%
Turnover(Buy-Sell-Buy)	16675	2.133%	2.218%	0.019%	0.585%	1.427%	2.893%	11.411%
Turnover(Sell-Buy-Sell)	15837	2.084%	2.239%	0.011%	0.515%	1.355%	2.828%	11.527%
Turnover(Sell-Buy)	12725	0.169%	0.355%	0.000%	0.011%	0.045%	0.148%	2.306%
Turnover(Buy-Sell)	14619	0.304%	0.589%	0.000%	0.023%	0.087%	0.283%	3.596%
Turnover(Buy-Buy-Buy)	17449	4.396%	3.524%	0.047%	1.723%	3.573%	6.134%	16.501%
Turnover(Sell-Sell-Sell)	16976	3.445%	3.017%	0.024%	1.167%	2.608%	4.896%	14.109%
Turnover(Other patttern)	17926	11.676%	7.682%	0.475%	5.902%	10.160%	15.921%	36.104%
Panel C: Control Variables								
CumRet	17946	17.680%	48.882%	-76.126%	-9.914%	11.877%	35.260%	244.796%
Dol_Volat (\$M)	17943	2210.438	5098.753	36.523	238.982	587.735	1666.786	35311.700
Tobin_Q	17942	1.830	1.270	0.759	1.092	1.383	2.014	8.296
Debt_Ratio	17886	0.241	0.181	0.000	0.090	0.230	0.356	0.830
MktCap (real, \$M)	17946	7437.179	17070.980	52.157	663.403	1849.385	5796.308	117141.200

Table 3: Summary of Institutional Investor Trading Pattern (1992-2007)

This table presents the average trading volume of a firm across all institutional investors engaging in a particular trading pattern within a year and the average number of institutional investors engaging in such a trading pattern. Panel A reports the information on trading volume with each trading pattern breakdown. The average trading volume per firm is computed by firstly summing all annual trading volume across all institutional investors engaging in the particular trading pattern in a particular stock, and then summing the result over all firms experiencing such trading pattern, and finally dividing it by the total number of such firms from 1992 to 2007. Panel B reports the information on the number of institutional investors with each trading pattern breakdown. The average number of institutional investors per firm is computed by first summing the number of institutional investors engaging in the particular trading pattern across all the firms experiencing such trading pattern, and then averaging the result by the total number of such firms from 1992 to 2007. The percentage is computed using the average total institutional trading volume (or the average total number of institutional investors) across all trading patterns as the base. We require an institutional investor to hold the stock for four consecutive quarters for her trade sequence to be valid. Note that for the trading pattern of “HHH” there is no trading volume due to no change in quarterly holdings.

Panel A: Trading volume			
Trading pattern	Number of firm	Average trading volume per firm	Average % of total trading volume
SBS	22168	5126034.32	8.5%
BSB	22629	4993632.44	8.9%
SB	16873	262238.64	1.1%
BS	19566	453924.91	1.8%
HHH	23334	NA	NA
BBB	23851	9415112.65	19.0%
SSS	23063	7952260.59	14.8%
Others	24649	25100637.38	49.9%
Total	24679	51323373.45	100%

Panel B: Number of institutional investors engaging in a particular trading pattern			
Trading pattern	Number of firm	Average number of institution investors per firm	Average % of total institutional investors
SBS	22168	9.0	7.2%
BSB	22629	9.0	7.6%
SB	16873	2.6	2.5%
BS	19566	3.4	3.4%
HHH	23334	8.8	9.6%
BBB	23851	14.9	13.1%
SSS	23063	14.6	10.5%
Others	24649	56.2	50.6%
Total	24679	113.3	100%

Table 4: The Impact of Institutional Investor’s Trading Aggressiveness on Pay-for-Performance Sensitivity of CEO equity-based incentives

This table reports the results of our regression model of pay-for-performance sensitivity of CEO option grants on the swing trading measures (“Buy-Sell-Buy”-type or “Sell-Buy-Sell”-type), along with control variables. A swing trading measure for a firm is defined as the sum of trading volume across all institutional investors engaging in either “Buy-Sell-Buy” or “Sell-Buy-Sell” trading pattern when trading the firm’s stock for a year, scaled by the total number of shares outstanding. In Column (1) the dependent variable is PPS of the sum of CEO’s both option grants (transformed into shares equivalents) and shareholdings. Column (2) uses PPS of CEO shareholdings as the dependent variables. Column (3) uses PPS of CEO option grants (including historical grants) as the dependent variable. *Top5_shrout* is the five largest institutional investors’ ownership of the firm. *CumRet* is the annual buy-and-hold cumulative return for the firm. *Dol_Volat* is the dollar volatility of the firm’s stock. *Ln(MktCap)* is the natural log of the firm’s size. $\Delta MktCap$ is the first difference of the firm’s market capitalization between year t and year $t-1$. *DebtRatio* is the debt ratio of the firm. *TobinQ* is the firm’s Tobin’s Q measure. The lagged values of independent variables are used in the model, except $\Delta MktCap$. We report t-statistics robust to heteroscedasticity for each estimate. Since the dependent variables are censored from below at 0, we use Tobit regression. The asterisks indicate statistical significance at the 1% (***), 5% (**), and 10% (*) levels.

	(1)		(2)		(3)	
	PPS_Total		PPS_CEO_Shares		PPS_Cum_Option	
Intercept	94.17122*** (18.39)	97.00074*** (18.31)	63.06455*** (10.95)	65.49703*** (13.38)	23.179*** (12.83)	26.8136*** (14.90)
Lag_Swing (BSB)	-53.35644** (-2.58)		-99.35978*** (-4.88)		40.71599*** (7.22)	
Lag_Swing (SBS)		-44.5986** (-2.22)		-81.06851*** (-4.08)		32.61161*** (5.81)
Lag_Top5_shrout	-42.77709*** (-6.92)	-41.30132*** (-6.67)	-49.13085*** (-7.91)	-47.31152*** (-7.62)	7.922282*** (5.70)	7.497914*** (5.30)
Lag_CumRet	4.858507*** (4.11)	4.224919*** (3.51)	2.914456** (2.48)	2.381568** (1.97)	2.158585*** (7.30)	2.029424*** (6.85)
Lag_Dol_Volat	.0001649 (1.52)	.0001991** (1.82)	7.60e-06 (0.07)	.0000342 (0.33)	.0001264*** (5.26)	.0001277*** (5.30)
Lag_Ln(MktCap)	-9.599085*** (-21.68)	-9.484876*** (-20.53)	-6.142044*** (-14.17)	-5.998301*** (-13.26)	-3.046771*** (-28.57)	-3.044467*** (-27.30)
$\Delta MktCap$	0.0000513 (1.22)	0.0000475 (1.11)	0.0000541 (1.24)	0.0000469 (1.05)	0.000026*** (2.91)	0.0000266*** (2.97)
Lag_ $\Delta MktCap$	-0.0000513 (-1.08)	-0.0000365 (-0.76)	-0.0000533 (-1.19)	-0.000047 (-1.03)	7.34E-06 (0.91)	1.29E-05 (1.57)
Lag_DebtRatio	-23.06827*** (-6.37)	-25.11625*** (-6.70)	-20.79339*** (-5.70)	-23.35997*** (-6.18)	-6387852 (-0.82)	-4607916 (-0.56)
Lag_TobinQ	4.926633*** (9.01)	4.187453*** (7.39)	3.944526*** (6.99)	3.195716*** (5.5)	.8659285*** (6.97)	.9374735*** (7.3)
Year effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R-squared	0.0183	0.0184	0.0136	0.0137	0.0342	0.0351
Observations	14450	13691	14450	13691	14450	13691

Table 5: The Impact of Number of Informed (Swing) Traders on Pay-for-Performance Sensitivity of CEO Equity-Based Incentives

This table reports the results of our regression model of pay-for-performance sensitivity of CEO option grants on the number of institutional investors engaging in the swing trades (“Buy-Sell-Buy”-type or “Sell-Buy-Sell”-type), along with control variables. We take the natural log of the number of such institutional investors in our analysis. In Column (1) the dependent variable is PPS of the sum of CEO’s both option grants (transformed into shares equivalents) and shareholdings. Column (2) uses PPS of CEO shareholdings as the dependent variables. Column (3) uses PPS of CEO option grants (including historical grants) as the dependent variable. *Top5_shrout* is the five largest institutional investors’ ownership of the firm. *CumRet* is the annual buy-and-hold cumulative return for the firm. *Dol_Volat* is the dollar volatility of the firm’s stock. *Ln(MktCap)* is the natural log of the firm’s size. $\Delta MktCap$ is the first difference of the firm’s market capitalization between year t and year $t-1$. *DebtRatio* is the debt ratio of the firm. *TobinQ* is the firm’s Tobin’s Q measure. The lagged values of independent variables are used in the model, except $\Delta MktCap$. We report t-statistics robust to heteroscedasticity for each estimate. Since the dependent variables are censored from below at 0, we use Tobit regression. The asterisks indicate statistical significance at the 1% (***) , 5%(**), and 10%(*) levels.

	(1)		(2)		(3)	
	PPS_Total		PPS_CEO_Shares		PPS_Cum_Option	
Intercept	75.02629*** (13.60)	74.65932*** (12.89)	43.17554*** (6.94)	45.78123*** (8.47)	24.17279*** (13.41)	24.89133*** (13.47)
Lag_Ln(NumMgr) (BSB)	-8.99823*** (-8.98)		-9.455583*** (-9.44)		.4985427** (2.29)	
Lag_Ln(NumMgr) (SBS)		-6.320855*** (-6.84)		-6.246129*** (-6.78)		.3782813* (1.86)
Lag_Top5_shrout	-43.88095*** (-7.15)	-43.12376*** (-6.97)	-51.47957*** (-8.35)	-49.81421*** (-8.02)	9.054053*** (6.53)	8.194861*** (5.79)
Lag_CumRet	3.075251** (2.58)	2.814987** (2.31)	.9994773 (0.84)	1.02151 (0.83)	2.290875*** (7.64)	2.080746*** (6.92)
Lag_Dol_Volat	.0002457** (2.30)	.0002303** (2.12)	.0001044 (1.03)	.000075 (0.73)	.0001118*** (4.62)	.0001178*** (4.88)
Lag_Ln(MktCap)	-5.470836*** (-8.32)	-6.34261*** (-9.40)	-1.905356*** (-2.93)	-2.985224*** (-4.48)	-3.186755*** (-21.08)	-3.15768*** (-19.88)
$\Delta MktCap$	0.0000647 (1.59)	0.0000572 (1.36)	0.0000695 (1.64)	0.0000566 (1.28)	0.0000242*** (2.70)	0.0000253*** (2.84)
Lag_ $\Delta MktCap$	-0.0000447 (-0.97)	-0.0000367 (-0.77)	-4.29E-05 (-0.98)	-4.40E-05 (-0.98)	3.77E-06 (0.46)	1.05E-05 (1.28)
Lag_DebtRatio	-23.08087*** (-6.41)	-25.14371*** (-6.73)	-20.84296*** (-5.75)	-23.46642*** (-6.23)	-5.5786662 (-0.74)	-3.3898626 (-0.47)
Lag_TobinQ	4.495405*** (8.2)	3.90789*** (6.89)	3.447179*** (6.1)	2.887458*** (4.97)	.9283258*** (7.41)	.9806677*** (7.61)
Year effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R-squared	0.0190	0.0188	0.0144	0.014	0.0336	0.0347
Observations	14450	13691	14450	13691	14450	13691

Table 6: The Impact of Institutional Investors' Trading Aggressiveness on Relative Weight placed on CEO Equity-Based Incentives

This table reports the results of our regression model of ratio of CEO's equity-based to non-equity-based pay allocation $\left[\frac{(\text{Equity-based pay allocation})_{it}}{(\text{Non-equity-based pay allocation})_{it}} \right]$ on institutional investors' "swing trading" measures ("Buy-Sell-Buy"-type or "Sell-Buy-Sell"-type), along with control variables. Equity-based pay allocation is proxied by *PPS_Total*. Non-equity-based pay allocation is estimated by dividing CEO's bonus pay (*Bonus*) by the difference of a non-price-based performance measure. We use four different accounting measures to construct the ratio. Column (1) uses *EPS*, which is the diluted earnings per share excluding extraordinary items. Column (2) uses *ROE*, computed as income before extraordinary items divided by total number of common shares. Column (3) uses *ROIC*, computed as income before extraordinary items divided by total invested capital. Finally, in Column (4) we use *NetIncome*. All the accounting measures are sourced from Compustat. We take the natural log of the ratio as the dependent variables in our regression analysis. A swing trading measure for a firm is defined as the sum of trading volume across all institutional investors engaging in either "Buy-Sell-Buy" or "Sell-Buy-Sell" trading pattern when trading the firm's stock for a year, scaled by the total number of shares outstanding. *Top5_shrout* is the five largest institutional investors' ownership of the firm. *CumRet* is the annual buy-and-hold cumulative return for the firm. *Dol_Volat* is the dollar volatility of the firm's stock. *Ln(MktCap)* is the natural log of the firm's size. ΔMktCap is the first difference of the firm's market capitalization between year t and year $t-1$. *DebtRatio* is the debt ratio of the firm. *TobinQ* is the firm's Tobin's Q measure. The lagged values of independent variables are used in the model, except ΔMktCap . We report t-statistics robust to heteroscedasticity for each estimate. The asterisks indicate statistical significance at the 1% (***) , 5%(**), and 10%(*) levels.

	(1)		(2)		(3)		(4)	
Intercept	- .3583341 (-0.68)	.3231572 (0.54)	-.7682716* (-1.84)	-.8576761** (-2.28)	-.7359566* (-1.66)	-.6833483* (-1.75)	.7098439* (1.84)	1.367953*** (3.60)
Lag_Swing (BSB)	4.121677*** (3.72)		3.735672*** (2.87)		4.459362*** (3.72)		5.298004*** (5.31)	
Lag_Swing (SBS)		4.06265*** (3.87)		4.55586*** (3.66)		3.529467*** (2.94)		4.184628*** (4.23)
Lag_Top5_shrout	.0516083 (0.18)	.3283259 (1.10)	.4725716 (1.38)	.6718104* (1.86)	-.2746308 (-0.84)	-.1359805 (-0.40)	.2207416 (0.80)	.5078036* (1.76)
Lag_CumRet	-.18543*** (-3.38)	-.1638256*** (-2.97)	-.0848013 (-1.33)	-.0860251 (-1.30)	-.0999193* (-1.74)	-.0882278 (-1.49)	.0380335 (0.75)	.036613 (0.71)
Lag_Dol_Volat	.0000198*** (3.55)	.000019*** (3.31)	.0000201*** (2.81)	.0000167** (2.27)	9.70e-06 (1.42)	7.91e-06 (1.13)	.0000235*** (3.42)	.0000218*** (3.06)
Lag_Ln(MktCap)	-1.145942*** (-53.76)	-1.132808*** (-49.86)	-1.043761*** (-41.00)	-1.019546*** (-37.40)	-1.057216*** (-44.63)	-1.036853*** (-41.36)	-.1564045*** (-7.32)	-.1374162*** (-5.98)
ΔMktCap	2.36e-06 (0.98)	2.84e-06 (1.19)	-5.22e-07 (-0.20)	-2.95e-07 (-0.11)	3.85e-06 (1.32)	3.25e-06 (1.07)	0.00000799** (2.36)	0.00000761** (2.10)
Lag_ ΔMktCap	1.00e-06 (0.30)	1.41e-06 (0.43)	-7.61e-06** (-2.43)	-7.45e-06** (-2.32)	1.42e-07 (0.05)	3.86e-07 (0.14)	3.59E-06 (0.89)	4.53E-06 (1.09)
Lag_DebtRatio	.730151*** (4.41)	.6625338*** (3.86)	1.887713*** (9.36)	1.819013*** (8.69)	-.0678991 (-0.38)	-.1738042 (-0.94)	.9533471*** (5.87)	.9638387*** (5.82)
Lag_TobinQ	.1860326*** (7.21)	.1807273*** (6.85)	.5267094*** (17.60)	.5077017*** (16.01)	.5276726*** (18.30)	.5144402*** (16.65)	.1515794*** (6.17)	.146265*** (5.81)
Year effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.5388	0.5356	0.4657	0.4583	0.5090	0.5053	0.1497	0.1505
Observations	6045	5739	5355	5048	5463	5171	6848	6482

Table 7: The Impact of Institutional Investors' Trading Aggressiveness on CEO Total Compensation and Key Components

This table reports the results of our regression model of CEO total pay components on institutional investors' "swing trading" measures ("Buy-Sell-Buy"-type or "Sell-Buy-Sell"-type), along with control variables. Column (1) uses *Total_Comp* as the dependent variable. In Column (2) the dependent variable is *Salary*. In Column (3) the dependent variable is *Bonus*. In Column (4) we use *Equity-based Pay* as dependant variable, computed by summing up CEO's restricted stock granted, stock options granted and long-term incentive pay (LTIP) from *Total_Comp*. A swing trading measure for a firm is defined as the sum of trading volume across all institutional investors engaging in either "Buy-Sell-Buy" or "Sell-Buy-Sell" trading pattern when trading the firm's stock for a year, scaled by the total number of shares outstanding. *Top5_shrout* is the five largest institutional investors' ownership of the firm. *CumRet* is the annual buy-and-hold cumulative return for the firm. *Dol_Volat* is the dollar volatility of the firm's stock. *Ln(MktCap)* is the natural log of the firm's size. $\Delta MktCap$ is the first difference of the firm's market capitalization between year t and year $t-1$. *DebtRatio* is the debt ratio of the firm. *TobinQ* is the firm's Tobin's Q measure. The lagged values of independent variables are used in the model, except $\Delta MktCap$. All the pay components (including *Total_Comp*) are in thousands and CPI deflated (2006=100). We report t-statistics robust to heteroscedasticity for each estimate. The asterisks indicate statistical significance at the 1% (***), 5%(**), and 10%(*) levels.

	(1)		(2)		(3)		(4)	
	Total_Comp		Salary		Bonus		Equity-based Pay (incl. LTIP)	
Intercept	-7757.132*** (-4.89)	-7626.805*** (-4.33)	-285.775*** (-5.80)	-331.444*** (-6.72)	-1811.317*** (-12.65)	-1541.501*** (-10.77)	-6622.824*** (-9.31)	-6601.095*** (-8.21)
Lag_Swing (BSB)	15188.9*** (5.10)		-16.00326 (-0.14)		1074.414** (2.39)		11580.22*** (5.11)	
Lag_Swing (SBS)		12432.1*** (4.48)		.1906302 (0)		626.6911 (1.44)		10052.18*** (4.68)
Lag_Top5_shrout	2993.451*** (5.23)	3026.025*** (5.18)	111.2778*** (3.94)	109.0987*** (3.75)	226.0113** (2.21)	207.2849** (1.96)	2627.051*** (5.87)	2643.221*** (5.81)
Lag_CumRet	825.2841*** (6.01)	872.9809*** (6.18)	-13.5102** (-2.58)	-8.529144 (-1.58)	136.8939*** (6.51)	156.5177*** (7.25)	532.9189*** (4.94)	580.7399*** (5.19)
Lag_Dol_Volat	.3497945*** (15.17)	.3449728*** (14.91)	.0024139*** (2.86)	.0022853*** (2.68)	.0467521*** (11.11)	.0459091*** (10.83)	.2438434*** (13.34)	.2395718*** (13.06)
Lag_Ln(MktCap)	1626.885*** (30.95)	1634.611*** (30.66)	159.7167*** (71.64)	160.0158*** (69.67)	251.3864*** (28.29)	253.8582*** (27.61)	1047.872*** (25.66)	1050.831*** (25.31)
$\Delta MktCap$	0.041666*** (2.95)	0.0377456*** (2.63)	0.0011415** (2.35)	0.0013015** (2.55)	0.0202875*** (6.97)	0.0205985*** (6.79)	0.0080393 (0.75)	0.003153 (0.29)
Lag_ΔMktCap	0.0692317*** (4.78)	0.0680292*** (4.68)	0.0009812* (1.94)	0.0009464* (1.85)	0.0137417*** (5.44)	0.0134548*** (5.29)	0.0424657*** (3.61)	0.0416368*** (3.52)
Lag_DebtRatio	1635.753*** (4.56)	1569.637*** (4.16)	187.4408*** (10.84)	181.7381*** (10.22)	342.9719*** (5.20)	367.1642*** (5.19)	727.9347*** (2.72)	635.7436** (2.28)
Lag_TobinQ	-232.4915*** (-3.82)	-198.989*** (-2.89)	-65.79373*** (-26.93)	-65.35087*** (-25.63)	-131.8537*** (-15.41)	-133.4412*** (-14.49)	47.81266 (0.98)	72.90486 (1.34)
Year effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.4060	0.4108	0.5119	0.5126	0.3756	0.3762	0.3397	0.3443
Observations	12104	11378	14450	13691	14450	13691	12104	11378

Table 8: The Impact of Institutional Investor’s Trading Aggressiveness on Pay-for-Performance Sensitivity of CEO Total Equity-based Compensation, using First-Difference Estimation

This table reports the results of first-difference regression model of pay-for-performance sensitivity of CEO total equity-based compensation on the turnover of institutional investors displaying a specific trading pattern, along with control variables. The turnover for a firm is defined as the sum of trading volume across all institutional investors displaying a particular trading pattern when trading the firm’s stock for a year, scaled by the total number of shares outstanding. Column (1) to Column (7) reports the regression results using turnover of a specific trading pattern as the explanatory variables in the following order: (1) Buy-Sell-Buy, (2) Sell-Buy-Sell, (3) Sell first then Buy, (4) Buy first then Sell, (5) Buy-Buy-Buy, (6) Sell-Sell-Sell, and finally (7) Others, which includes one occurrence of either Sell or Buy in the sequence. Column (8) uses the turnover of all trading patterns, which is the total institutional turnover rate, as the explanatory variable. Both the trading patterns of “Buy-Sell-Buy” and “Sell-Buy-Sell” are termed “swing trading” in our analysis. *Top5_shrout* is the five largest institutional investors’ ownership of the firm. *CumRet* is the annual buy-and-hold cumulative return for the firm. *Dol_Volat* is the dollar volatility of the firm’s stock. $\Delta MktCap$ is the first difference of the firm’s market capitalization between year t and year $t-1$. $Lag_ \Delta MktCap$ is the lagged value of $\Delta MktCap$. *DebtRatio* is the debt ratio of the firm. *TobinQ* is the firm’s Tobin’s Q measure. We report t-statistics robust to heteroscedasticity for each estimate. The asterisks indicate statistical significance at the 1% (***), 5% (**), and 10% (*) levels.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	-0.4798897 (-0.64)	-0.6027951 (-0.89)	-0.4446427 (-0.77)	-0.1636426 (-0.25)	-0.6334879 (-0.88)	-0.7224229 (-1.09)	-0.4676124 (-0.63)	-0.502718 (-0.67)
Δ Swing (BSB)	-24.62267*** (-2.86)							
Δ Swing (SBS)		1.618075 (0.23)						
Δ Turnover(Sell-Buy)			67.30281 (0.9)					
Δ Turnover(Buy-Sell)				-29.19164 (-1.05)				
Δ Turnover(BBB)					-2.918269 (-0.58)			
Δ Turnover(SSS)						1.667847 (0.29)		
Δ Turnover(others)							-7.273183** (-2.08)	
Δ InstTrade								-7.272452*** (-2.74)
Δ Top5_shrout	-6.848161 (-1.53)	-10.67877** (-2.18)	-6.646888 (-0.15)	-5.701654 (-1.14)	-7.037246 (-1.64)	-7.558173* (-1.71)	-8.425313* (-1.94)	-7.779767* (-1.82)
Δ CumRet	-0.1472725 (-0.29)	0.0589853 (0.12)	-0.432105 (-0.65)	-0.2646604 (-0.45)	0.2519968 (0.51)	0.2186184 (0.46)	0.2215559 (0.46)	0.2037429 (0.43)
Δ Dol_Volat	-0.0002463** (-2.14)	-0.0002346* (-1.90)	-0.0001771* (-1.70)	-0.0002716** (-2.15)	-0.0002571** (-2.23)	-0.0002628** (-2.25)	-0.0003696** (-2.18)	-0.0003582** (-2.12)
Δ MktCap	5.26E-06 (0.41)	0.00000105 (0.08)	-0.0000199 (-1.39)	1.83E-06 (0.14)	0.0000115 (0.91)	8.19E-06 (0.65)	0.00000977 (0.78)	9.00E-06 (0.72)
Lag_ Δ MktCap	0.0000266*** (2.62)	0.0000154 (1.60)	0.0000149* (1.70)	0.0000224** (2.46)	0.0000263*** (2.63)	0.0000229** (2.34)	0.0000296*** (2.75)	0.0000291*** (2.71)
Δ DebtRatio	10.92256*** (3.11)	9.16435** (2.39)	7.717145 (1.62)	6.070797* (1.72)	8.269856*** (2.66)	8.323223** (2.39)	12.40236*** (3.60)	12.38999*** (3.60)
Δ TobinQ	1.662852*** (2.72)	1.679288** (2.53)	2.362097*** (2.62)	1.635807** (2.13)	1.069321* (1.88)	1.044014* (-1.69)	1.172271** (2.25)	1.182339** (2.27)
Year effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry effect	No	No	No	No	No	No	No	No
R-squared	0.0058	0.0053	0.0083	0.0048	0.0042	0.0039	0.0054	0.0058
Observations	13813	12689	8808	10977	14824	14264	11510	15546

Table 9: The Impact of Institutional Investor’s Swing on Pay-for-Performance Sensitivity of CEO Total Equity-based Compensation, using First-Difference Estimation

This table reports the results of first-difference regression model of in pay-for-performance sensitivity of CEO total equity-based compensation on the alternative swing measure of institutional investors engaging in “BSB” or “SBS” trading patterns, along with control variables, *Swing2* (*BSB* or *SBS*). In particular, it is defined as the absolute value of the change in shareholdings from peak to trough in a year, summed across all institutional investors and scaled by the firm’s total number of shares outstanding. Column (1) uses *PPS_Total* as the dependent variable. Column (2) uses *PPS_CEOShares* as the dependent variable. Column (3) uses *PPS_cum_option* as the dependent variable. *Top5_shrout* is the five largest institutional investors’ ownership of the firm. *CumRet* is the annual buy-and-hold cumulative return for the firm. *Dol_Volat* is the dollar volatility of the firm’s stock. *ΔMktCap* is the first difference of the firm’s market capitalization between year *t* and year *t-1*. *Lag_ΔMktCap* is the lagged value of *ΔMktCap*. *DebtRatio* is the debt ratio of the firm. *TobinQ* is the firm’s Tobin’s *Q* measure. We report t-statistics robust to heteroscedasticity for each estimate. The asterisks indicate statistical significance at the 1% (***) , 5%(**), and 10%(*) levels.

	(1)		(2)		(3)	
	ΔPPS_Total		ΔPPS_CEO_Shares		ΔPPS_Cum_Option	
Intercept	-4692228 (-0.62)	-6043162 (-0.90)	-932802 (-1.27)	-1.0939* (-1.66)	.502578*** (7.44)	.5514675*** (8.05)
ΔSwing2 (BSB)	-59.12806*** (-2.7)		-43.67285** (-2.13)		-17.67951*** (-3.2)	
ΔSwing2 (SBS)		-12.90752 (-0.77)		-10.757 (-0.69)		1.818354 (0.38)
ΔTop5_shrout	-7.225643 (-1.61)	-10.71367** (-2.19)	-10.23311** (-2.39)	-11.80619** (-2.54)	2.331358** (2.08)	.9312296 (0.80)
ΔCumRet	-.1656615 (-0.33)	.0441506 (0.09)	-.3343588 (-0.68)	-.1693306 (-0.36)	.1886661* (1.67)	.2931229** (2.25)
ΔDol_Volat	-.0002514** (-2.18)	-.0002308* (-1.87)	-.0002415** (-2.07)	-.0002179* (-1.81)	-.0000176 (-0.63)	-9.53e-06 (-0.32)
ΔMktCap	5.07E-06 (0.40)	1.27E-06 (0.10)	0.0000107 (0.87)	9.61E-06 (0.83)	-5.58E-06 (-1.52)	-0.00000821** (-2.07)
Lag_ΔMktCap	0.0000273*** (2.69)	0.000015 (1.57)	0.0000237** (2.29)	9.03E-06 (1.00)	0.00000677** (1.99)	0.00000713** (2.02)
ΔDebtRatio	10.88901*** (3.10)	9.183876** (2.40)	11.64131*** (3.26)	8.585374** (2.34)	.5595935 (0.48)	1.367314 (0.84)
ΔTobinQ	1.657381*** (2.71)	1.685858** (2.54)	.888549 (1.5)	.5972372 (0.96)	.6960848*** (5.57)	.9055359*** (5.61)
Year effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry effect	No	No	No	No	No	No
Pseudo R-squared	0.0057	0.0053	0.0042	0.0033	0.0332	0.0375
Observations	13813	12689	13813	12689	13813	12689

Table 10: The Impact of Transient Institutional Investor’s Turnover on Pay-for-Performance Sensitivity of CEO Total Equity-based Compensation, Relative Weight placed on CEO Equity-Based Incentives, and Total CEO Compensation

This table reports the results of our regression model of several key dependent variables in the earlier analyses on the turnover of transient institutional investors along with control variables. Transient institutional investors are defined as in Bushee (1998, 2001). Their turnover (*TRA*) for a firm is defined as the sum of trading volume across all transient institutional investors for a year, scaled by the total number of shares outstanding. Column (1) uses *PPS_Total* as the dependent variable. Column (2) uses the ratio of CEO’s equity-based to non-equity-based pay allocation as the dependent variable, where the accounting measure involved is EPS as in Column (1) of Table 6. We take the natural log of this ratio in our regression. Column (3) uses *Total_Comp* as the dependent variable. *Top5_shrout* is the five largest institutional investors’ ownership of the firm. *CumRet* is the annual buy-and-hold cumulative return for the firm. *Dol_Volat* is the dollar volatility of the firm’s stock. *Ln(MktCap)* is the natural log of the firm’s size. Δ *MktCap* is the first difference of the firm’s market capitalization between year *t* and year *t-1*. *DebtRatio* is the debt ratio of the firm. *TobinQ* is the firm’s Tobin’s *Q* measure. The lagged values of independent variables are used in the model, except Δ *MktCap*. *Total_Comp* is in thousands and CPI deflated (2006=100). We report t-statistics robust to heteroscedasticity for each estimate. The asterisks indicate statistical significance at the 1% (***), 5% (**), and 10% (*) levels.

	(1)	(2)	(3)
	PPS_Total	Rel_Weight	Total_Comp
Intercept	93.43758*** (17.21)	.3612124 (0.53)	-7053.87*** (-4.00)
Lag_TRA	-30.13814*** (-3.05)	1.168239** (2.38)	12067.47*** (9.15)
Lag_Top5_shrout	-47.9702*** (-7.69)	.1788189 (0.64)	2317.689*** (4.18)
Lag_CumRet	4.142925*** (3.67)	-.1599767*** (-3.10)	762.1282*** (5.96)
Lag_Dol_Volat	.0001347 (1.29)	.0000199*** (3.60)	.3689931*** (16.18)
Lag_Ln(MktCap)	-9.735977*** (-22.40)	-1.143698*** (-56.26)	1469.353*** (29.32)
Δ MktCap	0.0000426 (1.03)	2.34E-06 (0.97)	0.0444482*** (3.10)
Lag_ Δ MktCap	-0.0000362 (-0.81)	1.04E-06 (0.31)	0.0723439*** (4.96)
Lag_DebtRatio	-21.99232*** (-6.03)	.8055143*** (4.98)	1562.944*** (4.57)
Lag_TobinQ	4.936174*** (9.04)	.1798757*** (7.06)	-236.8952*** (-3.74)
Year effect	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes
(Pseudo) R-squared	0.0189	0.5479	0.4117
Observations	15048	6321	12701