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Performance-Based Compensation and Firm Value: Experimental Evidence

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Abstract

Motivated by research reporting positive price reactions to adoption of performance-based compensation plans, we examine price reactions to compensation contracting in experimental markets. The design allows us to manipulate variables separately and study issues of adverse selection (sorting) and moral hazard (incentives). We find that managers select contracts based on their private information, and that information is conveyed to the market by the choice of compensation contract and reflected in price. Additionally, we find that managers do not always exert costly effort in spite of favorable incentives to do so (shirking). As a result, the market is skeptical of incentive benefits. Thus, while we find evidence of overbidding in some treatments, we find that market prices are consistent with private information revelation but undervalue incentive benefits.

JEL Classifications: C92, D82, G12, J33, M52

Keywords: compensation, experimental markets, sorting, incentives

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INTRODUCTION

In an effort to maximize value for shareholders, firms seek to hire the most highly skilled managers and to motivate those managers to act in the best interest of shareholders. Properly structured compensation contracts are designed to attract and retain the most capable managers in a competitive managerial labor market, thus solving an adverse selection problem. In addition, pay contracts address the moral hazard problem by providing incentives that motivate those managers to maximize their effort on behalf of the firm. The consequence of a well-designed compensation contract should be to increase firm value. A limited amount of empirical research supports this claim (Brickley, et. al. [1985]; Tehranian and Waegelein [1985]). However, the specific reason for this increase in firm value is difficult to pinpoint empirically (Warner ([1985]; Scholes [1991]).

This manuscript reports the results of laboratory experiments designed to highlight the impact of management compensation contracts on equity value. Subjects performing the role of managers must choose from a menu of compensation plans and then select a level of costly effort to exert on behalf of the firm. Simultaneously, a second set of subjects trade the shares of the firm in an experimental stock market.

We find that the resulting stock prices reflect a manager's private information about the firm's future prospects. This information is revealed to the equity market participants by the manager's selection of a performance-based compensation plan. In the context of the experiment, the private information possessed by the manager can be interpreted as insight into the future prospects of the firm, or equivalently, as an endowment of superior managerial ability. Thus, the use of performance-based pay serves as an effective sorting mechanism designed to identify the most highly skilled and/or best informed managers. Moreover, the effect of this sorting is reflected in stock prices. At the same time, stock prices anticipate the manager's incentive to exert effort with a considerable amount of skepticism. That is, although the incentive effect of the compensation plan is reflected in prices, the market prices also anticipate shirking on the part of the manager.

BACKGROUND

Brickley, Bhagat and Lease (1985) and Tehranian and Waegelein (1985) present empirical evidence indicating that stock prices respond favorably to the adoption of, or changes to, performance-based executive compensation plans. They argue that these positive price responses suggest that the market responds favorably to the alignment of shareholder and management interests. However, Warner (1985) and Scholes (1991) argue that other factors may explain these results. Specifically, the positive returns may reflect management's private information about the future prospects of the firm, or a net gain due to an efficient income tax avoidance strategy.[1]

Some empirical evidence supports the hypothesis that performance-based compensation alters management's investment decisions in such a way as to increase shareholder wealth (Amihad and Lev [1981]; Larker[1983]). Core and Guay (2001) conclude that stock-based compensation plans are largely driven by concerns about incentive alignment. On the other hand, compensation plan adoption may be a signal that current management has private information that indicates future profits should be higher than previously expected and hopes to benefit from compensation that links pay to performance. Similarly, prices could also increase as a result of an improved ability to attract the best executives from the pool of talent available. Lazear (2004) suggests that performance-based pay may serve less as a motivational device and more as tool to screen effective managers. Oyer and Schaefer (2005) argue that stock-based

[1] Specifically, compensation plans may be designed as part of a comprehensive tax avoidance strategy in which both the manager and the firm benefit from lower income taxes (Miller and Scholes [1982]; Smith and Watts [1982]). This potential explanation for the design of compensation plans is not examined in our experiments.

compensation plans serve primarily to sort and retain more productive employees, while Chen and Leng (2004) present evidence indicating that the sensitivity of compensation to firm performance is consistent with this sorting hypothesis.

These competing explanations – incentive and sorting effects – are not mutually exclusive. As such, it is difficult to differentiate between them based solely on archival data. *Ex post* we might ask: is the firm's improved performance due to the CEO's hard work? Or, was she simply more talented or better informed about future prospects of the firm when she negotiated the compensation contract? *Ex ante*, we would like to be able to design compensation plans that would suggest an affirmative answer to both questions. Waller and Chow (1985) show that managers select among alternative compensation contracts based on ability and the correlation between ability and incentives. Cadsby, Song and Tapon (2007) found that pay-for-performance contracts result in higher performance through both sorting and incentive effects. They find that highly skilled managers are more likely to select performance-based pay contracts and that such contracts lead to greater productivity regardless of skill level. Nevertheless, the impact on firm value is inferred in these studies. Neither study examines the link between the managerial labor market and the stock market to determine if an increase in performance is correctly anticipated by traders and reflected in stock prices.

In the following sections, we present a laboratory experiment designed to address these questions. The unique contribution of this study is to determine which factor(s) – sorting, incentives, or both – have an impact on the value of the firm. Experimental methods allow us to isolate the effect of each factor on prices. Thus we hope to gain insights that may not be easily identified using other methods.

EXPERIMENTAL DESIGN

We examine a setting where a firm hires a manager to supply unobservable effort resulting in a dividend that is paid to the owner at the end of the period. We report all dividend and cost information in an experimental currency (lira). An overview of the multi-stage setting follows:

Step 1: the manager receives information about the liquidating dividend. The information signal takes the form $y \in \{y_l, y_h\}$ regarding the liquidating dividend $d \in \{100, 400, 1{,}000\}$. The *ex-ante* probability that $y=y_h$ is 1/2. If the signal is y_h then the dividend has an equal probability of being 400 or 1,000. Symmetrically, if the signal is y_l then the dividend has equal probability of being 100 or 400. This information signal can be interpreted as the manager's inside information about the future prospects for the firm. It can also be interpreted as an endowment of manager ability. That is, managers receiving the high signal are endowed with superior ability and use this ability to produce higher expected dividends.

Step 2: The manager then selects a compensation package from a menu of contracts. The manager is offered a linear compensation contract that includes a fixed salary component and a variable, performance-based component that is tied to the dividend. The contract takes the form $W_i(d) = \alpha_i + \lambda_i(d)$, $i \in \{s,b\}$, with the following parameters:

Label	Type of contract	Parameter Values	Contract
SALARY (*s*)	Fixed salary	$\alpha_s = 100$, $\lambda_s = 0$	$W_s(d) = 100$
BONUS (*b*)	Performance-based	$\alpha_b = 0$, $\lambda_b = 0.25$	$W_b(d) = 0.25d$

The parameters are chosen so that regardless of the manager's risk preferences, as long as she has positive utility for money, she has an incentive to reveal her private information about the dividend (y_h or y_l) through her choice of compensation contract. That is, the selection of the compensation contract should sort the managers based on the information signal received, independent of the level of effort subsequently exerted.[2]

Step 3: After the manager selects her compensation package, a market opens for sale of the firm (stock). In each round, each market participant (trader) is endowed with 1,000 lira. Traders are asked to submit a bid for the firm in a second-price auction. The trader submitting the highest bid wins the auction and is sold the one share of the firm. The transaction price is set equal to the second highest bid in the auction. Traders who lose the auction, keep their endowment. The trader who wins the auction becomes the owner of the firm and keeps his endowment less the price paid for the firm (the second highest bid). The owner of the firm is entitled to the dividend, but must pay the manager's compensation.

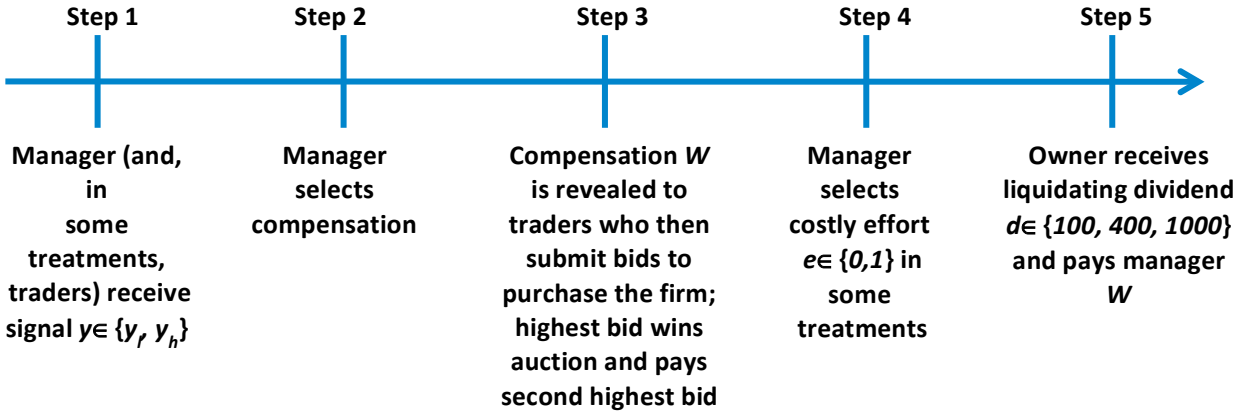
Step 4: In select treatments, after the market for the firm closes, the manager is given the opportunity to make a fixed payment in return for an increased likelihood of a higher dividend value. This decision is not revealed to the owner of the firm. This choice is designed to proxy for the manager's decision to exert personally-costly effort in order to increase the expected payoff to the firm. The effort choice is binary and the cost of effort is fixed at 30 lira when effort is chosen and zero otherwise. If effort is chosen, the highest dividend value that is feasible given the information signal is guaranteed. For example, if the manager sees the signal y_h and elects to exert costly effort, then the liquating dividend will be 1,000, but if the manager does not elect to exert effort, there is a 1/2 chance the liquidating dividend will be 400 and a 1/2 chance the dividend will be 1,000. While the owner would always prefer the manager to exert effort, it is in the manager's interest to exert effort only if the BONUS (performance-based) compensation plan is selected.[3]

Step 5: The liquidating dividend is drawn and realized. The manager is paid her compensation while the owner receives the dividend less the manager's compensation. The amount earned by a trader or a manager in any given round (including any unused endowment) is not available to use in subsequent rounds. These five steps are summarized in Figure 1.

[2] This is not the optimal contract obtained when a principal solves a programming problem that minimizes compensation subject to individual rationality and incentive compatibility constraints, though the contracts are structured to satisfy all such constraints. Specifically, the contracts provide an incentive for the manager to exert effort and reveal her private information about the dividend through the choice of the contract, but they do not maximize the owner's net payoff. In addition, the fixed salary ($W_s(d) = 100$) in the SALARY contract is akin to a reservation wage imposed by competition in a managerial labor market.

[3] While this design is rather simple, it was chosen to create a stark contrast between contracts in order to increase the power of statistical tests and highlight the impact on prices of the manager's compensation and effort choices.

Figure 1 – Experimental timeline



Treatments

We construct four experimental treatments in a 2-by-2 design by varying the privacy of the noisy signal and the ability of the manager to exert effort to increase the dividend. First we vary the information available to traders in the stock market. In the PRIVATE treatments, only the manager receives the information signal. Traders in the stock market see the manager's choice of compensation contract, but not the information signal. Thus the only information that the market has about the liquidating dividend is the manager's choice of compensation contract. In the PUBLIC treatments all parties see the signal and the compensation contract selected. Second, we vary the manager's opportunity to influence the expected dividend by exerting effort. In the EFFORT treatments, the manager is allowed to select an (unobservable) effort level that will increase the expected dividend, while in the NO-EFFORT condition, this option is not available.

PREDICTIONS AND HYPOTHESES

If we assume that the manager in this experiment strictly adheres to axioms of individual rationality and incentive compatibility, we can make the following predictions:

1. Managers receiving the high value of the noisy information signal (y_h) will select the BONUS compensation contract, while managers receiving the low value of the information signal (y_l) will select the SALARY compensation contract.
2. In the EFFORT treatment, managers will choose to exert costly effort after selecting the BONUS compensation contract, but not if the SALARY contract is selected.

Moreover, the choice of compensation contract or effort level should not differ between the PUBLIC and PRIVATE information treatments. These predictions allow us to compute the expected compensation to the manager conditional on the information signal, liquidating dividend, and the contract selected, as well as the expected payoff to the owner. These are presented in Table 1.

TABLE 1
Expected compensation and payoff conditional on contract choice and information signal

	Information signal	Predicted compensation contract	Expected compensation	Expected payoff to owner
NO-EFFORT Treatment	y_h	BONUS	175	525
	y_l	SALARY	100	150
EFFORT Treatment	y_h	BONUS	220*	750*
	y_l	SALARY	100	150

*Assumes that the manager elects to spend 30 lira to purchase (exert) effort which guarantees the highest possible dividend given the signal. If the effort is not selected, payoffs match the NO-EFFORT treatment.

The predictions deal with managers' choices of compensation contract given the information signal received, and their decisions about the level of effort to exert given the contract selected. Questions surrounding the use of performance-based compensation to sort and incentivize managers have been addressed extensively in the literature (for example, Waller and Chow [1985]; Cadsby, Song and Tapon [2007]) so these predictions are presented here for completeness. Our primary concern is how the market value of the firm is affected by the compensation arrangement with the manager and the information content of that arrangement. The expected payoffs to the owner, conditional on the information signal and the contract selected, should determine the price at which traders are willing to purchase the firm.

Our experimental design allows us to separate the effects of sorting and incentives to determine the effect of each on market prices. The first hypothesis, presented below in alternative form, addresses the question of sorting. The hypothesis will be supported if market participants infer that managers who select the BONUS contract received the high information signal (y_h) while those managers who select the SALARY contract received the low signal (y_l). If traders infer no information about the dividend from the contract selection, the prices should be (approximately) equal regardless of contract.

HYPOTHESIS 1: The market price of the firm will be greater whenever the manager chooses the BONUS compensation contract than when the SALARY contract is selected.

We vary the privacy of the information signal to determine if asymmetric information plays a significant role in the pricing of the firm. In the PUBLIC treatments, traders observe the signal directly and the contract is only relevant because it determines how much of the terminal dividend is paid as compensation to the manager. In the PRIVATE treatment, only the manager sees the information signal and the traders must infer information from the manager's contract selection. If the market accurately infers information about the signal from the contract selection, then prices should not differ between these two treatment conditions. Thus, our second hypothesis is presented in null form:

HYPOTHESIS 2: Market prices will not differ between the PUBLIC and PRIVATE information treatments.

The final hypothesis is concerned with the incentive effects of performance-based pay. If market participants anticipate that the manager will elect to incur the added cost of effort (thereby guaranteeing the highest possible dividend), then the market price should be higher in the EFFORT treatment than in the NO-EFFORT treatment whenever performance based compensation is selected by the manager. In alternative form:

HYPOTHESIS 3: The market price will be higher in the EFFORT treatment than in NO-EFFORT treatment, but only when the BONUS compensation contract is chosen and not when the SALARY contract is chosen.

Our experimental procedures and results are presented in the next section.

EXPERIMENTAL PROCEDURES AND RESULTS

The experiment was conducted at West-coast University in the United States. 180 subjects were recruited from a standard subject pool consisting primarily of undergraduate students. Subjects interacted with each other anonymously over a local computer network. The experiment was programmed and conducted using VB.net. The computers were placed within individual cubicles in such a way that each subject could only view his or her own computer screen. A subject participated either in the role of manager (labeled as "agent" to subjects) or as market participant ("trader") for the entire experiment. Managers and market participants where in separate rooms and were not allowed to communicate with each other except as designed by the experiment.

The experiments were conducted in eight sessions, each of which ran approximately seventy-five minutes. Each session consisted of 20 to 28 subjects. In each session, subjects were randomly divided by drawing lots into two groups (agents and traders) and the groups were assigned to separate rooms. None of the subjects knew anything about the experiment or his or her role prior to hearing the instructions. Once the subjects were assigned to their respective rooms, the experiment began, sequenced as follows:

1. The instructions were projected overhead and accompanied by prerecorded narration. Both groups of subjects received the same instructions. The instructions explained the experimental procedures, payoffs, and information structures used in the experiment. (The instructions are available upon request.) After completing the instructions, subjects were asked to answers several mutliple choice questions (also available in the appendix) to ensure that they understood the instructions. The subject's answers to these questions remained confidential, but those subjects responding with incorrect answers were prompted to repeat the question until the correct answer was selected. During and after the reading of the instructions, subjects were prompted to ask the experimenter in private any questions regarding the experiment procedures.
2. In each experimental session, subjects were asked to repeat the experiment twenty times (or twenty consecutive rounds). In each round, each manager (agent) was assigned to a group of three traders representing one market. This assignment was both random and blind. That is, in each round, the group of traders making up a market remained the same, but the agent assigned to that market was randomly reassigned each round. Moreover, the the identity of the agent assigned to a market in any given round was never revealed to the traders in order to minimize the possibility that an individual manager might develop a reputation. None of the participants were told the total number of traders or agents participating in the experiment or the number of the market groupings.
3. At the conclusion of the experiment, each participant individually signed and dated a payment receipt form and received payment. Traders were paid \$1 for every 1,000 lira earned. Managers were paid \$1 for every 150 lira for the EFFORT treatments, and \$1 for every 125 lira in the NO-EFFORT treatments. On average subjects earned \$20, and total earnings ranged from \$16.80 to \$24.40. Each subject was paid a \$7 participation fee in addition to the amount they earned during the twenty rounds.

Manager Contract Choices[4]

In Table 2, we report the mean frequency with which managers selected the BONUS contract conditional on the information signal received.[5] We predict that when a manager receives the high value

[4] We do not find any significant difference in manager behavior between sessions of the same treatment, and thus report the combined results.

[5] Each experiment session lasted twenty rounds and, in each round, each manager received an information signal. In each session, each manager received ten high signals (yh) and ten low signals (yl). Thus, we calculate two

of the noisy information signal (y_h), she will select the BONUS compensation contract, while the low value of the information signal (y_l) will lead the same manager to select the SALARY compensation contract. Overall managers' contract choices of are consistent with these predictions.[6] We do note that the contract selection inconsistencies were asymmetric. Managers were more likely to select the BONUS contract after receiving the low information signal than they were to select the SALARY contract given the high signal.

TABLE 2
Mean Frequency (Standard Error) of Managers Selecting the BONUS Contract by Treatment

	NO-EFFORT		EFFORT	
Information signal:	Low (y_l)	High (y_h)	Low (y_l)	High (y_h)
PRIVATE	0.07 (0.02)	0.98 (0.01)	0.08 (0.02)	0.98 (0.01)
PUBLIC	0.12 (0.03)	0.95 (0.02)	0.19 (0.03)	0.96 (0.02)

Interestingly the contract selection inconsistency is higher when information is PUBLIC. That is, managers are more likely to select the wrong contract in the PUBLIC treatment than in the PRIVATE treatment in all comparisons. This difference is especially noteworthy when the information signal value is low (y_l). In the PUBLIC treatments, managers selected the BONUS contract despite receiving the low signal (y_l) in 12 percent of the cases in the NO-EFFORT treatment and 19 percent of the time in the EFFORT treatment.[7]

We also predicted that managers would exert costly effort whenever the BONUS contract was selected, but not when they chose SALARY (prediction 2). In Table 3 we report the mean (standard error) of the frequency in which managers chose to exert costly effort given each type of contract. The reported frequencies are consistent with our prediction in that most managers chose the extra effort when the BONUS contract was selected, but rarely choose extra effort when the SALARY contract is selected. Yet, even though managers should always choose the extra effort if the BONUS contract is selected, the incidence of shirking is surprisingly high. Managers chose not to exert effort 35 percent of the time when the information signal was PRIVATE and 26 percent when the information was PUBLIC. Nevertheless, managers were much more likely to choose effort when the BONUS contract was selected than when the contract paid a fixed SALARY.[8] Furthermore, while the incidence of shirking was lower in the PUBLIC treatment, these differences between the PUBLIC and PRIVATE conditions are not statistically significant.

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frequencies for each manager conditional on the signal received. The means (standard errors) reported in Table 1 are mean frequencies (standard errors) calculated across managers.

6 We used a Wilcoxon, matched-pairs, signed-ranks test to test for a difference in this frequency between the high and low signal in each treatment. In all cases, the difference is statistically significant ($p < 0.01$, $N = 49$).

[7] However, the difference between PUBLIC and PRIVATE treatments was statistically significant in only one of these comparisons. BONUS is selected with a frequency of 0.19 when the information signal is PUBLIC, and 0.08 when the information is PRIVATE. In this one instance, the difference in mean selection frequency between the PUBLIC and PRIVATE conditions is significant (two-sample Wilcoxon rank-sum (Mann-Whitney) test, $p = 0.023$, $N = 26$).

[8] Wilcoxon matched-pairs signed-ranks test, $p < 0.01$, $N= 26$.

TABLE 3
Mean Frequency (Standard Error) of Managers Choosing to Exert Effort Conditional on Contract Selected

	SALARY	BONUS
PRIVATE	0.01	0.65
	(0.01)	(0.04)
PUBLIC	0.07	0.74
	(0.02)	(0.03)

Our predictions regarding contract choice are robust to differences in managers' risk preferences. That is, given the design of the compensation contracts offered in the experiments, risk-averse, risk-neutral and risk-seeking managers are all expected to choose the same contract conditional on the information signal received. However, once a contract is selected, the decision to expend additional effort may depend on the manager's risk preferences. When additional effort is selected, the manager's expected (net) compensation increases and its uncertainty decreases. Thus, a risk-seeking manager may prefer uncertain compensation over the guaranteed compensation that is paid if effort is exerted, even though choosing to exert effort leads to a higher net expected payoff. A frequency distribution of manager choices reveals that the mode was to always choose effort and most managers chose effort more often than not. Nevertheless, almost 30% of managers chose effort in less than one half of the situations when BONUS was selected.

Market Prices

Assuming risk-neutral traders, the market price for the firm should equal the expected value of the liquidating dividend net of the compensation paid to the manager. This expected value depends on traders' perceptions about the manager's choices regarding the compensation contract and the decision to exert effort when appropriate. If the manager is an expected-value maximizer, then she should always choose SALARY when the information signal is low (y_l) and BONUS when the signal is high (y_h). In addition, whenever the BONUS contract is selected, the manager should choose to exert costly effort to increase the expected payoff in the EFFORT treatments. If the traders believe that managers consistently act as expected value maximizers, then we would expect to see market prices equal to the expected values presented in Table 1.

From the experimental data, we calculate the average winning price, conditional on the compensation contract selected.[9] Table 4 presents the mean price and standard error by treatment, conditional on contract selected and, in the PUBLIC treatments, informational signal received. Our first hypothesis states that, in PRIVATE information treatments, the average price should be higher when the BONUS contract is selected by the manager relative to prices when the SALARY contract is chosen. As predicted, prices are consistently higher in those markets in which the manager selects the BONUS contract. This is true whether or not the manager has the option to exert additional effort. We compare average prices using a Wilcoxon signed-rank test and find support for Hypothesis 1 in both the EFFORT and NO-EFFORT treatments ($p<0.01$, N=49).

In PRIVATE information treatments, the contract selection determines how the manager is compensated and may convey information to the market about the expected dividend. In PUBLIC signal treatments, the contract selection does not convey information about the dividend and the price should be determined by which dividend signal (y_l or y_h) is revealed. Nevertheless, the contract selection is highly correlated with the signal and also affects the amount of compensation paid to the manager. Consequently, in the PUBLIC treatment, the market price should depend on both the signal and the contract. These prices will differ from predicted values whenever the manager's contract choice is not

[9] We also ran tests on the average bid rather than the winning bid. However, the results were substantively the same as those presented and have been omitted here. These results are available upon request.

consistent with the reported information signal. This occurs on approximately 16 percent of the cases (see Table 2) and reduces the power of statistical tests when these observations are included. Nevertheless, we find that prices in the PUBLIC treatments are higher when the manager selects the BONUS contract than when SALARY is selected ($p<0.01$, N=49, Wilcoxon signed-rank test).

TABLE 4
Mean Prices by Treatment Conditional on Contract Choice or Information Signal

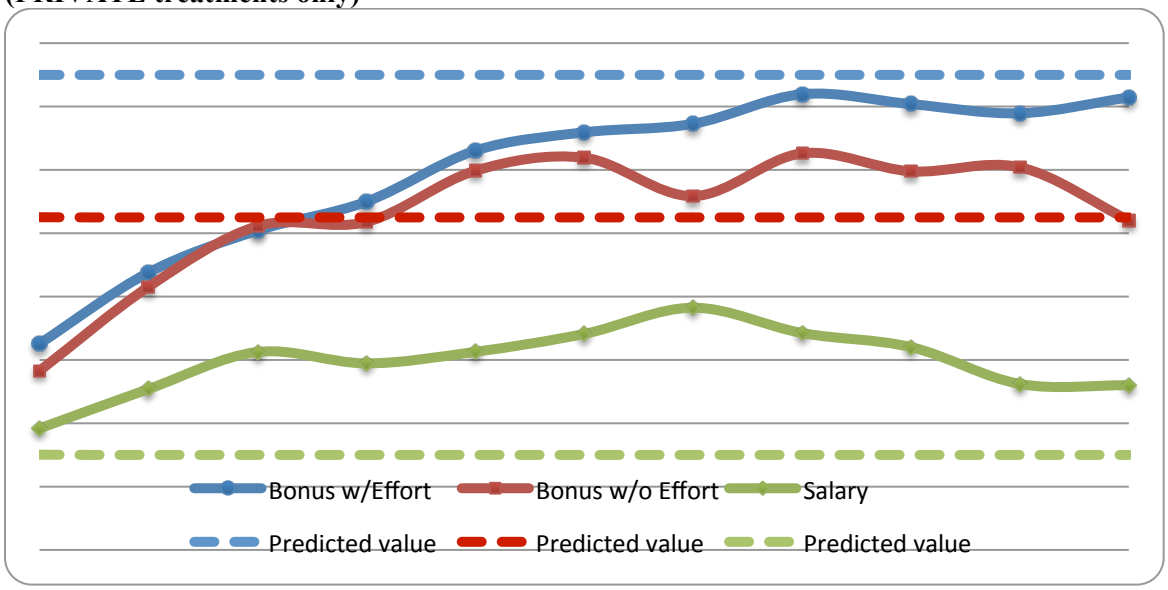
PRIVATE	NO-EFFORT		EFFORT	
Contract selection:	SALARY	BONUS	SALARY	BONUS
Mean price (Standard error)	342.66 (22.47)	533.22 (23.57)	261.02 (20.93)	593.66 (18.11)
PUBLIC	**NO-EFFORT**		**EFFORT**	
Contract selection:	SALARY	BONUS	SALARY	BONUS
Mean price (Standard error)	296.88 (19.56)	582.87 (21.21)	280.74 (20.35)	627.70 (18.93)
Information signal:	Low (y_l)	High (y_h)	Low (y_l)	High (y_h)
Mean price (Standard error)	267.85 (15.81)	632.70 (18.96)	283.94 (18.20)	676.42 (17.63)

In Figure 2, we plot the average price, sequenced over time, conditional on contract choice. We designed the experiment so that each manager sees 10 low signals and 10 high signals (randomly sequenced) during the course of each 20 round session. As a result, each market (group of traders) sees the manager select each contract type (SALARY or BONUS) approximately 10 times during the experimental session.[10]

We observe consistent over-pricing of the firm, relative to the expectations presented in Table 1, when managers choose the SALARY contract. Also, in the EFFORT treatment, prices are lower than expected when the BONUS contract is selected. Comparing mean prices in the EFFORT treatment to those in the NO-EFFORT treatment, we do not see significant differences in prices using the Wilcoxon ranked sum test. This is to be expected when SALARY is selected by the manager ($p=0.2975$, N=49). However, when BONUS is chosen, we predicted a difference in market value reflecting the effects of exerted effort. Nevertheless, the difference is only marginally significant ($p=0.0813$, N=49). Consequently, these univariate statistical tests provide only weak support, at best, for hypothesis 2.

[10] The price plots present the time series of average prices for a given contract choice. The first observation in each sequence represents the average market price for the first time a group of traders observed that particular contract, not necessarily the first round of trading.

Figure 2 – Plot of average market prices sequenced over time, conditional on contract choice (PRIVATE treatments only)



Regression Analysis of Market Prices

To further understand the prices we observed in the experimental asset markets, we regress the observed market prices on a series of dummy variables using generalized least-squares random effects models grouped by market with errors clustered by experimental session. The models include two or four independent dummy variables that are described in Table 5.

TABLE 5
Description of Independent Variables Used in Regression Models

Variable	Description	Frequency by treatment: PRIVATE Only	Frequency by treatment: PRIVATE & PUBLIC
BONUS	1 if BONUS contract selected, 0 if SALARY selected	251	490
EFFORT	1 if BONUS selected *and* EFFORT treatment, 0 if SALARY selected *or* NO-EFFORT treatment	126	260
PUBLIC/S	1 if PUBLIC signal treatment *and* SALARY contract selected, 0 otherwise	0	210
PUBLIC/B	1 if PUBLIC signal treatment *and* BONUS contract selected, 0 otherwise	0	239
Total observations used		480	929
Omitted observations:			
	PUBLIC treatment *and* SALARY selected given y_h		11
	PUBLIC treatment *and* BONUS selected given y_l		40
Total observations		480	980

We first examine prices from the PRIVATE treatments. In these 24 markets (480 price observations), traders did not receive information about the expected dividend and had to base their bids on information inferred from the manager's choice of compensation contract. Table 6 presents the results of the first regression model. We estimated the model using prices from all twenty rounds and then re-ran the model using rounds 1 – 10 and 11 – 20 separately to determine if the coefficients changed as the

experiment progressed. The results show that the constant β_0, is about twice as high as predicted. This is consistent with the earlier results indicating that the auction price is too high when the manager selects the SALARY contract. When the manager selects the BONUS contract, we expect to see a price premium of 375 (from Table 1, 525 – 150 = 375). The observed premium, as measured by β_1, is statistically significant, but considerably lower than this predicted value. This is partially explained by the high value for β_0. The sum of β_0 and β_1, equals the estimated market price when the manager selects the BONUS contract. For the model estimated using all twenty rounds, the regression indicates a price of 300.9 + 200.9 = 501.8. When rounds 1-10 are used to estimate the model, we get a price of 270.1 + 161.6 = 431.7; in rounds 11-20, the resulting price is 330.1 + 242.6 = 572.7. When compared to the predicted price of 525 these results suggest that, overall, traders undervalued the firm when the manager selected BONUS, but they overbid in the later rounds. The statistical significance of this price premium supports hypothesis 1 which argues that the price should be higher when BONUS contract is selected by managers.

TABLE 6

Results of Random Effects GLS Regression of Price on Dummy Variables
(PRIVATE treatments only)
Price = $\beta_0 + \beta_1 BONUS + \beta_2 EFFORT$
(Robust standard errors in parentheses; **p<.01; *p<.05)

Variable	Coefficient	Description	Predicted value	All Rounds	Rounds 1 - 10	Rounds 11 - 20
Constant	β_0	Price if SALARY selected	150	300.9** (31.2)	270.1** (29.1)	330.1** (47.3)
BONUS	β_1	Premium if BONUS selected	375	200.9** (10.4)	161.6** (6.2)	242.6** (23.8)
EFFORT	β_2	Premium if EFFORT available	225	125.3* (62.9)	104.3** (26.8)	150.5 (96.2)
		Number of observations		480	240	240
		Number of groups		24	24	24
		Adj. R-square		0.235	0.156	0.355
		Wald Chi-square		370.7**	688.3**	108.99**

The coefficient β_2 estimates the premium paid if the market expects the manager to exert effort given the incentive to do so. The predicted premium is 225 (from Table 1, 750 – 525 = 225) in the EFFORT treatment whenever the BONUS contract is selected. This coefficient is significantly positive overall and in rounds 1-10, but, at it is still well below the predicted value of 225. In rounds 11-20, the coefficient is higher, but not statistically significant. Hypothesis 2 suggests that there should be a price premium in the EFFORT treatments if BONUS is selected, because the manager has an incentive to exert extra effort thus increasing the expected dividend. We find some support for this hypothesis, but overall this support is not strong.

In Table 6, the dependent variable in the regression is price. This model is sufficient to test hypothesis 1 which states that the price should be higher when the manager selects the BONUS contract than when SALARY is chosen. In this formulation, we can reject the null hypothesis of "no difference" by observing that the value of the coefficient β_1 is significantly greater than 0. However, we also observed that the prices were not equal to the expected values presented in Table 1.

We estimated a second regression model with the price difference as the dependent variable. Here, price difference is defined as the observed price minus the theoretical price that would be expected under the null hypothesis. For example, if the manager selects the SALARY contract and traders infer no

information about the dividend from that choice (the null hypothesis) then the expected price would be 375. The alternative hypothesis is that traders infer the manager's private information about the dividend from her contract choice, in which case the price would be 150. Thus, 375 is the expected value used to calculate the price difference and the null hypothesis is that the price difference is zero. The alternative in this case is that the price difference is negative.

Table 7 presents the results of this second regression. The constant, β_0, measures the extent to which prices reflect private information when SALARY is selected. This coefficient is significantly negative overall and in rounds 1-10. However, in rounds 11-20, the constant is negative but not significantly different from 0, suggesting that very little information is inferred by traders from managers' choice of the SALARY contract. On the other hand, if BONUS is selected, the expected price is 575 under the alternative hypothesis. Thus we expect the coefficient β_1 to be positive. β_1 is positive and statistically significant in all periods. These results suggest that the manager's private information about the dividend was more accurately reflected in prices when the manager selected the BONUS contract than when the SALARY contract was chosen.

TABLE 7

Results of Random Effects GLS Regression of Price Differences on Dummy Variables
(PRIVATE treatments only; Price difference = price less expected price given null hypothesis)
Price Difference = $\beta_0 + \beta_1 BONUS + \beta_2 EFFORT$
(Robust standard errors in parentheses; **p<.01; *p<.05)

Variable	Coefficient	Description	Predicted sign	All Rounds	Rounds 1 - 10	Rounds 11 - 20
Constant	β_0	Price difference relative to the null hypothesis if SALARY is selected	–	-74.1** (31.2)	-104.9** (29.1)	-44.9 (47.3)
BONUS	β_1	Price difference relative to the null hypothesis if BONUS is selected	+	219.3** (10.4)	180.1** (6.2)	261.1** (23.8)
EFFORT	β_2	Price premium paid if EFFORT choice is available	+	125.3* (62.9)	104.3** (26.8)	150.5 (96.2)
		Number of observations		480	240	240
		Number of groups		24	24	24
		Adj. R-square		0.261	0.181	0.380
		Wald Chi-square		442.3**	854.3**	125.7**

Discussion

There are at least three reasons why we may see prices that differ from the predicted values. First, using expected net dividends as the predicted price assumes that traders are risk-neutral. We did not test for subjects' risk preferences and these preferences can affect prices in experimental markets if a sufficient portion of the traders behave as if they are risk-averse or risk-seeking. However, risk preference alone is unlikely to explain the magnitude of difference between observed and predicted prices.

Second, we used a second-price auction to determine market prices. One advantage of a second-price auction is that it tends to reduce the effect of the "winner's curse" on prices. We found that inexperienced subjects tended to overbid, perhaps due to the mistaken belief that overbidding is costless since they are not required to pay the amount bid, but pay the second highest bid, if their bid wins the auction. Markets tend to discipline such overbidding behavior; traders who pay more than the expected net dividend will lose money and (presumably) learn from their losses. Yet it is unclear from these

experiments how much experience is necessary before this market discipline fully kicks in. We found that prices were more reasonable on average in later rounds, suggesting that some learning had taken place, but the variance was high. Future research could use more experienced subjects (subjects with prior experience trading in the type of auction employed).

A third explanation for observed prices is that traders interpret managers' decisions with a dose of skepticism. Price predictions are based on the assumption that the managers' choice of compensation contract will convey information to traders in the PRIVATE treatment. However, this can only be true if traders believe that managers are selecting contracts consistent with the information signal received. If the traders are skeptical of the manager's announced selection, then the selection will serve as a noisy information signal in the PRIVATE treatments, while in the PUBLIC treatments, traders observe the signal directly and such skepticism is unnecessary. In other words, predicted prices will differ from those presented in Table 1 if traders assume that managers make contract choices with some error or if they suspect that managers avoid exerting extra effort when the incentive to do so is provided (shirking).

To illustrate, assume that traders believe that managers in the EFFORT treatment will choose to exert effort only 70 percent of the time when BONUS is selected, which is approximately what we observed in Table 3. With this assumption, the expected net dividend drops from 750 to 682.5. This may explain why traders were reluctant to pay a significant premium in the EFFORT treatment.

As an extreme example, if traders in the NO-EFFORT treatment believe that managers randomly choose among compensation contracts, the choice of contract would not convey any information at all about the dividend. The expected price would be 375 if SALARY is selected and 356.25 if BONUS is selected, the difference being solely determined by the amount of compensation paid to the manager. Even if choices are not completely random, skepticism about the managers' choices would lead to higher than expected prices if SALARY is selected by the manager, and lower than expected prices if BONUS is chosen.

As a test for skepticism, we ran a price regression in which we pooled the observations in the PRIVATE and PUBLIC treatments. Because skepticism is inconsistent with the PUBLIC information treatment, we added two variables that capture the difference between the PRIVATE and PUBLIC treatments. If skepticism is affecting prices in the PRIVATE treatments, we expect that prices PUBLIC treatments would be lower when the SALARY contract is chosen and higher when the BONUS contract is selected.

The results are presented in Table 8.[11] For the SALARY contract, the coefficients were negative in rounds 11-20 and overall, but not significant, suggesting no difference between the PUBLIC and PRIVATE treatments when this contract is selected. However, for the BONUS contract, the coefficients are positive and significant in rounds 1-10 and overall, which indicates some difference between treatments. The remaining coefficients are consistent with earlier results presented in Table 6.

Skepticism appears to partially explain the unexpected difference between prices in the PUBLIC and PRIVATE treatments. Recall that contract selection inconsistencies were asymmetric. Managers

[11] In the PUBLIC information treatment, traders observe both the information signal (y_l or y_h) and the contract choice and both observables affect price. When the contract selected is not consistent with the observed information signal, the expected price should differ from the predictions presented in Table 1. For example, if the signal is y_h, indicating that the dividend is either 400 or 1000, and the manager chooses SALARY the expected dividend net of compensation is 600 [(400 + 1000)/2 – 100]. However, if the signal is y_l and SALARY is selected, the price is 150. Although observable inconsistencies occurred in only 51 of 980 observations (see Table 5) the impact on expected prices is large enough to affect hypothesis tests. In Table 8, we omit these 51 observations, leaving 929 observations. We also estimated a regression model with control variables to control for observable inconsistencies using all 980 observations. These results, which are not materially different from those presented, are available from the authors upon request.

were more likely to select the BONUS contract after receiving the low dividend signal than they were to select the SALARY contract given the high signal. It is useful to view this asymmetry from the perspective of the traders, who only see the contract selection. The choice of contract by the manager is a noisy source of information about the expected dividend. The data indicates that the BONUS contract selection is more likely to be inconsistent with the signal, and thus is a less reliable message about expected dividends than is the SALARY choice. When we compared the prices in the PRIVATE treatments to those in the PUBLIC treatments we found that prices were lower in the PRIVATE treatments when BONUS was selected but not significantly different when SALARY was chosen. This evidence is consistent with traders being more skeptical about managers who chose BONUS than with those who chose SALARY.

TABLE 8
Results of Random Effects GLS Regression of Price on Dummy Variables
(PRIVATE and PUBLIC treatments)
Price = $\beta_0 + \beta_1 BONUS + \beta_2 EFFORT + \beta_3 PUBLIC/S + \beta_4 PUBLIC/B$
(Robust standard errors in parentheses; **p<.01; *p<.05)

Variable	Coefficient	Description	Predicted Sign	All Rounds	Rounds 1 - 10	Rounds 11 - 20
Constant	β_0	Price if SALARY selected	+	300.9** (29.0)	270.6** (27.0)	329.9** (43.9)
BONUS	β_1	Premium if BONUS selected	+	217.0** (28.0)	184.1** (29.7)	253.7** (34.8)
EFFORT	β_2	Premium if EFFORT available	+	92.8* (42.7)	58.4 (44.7)	128.6* (49.6)
PUBLIC/S	β_3	Effect of PUBLIC information signal on price when SALARY contract is selected	–	-30.2 (30.4)	14.9 (31.6)	-76.6 (45.9)
PUBLIC/B	β_4	Effect of PUBLIC information signal on price when BONUS contract is selected	+	90.5* (40.6)	127.6* (53.1)	48.8 (36.6)
		Number of observations		929	458	471
		Number of groups		49	49	49
		Adj. R-square		0.369	0.268	0.518
		Wald Chi-square		515.9**	454.9**	319.5**

CONCLUSION

Performance-based compensation contracts are designed to attract and retain the most capable managers in a competitive managerial labor market, and provide incentives that motivate those managers to maximize their effort on behalf of the firm. Empirical evidence indicates that these compensation plans are associated with increased stock prices. Yet it is heretofore unclear whether the compensation plan leads to higher stock prices (due to incentive effects) or the expectation of higher stock prices leads the firm to hire and retain managers who prefer performance based compensation (sorting). We conducted experiments that were designed to separate these two explanations.

Our results indicate that managers' private information about future dividends is (imperfectly) conveyed to market traders by the selection of a compensation contract. Traders in our experimental stock market paid a premium for the firm when the manager agreed to a compensation arrangement that was performance-based. We find an additional, though less significant, price premium in the EFFORT treatments. Because managers do not always choose to exert additional effort despite favorable incentives to do so (shirking) traders appear to be somewhat skeptical of incentive benefits as reflected in market prices. Hence, our results provide stronger support for the sorting hypothesis than for the incentive explanation.

Most of the research in management compensation assumes an owner who negotiates with a potential manager, or examines the manager's behavior after the contract is established. In this paper, we focused on the effect that the choice of compensation contract (and the message that this choice sends about the manager's skill, private information, and motivation) has on market prices. Future research should examine the link between compensation contracts that are a function of market prices and the value of the firm. When compensation contracts depend on stock prices, the sequence of events is critical. For example, if the compensation contract includes stock options or stock appreciation rights, the exercise price is typically set at the closing price on the grant date. However, if market participants know about the stock option plan before the grant date (as they typically do) then the price on the grant date may already reflect the effects of anticipated sorting and incentives on the manager's behavior. As the resulting exercise price increases in anticipation of the incentives, the potential influence of the incentives on the manager's behavior decreases. Moreover, a rational manager should be aware that this is the case and behave accordingly when selecting (agreeing to) a contract. This strategic behavior by both the manager and the market participants would be an interesting extension of this study.

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