Empire-Builders and Shirkers:
Investment, Firm Performance, and Managerial Incentives

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Abstract: We consider the equilibrium relationships between incentives from compensation, investment, and firm performance. In an optimal contracting model, we show that the relationship between firm performance and managerial incentives, in isolation, is insufficient to identify whether managers have private benefits of investment, as in theories of managerial entrenchment. We estimate the joint relationships between incentives and firm performance *and* between incentives and investment. We provide new results showing that investment is increasing in incentives. Further, in contrast to previous studies, we find that firm performance is increasing in incentives at all levels of incentives. Taken together, these results are inconsistent with theories of overinvestment based on managers having private benefits of investment. These results are consistent with managers having private costs of investment and, more generally, models of underinvestment.

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1. Introduction

How do managers choose the level of corporate investment? We consider how agency problems impact the investment decisions of managers. Agency problems could lead managers either to overinvest or underinvest. For example, Jensen (1986, 1993) argues that managers take wasteful, negative net present value investment projects because they derive private benefits from controlling more assets. This is overinvestment or empire-building. Alternatively, managers may forego some positive net present value investment projects because additional investments impose private costs on them. Because managers in general prefer to work less (i.e., they are inclined to shirk), and investing requires them to spend more time overseeing the firm's activities, managers will underinvest. These two agency problems provide very different characterizations of firm behavior.

Shareholders must find ways to alleviate these agency problems, since both private benefits and private costs ultimately reduce firm value. A natural way to do so is through the optimal provision of incentives through compensation to managers. We provide a flexible and tractable principal-agent model for analyzing the relationship between incentives, investment, and firm performance. We show that optimal incentive contracts can mitigate over- and underinvestment problems. The model delivers clear, testable implications that can help identify whether managers have private benefits or private costs of investment.

In our model, managers choose the level of investment. The first case we consider is that managers derive private benefits from investment, so that their utility is increasing in the level of investment. Managers are empire-builders and continue to choose investment projects even after all positive net present value investments have been taken. The second case is that investment is costly for managers. For example, the disutility of investment may come from bearing oversight responsibilities for that investment. In general, when firms expand existing facilities or start new product lines, managers are required to do more work–there is simply more activity to manage. If managers have private costs, they will forego some positive net present value investments in order to lessen the amount of work that they have to do. Given these assumptions, managers will overinvest in the first case and underinvest in the second case.

The optimal incentive contract for the manager ameliorates the over- or underinvestment problem. We show how the optimal contract depends on the manager's risk aversion, the variance of firm performance, the productivity of investment, and the magnitude of the private benefits or costs associated with investment, as well as other potential agency problems in the firm. In our model, changes in incentives, investment, and firm performance are all endogenous responses to changes in these underlying exogenous variables. This endogeneity plays a central role in our empirical work, where we estimate how performance and investment vary with changes in incentives, taking into consideration the changes in the underlying exogenous parameters.

In our model, we assume that the firm has sufficient funds to undertake all investment projects selected by the managers. In this sense, the firm is potentially subject to a free cash flow problem. Other studies have noted that debt, dividends, hostile takeovers, product and factor market competition, and board intervention are mechanisms that could be used to overcome a free cash flow problem. Compared to these other mechanisms, incentives can be adjusted frequently and inexpensively, and, when adjusted, they can be targeted precisely for the managers. Incentives from compensation should be the primary mechanism to influence managerial behavior.

Our results highlight the importance of investment. In order to differentiate between over- and underinvestment, we need to examine how both investment and firm performance respond to changes in incentives *in equilibrium*. An important implication of our model is that the existing evidence of overinvestment is not, in fact, sufficient to identify the agency problem as one of overinvestment. In a seminal paper, Morck, Shleifer, and Vishny (1988) find that over a range of incentives, firm performance is declining in incentives. They argue that this is because managers make investment decisions that serve to entrench them in their jobs (see also Shleifer and Vishny (1989)). As a result, firms are overinvesting. However, we show that a finding that firm performance is declining in incentives does not imply that firms are overinvesting. Such a finding can also be consistent with firms that are underinvesting.

In order to identify whether the agency problem is one of over- or underinvestment, we need to examine the relationship between investment and incentives in addition to the relationship between firm performance and incentives. In general, it is not possible to infer the nature of agency problems from the relationship between changes in firm performance and changes in corporate governance mechanisms–takeovers, board size, capital structure, dividend policy, and incentives. One must also examine the relationship between changes in corporate governance mechanisms and the actions taken by managers, such as investment decisions. Controlling for the productivity of investment, if investment and firm performance both increase or both decrease in incentives, this supports the private costs model and rejects the private benefits model. If instead investment and firm performance move in opposite directions with changes in incentives, this supports the private benefits model and rejects the private costs model.

We test our model using data on managerial incentives from Standard and Poor's ExecuComp dataset. ExecuComp collects comprehensive data for the top five executives (ranked annually by salary and bonus) from the S&P 500, S&P MidCap 400, and S&P SmallCap 600 companies from 1993 to 2001. We use investment and firm performance data from Compustat.

Empirically, we have two main findings. First, in contrast to the previous literature, we find that firm performance is increasing in incentives for all levels of incentives. This result is in contrast to the results in studies such as Morck, Shleifer, and Vishny (1988) and Himmelberg, Hubbard, and Palia (1999), which do not find a monotonically increasing relationship between performance and incentives. Second, previous studies of the relationship between firm performance and incentives have not examined the relationship between incentives and investment. We do so and estimate that investment is increasing in incentives. These two results jointly imply that agency concerns do not lead firms to overinvest. Instead, these findings are consistent with the presence of underinvestment that is mitigated through the use of optimal incentive contracts. These findings are robust to the inclusion of firm-level fixed effects and controls for other factors that could affect the level of investment and firm performance, such as capital structure, dividend policy, and firm size. Our results also suggest that the underlying sources of variation within and across firms are the variance of firm returns, managerial risk aversion, or some other source of agency problems unrelated to investment. We find no support for models based on private benefits of investment. Intuitively, it is hard to support an overinvestment problem due to agency concerns if greater incentives are associated with better firm performance *and* higher investment.

The remainder of the paper is organized as follows. In Section 2, we discuss related literature. In Section 3, we present the principal-agent model in which managers have either private benefits or costs of investment. In Section 4, we describe our data on incentives, firm performance, and investment. The econometric results are presented in Section 5. Section 6 concludes.

2. Related Literature

The idea that firms systematically overinvest originated with Jensen (1986), who argues that shareholders must find mechanisms to induce managers to disgorge free cash flow rather than to overinvest. Jensen focuses on the use of debt and dividends to force managers to pay out free cash flow and considers board monitoring and the threat of takeover as disciplinary devices to curtail overinvestment. A number of authors, including Stulz (1990), Chang (1993), Hart and Moore (1995), and Zwiebel (1996), have formalized Jensen's argument.

In this paper, we focus on the use of incentives from compensation or ownership to curtail agency behavior. We control directly for the use of debt and dividends in our empirical work. We note that mechanisms such as takeovers and board intervention require substantial, disruptive change whereas changing incentives through compensation does not. Given the relative ease with which incentives from compensation can be adjusted, the compensation contract is the natural mechanism to alleviate agency problems such as over- and underinvestment. Additionally, as discussed in Shleifer and Vishny (1997), there is evidence to suggest that these alternative mechanisms do not constrain managerial behavior. Bertrand and Mullainathan (1998) show that takeover activity has decreased markedly in response to antitakeover legislation. They also show that compensation incentives have partially offset the reduction in incentives from takeovers. Jensen (1993) and Yermack (1996) suggest that boards, and in particular larger boards, are ineffective at raising firm value.

The relationship between firm performance and managerial ownership has been used in previous work to support the overinvestment model. Morck, Shleifer, and Vishny (1988) estimate a piecewise linear relationship between managerial ownership and firm performance. They find that firm performance is increasing in ownership for ownership levels below 5 percent or over 25 percent but decreasing in ownership for ownership levels between 5 and 25 percent of the firm. They interpret their result as evidence that managers make investment decisions that entrench them in their positions for ownership in this range. As a result of entrenchment, firm performance is lower. Many subsequent papers (McConnell and Servaes (1990), Himmelberg, Hubbard, and Palia (1999), and Palia (2001)) have conducted similar analyses, with mixed results.

Other support for overinvestment comes from Jensen (1993), who provides illustrative calculations of the destruction of shareholder value at a number of the world's largest corporations. He argues that these firms would have generated much more value had they returned cash to their shareholders rather than invested in projects that turned out to be negative net present value. Kaplan (1989) analyzes changes in firm value, profitability and capital expenditures in a sample of seventy-six management buyouts at large public companies. He argues that management buyouts result in improved incentives. His results show that profitability increases and capital expenditures decrease after the buyouts. Other evidence of overinvestment is anecdotal in nature. For example, Burrough and Helyar (1990, p. 95) describe how managers at RJR Nabisco squandered shareholders' cash on corporate jet rides for dogs and celebrity golf tournaments.[1] In this paper, we examine the arguments for overinvestment both theoretically and empirically.

In addition, a number of models predict that firms will underinvest. Reasons for underinvestment include high leverage (Myers (1977)), dividend signaling (Miller and Rock (1985)), and more general asymmetric information between firms and capital markets (Myers and Majluf (1984)). Our underinvestment model is based on principal-agent considerations–investing may be personally costly for managers because managers have to oversee the investments that their firms make.

Existing empirical support for underinvestment comes from several sources. McConnell and Muscarella (1985) show that firm stock prices react positively to announcements of increases in capital expenditures. Poterba and Summers (1995) show that firms systematically evaluate investment projects using hurdle rates that exceed the firms' costs of capital. They argue that CEOs of U.S. firms have short capital budgeting time horizons and conclude that firms forego long-term, positive net present value investment projects. Both of these studies imply that firms could invest more and increase dollar returns to shareholders. The sensitivity of investment to cash flow, first documented by Fazzari, Hubbard, and Petersen (1988), also suggests that investment systematically differs from its optimal level. Hadlock (1998) demonstrates empirically that this sensitivity rises with ownership, which he argues is inconsistent with overinvestment.

In a subsequent paper to ours, Hennessy and Levy (2002) consider a number of determinants of firm level investment. They reject shirking and instead find evidence in favor of empire-building.

[1] A different strand of the empirical literature looks for evidence of overinvestment in corporate diversification (see, for example, Denis, Denis, and Sarin (1997) and Aggarwal and Samwick (2003a)).

Their results are not directly comparable to ours in that they focus strictly on the determinants of investment without considering the associated impacts on firm performance. Furthermore, because their proxy for empire-building preferences is whether or not the CEO is a founder, they are restricted to a much smaller panel than we are (808 observations versus 12,896 observations).

In this paper, we make seven contributions to the literature. First, we present a unified framework for considering over- and underinvestment due to principal-agent considerations. Second, we show that, as a matter of theory, the existing evidence for overinvestment from the managerial entrenchment literature is not sufficient to identify if overinvestment is in fact occurring. Third, we present a set of comparative statics that is sufficient to identify if either over- or underinvestment is occurring due to private benefits or costs in a principal-agent framework. Fourth, our focus on incentives from compensation allows us to look at the most direct way of dealing with agency concerns within the firm. Fifth, empirically, we test our comparative statics using a larger panel dataset than has been employed previously. Sixth, our results provide new, systematic evidence on the relationship between incentives and firm-level investment and relate this to firm performance. Seventh, our econometric approach allows us to identify underlying sources of exogenous variation that drive changes in incentives, investment, and firm performance, conditional on our theory being correct. Surprisingly, our results suggest that overinvestment, the focus of much of the literature that precedes this paper, is not a prominent feature of what we observe within firms.

3. Theoretical Results and Predictions

In this section, we show how incentives are determined if managers have either private benefits or private costs of investment. We also show how incentives, investment, and firm performance are related in equilibrium. Changes in these equilibrium outcomes are driven by changes in the underlying parameters of the model–managerial risk aversion, the variance of firm performance, the productivity of investment, and the magnitude of private benefits or costs of investment, as well as other potential sources of agency problems.

We consider a principal-agent setting in which managers choose investments as well as some other action such as an effort decision. The firm is assumed to have sufficient free cash flow to fund all investment projects the manager wishes to undertake. We assume that firm profits net of the amount invested are:

$$\pi = x + I - \frac{1}{2m} I^2 + \varepsilon \tag{1}$$

where x is the other action, I is the level of investment, m parameterizes how productive the firm's investment is, and ε is a normally distributed shock to profits with a mean of zero and a variance of σ^2. The generic action x could be an effort choice, a product market choice, a choice of organizational form or technology, a capital structure choice, an R&D choice, a diversification choice, or all of these (in which case x is a vector). The generic action x captures any other potential principal-agent problems that could arise besides the agent's investment choice.[2] Returns are concave in investment–there are diminishing returns to investing.[3] In the absence of any principal-agent problem, the optimal level of investment is given by the first order condition to equation (1):

$$I^o = m. \tag{2}$$

The optimal level of investment is determined only by the productivity of investment–firms that are more productive invest more.

The principal employs an agent who chooses an unobservable level of investment, or a level of investment that is observable but not verifiable. While shareholders could potentially monitor managers' investment choices, doing so is costly. Monitoring is particularly costly in large, publicly traded corporations in which ownership is dispersed. Furthermore, to the extent that investment is observed, it is observed as an accounting quantity that is easily manipulated by management. The important point for our model is that we assume that the level of investment is not contractible.[4] The action choice x is also not contractible.

The agent has negative exponential utility with a coefficient of absolute risk aversion of r. Following Holmstrom and Milgrom (1987), the agent receives an optimal contract that is linear in

[2] The inclusion of this additional source of an agency problem does not affect any of our conclusions, but does point out potential additional sources of exogenous variation that might lead to changes in incentives, investment, and firm performance.

[3] The specific functional form in equation (1) is not important. All we need is that firm profits are concave in investment and that there exists an interior optimal level of investment.

[4] In our empirical work, we use accounting data on investment from Compustat. Given that the level of investment is observable to us, one may question the assumption that investment is not contractible. There are several points to keep in mind about this. First, empirically, actual contracts for top managers do not appear to be written on investment. Indeed, as we note below, the overwhelming source of incentives for managers is holdings of stock and options. Second, to the extent that the level of investment can be contracted on, it is more subject to managerial distortion than are external measures of firm performance such as stock returns (although, clearly, stock returns can also be distorted). Baker (1992) shows that if the possibility of distortion is high, then a measure such as investment will not be used in the contract.

firm performance:

$$w = w_0 + \alpha\pi. \tag{3}$$

The agent receives a fixed wage component (salary) of w_0 and a performance-based component of $\alpha\pi$. In this setting, the agent's pay-performance sensitivity is α. We can also interpret the previous equation as a statement about the agent's wealth. If we assume, as is true of most executives, that a large fraction of their wealth is invested in their own firms, then w_0 is the component of wealth that is independent of the firm and $\alpha\pi$ is the component of wealth that depends on firm performance. In this case, α represents executive ownership in the firm.

We allow for either nonpecuniary private costs or benefits of investing for managers. As in Stulz (1990), we assume that the manager derives linearly increasing benefits or costs of the form BI from investing more. If $B > 0$, then every dollar of investment generates a marginal B dollars of utility for the manager. The manager enjoys private benefits from more investment or, equivalently, managing a larger firm (empire-building). If $B < 0$, then the manager incurs personal costs of investing. These take the form of oversight costs associated with greater investment. The more the firm invests, the more work the manager must do to actually manage the investment. Working is costly for the manager ($B < 0$), so the manager must be given incentives (α) in order to invest more.

The principal's problem is to maximize expected profits net of compensation for the agent, given that the agent will choose the level of investment and the action x to maximize her utility. The agent's certainty equivalent utility from a contract w is given by:

$$E(u) = w_0 + \alpha\left(x + I - \frac{1}{2m}I^2\right) - \frac{k}{2}x^2 + BI - \frac{r}{2}\alpha^2\sigma^2, \tag{4}$$

where $\frac{r}{2}\alpha^2\sigma^2$ represents the cost of the agent's risk aversion. The term $\frac{k}{2}x^2$ represents the agent's disutility from taking the generic action x, where k parameterizes the disutility function. In general, we can add any number of additional agency problems along the lines of the action choice x to our specification in equation (4) as long as they are unrelated to investment and enter independently.

The manager chooses the investment level and the action to maximize her certainty equivalent

(4). The levels of the action and investment are:

$$x^* = \frac{\alpha}{k}, \tag{5}$$
$$I^* = m + \frac{B}{\alpha} m.$$

When compared to the optimal level of investment in the absence of agency problems ($I^o = m$), we note three things. First, the level of investment chosen by the manager is distorted by B, her private benefits or costs of investment. If the manager has private benefits ($B > 0$), the manager will overinvest, $I^* > I^o$. If the manager has private costs ($B < 0$), the manager will underinvest, $I^* < I^o$. Second, the amount of over- or underinvestment is increasing in m. When investment is more productive, the level of investment is higher and managers are able to accommodate their private benefits or costs of investment to a greater degree than when investment is less productive. Third, the amount of over- or underinvestment is attenuated by incentives, α. The greater is α, the closer the manager's choice of investment will be to the level that is optimal in the absence of agency problems. This is true for both private benefits and private costs.

The principal's problem is to maximize net profits given the agent's choice of action and investment. Expected profits net of the agent's compensation are:

$$E(\pi - w) = x + I - \frac{1}{2m} I^2 - \frac{k}{2} x^2 + BI - \frac{r}{2} \alpha^2 \sigma^2 - u_0. \tag{6}$$

Here we assume that the managerial labor market is competitive, so that the agent is held to her reservation utility u_0 through the choice of w_0. Substituting the agent's choice of action and investment (equation (5)) into the expected net profit equation (6) and maximizing with respect to α yields the following first order condition:

$$\frac{1}{\alpha^3 k} \left(\left(B^2 mk + \alpha^3 \right) (1 - \alpha) - r \alpha^4 \sigma^2 k \right) = 0. \tag{7}$$

The first order condition defines an optimal contract α^*. There exists a unique optimal contract. This contract is on the interval $(0, 1)$. To see this, note that because the first order condition is polynomial, it is continuous in α. As $\alpha \to 0$, the function is positive. As $\alpha \to 1$, the function is negative. Therefore, there exists a root on $(0, 1)$. The second order condition is:

$$\frac{-3B^2 mk + 2B^2 mk\alpha - r\alpha^4 \sigma^2 k - \alpha^4}{\alpha^4 k} < 0 \quad \text{for} \quad \alpha \in (0, 1).$$

Because the second order condition is satisfied for all $\alpha \in (0,1)$, this implies monotonicity of the first order condition and thus proves uniqueness.

We obtain the following comparative statics by applying the implicit function theorem to equation (7):

$$\frac{\partial \alpha^*}{\partial i} < 0 \quad \text{for} \quad i \in \{r, \sigma^2, k\}, \tag{8}$$

$$\frac{\partial \alpha^*}{\partial m} > 0, \tag{9}$$

$$\frac{\partial \alpha^*}{\partial B} > 0, \text{ if } B > 0, \text{ or} \tag{10}$$

$$\frac{\partial \alpha^*}{\partial B} < 0, \text{ if } B < 0.$$

For equation (8), the optimal weight on firm performance, α^*, declines as risk aversion increases or the variance of the performance measure increases because shareholders must trade off incentives versus insurance for the managers. For the disutility k of the generic action, as k increases, it is more costly to induce the agent to take the generic action, so the equilibrium level of incentives to take this action decreases. Equation (9) follows because the more productive investment is, the more costly it is to the shareholders if the manager over- or underinvests. Incentives are therefore larger to counter the over- or underinvestment. Equation (10) shows that α^* increases as a manager's private benefits become larger and that α^* decreases as a manager's private costs become smaller in magnitude. The intuition for these results is that incentives are used to counteract the manager's private benefits or costs. If private benefits or costs increase (in absolute value), the manager must be given larger incentives. If private benefits or costs decrease (in absolute value), the manager can be given smaller incentives. These predictions are reported in the first and sixth columns of Table 1.

Aggarwal and Samwick (1999, 2003b) show that $\frac{\partial \alpha^*}{\partial \sigma^2} < 0$ is strongly supported empirically. This comparative static result shows that agents will have weaker incentives when the variance of the performance measure is larger. In those papers, managers at firms with the largest variances of stock returns have pay-performance sensitivities that are as much as an order of magnitude smaller than managers at firms with the smallest variances of stock returns. This result supports a general principal-agent framework, but it does not identify which problem is generating the data, either private benefits or private costs. Because the manager is risk averse, greater variance of shocks will always lead to lower powered incentives, regardless of whether $B > 0$ or $B < 0$.

In order to distinguish the two models based on the relationship between α and the exogenous parameters, we would need to observe whether B is positive. If managers have private benefits ($B > 0$) and we find that $\frac{\partial \alpha^*}{\partial B} > 0$, then this would constitute strong support for the model based on private benefits of investment. Conversely, if managers have private benefits and we find that $\frac{\partial \alpha^*}{\partial B} < 0$, then we would conclude that the model, at least in its basic form, is wrong. Unfortunately, B is unobservable in a large cross-section of firms.

We can reliably observe π, I, and α in a large panel of firms. In order to test the theory, we therefore derive comparative static predictions of how these three outcomes will change as the underlying parameters r, k, B, m, and σ^2 vary across firms and over time. In our model, a larger B in absolute value means that the shareholders are confronted with a larger agency problem. Managers with larger values of B will require greater incentives to mitigate their agency behavior. For a given B, lower values of r, σ^2, or k or higher values of m will allow shareholders to provide higher powered incentives. We focus on how investment and firm performance are affected by these incentives in equilibrium. The predictions that we will test are derived in the next two subsections and are summarized in Table 1.

3.1 Investment and Incentives

We start with the investment predictions. The optimal α^* from equation (7) is a function of the exogenous parameters r, σ^2, k, m, and B. We take the derivative of I^* with respect to the exogenous parameters and then demonstrate how I^* varies with α^* given a change in the exogenous parameter. Consider first the manager's risk aversion, the variance of firm returns, or the disutility of the action choice. The optimal level of investment from equation (5) changes due to r, σ^2, or k only through their effect on incentives α^*:

$$\frac{\partial I^*}{\partial i} = -\frac{Bm}{(\alpha^*)^2}\frac{\partial \alpha^*}{\partial i} \quad \text{for} \quad i \in \{r, \sigma^2, k\}. \tag{11}$$

Because optimal incentives decrease as risk aversion or the variance of returns increases, if the manager has private benefits of investment ($B > 0$), investment *increases* as risk aversion, the variance of firm returns, or the disutility of the action increases. The intuition is that increasing risk aversion or variance lowers incentives so as to insulate the manager from risk. Similarly, increasing the disutility of the action lowers incentives because inducing the action has become more costly. But incentives are also what constrain the manager's overinvestment. As incentives decrease, the manager invests more. If the manager has private costs ($B < 0$), investment decreases as these parameters increase. The manager again has lower incentives, but in this case lower incentives reduce investment. Fewer incentives induce the manager to underinvest even more. These predictions are reported in the second and seventh columns of the top row of Table 1.

Dividing both sides of equation (11) by $\frac{\partial \alpha^*}{\partial i}$ for $i \in \{r, \sigma^2, k\}$ while holding the other parameters constant yields:

$$\left.\frac{\partial I^*}{\partial \alpha^*}\right|_{\partial i} = -\frac{Bm}{(\alpha^*)^2} \quad \text{for} \quad i \in \{r, \sigma^2, k\}. \tag{12}$$

This expression relates the optimal level of investment to the optimal amount of incentives given a change in one of the exogenous parameters r, σ^2, or k. For $B > 0$, $\frac{\partial I^*}{\partial \alpha^*} < 0$. The manager is overinvesting and an increase in incentives due to a reduction in risk aversion, the variance of firm returns, or the disutility of the action lowers this overinvestment. For $B < 0$, $\frac{\partial I^*}{\partial \alpha^*} > 0$. The manager is underinvesting and an increase in incentives due to a reduction in risk aversion, the variance of firm returns, or the disutility of the action increases investment, thereby reducing underinvestment. These predictions are reported in the fourth and ninth columns of the top row of Table 1.

Now consider the private benefits or costs of investment, B. The optimal level of investment changes due to private benefits or costs through two effects:

$$\frac{\partial I^*}{\partial B} = \frac{m}{\alpha^*} - \frac{Bm}{(\alpha^*)^2}\frac{\partial \alpha^*}{\partial B}. \tag{13}$$

The first effect in equation (13) is the direct effect of a change in private benefits on the level of investment itself. If the manager derives more benefits from investing, the manager will increase the level of investment. The second effect in equation (13) is due to the effect of private benefits on incentives. Shareholders will increase incentives to offset the manager's higher propensity to invest. Because managers are risk averse, raising incentives is costly for managers, and this cost is ultimately borne by the shareholders. As a result, the increase in incentives will not fully offset the higher investment due to the manager's greater private benefits. The intuition is the same for a change in the private costs of investment. These predictions are in the second and seventh columns in the second row of Table 1.

Dividing equation (13) through by $\frac{\partial \alpha^*}{\partial B}$ while holding r, σ^2, k, and m constant yields:[5]

$$\left.\frac{\partial I^*}{\partial \alpha^*}\right|_{\partial B} = \frac{1}{2}\frac{2mB^2k - B^2mk\alpha + \alpha^3}{\alpha^2 B\,(1-\alpha)\,k}, \tag{14}$$

where we have used equations (7) and (10) to simplify the expression. This equation relates the optimal level of investment to the optimal amount of incentives given a change in private benefits or costs of investment. For $B > 0$, $\frac{\partial I^*}{\partial \alpha^*} > 0$. If there are private benefits, an increase in incentives is associated with an *increase* in investment. This result may seem paradoxical. The manager is overinvesting, and yet the increase in incentives seems to increase this overinvestment. However, incentives are not an exogenous variable that determine investment. The increases in incentives and investment are both equilibrium responses to the manager's higher private benefits. Although incentives increase in response to the increase in private benefits, incentives do not increase sufficiently to prevent the manager from overinvesting more. This prediction is exactly in line with the intuition from the entrenchment literature. In that literature, managers with higher incentives (ownership) engage in more activities to entrench themselves (overinvest). Here we give an optimal contracting and equilibrium interpretation to the entrenchment intuition.

For $B < 0$, $\frac{\partial I^*}{\partial \alpha^*} < 0$. If there are private costs, an increase in incentives is associated with a *decrease* in investment. The intuition is similar to the private benefits case. As B becomes more negative, the manager has more private costs and so the amount of incentives α^* that are optimally provided to the manager increases. Although incentives increase to offset the greater private costs, incentives do not increase sufficiently to prevent the manager from investing even less. Thus, underinvestment increases. These results are reported in the fourth and ninth columns of the second row of Table 1.

Finally, consider the productivity parameter, m. The optimal level of investment changes due to m through two effects:

$$\frac{\partial I^*}{\partial m} = 1 + \frac{B}{(\alpha^*)} - \frac{Bm}{(\alpha^*)^2}\frac{\partial \alpha^*}{\partial m}. \tag{15}$$

[5] Here we have abused notation by writing α's in place of equilibrium α^*'s in order to preserve readability of the expressions. We continue to do this through the remainder of the theory section.

Dividing through by $\frac{\partial \alpha^*}{\partial m}$ yields:

$$\left.\frac{\partial I^*}{\partial \alpha^*}\right|_{\partial m} = \frac{B^2 mk\left(4\alpha - 3\alpha^2 + 3B - 2B\alpha\right) + \alpha^4 + B\alpha^3}{B^2 k\alpha^2 (1-\alpha)} \tag{16}$$

$$> 0 \text{ for } B > 0 \text{ (always) and} \tag{17}$$

$$> 0 \text{ for } B < 0 \text{ and } |B| \text{ small} \tag{18}$$

$$< 0 \text{ for } B < 0 \text{ and } |B| \text{ large.} \tag{19}$$

The cutoff $\widehat{B}$ for B small (or large) falls in the interval $\alpha\frac{4-3\alpha}{3-2\alpha} > \left|\widehat{B}\right| > \alpha$. Even though α is an endogenously determined variable here which depends on B, we can use it to bound regions for the parameter B since we know that $\alpha^* \in (0,1)$ and $\frac{\partial \alpha^*}{\partial |B|} > 0$. These comparative statics are reported in the fourth and ninth columns of the bottom two rows of Table 1. It is worth noting that the notion of $|B|$ small here is not a very tight restriction. For example, $|B|$ small encompasses the case in which $|B| = \alpha$. From equation (5) in the case of private costs, $|B| = \alpha$ would imply no investment at all. Thus, the theoretical statement that $|B|$ is small can still imply large economic effects, and, in fact, is more likely to be the relevant case.

3.2 Firm Performance and Incentives

Now we turn to the profit predictions. Recall from equation (1) that $\pi = x + I - \frac{1}{2m}I^2 + \varepsilon$. We take the derivative of π with respect to the exogenous parameters and then show how π varies with α^*, given a change in the exogenous parameter. For any exogenous parameter i where $i \in \{r, \sigma^2, k, B\}$:

$$\frac{\partial \pi}{\partial i} = \frac{\partial x^*}{\partial i} + (1 - \frac{I^*}{m})\frac{\partial I^*}{\partial i}. \tag{20}$$

Dividing both sides by $\frac{\partial \alpha^*}{\partial i}$ while holding the other parameters constant yields:

$$\left.\frac{\partial \pi}{\partial \alpha^*}\right|_{\partial i} = \frac{1}{k} + \frac{B^2 m}{(\alpha^*)^3} > 0 \quad \text{for} \quad i \in \{r, \sigma^2\}, \tag{21}$$

$$\left.\frac{\partial \pi}{\partial \alpha^*}\right|_{\partial k} = \frac{1}{k} - \frac{\alpha^*}{k^2} / \frac{\partial \alpha^*}{\partial k} + \frac{B^2 m}{(\alpha^*)^3} > 0. \tag{22}$$

For changes in r and σ^2, the intuition for these results is exactly as given before. Increases in r and σ^2 reduce incentives, reducing the generic action and increasing investment if there are private benefits or reducing investment if there are private costs. Both the effect on the generic action and on investment result in decreases in firm performance. Therefore, the reduction in incentives is associated with a reduction in profits, or $\frac{\partial\pi}{\partial\alpha^*}\big|_{\partial i} > 0$, $i = r, \sigma^2$ for both private benefits and costs. For changes in the disutility k of the generic action, an increase in the disutility has two effects on the action x as well as an effect on investment I. First, because it is more costly to take the action, the agent will take less of it. Second, incentives are reduced when the action is more costly, again reducing the amount of the action taken. Third, because incentives are lower, if the agent is already overinvesting, there will be greater overinvestment. Similarly, if the agent is already underinvesting, there will be greater underinvestment. All three effects imply that when incentives are reduced due to an increase in the disutility of the action, firm performance is also reduced, or $\frac{\partial\pi}{\partial\alpha^*}\big|_{\partial k} > 0$. As throughout, the results for changes in k have the same predicted sign as for changes in r and σ^2. These results are reported in the fifth and tenth columns of the top row of Table 1.

Next consider changes in the magnitude of private benefits or costs of investment B.

$$\left.\frac{\partial\pi}{\partial\alpha^*}\right|_{\partial B} = -\frac{1}{2}\frac{mB^2k\,(2-\alpha) - \alpha^3 + 2\alpha^4}{\alpha^3\,(1-\alpha)\,k} < 0 \text{ for } mB^2k > 0.0081306. \tag{23}$$

Both the private benefits and private costs models yield the prediction that firm performance is decreasing in incentives if the underlying source of exogenous variation is the magnitude of the private benefits or costs.[6] These results are reported in the fifth and tenth columns of the second row of Table 1.

The intuition for these results is as follows. If there are private benefits of investment, an increase in those private benefits leads, in equilibrium, to an increase in incentives. However, the increase in incentives does not fully offset the higher investment due to higher private benefits, so the level of investment increases. Because the manager is overinvesting, the increase in investment decreases firm performance. Therefore, higher incentives will be associated with *lower* firm performance, or $\frac{\partial\pi}{\partial\alpha^*}\big|_{\partial B} < 0$. This is the most prominent feature of stories of managerial entrenchment. Similarly, if there are private costs of investment, an increase in the absolute value of private costs leads, in equilibrium, to an increase in incentives and a reduction in investment. Because the manager is underinvesting, the decrease in investment decreases firm performance. Therefore, higher incentives will be associated with *lower* firm performance, or $\frac{\partial\pi}{\partial\alpha^*}\big|_{\partial B} < 0$.

[6] These results are true as long as the sources of agency problems are not trivially small, hence the parametric restriction $mB^2k > 0.0081306$. This condition is sufficient, though certainly not necessary. To see where this comes from, note that for $mB^2k > 0.0081306$, the numerator of equation (23) will be positive for all $\alpha \in (0, 1)$.

Studies in the entrenchment literature typically focus on the reduced form relationship between firm performance and ownership. Morck, Shleifer, and Vishny (1988) find a negative relationship over an intermediate range of the data and view this result as support for the entrenchment hypothesis and overinvestment. Our model shows that this conclusion is not warranted. A finding that firm performance decreases in incentives is not sufficient to conclude that there are private benefits rather than private costs. Such a finding is also consistent with the private costs model (where there is no entrenchment) when the underlying source of variation is the magnitude of those private costs.

For m:

$$\frac{\partial \pi}{\partial m} = \frac{\partial x^*}{\partial m} + (1 - \frac{I^*}{m})\frac{\partial I^*}{\partial m} + \frac{1}{2m^2} I^2. \tag{24}$$

Dividing both sides by $\frac{\partial \alpha^*}{\partial m}$ while holding the other parameters constant yields:

$$\begin{aligned}
\left.\frac{\partial \pi}{\partial \alpha^*}\right|_{\partial m} &= \frac{1}{k} - \frac{B}{\alpha^*} \left.\frac{\partial I^*}{\partial \alpha^*}\right|_{\partial m} + \frac{1}{2m^2} \left(I^*\right)^2 \frac{1}{\frac{\partial \alpha^*}{\partial m}} & (25) \\
&= \frac{1}{2} \frac{-2\alpha^4 B^2 + \alpha^3 B^2 - 3\alpha^3 B^2 mk + 4mB^2 k\alpha^2 + \alpha^5 + mB^4 k\alpha - 2mB^4 k}{\alpha^3 B^2 \left(1 - \alpha\right) k} & (26) \\
&> 0 \text{ for } |B| \text{ small and} & (27) \\
&< 0 \text{ for } |B| \text{ large.} & (28)
\end{aligned}$$

Here the cutoff for $|B|$ small is a complex expression involving the parameters m and k as well as the optimal α^*. Nonetheless, it is straightforward to see that as $|B| \to 0$, $\alpha^* \nrightarrow 0$ and so $\left.\frac{\partial \pi}{\partial \alpha^*}\right|_{\partial m} > 0$. As $|B| \to \infty$, $\alpha^* \to 1$ and so $\left.\frac{\partial \pi}{\partial \alpha^*}\right|_{\partial m} < 0$. These results are reported in the fifth and tenth columns of the bottom two rows of Table 1. As noted with respect to $\left.\frac{\partial I}{\partial \alpha^*}\right|_{\partial m}$ earlier, the theoretical notion of $|B|$ small can still encompass situations in which $|B|$ has large economic effects.

4. Data

This section describes the data sources that we use to test the comparative static predictions of our principal-agent model. We use Standard and Poor's ExecuComp dataset to construct our measure of managerial incentives. ExecuComp contains data on all aspects of compensation for the top five executives (ranked annually by salary and bonus) at each of the firms in the S&P 500, S&P Midcap 400, and S&P SmallCap 600. Due to enhanced federal reporting requirements for fiscal years ending after December 15, 1992, we can measure incentives from 1993 to 2001.[7] Financial and operating data for the ExecuComp sample companies are drawn from the Compustat dataset. Monthly measures of stock returns from the Center for Research on Security Prices (CRSP) are utilized in calculations of the variance of returns.

Managers can receive pay-performance incentives from a variety of sources. The vast majority of these incentives are due to ownership of stock and stock options. Jensen and Murphy (1990) estimate that the typical CEO receives approximately \$3.25 of compensation per thousand dollar increase in shareholder wealth. Of this amount, \$2.50 is due to the median CEO's holdings of stock in the firm and \$0.15 is due to ownership of stock options. Increases in the present value of current and future compensation and decreases in the probability of dismissal are responsible for \$0.30 each. Hall and Liebman (1998) show that incentives from stock and particularly stock options have grown substantially since the sample period used by Jensen and Murphy (1990). Aggarwal and Samwick (1999) show that incentives from stock and options are roughly twenty times more important than annual compensation as a source of incentives for both CEOs and other top managers. Thus, our use of pay-performance sensitivities based on stock and option ownership captures the bulk of total incentives. Much of the managerial entrenchment literature has focused on incentives from stock ownership. Our measure of incentives is more inclusive in that it also covers options. For this reason, we call our explanatory variable "PPS" rather than "ownership."

ExecuComp contains precise data on the details of options granted in the sample year and on executives' holdings of stock in their own companies. It contains summary information on the value of options granted in years prior to the sample year. For stock, the pay-performance sensitivity is simply the fraction of the firm that the executive owns. A CEO who holds three percent of the stock outstanding in her firm has a pay-performance sensitivity from stockholdings of \$30 per thousand dollar change in shareholder wealth. In order to calculate incentives provided by options, we multiply the fraction of the firm's stock on which the options are written by the deltas of the options.

We calculate option deltas as follows. As noted above, there are two types of option holdings

[7] The ExecuComp data are collected directly from the companies' proxy statements and related filings with the Securities Exchange Commission. Our analysis in this paper uses data from the October 2002 release of the data. See Standard and Poor's (1995) for further documentation.

in the dataset: those granted in the sample year and those granted in years prior to the sample year. For options granted in the sample year, companies must report the number of securities, the exercise price, and exercise date. This information is sufficient to apply the Black-Scholes model directly when combined with data on volatility, interest rates, dividend yields, and stock prices. We follow the assumptions in Standard and Poor's (1995) about when options will be exercised. For option grants in sample year 1994 and earlier, we assume they will be exercised 80 percent through their term. For example, if the term of the options is 10 years, we assume that the options are exercised after eight years. For option grants in sample year 1995 and later, we assume the options will be exercised 70 percent through their term. The term structure of interest rates is obtained by interpolating the year-end Treasury yields for the 1-, 2-, 3-, 5-, 7-, 10-, and 30-year constant maturity series. In applying the Black-Scholes formula, we use the dividend yield for the company reported by ExecuComp and calculate the standard deviation of monthly stock returns over the prior 60 months for each company using data from CRSP. For example, to compute the standard deviation for a firm in 1993, we calculate the standard deviation of monthly returns from January, 1988, to December, 1992. If a firm has fewer than sixty but more than twelve months of data, then we use all of the available data. If a firm did not have at least twelve prior monthly returns for a given year, we impute the variance.[8] We multiply this value by $\sqrt{12}$ to get the standard deviation of continuously compounded annual returns.

For options granted in previous years, the proxy statement reports only the aggregate number of securities and the aggregate "intrinsic value" of the options that are in the money. The intrinsic value of each option is the stock price at the end of the fiscal year less the option's exercise price. Following Murphy (1999), we treat all existing options as a single grant with a five year remaining term and an exercise price such that the intrinsic value of all options is equal to that reported on the proxy statement. Apart from having to impute the exercise price and years remaining until exercise, the methodology for options granted in previous years is the same as for current option grants.

We calculate the incentives provided to top management by adding together the PPS for

[8] For firms that were missing data on variance for some years, we use the variance of the next available year's returns. For firms that had missing data on variance in all years, we use the sample's average variance in each year. Omitting these observations does not significantly change our results.

all executives for whom we can construct incentives at each firm in each year.[9] The PPS is measured as of the beginning of each fiscal year, and so is based on the SEC filings for the previous fiscal year. The first row of Table 2 reports that the mean top management team has a PPS equal to 7.634 percent of the firm. The interpretation of this number is that if the value of shareholder wealth increases by $1,000 over the course of the year, then the value of the stock and option holdings of the top management team will increase by $76.34. The distribution of incentives across firms is skewed to the right, with median incentives substantially lower at 3.61 percent. Other percentiles of the distributions are also reported, showing considerable variation in incentives in the ExecuComp sample.[10]

Although the SEC reporting requirement is for the top five officers (ranked annually) by salary and bonus, not all top management incentives are calculated based on exactly five executives. Missing data may cause there to be fewer executives reported in some years, and the ability to track the share holdings of some executives over time even if they should be replaced in the top 5 ranking may cause there to be more executives in other years. The second row of Table 2 shows that the median team has five executives, compared to a mean of 4.72. Over eighty percent of the teams have between 3 and 6 executives, inclusive. Econometrically, we control for any possible link between the size of the team and the team's incentives by including a dummy variable for each possible team size, ranging from 1 to 10.

The next two rows of Table 2 pertain to the two dependent variables that we use in our analysis, Tobin's Q and Investment, both of which are calculated from Compustat data. Tobin's Q is equal to the ratio of the sum of the market value of equity and the book value of debt to the book value of assets. Q is commonly used as a measure of firm profitability and performance (Morck, Shleifer, and Vishny (1988), McConnell and Servaes (1990), and Himmelberg, Hubbard, and Palia (1999)). Our calculation reflects average Q and abstracts from the effect of taxes on firm value. In our

[9] In our empirical specifications in Section 5, we report results using the PPS for the top management team so that our results will be more comparable to those in Morck, Shleifer, and Vishny (1988), McConnell and Servaes (1990), and Himmelberg, Hubbard, and Palia (1999). We have run the specifications using the PPS for CEOs only and the results are similar to those reported in Section 5.

[10] In some cases, there may be double counting of shares if more than one executive has potential ownership rights (e.g., executors of a trust, co-owners of another business that owns the shares). Because such arrangements are more frequent at higher levels of ownership, simple aggregation could lead to potentially large overstatement and a bias toward zero in regression coefficients on incentives. To make sure this is not affecting our results, we hand checked any outliers in shares owned, existing options, and option grants. We repeated this process with the fixed effect residuals, to make sure that such arrangements were done consistently over time. To promote comparability with other studies using ExecuComp, our regressions use the data as provided by ExecuComp. Our results are quite similar if such outliers are recoded based on ownership rather than control.

sample, the mean and median values of Q are 2.18 and 1.57, respectively. The middle 80 percent of the firms have Q values between 1.03 and 3.84. Investment is equal to capital expenditures for property, plant, and equipment divided by the stock of net property, plant, and equipment. Investment rates are 26.3 percent at the mean and 21.5 percent at the median. Ten percent of the firms invest less than 8.5 percent and ten percent invest more than 50.1 percent.

The rest of Table 2 presents the descriptive statistics for other variables that we control for in our econometric specifications for Q and Investment. The first two of these variables pertain to determinants of incentives, investment, and firm performance identified as exogenous variables by our theoretical model. We include the standard deviation of dollar returns to shareholders as a proxy for the risk exposure that a manager gets for a given PPS. This variable is calculated from CRSP data. We include the ratio of cash flow to capital as an indicator of a shock to productivity. Our model allows such a shock to affect all three endogenous variables, and, if properly controlled for, allows for a cleaner identification of private benefits or private costs. Many studies based on the work of Fazzari, Hubbard, and Petersen (1988) have also shown a relationship between cash flow and investment that results from imperfect capital markets rather than an agency problem, and so this ratio also serves to control for such imperfections.

To control for an effect of firm size, we include the log of firm sales as an explanatory variable. The next three variables reflect other decisions that are under the control of top management that may be related to agency problems in the firm. Jensen (1986) specifically discusses the role of high dividends and high leverage in constraining the extent to which free cash flow can result in overinvestment. We include the dividend yield and the ratio of debt-to-assets to control for these factors. There is also a large literature testing for a diversification discount, through which diversified firms are valued less than single segment firms.[11] We include the number of industry segments, as reported by Compustat, to control for the link between diversification and incentives, investment, and firm performance. The last three variables in the table are the capital-to-sales ratio and the ratios of R&D and advertising expenditures to capital. Himmelberg, Hubbard, and Palia (1999) include these variables in their study of ownership and performance as proxies for the scope of managerial discretion. Following their specification, we include both linear and quadratic terms for the log of firm sales and the ratio of capital to sales.

[11] See Aggarwal and Samwick (2003a) for a review of this literature and a model that relates it to agency problems.

We restrict our sample to those firm-years in which team pay-performance sensitivity, investment, and Q can be constructed. Within that sample of 12,896 firm-years for 2,227 firms, five of the variables (standard deviation of returns, debt-to-assets, number of segments, R&D-to-capital, and adverstising-to-capital) are missing for a few dozen to as many as several thousand observations, as shown in the first column of Table 2. In the empirical work below, we set the values of these variables to zero for observations where they are missing and include a dummy variable for whether the data were originally missing. This procedure allows us to keep the sample size as large as possible while controlling for any systematic relationship between the inability to measure a variable and the comovements of incentives, investment, and firm performance.

5. Empirical Results

Recognizing the endogeneity of incentives, investment, and firm performance, our identification strategy is built around the comparative statics collected in Table 1. Of the five exogenous parameters, we can observe reasonable proxies for the two that are related to the firm's operating environment: the variance of firm performance, σ^2, and the productivity of investment, m. We cannot observe the preference parameters: risk aversion, r, disutility of the action choice, k, or the magnitude of the private benefits or costs, B. Based on these characteristics, we provide two tests of the model. In the first, we estimate the following regressions for Tobin's Q and Investment:

$$Q_{it} = \beta_0 + \beta_1 PPS_{it} + \beta_2 F\left(\sigma_{it}^2\right) + \beta_3 \left(CF/K\right)_{it} + \sum_{k=1}^{K} \delta_k x_{it}^k + \lambda_i + \varepsilon_{it}. \tag{29}$$

$$(I/K)_{it} = \beta_0 + \beta_1 PPS_{it} + \beta_2 F\left(\sigma_{it}^2\right) + \beta_3 \left(CF/K\right)_{it} + \sum_{k=1}^{K} \delta_k x_{it}^k + \lambda_i + \varepsilon_{it}. \tag{30}$$

In these regressions, PPS_{it} is the calculated pay-performance sensitivity of the top management team; $(CF/K)_{it}$ is the ratio of cash flow to capital; and $F\left(\sigma_{it}^2\right)$ is the empirical cumulative distribution function of the variance of dollar returns to shareholders. The latter two variables are empirical proxies for m and σ^2 in the theoretical model. The other covariates are denoted by x_{it}^k. These other covariates include the variables listed in Table 2, dummy variables for missing data in the variables with fewer than 12,896 valid observations (shown in Table 2), a full set of dummy variables for each sample year, and a full set of dummy variables for each possible team size.

In our main regressions, we use three different estimation methods for equations (29) and (30): ordinary least squares, median, and fixed effects. The median regression differs from OLS in being less sensitive to outliers in the distribution of the dependent variable.[12] The fixed effects regression provides a more robust test of the comparative statics predictions of the model than does the OLS regression. Including a dummy variable for each firm (denoted by λ_i) removes the effect of any firm-specific characteristic that may affect both performance and incentives in a way not specified by our model. The fixed effects regression establishes a relationship between performance and incentives based only on changes within firms over time. The OLS regression establishes a relationship between performance and incentives based on comparisons both within and across firms. If firms are not otherwise identical, the OLS regression will be biased by unobserved, firm-specific factors whereas the fixed effect regression will not.

Controlling for changes in the productivity of investment is particularly important to our identification strategy. As Table 1 shows, if the private benefits or costs of investment are small, then we cannot identify the model as being one of either private benefits or costs because the comparative statics with respect to changes in the productivity of investment are identical. Since the case of private benefits or costs small is not very restrictive (in the sense that private benefits or costs can be empirically large while still meeting the theoretical definition of small), we believe ex ante this case is more likely to be empirically relevant. We include three sets of variables that may directly control for productivity differences in the regressions. The regressions include year effects, so that macroeconomic shocks that affect the valuation and investment decisions of all firms equally are factored out. We also rely on the fixed effect regressions to draw our main conclusions, so that cross-sectional differences in productivity across firms do not affect the estimated relationships. Finally, and most importantly, we include the ratio of cash flow to capital among our explanatory variables in the regressions. Positive shocks to productivity should be reflected in higher ratios of cash flow to capital.

Because we control for both changes in the productivity of investment and the variance of firm

[12] Median regression minimizes the sum of absolute deviations rather than the sum of squared deviations and is therefore less sensitive to outliers than is OLS. Further, since the median is a more robust measure of the center of the data than the mean, the precision of the estimates will also typically be higher in median regressions. See Koenker and Bassett (1982) and Buchinsky (1998) for discussions of median regression estimation.

performance, our estimated relationships between firm peformance and incentives and between investment and incentives will be identified based on variation induced by changes in private benefits or costs, changes in risk aversion, or changes in the disutility of the generic action choice.[13]

With the bottom two rows of Table 1 (variation in m) eliminated, the estimated signs of both $\frac{\partial I}{\partial \alpha}$ and $\frac{\partial Q}{\partial \alpha}$ will identify the nature of the agency problem as private benefits or private costs and the underlying source of variation. Specifically, if $\frac{\partial I}{\partial \alpha}$ and $\frac{\partial Q}{\partial \alpha}$ move in opposite directions, then the agency problem in investment is due to private benefits. If $\frac{\partial I}{\partial \alpha}$ and $\frac{\partial Q}{\partial \alpha}$ move in the same direction, then the agency problem in investment is due to private costs. Additionally, if $\frac{\partial Q}{\partial \alpha} > 0$, then the underlying source of exogenous variation is changes in risk aversion or the disutility of the generic action choice. If $\frac{\partial Q}{\partial \alpha} < 0$, then the underlying source of variation is changes in the private benefits or costs that managers derive from investing.

Our second approach to testing the model is based on instrumental variables. Rather than controlling for the observable exogenous parameters and ascribing the variation in the endogenous variables to the unobserved exogenous parameters, instrumental variable methods use only the variation in the (explanatory) endogenous variable that is attributable to the observable exogneous parameters. As a theoretical prediction, variance is a valid instrument in our model. Incentives depend on variance, but, in our model, firm performance and investment do not depend on variance apart from their dependence on incentives. In contrast, because the productivity of investment does affect firm performance and investment directly (in addition to its effects through incentives), we cannot use it as an instrument. The implications of the signs of $\frac{\partial I}{\partial \alpha}$ and $\frac{\partial Q}{\partial \alpha}$ for the sign of B are similar to those above. Since the variation is now coming only from σ^2, $\frac{\partial Q}{\partial \alpha}$ must be positive, and the model will be falsified if this is not found to be the case. The sign of $\frac{\partial I}{\partial \alpha}$ identifies the sign of B. If $\frac{\partial I}{\partial \alpha}$ is positive (negative), then the model is one of private costs (benefits).

5.1 Linear Specifications

We begin by examining the relationship between incentives and Tobin's Q and Investment in linear specifications. We address issues related to possibly nonlinearities and nonmonotonicities in $\frac{\partial I}{\partial \alpha}$ and $\frac{\partial Q}{\partial \alpha}$ and present instrumental variables regressions in the next subsections.

[13] In regressions not reported, we have also included higher order terms of the ratio of cash flow to capital to control for a possible nonlinear relationship between productivity shocks and investment and firm performance. The estimated coefficients on incentives are unaffected.

Table 3 presents the coefficients from linear regressions of Tobin's Q on top management incentives and the other explanatory variables listed in Table 2. In all three specifications, the coefficient on incentives is positive and statistically significant. Consistent with the mean value of Q being higher than the median value, the coefficient of 0.0047 in the median regression is lower than the coefficient of 0.0092 in the OLS regression. The fixed effect coefficient of 0.0137 is 50 percent larger than the OLS coefficient. We draw two preliminary conclusions from these results. First, to date, there has been no general finding that performance is increasing in incentives. In particular, our result contrasts with that of Himmelberg, Hubbard, and Palia (1999), who found essentially no relationship between Tobin's Q and managerial ownership in a fixed effects specification.

Second, although we cannot identify whether the agency problem is due to private benefits or private costs of investment, the positive relationship between firm performance and incentives allows us to identify the source of exogenous variation. Referring to the last columns in each panel of Table 1, a positive coefficient suggests that the source of exogenous variation is risk aversion or the disutility of the generic action choice. If risk aversion or the disutility of the action decreases, then shareholders will increase incentives provided to managers. Greater incentives reduce the agency problem due to private costs or benefits of investment and thereby increase firm performance. In contrast, if the underlying source of variation were the magnitude of private costs or benefits, then higher incentives would reflect an attempt to offset the higher private benefits or costs. Higher private benefits or costs lower firm performance. Based on the positive relationship between performance and incentives, we conclude that any variations in the magnitude of B are small in comparison with the variation in risk aversion or the disutility of the action. Based on the higher coefficient in the fixed effect regression compared to the OLS regression, we can also conclude that, to the extent that the magnitude of B does vary, it appears to do so across firms more than within firms over time.

It is important to be clear that observed changes in managerial incentives and firm performance and investment are equilibrium responses to changes in exogenous parameters. Therefore, the coefficients on the PPS terms in Table 3 *do not* represent the marginal effect of an exogenous change in managerial incentives on firm performance and investment. For example, the slope coefficient in the fixed effect regression for firm performance is 0.0137. Suppose that the top management team at a given firm is observed to have incentives of 5 percent in the form of stock and options. Increasing this team's incentives to 15 percent will not increase the value of Tobin's Q by $(15-5)*0.0137 = 0.137$. Managerial incentives of 5 percent are set in equilibrium, based on the exogenous parameters r, k, σ^2, m, and B. Increasing managerial incentives from the optimal level of 5 percent will lower the returns to shareholders at this firm.[14] Instead, the coefficient of 0.0137 implies that at a firm in which it was optimal to set managerial incentives to 5 percent, Tobin's Q is expected to be 0.137 lower than at a firm in which it was optimal to set managerial incentives to 15 percent. The firm in which managerial incentives of 15 percent are optimal may have managers with lower risk aversion or lower disutility of other unobserved action choices unrelated to investment. Differences in the underlying parameters generate the observed variation in both incentives and firm performance, as well as investment.

Table 4 presents the coefficients from an analogous set of linear regressions of investment on top management incentives and the other explanatory variables listed in Table 2. The results are very similar to those in Table 3. The coefficients on incentives are positive and significant in all three specifications. The OLS coefficient of 0.0011 is somewhat larger than the median regression coefficient of 0.0006 and smaller than the fixed effect regression coefficient of 0.0017. In the example above, we would expect the firm at which it were optimal to have managerial incentives of 15 percent to have an investment rate that is $(15-5)*0.0017 = 0.017$ higher than the investment rate of a firm in which higher risk aversion or higher disutility of other unobserved action choices unrelated to investment causes the optimal managerial incentives to be 5 percent.

Returning to Table 1, a positive coefficient for $\frac{\partial I}{\partial \alpha}$ rules out a model of private benefits with risk aversion or the disutility of the action as the source of exogenous variation. These results are consistent only with the model of private costs with risk aversion or the disutility of the action as the source of exogenous variation. The reason is intuitive: if risk aversion or the disutility of the action declines, so that it is less expensive to compensate the manager through incentives, then shareholders will take advantage of the opportunity to increase incentives, thereby pushing

[14] When incentives are set optimally, shareholders have traded off the benefits of reduced agency problems against the cost of compensating the manager. Higher-than-optimal incentives inefficiently expose managers to risk, deprive them of private benefits of investment, or force them to incur private costs of greater investment. Shareholders must then compensate managers for these added burdens, thereby lowering shareholders' returns relative to the optimum.

investment toward its optimal level (in the absence of an agency problem) and raising the value of the firm. If overinvestment were a feature of the data, then increases in firm performance associated with increases in incentives would also be associated with lower, not higher, levels of investment.

We can examine the coefficients on cash flow to capital directly and use these estimates of $\frac{\partial I}{\partial m}$ and $\frac{\partial Q}{\partial m}$ to provide further support for the underlying model. In the Tobin's Q regressions, the coefficients on cash flow to capital are positive in all specifications and significant in the OLS and fixed effect specifications. As shown in Table 1 and discussed above, a positive effect of productivity on firm performance rules out large values of $|B|$, whether they reflect private benefits or private costs. In the Investment regressions, the coefficients on cash flow to capital are positive and significant in all specifications. A positive effect of productivity on investment is further evidence against large values of $|B|$ in a private costs model.

To complete the discussion of productivity shocks, we verify the implication of the model that incentives are increasing in productivity. In Table 5, we estimate regressions of incentives on all of the other explanatory variables. The coefficients on cash flow to capital are positive in all three specifications and significant in the median and fixed effect regressions, as predicted by the theoretical model for either private benefits or costs. Table 5 also shows that $\frac{\partial \alpha}{\partial \sigma^2}$ is negative in all specifications, consistent with the most basic prediction of any agency model. When the firm's risk exposure is higher, managerial ownership is more costly to use, and in equilibrium incentives are lower.

In all of our regressions, we include additional covariates to control for other potential explanations for our results. We find that both dividend yields and debt-to-asset ratios are negatively related to both investment and Tobin's Q, with varying degrees of statistical significance. This result contradicts hypotheses that greater leverage or cash payouts improves firm performance by constraining overinvestment, as in other private benefits models such as Jensen (1986), Stulz (1990), Hart and Moore (1995), and Zwiebel (1996).[15] Consistent with the literature on the diversification discount (see Servaes (1996), Berger and Ofek (1995), Comment and Jarrell (1995), and Lang and Stulz (1994)), firms with more business segments have lower values of Tobin's Q.

[15] The insignificance of dividend yield in the fixed effect regression for Tobin's Q also suggests that a dividend signaling model (e.g., Miller and Rock (1985)) cannot explain our results for incentives, investment, and firm performance.

Investment is also lower at firms with more segments, but this effect is not significant. The effect of firm size, as measured by the logarithm of sales, on both Tobin's Q and investment is decreasing but at an increasing rate. The same is true for the ratio of capital to sales. Firms with more research and development expenditures or lower advertising expenditures tend to have higher values of both investment and Tobin's Q, but these effects are not significant in the fixed effect regressions.

To summarize our empirical results, we estimate positive relationships between incentives and both investment and firm performance. To the extent that we have controlled for changes in productivity shocks in our regressions, these estimates uniquely identify the model that generates the data. Because the equilibrium values of Tobin's Q and investment move together in response to changes in incentives, this suggests that the model is one of private costs rather than private benefits of investment. Because this direction is positive, this suggests that the underlying source of variation across the equilibrium outcomes is risk aversion or the disutility of another unobserved action choice rather than the magnitude of the private costs of investment. Based on the theoretical predictions detailed in Table 1, the weight of the evidence supports a model of private costs.

5.2 Piecewise Linear Specifications

The earliest papers that investigated the relationship between Tobin's Q and insider ownership specifically tested for a nonlinear and even nonmonotonic relationship. Hadlock's (1998) test of overinvestment based on the investment-cash flow sensitivity also posits a sensitivity that is nonlinear in the value of managerial incentives. The key finding in the early literature is that there was an intermediate range of ownership, 5 to 25 percent in Morck, Shleifer, and Vishny's (1988) original paper, over which the relationship between Q and ownership was downward sloping. This negative relationship was the basis for concluding that managerial entrenchment and overinvestment are important features of large corporations. In more recent work, Himmelberg, Hubbard, and Palia (1999) argued that these nonmonotonicities, and in fact the whole relationship, disappears in the presence of fixed effects.

Table 6 shows that our results do not support either of these conclusions. To match the early literature, we reestimate equations (29) and (30) using piecewise linear specifications allowing for different segments between top management incentives of 0 and 5 percent, 5 and 25 percent, and greater than 25 percent. In our sample, 7,662 observations (59.4 percent) have incentives in the bottom range, 4,260 observations (33.0 percent) have incentives in the middle range, and 974 observations (7.6 percent) have incentives in the top range. Table 6 reports the slopes of each of the three segments in fixed effect regressions for Tobin's Q and Investment that include the same explanatory variables as in Tables 3 and 4. The point estimates for the slopes are positive in all cases, and for both Q and Investment, the three slopes together are jointly significant with a p-value below 1 percent. For Tobin's Q, the lower and middle segments are individually significant, and for Investment, the middle segment is statistically significant. The predicted relationships at the mean of the other explanatory variables in the regression are shown in Figure 1 for Q and incentives and in Figure 2 for Investment and incentives. In both cases, the predicted values from the linear regressions in Tables 3 and 4 are shown for comparison.

We note three important features of these results. First, the slope of the middle segment is positive and significant rather than negative, as in the early literature. In fact, the slope of this critical segment is underestimated by the linear regressions. In further regressions (not shown) in which we split each segment in half, we find in the regressions for both Q and Investment that each segment is upward sloping and that the six coefficients are jointly significant. Second, the slope of the top segment for both Q and Investment is estimated to be flatter than in the linear specification, suggesting that most of the impact of reductions in risk aversion or the disutility of another unobserved action choice are realized by the time optimal incentives reach 25 percent of the firm. Third, we test the null hypothesis that the three slopes are equal to each other. This is a test for linearity. In both the Q and Investment regressions, we are able to reject the null hypothesis at the 5 percent level. However, since the slopes are all positive, the practical consequences of linearizing this concavity are small. The nonlinearity is not a nonmonotonicity and does not alter conclusions with respect to the model.

Thus, our results are well characterized by a linear specification. Our results, using more recent data and including fixed effects, differ markedly from both the early literature suggesting that the relationship is nonmonotonic due to a negatively sloped middle segment and with later results that found no relationship at all. Specifically, Morck, Shleifer, and Vishny (1988) use a single cross-section of 371 large firms in 1980. McConnell and Servaes (1990) use two cross-sections of 1,173 firms in 1976 and 1,093 firms in 1986. Cho (1998) has a single cross-section of 326 large firms in 1991. Himmelberg, Hubbard, and Palia (1999) have a panel of 2,630 observations from 600 firms from 1982 to 1992. We use a panel of 12,896 observations from 2,227 firms from 1993 to 2001.

5.3 Instrumental Variable Specifications

We next turn to the instrumental variables regressions based on equations (29) and (30). As noted above, our theoretical model suggests that the variance of firm performance is a valid instrument. In a similar context, Himmelberg, Hubbard, and Palia (1999) use firm size in addition to variance to instrument for managerial ownership in a regression for Tobin's Q. Table 5 shows that, empirically, incentives are negatively and significantly related to both variance and size, controlling for fixed effects and other covariates. The other requirement for a valid instrument–that it be unrelated to the dependent variable except through its correlation with incentives–is more difficult to verify. Table 4 shows that in the fixed effects specification for investment, both variables have negative coefficients and are only marginally significant, suggesting no predictive power for the portion of variance and firm size not correlated with incentives. Table 3 shows that in the fixed effects specification for Tobin's Q, both variables are negative and statistically significant. This may indicate a lack of exogeneity. The advantage of instrumenting is that the source of variation within the model is clearly identified and, further, that any sources of endogeneity outside of our model are eliminated. The disadvantage is that, with the instruments excluded, we have less confidence that the second stage regression is correctly specified.

With that caveat in mind, Table 7 shows the results of the fixed effect instrumental variable regressions for both Tobin's Q and Investment. For each dependent variable, two specifications are presented. The first uses just variance in the instrument set, and the second uses both variance and firm size. For Tobin's Q, the coefficients on incentives are 0.2919 and 0.1126, and for Investment, the coefficients are 0.0125 and 0.0101. In all cases, the coefficients are statistically significant and about an order of magnitude larger than the non-instrumented coefficients of 0.0137 and 0.0017 in Tables 3 and 4, respectively. That both coefficients are positive leads to the same support for the private costs model noted above. The substantially higher magnitude of the estimated relationships may come from two sources. First, in the non-instrumented regressions, the relationships between the endogenous variables may be due to r and k, but also B. To the extent that there is variation in B, it serves to weaken the positive relationships induced by variation in r and k. In the instrumented regressions, the only variation comes from the instruments, and so there is no offset from B or any other factor. Second, it may be that, among the exogenous variables, changes in variance are more important to the shareholders than changes in risk aversion or disutility of the generic action choice and hence more important to the contract.

The use of instrumental variables does not change the interpretation of the coefficients. The coefficient still represents the change in Q or Investment that is associated with a given change in incentives. The use of instrumental variables simply means that the change in incentives is induced only by a shift in the instruments, rather than all of the exogenous parameters. The coefficients do not represent the effect of a change in incentives absent a change in the exogenous parameters, which is not an equilibrium occurrence.

6. Conclusion

We examine how the separation of ownership and control affects investment and firm performance. We consider two variants of the principal-agent problem. In the first variant, managers have private benefits of investment and therefore overinvest. In the second variant, managers have private costs of investment and therefore underinvest. We show how compensation contracts will be designed to ameliorate over- or underinvestment problems. Given the optimal contracts we derive, we then test several implications of the theory.

For all specifications, we find that both investment and firm performance are increasing in incentives. These results are consistent with the presence of private costs and underinvestment. These results also suggest that the primary differences within and across firms are in the variance of firm returns, risk aversion, or some other generic agency problem unrelated to investment. In our framework, incentives are an endogenous variable and our tests are based on the equilibrium predictions of the model. Controlling for other factors, increases in incentives come from decreases in risk aversion, the variance of firm returns, or the disutility associated with some action unrelated to investment. The equilibrium increase in incentives then yields higher investment and better performance. Without any change in the underlying exogenous variables, an increase in incentives would lower net returns to shareholders and is therefore not optimal.

Our results reject principal-agent models based on private benefits of investment (empire-building, managerial entrenchment, perquisites consumption). Both investment and firm performance move in the same direction in response to changes in incentives, not in opposite directions. We also show that earlier empirical findings, based solely on the relationship between firm performance and managerial ownership, are insufficient to identify whether the agency problem is one of private costs or private benefits of investment. While there is surely anecdotal evidence of overinvestment problems at individual firms, our results suggest that they are not, on average, significant problems at a broad cross-section of U.S. corporations.

While our analysis finds no evidence for overinvestment, private benefits may be relevant for other managerial decisions, in restricted sets of firms, or in important sectors of the economy. For example, managers also make decisions about corporate diversification. Diversification decisions differ from investment decisions in that they are infrequent, large-scale changes in how a firm operates. In related work, Aggarwal and Samwick (2003a) examine diversification, incentives, and firm performance and find that diversification is increasing in incentives. They also find that for firms that change their level of diversification, the association between incentives and firm performance is weaker than for firms that do not change their level of diversification. These two findings suggest that diversification decisions are driven by a managerial preference for diversification, which is similar to the private benefits of investment that we examine here.

Based on our theoretical and empirical work, we make two contributions to the literature. First, the case for overinvestment based on private benefits is overstated, given the existing evidence. As a matter of theory, the relationship between firm performance and incentives does not identify the source of an agency problem as one of private benefits. Second, a more comprehensive test for overinvestment based on how both investment and firm performance change in response to changes in incentives provides no support for the private benefits model as a general phenomenon. We find support for the idea that managers underinvest. To the extent that they do, the positive relationship between investment and incentives suggests that contracts are structured to address this problem.

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Table 1
Comparative Static Predictions

Parameter Providing the Source of Variation	Private Benefits of Investment (B > 0)					Private Costs of Investment (B < 0)				
	Sign of $\partial\alpha/\partial i$	Sign of $\partial I/\partial i$	Sign of $\partial\pi/\partial i$	Sign of $\partial I/\partial\alpha$	Sign of $\partial\pi/\partial\alpha$	Sign of $\partial\alpha/\partial i$	Sign of $\partial I/\partial i$	Sign of $\partial\pi/\partial i$	Sign of $\partial I/\partial\alpha$	Sign of $\partial\pi/\partial\alpha$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Risk Aversion (r) or Variance of Returns (σ^2) or Disutility of Action (k)	-	+	-	-	+	-	-	-	+	+
Private Benefit or Cost of Investment (B)	+	+	-	+	-	-	+	+	-	-
Productivity (m) for |B| large	+	+	-	+	-	+	-	-	-	-
Productivity (m) for |B| small	+	+	+	+	+	+	+	+	+	+

Notes:
1) Each cell in the table represents the predicted sign of the change in profits or investment when managerial incentives change.
2) Each row specifies a different underlying (exogenous) parameter of the model in Section 3 that could be changing to generate the shifts in equilibrium incentives (α), investment (I), and profits (π).
3) See Section 3 for a discussion and derivation of the comparative static predictions.

Table 2
Descriptive Statistics for Variables Used in Econometric Analyses

Variable	Number of Observations	Mean	Standard Deviation	10th Percentile	25th Percentile	Median	75th Percentile	90th Percentile
Team PPS	12,896	7.634	10.719	0.496	1.327	3.611	8.999	20.557
Size of Team	12,896	4.721	1.088	3	4	5	5	6
Tobin's Q	12,896	2.179	2.126	1.031	1.198	1.569	2.352	3.838
Investment/Capital	12,896	0.263	0.210	0.085	0.138	0.215	0.344	0.501
Std Dev of Returns	12,538	1063.32	3404.97	75.29	134.42	299.13	791.61	2032.54
Cash Flow/Capital	12,896	0.960	3.431	0.134	0.237	0.499	0.997	2.058
Ln(sales)	12,896	6.925	1.610	5.024	5.917	6.870	7.957	9.057
Dividend Yield	12,896	1.343	2.236	0.000	0.000	0.518	2.193	3.780
Debt/Assets	12,838	0.239	0.191	0.001	0.077	0.230	0.356	0.465
Num. of Segments	12,513	1.810	1.191	1	1	1	2	3
Capital/Sales	12,896	0.544	2.164	0.063	0.126	0.243	0.533	1.361
R & D/Capital	7,040	0.479	1.329	0.000	0.013	0.105	0.475	1.246
Advertising/Capital	3,053	0.316	0.731	0.021	0.048	0.122	0.315	0.670

Notes:
1) Pay-performance sensitivities (PPS) represent incentives provided by direct ownership of stock and stock options for each top management team. The Team's PPS is the sum of the PPS for all executives for which data are available. They are expressed as percentages of the firm, from 0 to 100.
2) Pay-performance sensitivities are calculated from ExecuComp. The standard deviation of monthly returns is based on dollar returns calculated from CRSP, expressed in millions. All other variables are calculated from Compustat.
3) All dollar values are in millions of constant 1997 dollars.
4) The sample is comprised of 2,227 firms observed in any year between 1993 and 2001.

Table 3
Regressions of Tobin's Q on Top Management Incentives, by Estimation Method

	OLS	Median	Fixed Effect
Intercept	6.3664	4.1324	3.7827
	(0.4718)	(0.2270)	(0.8066)
Team PPS	0.0092	0.0047	0.0137
	(0.0019)	(0.0009)	(0.0032)
CDF of Std Dev	2.8995	1.3686	-1.5333
	(0.1391)	(0.0505)	(0.2387)
Missing Std Dev	1.4493	0.8001	-0.6232
	(0.1008)	(0.0488)	(0.1818)
Cash Flow/Capital	0.0453	0.0130	0.0455
	(0.0116)	(0.0115)	(0.0139)
Ln(sales)	-0.9984	-0.5519	-0.4656
	(0.1270)	(0.0566)	(0.2090)
$Ln(sales)^2$	0.0371	0.0213	0.0465
	(0.0082)	(0.0035)	(0.0140)
Dividend Yield	-0.0094	-0.0087	-0.0104
	(0.0069)	(0.0029)	(0.0099)
Debt/Assets	-1.3510	-0.8762	-1.2842
	(0.1178)	(0.0609)	(0.2059)
Missing D/A	0.0138	-0.0534	-0.0755
	(0.2657)	(0.1056)	(0.2681)
Num. Of Segments	-0.1261	-0.0340	-0.0672
	(0.0098)	(0.0055)	(0.0145)
Missing Segments	-0.5087	-0.0905	-0.1257
	(0.0866)	(0.0358)	(0.0813)
Capital/Sales	-0.2400	-0.1186	-0.1072
	(0.0326)	(0.0171)	(0.0489)
$(Capital/Sales)^2$	0.0011	0.0006	0.0006
	(0.0001)	(0.0007)	(0.0002)
R & D/Capital	0.0950	0.2036	-0.0010
	(0.0478)	(0.0519)	(0.0360)
Missing R&D/K	-0.2645	-0.0867	0.0744
	(0.0310)	(0.0167)	(0.0861)
Advertising/Capital	-0.0405	-0.0024	0.0063
	(0.0941)	(0.0531)	(0.0852)
Missing Adv/K	-0.1157	-0.0803	0.1711
	(0.0443)	(0.0201)	(0.0565)
R-squared	0.2134	0.1390	0.5918

Notes:

1) Each regression pertains to our sample of 2,227 firms and 12,896 firm-years.
2) Each regression also includes year effects and dummy variables for the number of executives on the top management team (not reported).
3) Heteroskedasticity-robust standard errors are reported beneath each coefficient. For median regressions, standard errors are based on 200 bootstrap replications.
4) R-squareds for OLS and Fixed Effect are the adjusted r-squareds. The r-squared for the median regression is the pseudo r-squared.

Table 4
Regressions of Investment on Top Management Incentives, by Estimation Method

	OLS	Median	Fixed Effect
Intercept	0.5799	0.5116	0.4600
	(0.0373)	(0.0374)	(0.0873)
Team PPS	0.0011	0.0006	0.0017
	(0.0002)	(0.0002)	(0.0004)
CDF of Std Dev	0.0862	0.0370	-0.0615
	(0.0112)	(0.0092)	(0.0352)
Missing Std Dev	0.00754	0.0296	-0.0167
	(0.0119)	(0.0098)	(0.0248)
Cash Flow/Capital	0.0095	0.0183	0.0083
	(0.0022)	(0.0023)	(0.0025)
Ln(sales)	-0.0554	-0.0528	-0.0411
	(0.0097)	(0.0093)	(0.0241)
$Ln(sales)^2$	0.0021	0.0028	0.0027
	(0.0006)	(0.0006)	(0.0017)
Dividend Yield	-0.0118	-0.0161	-0.0028
	(0.0032)	(0.0010)	(0.0010)
Debt/Assets	-0.1227	-0.1414	-0.0268
	(0.0161)	(0.0098)	(0.0337)
Missing D/A	0.0251	0.0043	-0.0021
	(0.0287)	(0.0336)	(0.0700)
Num. Of Segments	-0.0110	-0.0045	-0.0029
	(0.0015)	(0.0010)	(0.0035)
Missing Segments	-0.0328	-0.0078	-0.0072
	(0.0089)	(0.0066)	(0.0114)
Capital/Sales	-0.0269	-0.0186	-0.0086
	(0.0042)	(0.0040)	(0.0035)
$(Capital/Sales)^2$	0.00013	0.00010	0.00005
	(0.00002)	(0.00035)	(0.00001)
R & D/Capital	0.0204	0.0487	0.00004
	(0.0048)	(0.0066)	(0.00433)
Missing R&D/K	-0.0018	0.0010	0.0087
	(0.0046)	(0.0032)	(0.0130)
Advertising/Capital	-0.0104	0.0017	-0.0104
	(0.0115)	(0.0094)	(0.0065)
Missing Adv/K	-0.0218	-0.0120	-0.0104
	(0.0050)	(0.0035)	(0.0065)
R-squared	0.1884	0.1824	0.4647

Notes:
1) Each regression pertains to our sample of 2,227 firms and 12,896 firm-years.
2) Each regression also includes year effects and dummy variables for the number of executives on the top management team (not reported).
3) Heteroskedasticity-robust standard errors are reported beneath each coefficient. For median regressions, standard errors are based on 200 bootstrap replications.
4) R-squareds for OLS and Fixed Effect are the adjusted r-squareds. The r-squared for median regressions is the pseudo r-squared.

Table 5
Regressions of Top Management Incentives on Economic Variables, by Estimation Method

	OLS	Median	Fixed Effect
Intercept	20.8748	15.9679	17.1346
	(1.5268)	(0.8285)	(3.0080)
CDF of Std Dev	-3.3184	-2.4378	-4.9627
	(0.5868)	(0.2486)	(0.6629)
Missing Std Dev	-3.7991	-1.8787	-3.8620
	(0.5064)	(0.2208)	(0.5764)
Cash Flow/Capital	0.0700	0.1719	0.0997
	(0.0358)	(0.0294)	(0.0483)
Ln(sales)	-1.9963	-2.6085	-1.6812
	(0.3561)	(0.1930)	(0.8067)
$Ln(sales)^2$	0.0458	0.1230	0.0232
	(0.0215)	(0.0114)	(0.0540)
Dividend Yield	-0.6103	-0.5005	-0.0354
	(0.1515)	(0.0301)	(0.0228)
Debt/Assets	-4.0657	-0.1481	-0.3654
	(0.6037)	(0.2488)	(0.6144)
Missing D/A	1.3530	0.2436	-0.7228
	(1.3241)	(1.0694)	(0.6802)
Num. Of Segments	-0.0456	-0.0551	0.2223
	(0.0985)	(0.0237)	(0.0686)
Missing Segments	0.8013	-0.1075	1.5298
	(0.6060)	(0.1664)	(0.3658)
Capital/Sales	-0.9621	-0.6247	0.0123
	(0.2168)	(0.0926)	(0.1723)
$(Capital/Sales)^2$	0.0041	0.0025	-0.0004
	(0.0010)	(0.0068)	(0.0008)
R & D/Capital	-0.8129	-0.3273	0.1537
	(0.1856)	(0.0938)	(0.0985)
Missing R&D/K	1.0717	0.3339	0.2727
	(0.2303)	(0.0880)	(0.3019)
Advertising/Capital	1.1002	0.0248	0.0612
	(0.4888)	(0.3496)	(0.3994)
Missing Adv/K	-1.6051	-0.2665	0.3975
	(0.2614)	(0.0958)	(0.2231)
R-squared	0.1354	0.1323	0.8421

Notes:
1) Each regression pertains to our sample of 2,227 firms and 12,896 firm-years.
2) Each regression also includes year effects and dummy variables for the number of executives on the top management team (not reported).
3) Heteroskedasticity-robust standard errors are reported beneath each coefficient. For median regressions, standard errors are based on 200 bootstrap replications.
4) R-squareds for OLS and Fixed Effect are the adjusted r-squareds. The r-squared for Median regressions is the pseudo r-squared.

Table 6
Piecewise Linear Fixed Effect Regressions of Tobin's Q and Investment on Top Management Incentives

	Tobin's Q	Investment
Lower Segment Min(PPS, 5)	0.0443 (0.0184)	0.0026 (0.0023)
Middle Segment Max(0,Min(PPS,25)-5)	0.0177 (0.0070)	0.0032 (0.0009)
Upper Segment Max(0,PPS-25)	0.0076 (0.0043)	0.0006 (0.0005)
P-value for Joint Significance	0.0000	0.0000
P-value for Linearity	0.0493	0.0107
Adjusted R-squared	0.5919	0.4650

Notes:
1) Each regression pertains to our sample of 2,227 firms and 12,896 firm-years.
2) Each regression also includes all of the covariates from Tables 3 – 5, year effects, firm fixed effects, and dummy variables for the number of executives on the top management team (not reported).
3) Heteroskedasticity-robust standard errors are reported beneath each coefficient.

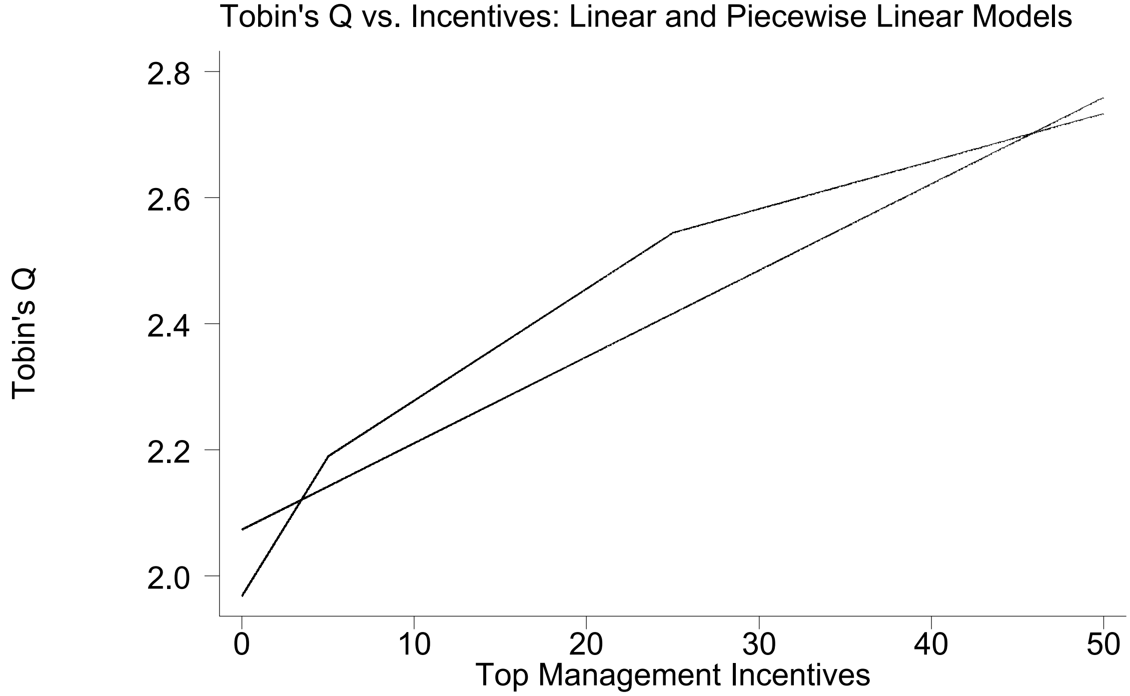
Table 7
Instrumental Variable Fixed Effect Regressions of Q and Investment on Top Management Incentives

	Tobin's Q		Investment	
Intercept	-0.8881	1.6848	0.2778	0.2404
	(0.9905)	(0.1787)	(0.0880)	(0.0198)
Team PPS	0.2919	0.1126	0.0125	0.0101
	(0.0436)	(0.0186)	(0.0039)	(0.0021)
CDF of Std Dev	-----	-----	-----	-----
Missing Std Dev	-----	-----	-----	-----
Cash Flow/Capital	0.0186	0.0377	0.0073	0.0074
	(0.0103)	(0.0072)	(0.0009)	(0.0008)
Ln(sales)	-0.0238	-----	-0.0245	-----
	(0.1836)		(0.0163)	
Ln(sales)^2	0.0408	-----	0.0025	-----
	(0.0119)		(0.0011)	
Dividend Yield	-0.0000	-0.0086	-0.0024	-0.0026
	(0.0112)	(0.0088)	(0.0010)	(0.0010)
Debt/Assets	-1.1815	-1.2801	-0.0228	-0.0260
	(0.1796)	(0.1416)	(0.0160)	(0.0156)
Missing D/A	0.1467	-0.0260	0.0068	0.0027
	(0.3853)	(0.3040)	(0.0342)	(0.0336)
Num. Of Segments	-0.1260	-0.0566	-0.0051	-0.0036
	(0.0315)	(0.0231)	(0.0028)	(0.0026)
Missing Segments	-0.5444	-0.1815	-0.0232	-0.0164
	(0.1551)	(0.1113)	(0.0138)	(0.0123)
Capital/Sales	-0.1154	-0.0978	-0.0090	-0.0062
	(0.0323)	(0.0212)	(0.0029)	(0.0023)
(Capital/Sales)^2	0.0007	0.0006	0.00006	0.00004
	(0.0001)	(0.0001)	(0.00001)	(0.00001)
R & D/Capital	-0.0433	-0.0054	-0.0016	-0.0002
	(0.0346)	(0.0269)	(0.0031)	(0.0030)
Missing R&D/K	0.0124	0.0538	0.0066	0.0069
	(0.1498)	(0.1183)	(0.0133)	(0.0131)
Advertising/Capital	-0.0114	-0.0078	-0.0137	-0.0137
	(0.0911)	(0.0721)	(0.0081)	(0.0080)
Missing Adv/K	0.0567	0.1231	-0.0149	-0.0139
	(0.0858)	(0.0671)	(0.0076)	(0.0074)

Notes:

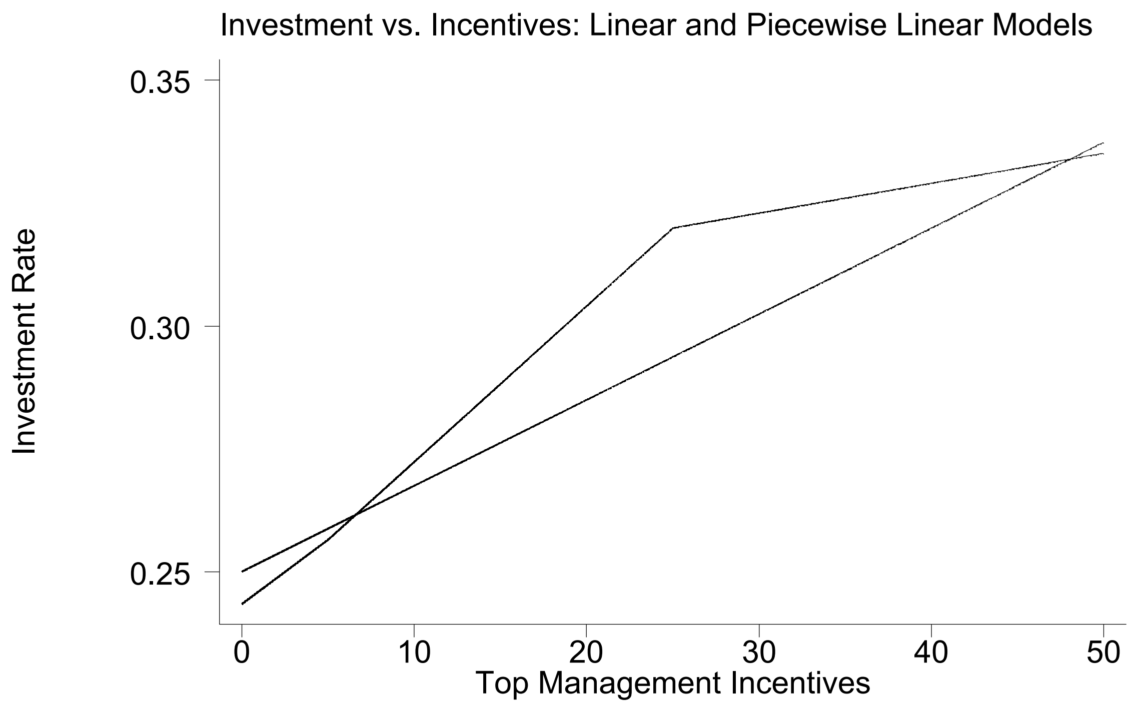
1) Each regression pertains to our sample of 2,227 firms and 12,896 firm-years.
2) Each regression also includes year effects and dummy variables for the number of executives on the top management team (not reported).
3) For each dependent variable, the first specification uses the standard deviation of dollar returns and the dummy for whether it was originally missing as instrumental variables. The second column also uses the log of sales and its square as instrumental variables.

Figure 1



Tobin's Q vs. Incentives: Linear and Piecewise Linear Models
2.8
2.6
2.4
2.2
2.0
Tobin's Q
0
10
20
30
40
50
Top Management Incentives

Figure 2


Investment vs. Incentives: Linear and Piecewise Linear Models
0.35
0.30
0.25
Investment Rate
0
10
20
30
40
50
Top Management Incentives