Abstract: I model inefficient resource allocations in M-form organizations due to influence activities by division managers that skew capital budgets in their favor. Corporate headquarters receives two types of signals about investment opportunities: private signals that can be distorted by managers, and public signals that are undistorted but noisy. Headquarters faces a tradeoff between the cost of attaining an accurate private signal and the value of the information the signal provides. In contrast to existing models of “socialism” in internal capital markets, I show that investment sensitivity to Q is higher than first-best in firms where division managers hold equity. When managers face high private costs from distorting information, headquarters may commit to investment contracts that ignore private signals and place too much weight on public signals (i.e. Q). This key result is consistent with evidence presented in Scharfstein (1997).

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Address: Harvard Business School, Soldiers Field Road, Boston, MA 02163 USA
Email: jwulf@hbs.edu
1. Introduction

Evidence suggests that diversified conglomerates have active internal capital markets—firms use cash flow generated by one division to invest in another. While extensive research in financial economics analyzes both the benefits and costs of capital allocation within the firm’s hierarchy, a reasonable goal for future research is to better understand what factors explain the variation in efficiency of internal capital markets across firms.¹ In pursuit of this goal, I model a particular type of costly behavior by division managers— influence activities that distort private information about investment opportunities—that leads to novel predictions about inefficiencies in internal capital markets.² For example, I find that asymmetric information can lead to investment sensitivity to public signals (i.e. Q) that is higher than first-best. Instead of a measure of efficient capital allocation, increasing sensitivity to Q may be the firm’s attempt to mitigate division manager incentives to distort informative private signals. This is in contrast to much of the internal capital markets literature, which implicitly assumes that divisional investment sensitivity to industry Q increases with investment efficiency.

Information and knowledge production within the firm’s hierarchy is a subject of recent research in organizational economics (e.g. Aghion and Tirole, 1997; Garicano, 2000; Dessein, 2002; Stein, 2002; Marino and Matsusaka, 2005). In this paper, I consider how the M-form organization creates perverse incentives for division managers to distort private signals that are transmitted to headquarters about competing investment opportunities. I identify circumstances under which this problem is most pronounced and subsequently show how investment contracts implicit in capital budgeting processes can mitigate this rent-seeking behavior. While this model makes several novel predictions concerning the cross-sectional variation in the efficiency of

¹ See Stein (2003) for a summary of research that discusses both costs and benefits of internal capital markets.
² The concept of influence activities [Milgrom (1988, 1990), Milgrom and Roberts (1988, 1992) and Meyer, Milgrom and Roberts (1992)] in this paper take the form of signal-jamming, in which players “jam” or distort signals that others receive [Fudenberg and Tirole (1986) and Holmstrom (1999)]. See
internal capital markets across firms, the most important result is the following. For smaller divisions, firms increase the sensitivity of investment to public signals (i.e. Q) above first-best when “core” division managers hold equity. When managers hold equity and the private costs of investment distortion are large, headquarters attempts to mitigate influence activities by ignoring valuable private information and places “too much” weight on public signals. This key result is consistent with evidence presented in Scharfstein (1997). More broadly, the model predicts that inefficiencies are more pronounced in firms with: more influential division managers, less firm-level incentive pay (i.e. smaller equity holdings) for division managers, and lower quality in public signals about investment opportunities.

Bower’s classic clinical study (1970) documents how better-informed division managers misrepresent project opportunities to decision makers at headquarters. A more recent example of the potential effect of influence activities in the internal capital market is IBM’s inability to capitalize on its early success in the development of its personal computer business. Mills and Friesen (1996) argue that

“it was mainframe-myopia that so severely damaged IBM in the 1990’s” and that “division executives began to put the welfare of their own organizations above that of the corporation as a whole...in the resistance of the mainframe division to the introduction of new technology.”

Based on accounts of IBM’s history, it seems that skepticism by the mainframe division about investment opportunities for the IBM PC division was partially to blame for the inconsistent success in personal computers.3

One of corporate headquarters’ primary responsibilities is efficient resource allocation. However, accurate information about relative investment opportunities is typically unavailable,
especially in new products and developing businesses. As a part of the capital budgeting process, headquarters relies on several sources of information from division managers—private information such as managerial recommendations (that may be distorted) and public information such as industry Q (that cannot be distorted, but is noisy). To the extent that division managers prefer larger capital budgets, they have the incentive to engage in costly influence activities in order to increase the capital allocated to their division. Division managers of core businesses (large, established divisions) are more powerful than managers of developing businesses (small, newer divisions) because they have greater control over valuable firm resources (Rajan and Zingales, 2000a). Core division managers can distort the transmission of private information to headquarters about the investment prospects of developing businesses. Headquarters cannot observe the core division manager’s action, but does observe the realizations of both signals about the developing division’s investment prospects—the possibly distorted, private signal and the noisy, public signal.4

Certainly, one extreme way to address the incentive disparity between headquarters and division managers is to eliminate the internal capital market by either spinning off divisions (Gertner, Powers and Scharfstein, 2002; Inderst and Laux, 2005) or instituting policies that limit the role of headquarters in allocating capital (Ozbas, 2005). Another less extreme approach is to rotate division managers across different divisions (similar to General Electric) to lessen it."

1A specific example that motivates this paper’s model is based on the author’s experience as Vice-President of Corporate Planning and Development for a Fortune 100 firm in financial services. In this capacity, I was involved in investment committee meetings to evaluate new business opportunities. The firm operated in three primary product segments and, at the time, was considering diversification into several businesses related to the core business. In several instances, the Executive Vice President of the core division and member of the firm’s investment committee supported investment in new businesses if the unit reported to him, but was less optimistic about the new business prospects if the unit reported directly to the President and Chief Operating Officer. Managers of new businesses had shorter tenure and filled positions at lower levels in the hierarchy than the core division manager. They were never members of the investment committee. In this organization, support from the core business division manager was critical to the ongoing capital commitment and the ultimate success of developing businesses. While the decision not to invest may have been optimal in each of these instances (although subsequent developments
incentives to lobby for capital (Stein, 2003). Alternatively, firms can design management processes or incentives to mitigate information distortion. For example, firms design capital budget processes as mechanisms to elicit revelation of private information (Harris and Raviv, 1996, 1998; Antle & Eppen, 1985) or raise hurdle rates in their evaluation of potential investment projects as a crude method of addressing agency problems (Poterba and Summers, 1995). Finally, firms link division manager compensation to firm performance in bonus contracts and through equity-based incentives to address potential problems in internal capital markets (Palia, 1999; Wulf, 2002).

In this paper, I combine the latter two approaches—the design of capital budgeting processes and division manager compensation schemes—in a model in which firms address incentive concerns in capital allocation. As a solution to mitigate influence activities, headquarters designs ex ante investment contracts that specify the optimal weights placed on private and public information in the capital allocation decision—with the weights determined by the factors that represent the manager’s ability to distort information, the private cost of signal-jamming, and the noise in the public signals. The optimal investment contract results in the standard trade-off between the cost of controlling the division manager’s action and the value of that action. In this context, the specific trade-off is between the cost of attaining an accurate private signal and the value of the information the signal provides. The value, in this case, is more efficient resource allocation.

While the model in the paper does not derive optimal compensation contracts, the core division manager’s incentive pay consists of an exogenously determined fraction of firm profits. Since compensation of division managers is linked to firm performance, managers are penalized through lower incentive pay because investment distortion leads to lower firm performance. Clearly, there are many reasons why firms offer incentive pay: for example, to induce managerial 

by competitors suggested missed opportunities), this anecdote characterizes the mechanism by which division managers can influence resource allocation.
effort. However, such motivations are absent from the present model because I am mainly interested in modeling the effect of information distortion on investment.

The paper’s main contribution is a model of information distortion about competing investment opportunities by division managers in M-form firms. This paper’s model differs from earlier models of internal capital markets in several ways. First, it focuses on the relative quality of different information sources in allocating capital across divisions. In a related paper, Stein (2002) shows that division manager incentives to generate “soft” information in M-form organizations are reduced. While he focuses on incentives to produce information, in contrast, I focus on incentives to prevent distortion of information. Second, the results identify circumstances when firms ignore valuable information and the investment sensitivity to public information \( Q \) is “too high” relative to first-best. This is in contrast to the models that predict a reduced sensitivity to \( Q \) relative to standalone firms. Third, since the model identifies the settings in which the influence problem is most severe, the results have implications for firms in the design of optimal capital budgeting processes—a critical administrative process that governs the allocation of resources within M-form organizations (Simon, 1945). Finally, the paper develops an economic model of a management phenomenon that links together the literatures on influence activities, signal-jamming, and optimal investment contracts in an application to internal capital markets.

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5 Job rotation would mitigate, but not eliminate the inefficiency arising from influence activities.
6 For example, Jensen and Meckling (1976) discuss the role of incentive contracts in eliciting managerial effort; Baker, Gibbons and Murphy (1994) explore the combined use of subjective and objective performance measures in incentive contracts to motivate managers.
7 For a model of moral hazard in investment decisions which distinguishes between both “hard” and “soft” performance measures and the relationship to contractibility, see Mukherji and Nagarajan (1995).
8 Milgrom and Roberts (1988) find a similar result (i.e. that influence activities can be mitigated by ignoring signals that are subject to manipulation), but in a different context and under different assumptions. Their model is set in the internal labor market and influence costs arise from effort distortion. In my model, influence costs arise from information distortion. In this paper, I am applying and adapting the influence cost model to internal capital markets where information transmission is a central issue.
Existing papers in financial economics investigate the effect of divisional manager power struggles or rent-seeking on capital allocation and generally predict “socialism” in internal capital markets whereby weaker divisions get subsidized by stronger ones (Rajan, Servaes, Zingales, 2000 and Scharfstein and Stein, 2000). Rajan, Servaes and Zingales (2000) develop a model in which the principal optimally transfers capital towards the small division with weak opportunities, in order to make this division behave more cooperatively in joint production with other divisions. The authors find support for inefficient cross-subsidies and that the extent of inefficiency is positively related to the diversity of resources and investment opportunities across divisions. Similarly, this paper’s model also predicts inefficiencies and a key assumption about differential power between the division managers of large, core businesses vs. small, developing businesses is a more restricted version of their finding on diversity of resources. However, I explicitly model how influence activities distort the information that is available to headquarters which in turn affects investment efficiency. Moreover, Rajan, Servaes and Zingales (2000) make no predictions about how division manager compensation (or equity ownership) or the uncertainty in divisional investment opportunities affect internal capital market efficiency across firms.

The model in this paper allows division managers to be compensated in terms of capital allocations (because they prefer managing larger divisions) in addition to being penalized by the reduced value of equity holdings. In featuring two forms of compensation, this model is similar to Scharfstein and Stein’s (2000) two-tiered agency model that predicts that large socialist-type inefficiencies are more likely when the CEO has low-powered incentives. Providing empirical support for their model, Scharfstein (1997) finds that investment of small divisions of multi-

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9 A related paper is that by Inderst and Laux (2005) which explores the implications of an internal capital market for new investment opportunities (in contrast to existing businesses) by self-interested division managers. Another paper dealing with the issue of managerial rent-seeking is Glaser and Sautner (2007) that finds that divisions whose managers have more bargaining power are able to appropriate a greater share of “windfall” cash flows for their capital allocation.
business firms is less sensitive to investment opportunities than stand-alone firms, but it is greater when top management owns more equity. While this finding is broadly consistent with my model’s main result, the explanation for the result is quite different: when division managers face high private costs from distorting information (i.e. high equity), headquarters commits to investment contracts that ignore private signals and place “too much” weight on public signals (i.e. Q). As such, higher investment sensitivity to public signals is a second-best solution to an asymmetric information problem. Adding to the evidence that division manager incentives are important, both Palia (1999) and Wulf (2002) find evidence that there are greater inefficiencies in internal capital markets when division manager compensation is less closely linked to overall firm performance. While this paper’s model makes some similar predictions as Scharfstein and Stein (2000), their model makes no predictions about division manager equity. Moreover, the results in this paper also highlight the importance of relative bargaining power of division managers and noise in public signals about investment opportunities.

The remainder of the paper is organized into four parts. Section 2 presents the model of influence and signal distortion. Section 3 solves for the value-maximizing investment rules under influence and derives specific predictions regarding investment sensitivity to signals. Section 4 discusses existing evidence in the literature. Section 5 concludes.

2. A Model of Influence and Signal Distortion

2.1. Overview

Efficiency of resource allocation in multi-divisional firms certainly varies across firms and the ability to influence allocation decisions varies across managers within firms. One setting in which we might expect allocation decisions to be particularly vulnerable to influence by division managers is in decisions related to new products or developing businesses.\(^{10}\) First, firm-specific

\(^{10}\)Influence in internal capital markets may help explain the finding by Acs and Audretsch (1988) that small firms were 43% more innovative than larger firms in manufacturing industries were and exhibited an
human capital of a new business manager is more limited in comparison to a core division manager and they typically have shorter tenure making them less entrenched (Shleifer and Vishny, 1989). Furthermore, they control fewer firm resources in the potential power struggles within the firm when property rights are not clearly defined (Rajan and Zingales, 1998). Second, investment prospects for developing businesses are more uncertain. Uncertainty is greater both in industries in early stages of development and in industries in which the firm has limited prior experience. Therefore, I model the interaction between the two division managers in a firm in which we would expect the ability to influence allocation decisions to be the most extreme: the division manager of the core business (large, established division) versus the division manager of the developing business (small, newer division with less predictable returns).

Consider a firm with two divisions: a large, established division (L) (or core division) with known returns; and a smaller, newer division (S) with unknown returns. Headquarters (H) faces a fixed capital budget for new investment and invests in either S or L (or both). H wants to maximize investment returns, while the division managers of S and L prefer larger budgets. The manager of L (hereafter referred to as L) is influential and can engage in costly influence activities to distort private signals that H receives about investment returns in S and thereby skew capital in favor of L. For simplicity and consistent with the characterization that the small division manager (S) has limited firm-specific human capital, it is assumed that S is not influential (i.e. S is a passive agent). In order to control signal distortion, H offers ex ante investment contracts to division managers that make investment rules contingent on signals about investment opportunities in S and the environment in which the manager operates (characterized by the innovation-per-employee ratio 2.38 times greater than large firms exhibit. Other examples that are consistent with managers influencing capital allocation decisions regarding new products are discussed in Christensen (1997). He argues that established firms with a strong customer focus miss important investment opportunities that ultimately are exploited by entrepreneurial firms. For example, Seagate Technology was late in offering a 3.5-inch disk drive primarily because of opposition from the marketing organization and senior executives who argued that customers expressed no need for the product (p. 20). Another explanation is that the managers of the existing 5.25-inch standard opposed the new product and persuaded senior management that the market for the new technology was insignificant.
exogenous parameters). The optimal investment contract is characterized by the ability of the
manager to influence, the private cost of doing so (e.g. foregone compensation), and the quality
of the signals about investment opportunities.

2.2. Influence Activities and Signal Distortion

Investment in \( S \) generates either low returns (bad type) or high returns (good type). \( S \)'s type
is represented by \( t \in \{ t_b, t_g \} \). \( H \) does not know the type, but knows its distribution: \( \Pr(t_b) = \theta \)
and \( \Pr(t_g) = 1 - \theta \) where \( \theta \in (0,1) \). \( H \) also observes two signals about \( S \)'s type: a public signal
(that cannot be influenced by \( L \), but is noisy) and a private signal (that can be influenced). The
public signal is denoted by \( \Pi \in \{ \Pi_b, \Pi_g \} \) and is a function of \( S \)'s type and some noise. The
distribution of \( \Pi \) is defined by the following conditional probabilities:

\[
\Pr(\Pi_b | t_b) = \Pr(\Pi_g | t_g) = \psi \quad \text{and} \quad \Pr(\Pi_b | t_g) = \Pr(\Pi_g | t_b) = 1 - \psi , \quad \text{where} \quad \psi \in (0,1) \]

is a parameter representing the quality or “fraction right” of the public signal (and \( 1 - \psi \) represents
the noise in the public signal). Thus, given a bad type, the probability that the public signal also
will be bad is equal to \( \psi \).\(^{11}\) Examples of the public signal are industry Q or division profitability.
While \( S \)'s profitability is a noisy indicator of investment opportunities, it is not likely to be
distorted by \( L \).

In addition to the public signal, \( H \) receives a private signal from \( S \). Examples of the private
signal include information about new product development, the adoption of a division’s product
as a standard, or a pending sale to a large customer. While the signal that \( S \) observes is perfect, \( L \)
can take a costly action (i.e. to engage in influence activities or not) that may distort the
\textit{transmission} of this signal to \( H \). This private signal can be thought of as the investment
recommendation that \( S \) makes to \( H \) as part of the capital budgeting process. Influence activities
are efforts that cast doubt on the potential viability of \( S \)'s business. They can occur in a variety of

\(^{11}\) Without loss of generality, and to eliminate duplicate cases, I restrict \( \psi \) to \( \psi \in (1/2,1) \).
settings ranging from formal meetings (i.e. investment committee meetings) to casual comments in the hallways.  

The private signal is denoted by $\sigma \in \{\sigma_b, \sigma_g\}$ and hereafter represents the (possibly distorted) signal that is received by $H$. If $L$ chooses not to influence, this signal reveals $S$’s type with certainty (i.e. $\sigma = t$). However, if $L$ chooses to influence, the private signal received by $H$ will be distorted with some probability. Specifically, with probability $\phi$, $H$ will receive a bad private signal when $S$’s type is good. The conditional probabilities given influence by $L$ are $\Pr_I(\sigma_b | t_g) = \phi$ and $\Pr_I(\sigma_g | t_g) = 1 - \phi$ where $\phi \in (0,1)$ is a parameter representing the “distortion success” of $L$’s action on the private signal. Finally, if $L$ chooses to influence, he incurs a private cost. This private cost has two components that I will define more precisely in section 2.3: (i) foregone compensation when division manager pay is linked to firm performance (or is equity-based) and investment is distorted, and (ii) loss in future income to $L$ from being dismissed or not promoted if influence activities are discovered.

To mitigate influence activities, $H$ designs ex ante investment contracts with commitment for each division manager ($S$ and $L$) that specify investment levels and that are functions of both private ($\sigma$) and public ($\Pi$) signal realizations (and the exogenous parameters—$\Theta, \phi, \psi, x, c_0$), but not of $S$’s type ($t$) since it is unobservable to $H$. While a common assumption in the literature is that headquarters cannot commit to ex ante state-contingent capital allocations, I argue that reputational concerns in a repeated game combined with fixed budgeting rules make this a

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12 In equilibrium, $H$ knows whether $L$ engages in influence activities. However, influence activities by $L$ introduce noise into the private signal which $H$ cannot completely correct for because the private signal received by $H$ is distorted with some probability. In this way, influence activities introduce inefficiency.  
13 It is assumed that $L$ has no private information about $S$’s type and either chooses to influence the transmission of $S$’s private information to $H$ or not (i.e. a moral hazard problem). Alternatively, this could be modeled as an adverse selection problem in which $L$ also has information about $S$’s type. However, due to the asymmetric effect of influence activities (i.e. only good private signals can be distorted), this change would not affect the qualitative results of the model.
plausible assumption (Harris and Raviv, 1996). The optimal contracts offered to \( S \) and \( L \) are represented by \( I^S(\sigma, \Pi) \) and \( I^L(\sigma, \Pi) \), where \( I \) is the investment in each division given both signal realizations.

2.3. Technology and Preferences

Headquarters represents shareholders and maximizes shareholder wealth defined as the sum of expected returns net of investment in each division. I assume linear returns from investment in both divisions and denote \( r^S_t \) and \( r^L \) as the respective rates of return net of the cost of investment in \( S \) and \( L \). The net return from \( S \) is a function of \( S \)'s type and is equal to \( r^S_t \cdot I^S(\sigma, \Pi) \), while the net return from \( L \) is known and is equal to \( r^L \cdot I^L(\sigma, \Pi) \). I assume that \( r^S > r^L \) and that the expected return from investment in \( S \) equals the known return from investment in \( L \) (i.e. \( \theta r^S + (1-\theta) r^L = r^L \)). Total expected firm value \( (V) \) is then

\[
V = E[r^S_t \cdot I^S(\sigma, \Pi) + r^L \cdot I^L(\sigma, \Pi)].
\]

\( L \) is assumed to receive a share \( x \) of firm profits as incentive pay, while \( H \) receives the remaining \((1-x)\) share. Thus, \( H \)'s expected payoff is defined as \((1-x)\) of the sum of the expected returns net of investment from each division and is given by

\[
(1-x)E[r^S_t \cdot I^S(\sigma, \Pi) + r^L \cdot I^L(\sigma, \Pi)].
\]

Note that since \( x \) is exogenously determined, \( H \) maximizes total firm value \( V \).

Consistent with annual capital budgeting processes within firms and for simplicity, it is assumed that a fixed amount of capital is raised at the corporate level (represented by \( \bar{I} \)) and then allocated across divisions. While this is an extreme assumption and in many firms capital is not

\[\text{\footnotesize{\textsuperscript{14}} The conditional probability notation implies that while both the public and private signals are dependent upon the type, the noise in the public signal and the probability of successful distortion associated with the private signal are independent.}\]
fixed, most firms face an upward sloping capital supply function. Influence activities would be less of a problem in firms with flexibility in their capital budgets. However, so long as there is an increasing cost of capital and divisions “pay” for capital, \( L \) has the incentive to reduce the capital allocated to \( S \). In addition to firms facing capital constraints, I assume that divisions can only receive capital from corporate headquarters and that all capital is invested in the two divisions. These assumptions imply that the sum of the investments in both divisions equals the total capital available to invest, i.e.

\[
I^S(\sigma, \Pi) + I^L(\sigma, \Pi) = \bar{I} \text{ where } 0 \leq I^S(\sigma, \Pi), I^L(\sigma, \Pi) \leq \bar{I} \tag{3}
\]

Finally, division managers derive utility from the size of investment in their division. For simplicity, \( L \)'s utility function is the sum of (i) linear utility from investment in \( L \), (ii) incentive pay deriving from an \( x \) share of firm profits, and (if \( L \) chooses to influence) (iii) the loss in future income to \( L \) from being dismissed or not promoted if influence activities are discovered, which is exogenously given as \( c_o \):

\[
U^L = E[I^L(\sigma, \pi)] + xV - c_o \text{ if } L \text{ engages in influence activities,}
\]

\[
U^L = E[I^L(\sigma, \pi)] + xV \text{ otherwise.}
\]

I assume that \( x \) is positive. Let \( V_D \) equal expected firm value if \( H \) deters influence activities, so that \( L \) does not engage in influence activities. Let \( V_A \) equal expected firm value if \( H \)

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15 The investment contract in this paper is an implicit contract that is self-enforcing in the sense that it can be enforced not by the courts but by the firm’s concern for its reputation among managers and ultimately in the labor market (Holmstrom, 1981).

16 Several studies document capital rationing in practice (e.g. Taggart, 1987). Theoretically, the fixed capital budget may arise from asymmetric information in the external capital market. Specifically, Bolton and Scharfstein (1990) argue that investors may terminate a firm’s funding if its performance is poor (capital rationing) to ensure that the firm does not divert resources to itself at the expense of investors. Alternatively, Holmstrom and Ricart i Costa (1986) argue that when investment is informative about managerial talent, capital rationing may be used to offset manager’s incentives to overinvest.

17 In theory, another possible form of incentive pay would be to condition pay on divisional investment. For example, headquarters could control influence activities by “punishing” managers when their division receives a high capital allocation. In this model, this is equivalent to paying the manager a positive share of firm profits: managers are punished for inefficiently high capital allocations, which reduce profits. Equity-based pay is commonly observed in practice.
allows influence activities, so that $L$ engages in influence activities. (The Deter and Allow regimes are further discussed in section 2.4.) Then $L$’s payoff if he does not influence equals

$$U^L = E[I^L(\sigma, \pi)] + xV_D \tag{4}$$

while $L$’s payoff if he engages in influence activities equals

$$U^L = E[I^L(\sigma, \pi)] + xV_A - c_0 = E[I^L(\sigma, \pi)] + xV_D - \tilde{c} \tag{5}$$

where $\tilde{c} = x(V_D - V_A) + c_0$ represents the private costs of influence to $L$. $\tilde{c}$ is the sum of two components. The first term ($x(V_D - V_A)$) represents the effect of distortion on the equity holdings of $L$. More broadly, when division manager pay is linked to firm performance, either through the use of stock-based pay or an explicit weight on firm performance in annual bonus plans, managers are penalized through lower incentive pay because investment distortion leads to lower firm performance. The second term ($c_0$) represents loss of potential future income for $L$, as discussed earlier.

Timing occurs as follows: (1) $H$ offers an investment contract to each division manager $[I^S(\sigma, \Pi)$ to $S$ and $I^L(\sigma, \Pi)$ to $L]$. (2) $L$ chooses whether to engage in influence activities or not. (3) Both private ($\sigma$) and public ($\Pi$) signals are transmitted to $H$ and observed by all players. (4) $H$ implements the investment contracts and allocates capital ($\tilde{I}$) between $S$ and $L$. Payoffs to $H$ and $L$ are then realized. If $L$ chooses to influence, then he incurs a cost ($c_0$) which is foregone future income.

This game is solved in two steps. First, I derive the value-maximizing investment rules under the two possible regimes: one in which $H$ “deters influence activities” ($D$) and the other in which $H$ “allows (or induces) influence activities” ($A$). Following this, I consider the optimal regime as a function of the five exogenous parameters: $\phi$ (the distortion parameter or the probability that $L$’s influence distorts the private signal), $\psi$ (the quality of the public signal), $x$ ($L$’s share of firm
profits), $c_0$ (foregone future income due to influence activities) and $\Theta$ (the probability that $S$ is a bad type). In this paper, I focus on the optimal regime and the implications for investment behavior as a function of $\phi$, or $L$’s ability to distort the private signal.

I will present many of the results in terms of the variable $c = c_0 / \left(1 - x \left(p_g^s - p_L^s\right)\right)$, which summarizes the private costs of influence to $L$. As we may expect, $c$ is increasing in $c_0$ and increasing in $x$ (a larger share of firm profits $x$ means that $L$ incurs a larger loss when he engages in influence activities).

2.4. The Firm’s Objective

In firms with influence activities (i.e. a second-best world), $H$ faces a tradeoff between the cost of attaining an accurate private signal and the value of the information the signal provides. In some firms, contracts are designed to deter influence, while in other firms contracts allow or induce influence (i.e. not designed to mitigate influence activities). The type of contract offered by $H$ depends on the values of the exogenous parameters that vary across firms.

In the deter regime ($D$), $H$’s objective is to solve for the investment rule that maximizes the expected sum of the returns net of investment of the two divisions while ensuring that $L$’s expected utility from influencing is less than or equal to that from not influencing. If $E_D$ represents the expectations under deter (where $L$ does not influence) and $E_A$ represents the expectations under allow (where $L$ chooses to influence), profits under the respective regimes are

$$V_D = E_D \left[ r_s^L \cdot I_s^L (\sigma, \Pi) + r_L^L \cdot I_L^L (\sigma, \Pi) \right]$$

and

$$V_A = E_A \left[ r_s^L \cdot I_s^L (\sigma, \Pi) + r_L^L \cdot I_L^L (\sigma, \Pi) \right].$$

Since firm value is higher when $L$ does not distort, this term is strictly positive in equilibrium.
The firm’s problem in the deter regime is to

$$\max_{i^*, i^+} V_D$$

subject to

$$E_A[I^L(\sigma, \Pi)] - \tilde{c} \leq E_D[I^L(\sigma, \Pi)]$$

and

$$I^S(\sigma, \Pi) + I^L(\sigma, \Pi) = \bar{I}$$

The incentive compatibility constraint for $L$ i.e. the “no-influence constraint” [equation (9)] is central to the analysis. The left side is $L$’s expected utility given $L$ chooses to influence, while the right side is that given a choice of no influence. $H$ makes $L$ indifferent to influencing (i.e. in equilibrium, the incentive compatibility constraint binds) by committing to an ex ante investment contract that reduces investment in $L$ and increases investment in $S$ in certain states of the world. In equilibrium, $L$ chooses not to influence.

By contrast, in the allow regime ($A$), the firm’s problem is

$$\max_{i^*, i^+} V_A$$ subject to

$$E_A[I^L(\sigma, \Pi)] - \tilde{c} \geq E_D[I^L(\sigma, \Pi)]$$ and $$I^S(\sigma, \Pi) + I^L(\sigma, \Pi) = \bar{I}$$. That is, $H$ offers a contract that, in equilibrium, leads to $L$ choosing to influence.

3. Optimal Investment Contracts and Investment Behavior

In this section, I first present the second-best equilibrium allocations of the two regimes for the four possible states. I briefly describe the intuition for the results in Section 3.1. Since variation in investment levels can be explained by several models— influence activities in internal capital markets being one such model—I derive more specific empirical implications of the signal distortion model for each regime. I calculate investment sensitivity to the public signal (or the implied weights on the public signal) and evaluate how this measure changes as managers become more influential (Section 3.2). Finally, in Section 3.3, I determine the optimal contract
(or preferred regime) as a function of the exogenous parameters and then I discuss more extensively the intuition for the results.

3.1. Value-Maximizing Investment Rules

3.1.1. First-Best

The solutions to the above linear programming problems are presented in Table 1 (refer to Appendix A for derivations). In this table, the pairs represent investment in $S$ and $L$ ($I^S, I^L$). In order to identify investment distortion, the following discussion uses the first-best allocation as a benchmark and compares the investment rules under each regime. In a first-best world, $H$ receives an undistorted private signal from $S$ and hence knows $S$’s type. Capital is allocated efficiently between divisions. $H$ allocates none to $S$ and all to $L$ when $S$ is bad.\(^{19}\)

3.1.2. Second-Best

In a second-best world, some firms design the contract to deter influence, while in other firms contracts are designed to allow influence. The optimal contract depends on the relative cost of the ex ante investment distortion for incentive purposes compared to the value of the information the undistorted signal provides. First, consider the effect of influence activities by comparing the allocation under the deter regime to the first-best allocation (case 2.1 versus case 1 in Table 1). The differences occur in the states with incongruent private and public signals (hereafter referred to as mixed-signal states). Consider case 2.1i. Note that in the deter regime the private signal is not distorted and $H$ knows $S$ is a bad type. Despite this, $H$ commits to allocate capital to $S$ even when it is bad: in the second mixed-signal state ($\sigma_h, \Pi_g$), $H$ allocates "too much" to $S$ ($\Sigma_1$ versus 0) and "too little" to $L$ ($\bar{T} - \Sigma_1$ versus $\bar{T}$) relative to first-best. By penalizing $L$ in the event of a bad private signal, $H$ mitigates the incentive for $L$ to distort the

\(^{19}\) At very low levels of the distortion parameter ($\phi \leq \phi_{\text{mix}}$), the manager will not have an incentive to distort signals. The expected gains from influence are less than the costs. Firms offer the first-best contract.
**private signal.** In equilibrium, L does not influence since the no-influence constraint is satisfied.

The measure of investment distortion is represented by $\Sigma_1$, where $0 < \Sigma_1 < \bar{T}$.

Next, compare the two deter cases (case 2.1i versus case 2.1ii). The two cases depend on the distortion-to-cost ratio ($\phi / c$) or the probability that the signal is distorted relative to L’s private cost of influence. This ratio can be thought of as a measure of L’s ability to influence. Firms with less influential managers (i.e. low distortion-to-cost, $\phi < \phi_d$) offer contracts that distort investment in only one mixed-signal state (case 2.1i). However, when managers are more influential (i.e. high distortion-to-cost, $\phi > \phi_d$), firms offer contracts that require investment distortion in both mixed-signal states. Specifically, $H$ allocates “too little” to a good $S$ ($\Sigma_2$ versus $\bar{T}$) and “too much” to a bad $S$ ($\bar{T}$ versus 0) relative to first-best. Note that $0 < \Sigma_2 < \bar{T}$.

Since deterring influence activities is costly to the firm, it is not always optimal for firms to offer contracts with that as a goal. When the cost of deterrence exceeds the value of the information conveyed through accurate private signals, firms design contracts that allow influence activities (i.e. case 2.2 in Table 1). The allocations in this regime fall into two cases that depend on the value of $\phi \psi / (1 - \psi)$. This term is increasing in distortion of the private signal ($\phi$) and decreasing in the noise of the public signal (which decreases with $\psi$), and so it can be thought of as a measure of the relative quality of the private and public signals. It is important to note that, in the allow regime, bad private signals received by headquarters may be distorted.

Focusing on the second case first (i.e. high distortion-to-noise or case 2.2ii, $\phi > \phi_d$), $H$ follows the good public signal when it receives a bad private signal because the private signal is not informative when distortion is high. The good public signal “outweighs” the bad private signal and all capital is allocated to $S$. In the other case (case 2.2i—low distortion-to-noise, $\phi < \phi_d$),

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20 Because $\phi_d$ is a multiple of $c$, this is a condition on $\phi / c$. See Appendix A for the expression for $\phi_d$. 
“too little” capital is allocated to a good S because, for some realizations, H receives a bad private signal when S is good. In both of the allow cases, H follows the private signal when it is good, because signal-jamming generates one-sided errors.

(Insert Table 1 about here.)

While the model predicts that influence activities lead to investment distortion, importantly, it identifies the circumstances that determine the extent of inefficiency across firms. There are two types of investment distortion: underinvestment in small divisions with good prospects and overinvestment in small divisions with poor prospects. The equilibrium results in Table 1 lead to the following empirical implications for investment allocations (or levels):

**Empirical Implications—Investment Allocations:** Investment distortion is greater in firms with: (i) more influential managers (i.e. higher $\phi$) (ii) lower private costs to managers of influencing (i.e. lower c) and (iii) lower quality of the public signal (i.e. lower $\psi$). In addition, when private signal distortion is high ($\phi > \phi_D$ and $\phi > \phi_A$), both types of distortion may occur—underinvestment in small divisions with good prospects or overinvestment in small divisions with poor prospects—depending on the state of the world.

3.2. Investment Sensitivity to Public Signals by Regime

Analyses of average investment levels as presented in Section 3.1 are subject to many interpretations. Certainly, more compelling evidence would include cross-sectional correlations

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21 Comparing with Table 1, this condition is equivalent to $\phi \psi / (\psi^2 - \psi) > 1$, which corresponds to high distortion-to-noise. Refer to Appendix A for more details.
between measures of investment inefficiencies and the relevant variables as predicted by theory.

To go one step further in making specific predictions of the use of investment contracts to control influence activities, I analyze investment sensitivity to signals (or optimal weights placed on signals in the investment decision). Ultimately, an empirical test would use a proxy for the public signal, because the private signal would never be observed. So, I consider investment sensitivity to the public signal for the small division [represented by $S_{\Pi} = \Delta E(I^S | \Pi) / \Delta \Pi$] and evaluate it as a function of the manager’s ability to influence.\(^{23}\) Intuitively, $S_{\Pi}$ represents the change in the capital allocated to $S$ as the public signal changes from bad to good.

In a first-best world, influence activities are never undertaken and the private signal is undistorted. Hence, while investment sensitivity to the public signal in the first-best contract ($S_{\Pi FB}$) is a function of the signal-to-noise of the public signal and the odds ratio of a bad type, it is not a function of the division manager’s ability to influence (Figure 1). However, in a second-best world, investment sensitivity to the public signal is a function of $\phi$. In what follows, I derive investment sensitivity (or weight on the public signal) for both deter and allow regimes, and then determine the optimal regime as a function of the parameters (Section 3.3).

In the deter regime, investment sensitivity to the public signal ($S_{\Pi D}$) is greater than first-best and is an increasing function of the probability of distortion (Figure 1). In other words, the increase in the capital allocated to $S$ as the public signal changes from bad to good is higher than first-best and this difference is greater in firms in which managers have greater ability to influence. The reasoning is as follows. In order to deter influence, firms commit to making division investment less sensitive to the private signal (the one that can be influenced) and more

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\(^{22}\) To see this, note that firm value is decreasing in investment distortion. We may then verify, using expressions from Appendix A, that $\partial V_p / \partial \phi < 0, \partial V_p / \partial \psi > 0$, and $\partial V_p / \partial \psi > 0$. Similarly, observe that $\partial V_d / \partial \phi < 0, \partial V_d / \partial \phi > 0$, and $\partial V_d / \partial \psi > 0$, with strict inequality for some parameter values.

\(^{23}\) Refer to Appendix A for expressions for $S_{\Pi}$ in each regime. This derivation is necessary for an explicit mapping to the observables in an empirical test.
sensitive to the public signal (the noisy signal that cannot be influenced). Greater weight is given to the public signal in a way that is ex post inefficient (i.e. $S_{\Pi D}$ is “too high” relative to $S_{\Pi FB}$). This difference in the weights ($S_{\Pi D} - S_{\Pi FB}$) is another measure of the investment distortion and it is greater in firms with more influential managers (i.e. firms with larger distortion parameters).

(Insert Figure 1 about here.)

In contrast, in the allow regime, investment sensitivity to the public signal ($S_{\Pi A}$) is below first-best and is a decreasing function for low probability of distortion ($\phi < \phi_A$), and is above first-best and is an increasing function for high probability of distortion ($\phi > \phi_A$) (Figure 2). That is, there is a non-monotonic relationship between investment sensitivity to the public signal and the probability of distortion. The reasoning is as follows. Firms offer contracts that allow influence activities because the cost of achieving an accurate signal exceeds the value of the additional information. Therefore, $H$ allocates capital on a potentially distorted private signal. When the public signal is noisy relative to the private signal (low distortion-to-noise, $\phi < \phi_A$), $H$ makes investment based on the private signal. Because $L$ engages in influence activities, the private signal is distorted and the correlation between the private signal and public signal decreases. As a result, investment is less sensitive to the public signal relative to first-best. Lower weight is given to the public signal in a way that is ex post inefficient (i.e. $S_{\Pi A}$ is “too low” relative to $S_{\Pi FB}$), and $H$ invests “too little.”

In the other case, when the public signal is more informative than the private signal (high distortion-to-noise, $\phi > \phi_A$), greater weight is given to it relative to first-best (i.e. $S_{\Pi A}$ is “too high” relative to $S_{\Pi FB}$) and $H$ invests “too much” when the public signal is good. The difference in investment behavior below the critical value ($\phi_A$) versus above is caused by the switch of
investment levels in the mixed-signal state \((\sigma_b, \Pi_g)\) between the two cases in the allow regime. That is, when managers are more influential, firms offer contracts that differ from the first-best contract in the mixed-signal state \((\sigma_b, \Pi_g)\). With less managerial influence, firms offer the first-best contract. However, in the allow regime, investment distortion always occurs in both mixed-signal states. This distortion is a direct result of influence activities (rather than a distorted investment contract as in the deter case). Similar to the deter regime, the extent of the inefficiency is greater in firms with higher probabilities of signal distortion.  

(Insert Figure 2 about here.)

### 3.3. Optimal Investment Contracts (or Preferred Regime)

The value-maximizing investment rules (Table 1) lead to implications for investment behavior for each regime (Figure 1 and 2). However, these rules say nothing about which regime is optimal for \(H\). By comparing the degree of investment distortion under each regime, I determine the optimal contract (or preferred regime) as a function of the exogenous parameters and then I discuss more extensively the intuition for the results.

In a first-best world, investment sensitivity to the public signal is not a function of the distortion parameter. In contrast, in firms with influence problems, investment behavior is a

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24 The non-monotonicity is generated by the binary nature of the influence decision. The existence of a range over which \(S_{\mathrm{in}}\) decreases \((\phi < \phi_d)\) can be explained by the probabilistic relationships between investment levels and public signal realizations. Specifically, as \(\phi\) increases, there is a higher probability of an inaccurate private signal in the mixed-signal state \((\sigma_b, \Pi_g)\) i.e. higher \(\Pr(\sigma_b, \Pi_g | t_s)\). (Or, we see good private signals less often.) Also, in this state, \(H\) invests zero in \(S\). Since a good public signal leads to low investment, this implies that the sensitivity of investment to the public signal is decreasing. The opposite holds for \(\phi > \phi_d\).

25 The optimal contract maximizes total payoff. That is, \(H\) will allow or deter based on the value of \(\arg \max_{s, t} (v_s, v_o)\).
function of managerial ability to distort private signals. While the precise solutions vary depending on parameter values, there are two distinct cases.

Case 1: Investment Pattern 1:

High private cost of influence to investment \[ \left( \frac{c}{I} \right) > \left( \frac{(1 - \theta)(1 - \psi)}{\psi} \right) \]

For firms with influence problems (i.e. \( \phi \geq \phi_{\text{min}} \)), investment sensitivity to the public signal is greater than first-best and is an increasing function of the distortion parameter (Figure 3). When private costs of influence to the manager are high relative to the size of the capital budget \( (c/I \text{ large}) \), it is less costly for the firm to deter influence (i.e. easier to satisfy incentive compatibility). In this case, the value of the information in the accurate private signal is greater than the cost of attaining it. Firms allocate capital by placing “too much” weight on the public signal and “too little” weight on the private signal relative to first-best.

When are private costs to the division manager of influencing high? When incentive compensation is linked to firm performance (i.e. equity-based pay) division managers are penalized because investment distortion leads to lower firm performance. It follows that in M-form firms with heterogeneous divisions that are diverse in size and are operated by division managers with high equity holdings, we would expect to see higher investment sensitivity to

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26 Firms with influence problems are defined as those firms in which the distortion parameter is large enough for division managers to have the incentive to engage in influence activities, i.e. \( \phi \geq \phi_{\text{min}} \).

27 The two patterns depend on the ordering of the critical values of the distortion parameter and, in turn, can be characterized by restrictions on the manager’s private cost \( c \) relative to the size of the capital budget \( I \).

28 This corresponds to the case of high \( x \) in the model; recall that the summary variable for private costs of influence \( c = c_0 / (I - x(\tau^S - \tau^L)) \) is increasing in \( x \).
industry Q relative to first-best. Moreover, as the vulnerability to influence increases, or the large division manager becomes more powerful relative to the small division manager, division investment sensitivity to industry Q should increase. This result suggests that higher investment sensitivity to industry Q is not always an indicator of efficient internal capital markets. Instead, it may be a sign that firms are facing asymmetric information problems, and attempting to mitigate incentives for managers to distort informative private signals.

**Case 2: Investment Pattern 2:**

Low private cost of influence to investment \( \left[ \frac{c}{I} < (1 - \psi)(1 - \theta) \right] \)

The optimal investment contract generates a non-monotonic relationship between investment sensitivity to the public signal and the distortion parameter (Figure 4). When private costs of influence are low relative to the size of the capital budget \( c/I \), it is costly (in terms of investment distortion) for \( H \) to deter influence. For intermediate values of \( \phi \), \( H \) chooses to allow influence activities; investment sensitivity to the public signal is smaller than first-best and is a decreasing function of the distortion parameter. In this case, the cost of attaining an accurate private signal exceeds the value of the information. However, for extreme (small and large) values of the distortion parameter, \( H \) chooses to deter influence activities and investment behavior is similar to Case 1 above.

(Insert Figure 4 about here.)

In contrast to the first case in which firms always deter influence activities, here the cost of deterring may outweigh the benefit of having undistorted information. This occurs for intermediate values of \( \phi \). This case predicts that in M-forms where division managers hold little
equity and are moderately influential, we would expect to see lower investment sensitivity to Q for the small division relative to first-best.

These two patterns of investment behavior can be summarized in the following statement of empirical implications:

*Empirical Implications—Investment Sensitivity to Public Signals: Multi-divisional firms’ investment sensitivity to public signals (\(S_{\Pi}\)) in small, developing divisions can be characterized by either

(i) a high-valued (above first-best) and increasing function of \(\phi\) when private costs of influence (c) are high (Figure 3) or

(ii) a low-valued (below first-best) and decreasing function for intermediate values of \(\phi\) and a high-valued (above first-best) and increasing function for high or low values—i.e. a non-monotonic relationship between investment sensitivity to the public signal and the distortion parameter—when private costs are low (Figure 4).

To sum up, when the private cost of influence (which is represented by c in the model) is high relative to size of the capital budget, firms will allocate capital to mitigate influence activities by placing less weight on private signals (i.e. managerial recommendations) and more weight on public signals (i.e. Q) relative to first-best. More specifically, firms will increase the sensitivity of investment to public signals for small divisions above first-best when core division managers hold equity. In firms where division manager compensation has no link to firm performance, sensitivity of investment to public signals will be below first-best. More broadly, the model predicts that inefficiencies are more pronounced in firms with: more influential division managers, less firm-based incentive pay (i.e. smaller equity holdings) for division managers, and lower quality in public signals about investment opportunities.
4. Empirical Implications

Several existing empirical findings are consistent with the central predictions of my model. First, using segment-level data from COMPUSTAT, Shin and Stulz (1998) find that while investment in small segments of diversified firms are positively related to cash flows of other divisions, investments appear to be independent of the division’s own investment prospects. This finding is consistent with my model’s prediction that small, developing divisions with weak prospects get too much capital and those with strong prospects get too little. Second, and more broadly, several papers provide evidence that, on average, internal capital markets engage in “socialist” cross-subsidization, allocating too much to divisions with low industry Q and too little to divisions with high industry Q (e.g. Rajan, Servaes and Zingales, 2000; Scharfstein, 1997).

Scharfstein (1997) finds that investment sensitivity to industry Q in diversified firms increases when management holds equity. This is in agreement with my model, which predicts that high managerial equity stakes (i.e. high private cost of influence (c)) are associated with investment sensitivities to industry Q that are higher than first-best, while investment sensitivities below first-best may occur with low equity stakes. While this evidence is also broadly consistent with the predictions of Scharfstein and Stein (2000), their model hinges on agency problems between the CEO and outside investors since the CEO is an agent. In contrast, in my model, headquarters is a principal rather than an agent, and when division managers hold equity they face a private cost of distorting investment. The model of Scharfstein and Stein (2000) makes no predictions about compensation contracts or equity holdings for division managers.

In addition to socialist cross-subsidies, Rajan, Servaes, and Zingales (2000) find that the extent of this inefficiency is positively related to the diversity of resources and investment opportunities across divisions. This finding is consistent with the (more restrictive) prediction in
my model that the influence problem is most pronounced in a firm with divisions that are diverse in size—i.e. a large and small division—as a proxy for a division manager’s ability to influence. However, while division size is representative of the extremes in managerial ability to influence, a better measure might be the manager’s tenure or the relatedness of the businesses. More broadly, in my model the ability to influence is somewhat analogous to the power or strength of division managers in Rajan, Servaes, and Zingales (2000) and Scharfstein and Stein (2000).

In a more recent empirical paper, Xuan (2006) finds that CEOs give more capital to unaffiliated divisions (i.e. divisions that CEOs have never managed) and this is more pronounced in multi-divisional firms that operate in related businesses. If one argues that CEOs are more likely to be affiliated with large divisions (and less likely with small) and that large division managers have less ability to influence information in firms with related businesses (because CEOs know more about the small division’s business because of relatedness), then the findings are consistent with the predictions of my model: (i) Firms may distort investment towards small divisions (i.e. unaffiliated to the CEO), and (ii) this distortion towards small divisions is particularly pronounced in firms that operate in related businesses (or when large division managers are less influential).

The private cost to managers of influence activities can be thought of as the lost future income from dismissal or missed promotions as a result of influencing. Firms with job-rotation or high turnover may be less able to hold managers accountable for their roles in investment decisions, thereby reducing the chances of detecting information distortion (Stein, 2003). However, another more quantifiable interpretation of this cost is the compensation that division managers lose when incentive pay is linked to firm performance. In this case, managers are

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29 Importantly, this statement assumes that small, developing divisions are analogous to small divisions as defined in existing studies.
30 While determining CEO tenure may be possible using proxy statements, determining division manager tenure is significantly more difficult. Usually a division’s size is correlated with the amount of resources controlled by division managers (e.g. size of capital budgets and number of employees) and hence is a reasonable measure of division manager “power” within the firm.
penalized through lower incentive pay because investment distortion leads to lower firm performance. Consistent with this, Palia (1999) finds less cross-subsidization when division manager compensation is more closely linked to firm performance (either through stock ownership or options). Moreover, Wulf (2002) finds reduced investment distortion when there is a greater weight placed on firm performance in division manager bonuses. The findings in both of these papers are consistent with one of the main findings of this model: investment distortion is less pronounced in firms in which division managers face higher private costs of influencing represented by firm-based compensation.

Empirical research on internal capital markets has been criticized for measurement error in the use of industry Q as a proxy for segment investment opportunities (e.g. Maksimovic and Phillips, 2002; Villalonga, 2004; Campa and Kedia, 2002; Chevalier, 2004; Whited, 2001). On a related point, this model’s prediction about noise in public signals suggests that empirical work using either industry Q or divisional profitability/cash flow should adjust for the accuracy of these measures as proxies for investment opportunities. These measures are better signals of investment opportunities in stable, more predictable industries (e.g. textiles) in comparison to rapidly changing industries (e.g. pharmaceuticals). Hence, ceteris paribus, a diversified firm should place less weight on the public signal for a developing pharmaceuticals business and more weight on managerial recommendations in allocating capital to that division in comparison to a textiles division. Building on the main finding of Rajan, Servaes, and Zingales (2000), it is not just diversity in resource-weighted opportunities across divisions that determines the extent of inefficiencies, but also diversity in quality of public signals about investment opportunities.

5. Conclusion

The efficiency of resource allocation decisions within an organization ultimately depends on the quality of the information available to the decision-maker. The intent of this paper is to
develop an economic model that considers division manager incentives to influence capital allocation decisions based on different types of information in M-form organizations. Decision-makers place less weight on subjective, distortable information (e.g. managerial recommendations) and more weight on objective, but noisy information (e.g. industry Q) to offset incentives for division managers to distort information about investment opportunities. Investment inefficiency depends on the ability of managers to distort information, the presence of firm-level compensation incentives for division managers, and the quality of public signals of investment opportunities. By arguing that managerial ability to distort private signals is greater in certain types of firms, the model leads to testable implications for division investment sensitivity to public signals across firm characteristics. I highlight several empirical findings of related work that are generally consistent with the model’s predictions.

One important point that this paper makes is that high investment sensitivity to public information may be a sign of inefficiency in internal capital markets. Firms that face asymmetric information problems, attempt to mitigate incentives for managers to distort more informative private signals by increasing investment sensitivity to public information above the first-best level. This is in contrast with much of the internal capital markets literature, which implicitly assumes that divisional investment sensitivity to industry Q increases with investment efficiency.

The importance of influence activities in the allocation of capital across divisions may help explain empirical findings about large firms. For example, large multi-business firms have difficulty in creating a desirable entrepreneurial climate and are generally less successful than small firms in developing new products and businesses. One caveat is that this paper has not explained why multi-divisional firms should exist if investment inefficiencies are prevalent. It must be that other advantages outweigh the costs of an internal capital market or that firms learn of these inefficiencies over time and eventually correct them. Clearly, there is more work to be done to understand the decisions firms make regarding organizational structure.
Table 1

**First-Best Contract and Value-Maximizing Investment Rules—[Deter (D) and Allow (A) Influence Regimes]**

[pairs represent small and large division investment ($I^S, I^L$)]

<table>
<thead>
<tr>
<th>Cases</th>
<th>Signal Realizations</th>
<th>( (\sigma_h, \Pi_h) )</th>
<th>( (\sigma_g, \Pi_h) )</th>
<th>( (\sigma_h, \Pi_g) )</th>
<th>( (\sigma_g, \Pi_g) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. First-Best Contract ( (I^S_{FB}, I^L_{FB}) ) ( (\phi &lt; \phi_{min}) )</td>
<td></td>
<td>( (0, \bar{I}) )</td>
<td>( (\bar{I}, 0) )</td>
<td>( (0, \bar{I}) )</td>
<td>( (\bar{I}, 0) )</td>
</tr>
<tr>
<td>2. Second-Best Contracts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1 Deter Influence ( (I^S_D, I^L_D) )</td>
<td></td>
<td>( (0, \bar{I}) )</td>
<td>( (\bar{I}, 0) )</td>
<td>( (\Sigma_1, I - \Sigma_1)^1 )</td>
<td>( (\bar{I}, 0) )</td>
</tr>
<tr>
<td>i. Low distortion-to-cost ( (\phi_{min} &lt; \phi &lt; \phi_D) )</td>
<td></td>
<td>( (0, \bar{I}) )</td>
<td>( (\bar{I}, 0) )</td>
<td>( (\bar{I}, 0) )</td>
<td>( (\bar{I}, 0) )</td>
</tr>
<tr>
<td>ii. High distortion-to-cost ( (\phi &gt; \phi_D) )</td>
<td></td>
<td>( (0, \bar{I}) )</td>
<td>( (\bar{I}, 0) )</td>
<td>( (\bar{I}, 0) )</td>
<td>( (\bar{I}, 0) )</td>
</tr>
<tr>
<td>2.2 Allow Influence ( (I^S_A, I^L_A) )</td>
<td></td>
<td>( (0, \bar{I}) )</td>
<td>( (\bar{I}, 0) )</td>
<td>( (0, \bar{I}) )</td>
<td>( (\bar{I}, 0) )</td>
</tr>
<tr>
<td>i. Low distortion-to-noise ( (\phi_{min} &lt; \phi &lt; \phi_A) )</td>
<td></td>
<td>( (0, \bar{I}) )</td>
<td>( (\bar{I}, 0) )</td>
<td>( (\bar{I}, 0) )</td>
<td>( (\bar{I}, 0) )</td>
</tr>
<tr>
<td>ii. High distortion-to-noise ( (\phi &gt; \phi_A) )^3</td>
<td></td>
<td>( (0, \bar{I}) )</td>
<td>( (\bar{I}, 0) )</td>
<td>( (0, \bar{I}) )</td>
<td>( (\bar{I}, 0) )</td>
</tr>
</tbody>
</table>

Note: The table presents the four possible combinations of private and public signal realizations; e.g. \((\sigma_h, \Pi_h)\) represents a bad private signal and a bad public signal. Since the signals are both binary random variables, \((I^S, I^L)\) is a four-tuple.

1, 2 Note that \(0 < \Sigma_1 < I\) and \(0 < \Sigma_2 < I\).
3 For some parameter values in this case, there is no “Allow” contract that satisfies incentive compatibility while maximizing H’s profit (given that L influences.) For more details and derivations of the expressions that appear in this table, please refer to Appendix A.
Small Division Investment Sensitivity to the Public Signal

Figure 1: For $\phi < \phi_{min}$, investment sensitivity to the public signal is at the first-best level ($S_{PIFb}$). In the deter regime ($\phi_{min} < \phi < 1$), investment sensitivity is $S_{PID}$. Investment sensitivity is continuous in $\phi$ everywhere. Refer to Appendix A for expressions for $\phi_{min}, \phi_D, S_{PIFB}$ and $S_{PID}$.

Figure 2: For $\phi < \phi_{min}$, investment sensitivity to the public signal is at the first-best level ($S_{PIFb}$). In the allow regime ($\phi_{min} < \phi < 1$), investment sensitivity is $S_{PIA}$. If $\phi_i < \phi_D$, then on the interval $\phi_i < \phi < \phi_D$, there is no “Allow” contract that satisfies incentive compatibility while maximizing $H$’s profit (given that $L$ influences.) For more details and expressions for $\phi_{min}, \phi_i, \phi_D, S_{PIFB}$ and $S_{PIA}$, please refer to appendix A.
Small Division Investment Sensitivity to the Public Signal

**Figure 3**
High private cost/investment case: \( \frac{c}{I} > \frac{(1-\theta)(1-\psi)}{\psi} \)

**Investment Pattern 1 (IP1)—High-valued, Increasing Function**

**Figure 4**
Low private cost/investment case: \( \frac{c}{I} < (1-\psi)^2(1-\theta) \)

**Investment Pattern 2 (IP2)—Non-Monotonic Function**

\[ S_{\text{TIA}} \]
\[ S_{\text{TID}} \]
\[ S_{\text{TIF}} \]

**Figure 3:** For \( \phi < \phi_{\text{min}} \), investment sensitivity to the public signal is at the first-best level \( S_{\text{TIFB}} \). For \( \phi_{\text{min}} < \phi < 1 \), the second-best optimal contract deters influence and investment sensitivity is \( S_{\text{TID}} \). The investment pattern illustrated above in Figure 3 holds when \( \frac{c}{I} > \frac{(1-\theta)(1-\psi)}{\psi} \). See Appendix A for more details and expressions for \( \phi_{\text{min}}, \phi_1, \phi_0, S_{\text{TIFB}}, S_{\text{TID}} \) and \( S_{\text{TIA}} \).

**Figure 4:** For \( \phi < \phi_{\text{min}} \), investment sensitivity to the public signal is at the first-best level \( S_{\text{TIFB}} \). The second-best optimal contract allows influence and investment sensitivity equals \( S_{\text{TIA}} \) on some interval that lies between \( \phi_{\text{min}} \) and \( \phi_0 \). Elsewhere, the second-best optimal contract deters influence and investment sensitivity is \( S_{\text{TID}} \). The investment pattern illustrated above in Figure 4 holds when \( \frac{c}{I} < (1-\psi)^2(1-\theta) \). See Appendix A for more details.
References


Appendix A: Derivations

This section briefly derives the expressions for payoff functions and investment contracts that I discuss in the paper.

Preliminaries

The following observations are made without proof (which simply requires some algebra.) If $L$ does not influence, total payoff is (from equation (6))

\[
V_D = (1 - \theta)(r^g - r^L)\psi[I^S(\sigma_g, \Pi_g) - I^S(\sigma_b, \Pi_b)] + (1 - \psi)[I^S(\sigma_g, \Pi_b) - I^S(\sigma_b, \Pi_g)] + Tr_2
\]

While if $L$ engages in influence activities, total payoff is (from equation (7))

\[
V_A = (1 - \theta)(r^g - r^L)\left[\phi(1 - \psi) - \psi[I^S(\sigma_g, \Pi_b)] + [\phi(1 - \psi)I^S(\sigma_g, \Pi_g)]\right] + \psi[I^S(\sigma_g, \Pi_b) - I^S(\sigma_b, \Pi_g)]
\]

In addition,

\[
E_D[I^L(\sigma, \Pi)] - E_D[I^L(\sigma, \Pi)] = (1 - \psi)[I^S(\sigma_g, \Pi_b) - I^S(\sigma_b, \Pi_b)] + \psi[I^S(\sigma_g, \Pi_g) - I^S(\sigma_b, \Pi_g)]
\]

First Best: $\phi_{\min}$

The first-best outcome is attainable if and only if $L$ prefers not to influence (i.e. $E_D[I^L(\sigma, \Pi)] - \bar{c} \leq E_D[I^L(\sigma, \Pi)]$ from equations (4) and (5)) under the investment contract $I^S(\sigma_g) = \bar{I}, I^S(\sigma_b) = 0$. A little algebra reveals that this holds whenever

\[
c = \frac{c_0}{(1 - x(r^g - r^L))} \geq \phi(1 - \theta)\bar{I}.
\]

This confirms that $\phi_{\min} = \frac{c}{(1 - \theta)\bar{I}}$.

Deter (D) Regime: $\Sigma_1, \Sigma_2, \phi_D$

Recalling equations (8) and (9), $H$'s problem in the deter regime is $\max_{i^*, j^*} V_D$ subject to $E_D[I^L(\sigma, \Pi)] - \bar{c} \leq E_D[I^L(\sigma, \Pi)]$.

Substituting, the constraint becomes

\[
(1 - \psi)[I^S(\sigma_g, \Pi_b) - I^S(\sigma_b, \Pi_b)] + \psi[I^S(\sigma_g, \Pi_g) - I^S(\sigma_b, \Pi_g)] \leq \frac{c}{\phi(1 - \theta)}.
\]

Note that this IC constraint is binding in equilibrium. Inspecting the expression for $V_D$ and comparing to the constraint, it is clearly optimal to set $I^S(\sigma_b, \Pi_b) = 0, I^S(\sigma_g, \Pi_g) = \bar{I}$. Also, it is optimal to maximize $I^S(\sigma_g, \Pi_b)$. Thus whenever possible, we set $I^S(\sigma_g, \Pi_b) = \bar{I}$; this and the equality of the constraint imply $I^S(\sigma_b, \Pi_g) = \frac{1}{\psi(1 - \theta)}(\bar{I} - \frac{c}{\phi(1 - \theta)}) = \Sigma_1$. 

36
For this to be the optimal deter contract, we must have $0 \leq I^S(\sigma_g, \Pi_g) \leq I$, or equivalently (after some manipulation) $\phi_{\text{min}} \leq \phi \leq \frac{c}{I(1-\psi)(1-\theta)} = \phi_d$. Otherwise, we set $I^S(\sigma_g, \Pi_g) = I$, and the constraint then implies $I^S(\sigma_g, \Pi_g) = \frac{1}{1-\psi} \frac{c}{\phi(1-\theta)} = \Sigma_\phi$.

**Allow (A) Regime: $\phi, \psi$**

$H$’s problem in the allow regime is $\max_{\lambda, j, \lambda'} V_d$ given $E_d[I^L(\sigma, \Pi)] - \bar{c} \geq E_d[I^L(\sigma, \Pi)]$. We first consider the case where $L$ chooses to influence given $H$’s optimal investment contract. As mentioned previously, it is optimal to set $I^S(\sigma_g, \Pi_g) = I^S(\sigma_g, \Pi_g) = I$. Next, to calculate optimal $I^S(\sigma_b, \Pi_b)$ we simply check if $E_d[r^S | (\sigma_b, \Pi_b)] \geq r^L$; similarly for optimal $I^S(\sigma_g, \Pi_g)$. With this in mind, it is easy to check that $E_d[r^S | (\sigma_b, \Pi_b)] \leq r^L$ holds whenever $\psi \geq \frac{1}{2}$, as we assume; so $I^S(\sigma_b, \Pi_b) = 0$. On the other hand, $E_d[r^S | (\sigma_g, \Pi_g)] \geq r^L$ if and only if $\phi \geq \frac{1-\psi}{\psi} = \phi_\lambda$, so $I^S(\sigma_g, \Pi_g) = 0$ when $\phi < \phi_\lambda$ and $I^S(\sigma_b, \Pi_b) = I$ when $\phi > \phi_\lambda$.

Note that we have assumed so far that $L$ always engages in influence activities given $H$’s investment choice. This may not always be true when $I^S(\sigma_g, \Pi_g) = I$. In this case, the difference in payoff to $L$ between influencing and not influencing is

\[
\phi(1-\theta)(1-\psi)[(r_g^S - r^L) - 1]I - c_0.
\]

If $\phi > \phi_\lambda$ and $\phi(1-\theta)(1-\psi)[(r_g^S - r^L) - 1]I - c_0 < 0$ (or equivalently $\phi_\lambda < \phi < \phi_d = \frac{c}{(1-\theta)(1-\psi)I}$) so there is no “Allow” contract that satisfies incentive compatibility while maximizing $H$’s profit (given that $L$ influences) \(^{31}\) and the Allow regime has no solution on this interval.

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\(^{31}\) Since any mixed equilibrium where $L$ randomizes between influencing and not influencing is dominated by a Deter strategy for $H$, I do not consider mixed equilibria on this interval.
Payoffs: \( V_D, V_A \)

Given \( H \)'s optimal investment contract, it is then straightforward to calculate total payoff in each regime using the expressions for \( V_D, V_A \) from equations (6) and (7). Denote total payoff in the first-best case as \( V_{FB} \). Omitting tedious algebra, we get

**Total Payoff**

\[
V_{FB} = (1 - \theta)\left( r^S_g - r^D_l \right) \bar{T} + \bar{T}r^D
\]

**First Best:**

\[
\begin{align*}
\phi &< \phi_{\min} \\
V_D &= (1 - \theta)\left( r^S_g - r^D_l \right) \left( 2\psi - 1 \right) T + \frac{1 - \psi}{\psi} \frac{c}{\phi(1 - \theta)} + \bar{T}r^D
\end{align*}
\]

**Deter (D) Regime:**

\[
\begin{align*}
\phi_{\min} &< \phi < \phi_D \\
V_D &= (1 - \theta)\left( r^S_g - r^D_l \right) \left( 2\psi - 1 \right) T + \frac{1 - \psi}{\psi} \frac{c}{\phi(1 - \theta)} + \bar{T}r^D
\end{align*}
\]

\[
\phi > \phi_D
\]

**Allow (A) Regime:**

\[
\begin{align*}
\phi_{\min} &< \phi < \phi_A \\
V_A &= (1 - \theta)\left( r^S_g - r^D_l \right) (1 - \phi) \bar{T} + \bar{T}r^D
\end{align*}
\]

\[
\phi < \max\{\phi_D, \phi_A\}
\]

**Investment Sensitivities:** \( S_{I^{FB}}, S_{I^{ID}}, S_{I^{IA}} \)

Noting that

\[
S_{I^{\phi}} = \frac{\Delta E(I^{\phi} \mid \Pi)}{\Delta \Pi} = E(I^{\phi} \mid \Pi_\phi) - E(I^{\phi} \mid \Pi_a) \quad \text{where}
\]

\[
E(I^{\phi} \mid \Pi) = \Pr(\sigma_g / \Pi) \cdot I^{\phi}(\sigma_g, \Pi) + \Pr(\sigma_g / \Pi) \cdot I^{\phi}(\sigma_g, \Pi),
\]

We can calculate investment sensitivities in each regime. Again omitting tedious algebra, we get

**Investment Sensitivity (\( S_{I^{\phi}} \))**

**First Best:**

\[
\begin{align*}
\phi &< \phi_{\min} \\
S_{I^{FB}} &= \left[ \frac{(1 - \theta)\psi}{(1 - \theta)\psi + (1 - \psi) \theta} - \frac{(1 - \theta)(1 - \psi)}{(1 - \theta)(1 - \psi) + \psi \theta} \right] \bar{T}
\end{align*}
\]

**Deter (D) Regime:**

\[
\begin{align*}
\phi_{\min} &< \phi < \phi_D \\
S_{I^{ID}} &= S_{I^{FB}} + \frac{1 - \psi}{\psi} \left( \frac{c}{\phi(1 - \theta)} \frac{\theta}{(1 - \theta)\psi + (1 - \psi) \theta} \right)
\end{align*}
\]

\[
\phi > \phi_D
\]

**Allow (A) Regime:**

\[
\begin{align*}
\phi_{\min} &< \phi < \phi_A \\
S_{I^{IA}} &= (1 - \phi) S_{I^{FB}}
\end{align*}
\]

\[
\phi > \max\{\phi_D, \phi_A\}
\]

\[
S_{I^{IA}} = \left[ 1 - \frac{(1 - \phi)(1 - \theta)(1 - \psi)}{(1 - \theta)(1 - \psi) + \psi \theta} \right] \bar{T}
\]
Note that $S_{IL} \rightarrow \bar{I}$ as $\psi \rightarrow 1$ or $\phi \rightarrow 1$. An analogous measure for the investment sensitivity to the private signal is $S_\sigma = \frac{\Delta E(I^S | \sigma)}{\Delta \sigma}$ where $S_{FB} = \bar{I}$ (i.e. in first-best, investment in $S$ changes from 0 to $\bar{I}$ when the private signal changes from bad to good). Note that $S_{ILFB} \rightarrow S_{FB} = \bar{I}$ as $\psi \rightarrow 1$ or $x \rightarrow \infty$ (i.e. in first-best, investment sensitivity to the public signal converges to that of the perfect, private signal as noise in the public signal goes to zero).

**Investment Pattern 1 (from Figure 3—high private cost/investment case (equity)):**

To show that the investment pattern described in Figure 3 holds under the condition $\frac{c}{T} > (1-\theta)(1-\psi)$, note first that $S_{ILD}$ is increasing and continuous in $\phi$ everywhere, and is concave on $\phi_{\min} < \phi < \phi_D$ and on $\phi_D < \phi < 1$. Also, $S_{ILD}$ is decreasing in $\phi$ on $\phi_{\min} < \phi < \phi_A$ and is increasing thereafter, and has constant slope on $\phi_{\min} < \phi < \phi_D$ and on $\max\{\phi_A, \phi_D\} < \phi < 1$. We can then check that (i) $\phi_D > \phi_{\min} > \phi_A$, (ii) $V_D(\phi_D) > V_A(\phi_A)$, and (iii) $V'_D(\phi) > V'_A(\phi)$ for $\phi > \phi_D$, where $V'_A(\phi)$ is total payoff under the optimal allow contract and $V_D(\phi)$ is total payoff under the optimal deter contract for distortion parameter $\phi$, which generates the observed investment pattern.

**Investment Pattern 2 (from Figure 4—low private cost/investment case (no equity)):**

To show that the investment pattern described in Figure 4 holds under the condition $\frac{c}{T} < (1-\psi)^3(1-\theta)$, note the properties of $S_{ILD}$ and $S_{ILD}$ mentioned above; it is then straightforward to verify that that (i) $\phi_A > \phi_D > \phi_{\min}$, (ii) $\pi_D(\phi_D) < \pi_A(\phi_A)$, (iii) $V_D(\phi_A) > V_A(\phi_A)$ and (iv) $\pi'_D(\phi) > \pi'_A(\phi)$ for $\phi > \phi_A$. This then implies that the observed investment pattern holds.
Appendix B: Proposed Empirical Test

In this appendix, I discuss an approach to test the empirical implications of the influence model; specifically, how investment sensitivity to signals varies with the environment that the manager operates in.

Compustat Industry Segment (CIS) data reports segment information for approximately 6500 firms per year. Information includes key financial statistics and SIC codes at the segment level. While the level of aggregation of these data is typically higher than that of the division, capital allocation decisions also are made at the line of business (or segment) level.

The model distinguishes between two types of divisions within the firm: (i) large, established divisions with known returns (L) and (ii) smaller, newer divisions with unknown returns (S). However, in order to focus on the extremes, one could estimate an investment equation for the small divisions using the segment with the smallest sales in each year to represent the division with the least influential (or passive) manager and the least predictable returns (smaller, newer division) and the segment with the largest sales in each year to represent the division with the most influential manager and the most predictable returns (larger, established division).

The central idea behind an empirical strategy would be based on the premise that the manager’s ability to influence (i.e. the probability of signal distortion) varies across firms and, as a result, firms with certain characteristics suffer more from investment distortion due to influence activities. One measure commonly used in empirical research as a reasonable proxy for the public signal about investment opportunity is median Q for the division’s industry. Another possibility is lagged segment profitability (represented by $\Pi_{S-1}^S$ and defined as operating income/assets for S).

Proxies for the probability of signal distortion could be based on two firm characteristics: the relatedness of division operations and the number of divisions within the firm. First, if the firm is more focused (or less diversified) and the businesses of the small and large divisions are closely related, one could argue that L should be less influential in denigrating S’s investment prospects. This is because the CEO is better informed and less easily influenced. It follows that the probability of signal distortion is lower in firms with more closely related businesses. Ultimately, whether managers are more influential in distorting information in focused or diversified firms is an empirical issue. To measure the relatedness of division businesses, one could construct a diversification measure (e.g. HHI) based on segment industry classifications.

The second characteristic used as a proxy for the probability of signal distortion could be the number of divisions within the firm. If the firm has more divisions, the CEO is less knowledgeable about each division’s business and is more likely to be swayed by influential division managers. Or said differently, there is more noise in the transmission of private information in a firm with more divisions. For example, since General Electric’s CEO manages nine business segments (in 1998), his knowledge of each division and his ability to personally evaluate investment opportunities is more limited relative to a firm with two divisions. It follows

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32Empirical evidence suggests there are benefits to firms staying close to their core business [e.g. Comment and Jarrell (1995), Berger and Ofek (1995) and an extensive list of more current papers including Berger et al (2002)]. The empirical results on whether relatedness is beneficial or costly to the efficiency of internal capital markets are mixed. See Stein (2003) for a discussion of these results and a review of the literature on the diversification discount.
that firms with more divisions should suffer from greater investment inefficiencies relative to firms with fewer divisions.\textsuperscript{33}

While the ex ante contract would not be observable to the econometrician, one can observe ex post investment and profits for the small segment and the relevant firm characteristics. The econometric specification would be a regression of investment in the small division ($I^S$) on either industry $Q$ or lagged profits of the small division ($\Pi_{-1}^S$, as the proxy for the public signal), while specifying the regression coefficient ($\beta_0$) as a linear function of firm characteristics ($\Omega$, as proxies for the distortion parameter). The coefficient on industry $Q$ measures the sensitivity of investment to industry $Q$ as a function of firm characteristics. Hence, $\hat{\beta}_0(\Omega)$ would be an estimate of $S_{\Pi}(\phi) = \Delta E(I^S \mid \Pi) / \Delta \Pi$ as derived in the model (i.e. investment sensitivity to the public signal as a function of the distortion parameter). This coefficient measures how much weight is placed on industry $Q$ in determining segment investment and this weight varies by firm characteristics.\textsuperscript{34}

Based on the above specification, there are two empirical tests of the influence model.

1. Do firm characteristics have any predictive power in determining segment investment sensitivity to $Q$ (i.e. are the components of $\Omega$ statistically significant)?

2. Is the relationship between investment sensitivity to industry $Q$ and firm characteristics similar to either the increasing or the non-monotonic relationship predicted by the model? Is $\hat{\beta}_0(\Omega)$ either a high-valued, increasing function of the distortion parameter, as the model predicts when the private cost of influence is high (i.e. high managerial equity holdings) (Figure 3)? Or is it a low-valued, decreasing function for intermediate values of the distortion parameter and a high-valued, increasing function for extreme values, as is the case when the private cost of influence is low (Figure 4)?

\textsuperscript{33} This is the opposite prediction of the model developed in de Motta (2003).

\textsuperscript{34} Note, one may argue that the estimate of this coefficient may be biased due to omission of the private signal in the investment equation. However, the theoretical derivation of investment sensitivity to the public signal implies that the investment equation without the private signal is the correct econometric specification. This is because the dependent variable is expected investment and is derived by taking expectations over the private signal. Hence, the effect of the private signal is already incorporated into the dependent variable of the regression equation and including it as an independent variable would result in misspecification.