Large Shareholder Trading and Investment Complexity

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Abstract

Complex investments are investments that are difficult to value in the short-term. In this paper, we analyze the incentives of a manager who is compensated based on short-term stock prices to invest in complex long-term investments. In particular, we explore how the manager’s investment decision is affected by the presence of a large institutional shareholder whose horizon is finite. The analysis focuses on the observation that the horizon mismatch between the large shareholder and the project can result in a bias in the trading of the institutional investor. The resulting equilibrium is such that investment in long-term complex projects lowers the incentive of institutional investors to collect costly information and hence reduces the informativeness of the short-term stock price. Furthermore, a larger ownership by institutional investors increases their trading bias upward, which in turn induces the firm to invest in more complex projects. Thus, our model suggests that large ownership by institutional investors may actually exacerbate concerns of uninformative stock prices.

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1 Introduction

Market observers attribute the recent financial crises in part to the popularity of new asset classes that were difficult to evaluate. This paper investigates the broader question of what are the conditions under which “complex” investments are an optimal choice of short-term focused myopic managers. In particular, we analyze the incentive of a manager, who is compensated based on the short-term stock price, to invest in such assets and how this incentive is affected by the presence of institutional shareholders (e.g., mutual funds and hedge funds).

Our analysis starts with the notion that large shareholders have a monitoring technology that allows them to collect costly information about the investment made by the firm and that this information is used for generating trading profits in the stock market, rather than for purposes of intervening in the firm’s operations. We depart from the existing literature by allowing for the possibility that the large shareholder is himself an agent who is subject to an agency problem. In particular, we model the large shareholder as a manager of a fund whose job at the fund has a finite horizon that may be shorter than the time it takes the market to understand the value of the firm’s investment project. This means that the fund manager collects information and trades on it with the objective of maximizing the change in the value of his portfolio over his finite employment horizon.

We solve for the decision of the firm’s manager to invest in complex long-term projects as well as that of the fund manager to become informed about the investment project’s true value. One can think of the firm’s choice, for example, as the decision of whether or not to invest in R&D type projects, which tend to be hard to evaluate in the short term. Alternatively, the firm can invest in short-term simple projects whose outcome will become known in the near future. We assume, for simplicity, that the investment project’s complexity does not directly affect the value of the project. Rather, a more complex project is simply a project whose true value is less likely to become public information by the end of the mutual
fund manager’s tenure at the mutual fund.¹

Modeling the agency problem at the fund level (albeit in a very simple way) turns out to have several implications regarding the trading behavior of the large shareholder and the investment decision of the firm. First, the fact that the fund manager is compensated based on the change in the value of his portfolio and that there is a non-zero probability that he leaves the fund before his information is fully reflected in the stock price results in an upward trading bias. In particular, the fund manager’s trading will be influenced both by his information as well as by the mutual fund’s initial equity stake in the firm. This, in turn, will also affect the fund manager’s ex-ante incentive to collect information.

Second, the manager of the firm understands the fund manager’s motivation to collect information and his motivation to bias upward his demand for the stock. Hence, when making his decision about effort and project type, he takes into account that investing in a more complex project will increase the probability that the market will not be able to understand the value of the investment during the fund manager’s tenure. The extent to which the short-term stock price reflects information about the project will then be a critical factor in the determination of the investment made by the manager of the firm.

The analysis of the resulting Perfect Bayesian Equilibrium yields several key findings. First, we find that investment in more complex projects reduces the fund manager’s incentive to produce information, which then makes stock prices less informative. The less informative the stock price the lower is the effort exerted by the manager of the firm, and hence the lower is firm value.

Second, we find that a larger equity stake in the hands of a mutual fund or hedge fund induces the firm to invest in more complex projects that are harder for the market to figure out in the short term. This is because a mutual fund with a larger initial equity stake will

¹If complex projects are assumed to decrease firm value they can be interpreted as projects that help the manager hide information as in Stein (1989) or Goldman and Slezak (2006). If, on the other hand, complex projects are assumed to increase firm value they can be interpreted as suggesting that long-term projects are more valuable than short-term ones. In either specification the main results of the paper will still hold but the solution to the model becomes a bit more cumbersome.
lead the fund manager to submit an upwardly biased demand for additional shares, thereby pushing up the short-term stock price. This, will further increase the incentive of the manager of the firm to confuse the market about the true value of the project. The above results imply that larger ownership by institutional investors will end up lowering the long-term value of the firm.

Finally, while larger institutional ownership leads to a lower firm value, we also find that the optimal institutional equity stake that maximizes the expected trading profits of the fund is positively correlated with the growth opportunities of the firm and hence with firm value. Namely, we find that although a larger equity position at the hand of institutional investors will lower firm value, an empirical test of the cross section relation between firm value and the ownership stake should find a positive correlation.

Our paper builds on the work of Kyle (1985) who models equilibrium asset prices in the presence of an informed investor and liquidity traders. Using this framework, we present a model of endogenous information collection by a large shareholder. Thus, our paper relates to the following three strands of the literature on shareholder monitoring: The first deals with active large shareholders who collect information and intervene in the firm’s operations if need be.2 The second strand discusses how stock market information affects real investments.3

The third strand of the literature, which is closest in spirit to this paper, analyzes the value of large shareholders who are passive. Holmström and Tirole (1993) show how large shareholders collect information that affects stock prices and hence the incentive of the manager to invest. Edmans (2009) uses short sale constraints to show that there is a positive link between block size and information collection.4 Admati and Pfleiderer (2009) show that the existence of large shareholders who follow the wall street rule can be either beneficial or

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3See, e.g., Dow and Gorton (1997), Goldman (2004), Strobl (2008), and Dow, Goldstein, and Guembel (2007).

4In related work Edmans and Manso (2010) analyze large shareholder trading in a setting with multiple large shareholders and show that governance via selling shares may actually be enhanced by having more than one large shareholder.
harmful depending on the type of agency problem that is plaguing the firm. Unlike these papers, we allow for the possibility that the horizon of the large shareholder is short in the sense that his private information does not necessarily become public by the end of his tenure. This is similar to the problem studied in Goldman and Slezak (2003) who focus on the asset pricing implication of these mutual fund-initiated trades.

The remainder of the paper is organized as follows. Section 2 describes the model. Section 3 provides an analysis of the main results. Section 4 discusses some empirical implications. Section 5 concludes.

2 The Model

We consider an economy with a single firm. The firm is all-equity financed and has a single, perfectly divisible share outstanding. All agents in the model are assumed to be risk neutral. The model takes place over times 0, 1, and 2.

2.1 Firm and Manager

The firm is run by a manager who is compensated based on the short-term (time 1) stock price. The manager is risk neutral and is wealth constrained so that the agency problem cannot be solved by selling the firm to the manager.5

At time 0, the manager of the firm invests in a new project. The project’s payoff is given by \( v = g e + \epsilon \), where \( g > 0 \) captures the firm’s growth potential, \( e \geq 0 \) denotes the manager’s effort choice, and \( \epsilon \) is a normal random variable with mean zero and variance \( \tau^{-1}_v \).

The manager’s effort choice is not observable. The assumption that firm value is increasing in \( e \) captures the idea that more effort on the part of the manager implies a higher average payoff to the firm. Exerting effort is assumed to be costly to the manager. We assume that

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5We make the standard assumption that the manager cannot be compensated based on the long-term value of the firm. The main results of the paper will still go through if we also include a long-term component in the compensation contract, as long as the short-term component of the contract is non-zero.
exerting an effort level of $e$ reduces the manager’s expected utility by $c e^2 / 2$.

In addition to his effort the manager is also able to affect firm value by his choice of the type of project the firm invests in. Project type is parameterized based on the level of project complexity.

**Definition 1** Project complexity is defined as $1 - \delta$ where $\delta$ denotes the probability that the project payoff $v$ will be publicly revealed by the time the large shareholder leaves his job at the mutual fund at time 2.

The above definition of project complexity relates to the horizon of the project. In addition, because date 2 is defined as the date at which the large shareholder leaves his position at the fund, the parameter $\delta$ can also be viewed as a function of the horizon of the large shareholder. For this reason, we assume that the choice of $\delta$ is observed by the manager of the firm and by the large shareholder but not by the market maker (although the market maker will solve for the correct level of complexity in equilibrium).\textsuperscript{6}

**Assumption 1** Project type $\delta \in [\delta_L, \delta_H]$.

While $\delta$ can be any number between zero and one, we assume that the investment opportunity set restricts $\delta$ to be in the above range. We require that $\delta_L > 0$ for the equilibrium to be well defined, but $\delta_H$ can be equal to one without any impact on the results.

The above modeling framework implies that the stock price at time 2 is given by:

$$P_2 = \begin{cases} v, & \text{with probability } \delta \\ P_1, & \text{with probability } 1 - \delta \end{cases}$$

where $P_1$ denotes the equilibrium stock price at time 1.

\textsuperscript{6}The assumption that the large shareholder observes $\delta$ is similar to the standard assumption that he observes the manager’s effort choice (with noise) by obtaining a signal about the value of the project. In contrast, the market maker is never assumed to have the technology to observe this signal and hence, there is no reason to assume he observes $\delta$. 

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The manager leaves the firm at time 1. His compensation is assumed to be a linear function of the time 1 stock price $P_1$. For tractability, we assume that the compensation payment is made by the initial owners of the firm. This ensures that there is no interaction between the managerial contract and equilibrium stock prices, which simplifies our analysis without affecting the payoffs to the different parties.\(^7\)

### 2.2 Large Shareholder and Price Formation

The equity ownership is such that the manager owns a fraction $\omega$ of the firm, a single large shareholder owns a fraction $b$ of the firm, and the rest is held by small shareholders. The large shareholder (the mutual fund manager) has a technology that allows him to collect information about the value of the firm’s investment project after the investment is made at time 0 but before the manager of the firm is compensated at time 1. Specifically, the large shareholder observes the realization of a signal $s = v + \eta$, where $\eta \sim \mathcal{N}(0, \tau_s^{-1})$. The error term $\eta$ is independent of $\epsilon$.

Based on his private information, the large shareholder then submits a market order for $x$ shares. Collecting information is costly in the sense that the precision of the observed signal can be increased at a cost. After the large shareholder observes the type of the investment made (i.e., its complexity) $\delta$ he selects the precision of his signal by incurring a cost of $\kappa \tau^2/2$. This means that the large shareholder observes a signal $s$ with a precision of $\tau_s = \tau_v \tau/(1 - \tau)$.\(^8\) The information technology implies that a higher value of $\tau$ results in a more informative signal.

The large shareholder’s ownership stake, $b$, is assumed to be publicly observable. Finally, the large shareholder expects to leave his position at the mutual fund at time 2. Whether or not his private information is publicly known by that time will depend on the type of the project chosen by the manager of the firm. The objective function of the large shareholder

\(^7\)The same assumption has been made by Holmström and Tirole (1993).

\(^8\)Note that $\tau_s$ is increasing in $\tau$. 
is to maximize the change in the value of his portfolio between time 0 and time 2,\[ \Pi = (x + b)P_2 - xP_1 - bP_0. \]

At time 1, the firm’s shares are traded in a competitive market-making system similar to that of Kyle (1985). In addition to the large shareholder, there are liquidity traders who trade for reasons exogenous to the model. The aggregate demand of these liquidity traders is given by \( u \sim N(0, \tau_u^{-1}) \) and is independent of the stock price \( P_1 \) (and all other random variables in the model). The large shareholder and liquidity traders submit their demands to a risk neutral market maker who sets the price and acts as a counterpart to all trades. The market maker observes the total order flow \( x + u \), but not its individual components. Bertrand competition among market makers leads to zero expected profits, so that \( P_1 \) equals the expected value of a share, conditional on the observed order flow.

### 3 Analysis

In this section, we solve for the equilibrium of the economy defined above. The equilibrium concept we use is that of a Perfect Bayesian Equilibrium (PBE). Formally, a PBE of our economy is:

(i) Managerial choice of effort and investment type which maximize his expected wage.

(ii) The large shareholder’s choice of information collection and demand for the stock which maximize his expected profits. And,

(iii) A pricing rule \( P_1 \) by a competitive market maker who sets the price equal to the expected value of the firm, conditional on the observed order flow and his beliefs about the trading strategy of the large shareholder and the investment decision of the manager of the firm.

Finally, each agent holds beliefs about the other agents’ strategies, and these beliefs have to be correct in equilibrium.
### 3.1 Stock Market Equilibrium

Following Kyle (1985), we consider linear equilibria and conjecture that the price function is given by:

\[ P_1 = \mathbb{E}[v|\mathcal{F}_1^M] = \mathbb{E}[v|\mathcal{F}_0^M] + \lambda (z - \mathbb{E}[z|\mathcal{F}_0^M]), \tag{2} \]

where \( z = x + u \) is the net order flow observed by the market maker and \( \mathcal{F}_1^M (\mathcal{F}_0^M) \) denotes the market maker’s time 1 (time 0) information set: \( \mathcal{F}_0^M = \{b\} \) and \( \mathcal{F}_1^M = \{b, z\} \). Letting \( \hat{e}_M \) denote the managers choice of effort expected by the market maker, we have \( \mathbb{E}[v|\mathcal{F}_0^M] = g\hat{e}_M \). Of course, in equilibrium \( \hat{e}_M = e^* \).

Based on the fund manager’s time 1 information set \( \mathcal{F}_1^B = \{s, \delta, b\} \), the expected payoff of the stock is given by:

\[ \mathbb{E}[v|\mathcal{F}_1^B] = (1 - \tau) g\hat{e}_B + \tau s, \tag{3} \]

where \( \tau = \tau_s/(\tau_v + \tau_s) \) and \( \hat{e}_B \) denotes the large shareholders expectation of the equilibrium effort choice made by the manager of the firm.

Recall that at the end of the fund manager’s planning horizon (time 2), the stock price is equal to \( v \) with probability \( \delta \) and equal to \( P_1 \) with probability \( 1 - \delta \). The fund manager’s optimization problem can then be written as:

\[ \max_x \delta \mathbb{E}[v - P_1|\mathcal{F}_1^B] x + \delta \mathbb{E}[v|\mathcal{F}_1^B] + (1 - \delta) \mathbb{E}[P_1|\mathcal{F}_1^B] b, \tag{4} \]

where:

\[ \mathbb{E}[P_1|\mathcal{F}_1^B] = g\hat{e}_M + \lambda (x - \mathbb{E}[z|\mathcal{F}_0^M]). \tag{5} \]

**Lemma 1** The fund manager’s optimal demand function that maximizes the expected change in the value of his portfolio is given by:

\[ x^* = \frac{1}{2\lambda} \left( \tau (s - g\hat{e}_B) + g\hat{e}_B - g\hat{e}_M \right) + \frac{1}{2} \left( \mathbb{E}[z|\mathcal{F}_0^M] + \frac{1 - \delta}{\delta} b \right) \]
The demand function in Lemma 1 illustrates how the choice of project complexity affects the fund manager’s trading strategy. In the standard Kyle (1985) model, \( \delta \) is assumed to be equal to one and, therefore, the fund manager’s demand never depends on his initial position, \( b \). Once we relax this assumption, we find a new, additional, motive for trading. While the fund manager wants to maximize his trading profits, he is now also concerned about how his trades will affect the future stock price at time 2. Because there is a non-zero probability that his private information will not become public information by the end of his tenure with the mutual fund he now has an additional incentive to shade his trades upwards, regardless of the information he has.

The trading bias is given by the term \( \frac{1-\delta}{\delta} b \). The reason for this upward bias is because in the case that the fund manager’s private information is not revealed by date 2 his remaining shares will be valued based on the interim price \( P_1 \). The extent to which he “biasses” his demand will depend on the size of his initial block \( b \) and the probability \( \delta \). This in turn will be determined by the complexity of the project chosen by the firm. Note, that in equilibrium, this bias will not be reflected in the stock price, as the market maker is assumed to undo the bias completely.\(^9\)

Because \( \hat{e}_B = \hat{e}_M = e \) in equilibrium, we have that \( \mathbb{E}\left[ s - g \hat{e}_B | \mathcal{F}_0^M \right] = 0 \) and hence the expected order flow is given by:

\[
\mathbb{E}\left[ z | \mathcal{F}_0^M \right] = \frac{1 - \hat{\delta}_M b}{\hat{\delta}_M b},
\]

where \( \hat{\delta}_M \) denotes the market maker’s beliefs about project complexity \( \delta \). Hence, we have:

\[
x^* = \frac{1}{2\lambda} \left( \tau (s - g \hat{e}_B) + g \hat{e}_B - g \hat{e}_M \right) + \frac{1}{2} \left( \frac{1 - \delta}{\delta} + \frac{1 - \hat{\delta}_M}{\hat{\delta}_M} \right) b.
\]

**Lemma 2** Given the optimal demand of the fund manager and the demand by the liquidity

\(^9\)This is due to the somewhat strong assumption that the market maker is fully aware of all potential trading biases when deciding on the equilibrium stock price.
traders, the market maker sets the equilibrium price so that he earns zero profits in expectation. The resulting price function is given by:

\[ P_1 = \mathbb{E}[v|\mathcal{F}_0^M] + \frac{\hat{\tau}_M}{2\lambda} \text{var}[v|\mathcal{F}_0^M] \left( z - \mathbb{E}[z|\mathcal{F}_0^M] \right), \]  

(9)

where \( \hat{\tau}_M \) denotes the investor’s signal precision expected by the market maker. The equilibrium price coefficient is equal to:

\[ \lambda = \frac{1}{2} \sqrt{\frac{\tau_v \hat{\tau}_M}{\tau_v}}. \]  

(10)

Lemma 2 is a standard result from Kyle (1985). Note that \( \text{var}[v|\mathcal{F}_0^M] = \tau_v^{-1} \) and \( \text{var}[s|\mathcal{F}_0^M] = \tau_v^{-1} \hat{\tau}_M^{-1} \) because the signal precision \( \tau \) is not observed by the market maker. Substituting these expressions into the above formula and equating the coefficient of \( z \) to \( \lambda \) yields the price coefficient \( \lambda \). In what follows, we will analyze how this price function affects the fund manager’s incentive to collect information as well as the effort choice and choice of project complexity made by the manager of the firm.

### 3.2 Information Acquisition

Prior to making his trade, the fund manager collects information about the future value of the firm’s project. His ex ante expected profit (before he observes his private signal \( s \)) is given by:

\[
\mathbb{E}[\pi|\mathcal{F}_0^B] = \mathbb{E}[\mathbb{E}[P_2 - P_1|\mathcal{F}_1^B] x^* + \mathbb{E}[P_2|\mathcal{F}_1^B] b|\mathcal{F}_0^B] - bP_0
\]

\[= \frac{\delta \tau^2}{4\lambda} \mathbb{E}\left[(s - g\hat{g}B)^2|\mathcal{F}_0^B\right] + (\delta g\hat{g}B + (1 - \delta) g\hat{g}M)b - bg\hat{g}M, \]

(11)

Note that the fund manager observes the firm’s choice of \( \delta \) and that this choice does not depend on the signal precision \( \tau \) as \( \tau \) is not observed by the firm.\(^{10}\) Note also that, in

\(^{10}\)Of course, the choice of \( \delta \) will depend on the signal precision that the manager expects the investor to
equilibrium, the belief’s of the investor and the market maker about $e$ and $\delta$ are correct (i.e., that $\hat{e}_B = \hat{e}_M = e^*$ and $\hat{\delta}_M = \delta^*$).

The fund manager then decides on the optimal level of information collection by choosing the signal precision $\tau$ that maximizes his expected profit.

**Lemma 3** The fund manager’s optimal choice of information precision is given by:

$$
\tau^* = \arg \max_{\tau} \frac{\delta}{4\lambda} \frac{\tau}{\tau_v} - \frac{\kappa}{2} \tau^2, \quad (14)
$$

which yields:

$$
\tau^* = \frac{\delta}{4\lambda \kappa \tau_v}. \quad (15)
$$

Lemma 3 shows that project complexity $\delta$ directly impacts the fund manager’s decision to collect information. In particular, if the manager of the firm chooses a project that is more complex (low $\delta$), the probability that its value will become public by the time the mutual fund manager’s tenure ends at time 2 is small. Therefore, the fund manager’s expected trading profits based on his private information are lower which lead him to spend less on information collection (i.e., choose a lower $\tau$). This insight is a critical component of our analysis and our departing point from much of the earlier literature. In fact, previous papers have argued that more complex or long-term projects are better for the firm as long as there is a large shareholder. However, this argument relied on the implicit assumption that the large shareholder had an infinite horizon. The fact that we model this horizon explicitly allows us to show that long-term or complex projects actually deter information collection.

Finally, by construction $\tau \in [0, 1]$ so that we need to impose the following sufficient condition on the parameters of the model to satisfy the upper bound of this constraint.

**Assumption 2**

$$
\left( \frac{1}{4\kappa^2 \tau_v \tau_u} \right)^{\frac{1}{3}} \leq 1
$$

choose.
Thus, as long as, for example, $\kappa$ is sufficiently large $\tau^*$ will remain below one.

From equations (10) and (15), we can solve for the equilibrium price coefficient as a function of the choice of project complexity and obtain the following:

$$\lambda^*(\delta_M) = \left( \frac{\delta_M \tau_u}{16 \kappa \tau_c^2} \right)^{\frac{1}{3}}. \quad (16)$$

This expression further illustrate the impact that the (expected) project complexity has on the investor’s information collection activities and, hence, on the liquidity of the firm’s stock. As the manager of the firm is expected to select a more complex project, the market maker responds by lowering the sensitivity of the price to the order flow. This reflects the idea that the order flow is less informative about complex long-term projects. Thus, the project’s characteristics also affect the (endogenous) liquidity of the stock.

### 3.3 Managerial Choice of Effort

Up to now we have analyzed the fund manager’s strategic behavior while taking the actions of the manager of the firm as given. In this subsection and the subsection that follows we will consider how the manager’s effort decision and choice of project complexity are affected by his expectation of the trading behavior of the fund manager and the fund manager’s expected level of information collection.

Starting from the assumption that the manager’s compensation is a linear function of the stock price $P_1$ we can write down the managers optimization problem for his choice of effort as follows:

$$\max_{e} \omega E [P_1 | F_0^{MGR}] - \frac{C}{2} e^2, \quad (17)$$

where $F_0^{MGR} = \{\delta, e, b\}$ is the manager’s time 0 information set.

Substituting the fund manager’s optimal demand into the price function in (2) and taking
expectations, we have:

\[ \mathbb{E} \left[ P_1 | \mathcal{F}_0^{MGR} \right] = g \hat{e}_M + \frac{1}{2} (\hat{\tau}_{MGR} g(e - \hat{e}_B) + g(\hat{e}_B - \hat{e}_M)) + \frac{\lambda}{2} \left( \frac{1 - \delta}{\delta - 1} - 1 - \frac{\hat{\delta}_M}{\delta_M} \right) b, \quad (18) \]

Note that the manager does not observe the precision of the fund manager’s signal. For this reason we denote by \( \hat{\tau}_{MGR} \) the signal precision that the manager expects the investor to choose. Hence, the manager’s effort choice \( e \) only affects the expected stock price through its effect on the signal \( s \). The manager does not take its effect on the signal precision into account, because \( e \) is not observed by the investor.

**Lemma 4** The manager’s optimal investment in effort is given by:

\[ e^* = \frac{\omega g}{2e} \hat{\tau}_{MGR}. \quad (19) \]

The above is the standard result for the optimal choice of effort with the addition that effort increases with \( \hat{\tau}_{MGR} \). If the manager of the firm expects the large shareholder to collect information then he expects his effort to impact the signal observed by the fund and therefore the stock price. Then and only then would he spend the private cost of making an effort. As the expected precision of the signal goes up the manager correctly expects the stock price to be more informative about the value of his project. Hence, he will increase his effort. Finally, as the manager’s effort increases firm value also goes up.

### 3.4 Managerial Choice of Project Complexity

The manager of the firm’s choice of project complexity, \( \delta \) solves the following problem:

\[ \max_{\delta \in [\delta_L, \delta_H]} H \equiv \omega \mathbb{E} \left[ P_1 | \mathcal{F}_0^{MGR} \right] - \frac{c}{2} (e^*)^2. \quad (20) \]
When making his investment decision the manager of the firm takes into account the fact that his choice affects the expected stock price $E[P_1 | \mathcal{F}_0^{MGR}]$ and, hence, his expected compensation in two ways. First, it affects the stock price through its effect on the fund manager’s trading strategy (if $b \neq 0$). Second, it influences the fund manager’s optimal choice of signal precision $\tau$ and thus managerial effort and firm value. As mentioned earlier, we assume that the set of available projects is constrained to be within a certain range of complexity levels. In particular, $1 - \delta_L$ and $1 - \delta_H$ represent the minimum and the maximum complexity levels given the set of available projects.

The first-order condition of the above optimization problem can be written as:

$$
\frac{dH}{d\delta} = \partial H \frac{d\hat{e}^*}{d\delta} + \partial H \frac{d\hat{e}^*}{\partial \hat{e} B} \frac{d\hat{e}^*}{d\delta} + \frac{\partial H}{\partial \hat{\tau}^{MGR}} \frac{d\hat{\tau}^{MGR}}{d\delta} + \frac{\partial H}{\partial \delta} |_{\{z\} < 0}.
$$

(21)

Using equations 18, and 19, and the fact that the first term is zero due to the envelope theorem, we have:

$$
\frac{dH}{d\delta} = \frac{\omega^2 g^2}{4c} \left( 1 - \hat{\tau}^{MGR} \right) \left( \frac{1}{4\kappa \tau v \lambda} \right) - \frac{\omega \lambda b}{2\delta^2}.
$$

(22)

The first term is positive because $\hat{\tau}^{MGR} = \tau^* < 1$, while the second term is negative as $b > 0$.

Using equations 15 and 10, the first-order condition can then be written as:

$$
f(y) \equiv -y^3 + h_2 y^2 - h_0 = 0,
$$

(23)

where $y = \delta^2$ and:

$$
h_2 = \left( 4 \kappa^2 \tau v \tau_u \right)^{\frac{1}{3}},
$$

(24)

$$
h_0 = \left( \frac{3 c \kappa \tau u}{\omega} \right) \frac{b}{g^2}.
$$

(25)

Because $h_2$ and $h_0$ are positive, it follows from Descartes’ rule of sign that the polynomial in (23) has at most two positive roots. Thus, a sufficient condition for the first-order condition
to have a unique root in the interval \([0, 1]\) is that the left-hand side of (23) evaluated at \(y = 1\) is positive, i.e.:

\[ h_2 - h_0 < 1. \] (26)

The second-order condition for the root \(y^* \in [0, 1]\) to be a maximum is given by:

\[ y^* > \frac{2h_2}{3}. \] (27)

If this second-order condition is satisfied, it follows immediately from the implicit function theorem that the optimal choice of \(\delta\) is decreasing in the block size \(b\) and increasing in the firm’s “growth opportunities” \(g\). To see this, note that at the maximum:

\[ \frac{df}{dy}\big|_{y=y^*} < 0. \] (28)

Further, because \(h_0\) is increasing in \(b\) and decreasing in \(g\), we have:

\[ \frac{df}{db} < 0 \quad \text{and} \quad \frac{df}{dg} > 0. \] (29)

By the implicit function theorem we then have the following proposition.

**Proposition 1** The optimal project complexity chosen by the firm’s manager is increasing in the ownership stake \(b\) of the mutual fund and decreasing in the firm’s growth opportunities \(g\), i.e.:

\[ \frac{dy^*}{db} < 0 \quad \text{and} \quad \frac{dy^*}{dg} > 0. \] (30)

The first order condition in (23) can be used to show how the optimal choice of project complexity will vary with various microstructure components of the stock price as well as the cost of information collection and the wage contract. Proposition 1 focuses on two specific comparative statics which state that (i) a larger ownership by a mutual fund will result in
firms investing in more complex projects, and that (ii) firms with a higher growth rate will invest in less complex projects.

The intuition for the first result starts with the observation that a larger ownership stake leads to a larger upward bias in the mutual fund’s demand for shares. This bias is larger the more complex the project is (as can be seen from (8)). Thus, a larger block size induces the manager of the firm to select a more complex project in order to increase the short-term stock price.

The intuition for the second result comes from the fact that, as the firm’s growth rate increases, so does the value of making a high effort. Hence, a higher value of $g$ increases the incentive of the manager to invest in projects whose value will be incorporated into the short-term stock price. This is done by investing in less complex and more short-term projects.

The main results derived so far are summarized in the following corollary.

**Corollary 1** A larger ownership stake by the mutual fund leads the manager of the firm to invest in more complex, long-term projects. This, in turn, lowers the fund manager’s incentive to collect information and hence leads to a reduction in effort by the manager of the firm. Thus, larger ownership by mutual funds result in a lower firm value.

The first part of the corollary highlights a result of the model that is similar to the central result derived in Edmans (2009). In both papers it is shown that a larger ownership of shares by ”passive” large shareholders can induce management to invest in long-term projects. However, the underlying reason for this result, and the implications which follow, are very different in the two papers.

Relying on short sale constraints and a large shareholder who is assumed to have essentially an infinite horizon, Edmans (2009) shows that the larger is the ownership of a large shareholder the more information he will collect and thereby the lower will be the level of managerial myopia. In contrast, our analysis relies on the assumption that the large shareholder is an agent (a mutual fund manager) who has a finite horizon. This setting leads us
to conclude that long-term (or as we call them more complex) projects may actually result in less information production. In particular, we show that a larger ownership stake by a mutual fund or a hedge fund manager can lead to a reduction in price informativeness and a decrease in firm value.

In sum, we argue that large ownership stakes controlled by agents with a finite horizon will induce investment in complex long-term projects not because these investments increase firm value but rather because these investments reduce the likelihood that the market will learn about the true value of the project, and hence will allow the large shareholder and the manager of the firm to benefit from manipulating upward the short-term stock price. This is done for the purpose of increasing expected compensation.

It is interesting to note that, both the manager of the firm and the large shareholder would like to increase complexity (i.e., lower $\delta$ ) so as to push up the short-term stock price. While this is the benefit of choosing a more complex project the cost is that it ends up lowering the expected informativeness of the stock price and hence managerial effort and firm value. If one assumes that the market maker observes $\delta$ directly then from equations 8 and 9 one can see that the benefit to the two agents from selecting a more complex project disappears. The reason being that in this case the market maker simply reverses any price manipulation by the large shareholder. In this case then complex projects are always suboptimal and the manager ends up selecting a project with $\delta = \delta_H$.

As mentioned earlier, assuming that the market maker does not observe $\delta$ is equivalent to the standard assumption that the market maker does not observe managerial effort, $e$ even though the large shareholder does (via the signal $s$). Of course, in the equilibrium of the model the market maker correctly anticipates the expected upward bias in order flow and adjusts the price function accordingly.

Furthermore, as we are in a signal jamming equilibrium in which complex projects end up destroying value one could also argue that the manager of the firm may be better off informing the market maker of his choice of $\delta$. However, once the manager informs the market maker
that $\delta = \delta^{**}$ and the market maker selects the price based on this information, it is always in the interest of the manager to select a lower $\delta$ so as to push up the short-term stock price. Any report made by the manager of the firm to the market maker about his choice of $\delta$ would then be non-credible.

In the next section we explore what is the optimal ownership stake of the fund manager.

### 3.5 Optimal Ownership Stake

There may be several approaches to solve for the optimal block size $b$. Our approach in this section is simply to solve for the block size $b^*$ that maximizes the fund manager’s expected profits from trading on his information. Recall that we have assumed that firm value is equal to $V = g e^* + \epsilon$ which is not directly impacted by the activity of the fund manager. One can imagine situations in which $V = V(b)$ is an increasing function whenever the large shareholder also engages in active monitoring of the firm. For the most part, we focus on motivations that are based on trading profits due to private information. Thus, our analysis will highlight the optimal ownership structure when institutional shareholders are passive monitors.

In this setup the fund manager’s objective is to maximize his expected trading profits which can be written as,

$$\max_b \left( \frac{1}{2^5 \kappa \tau_2 \tau_a} \right)^\frac{1}{3} (\delta^*)^\frac{2}{3}$$

Equation 31 shows that the expected profits of the fund manager are maximized when $\delta^*$ is equal to $\delta_H$. This is very intuitive as expected trading profits are highest when there is a high probability that at time 2 the value of the selected project will become public information. The optimal ownership stake, $b^*$, is then set to induce the manager of the firm to invest in the least complex project.

**Lemma 5** The optimal ownership stake of the fund manager, $b^*$, is characterized by equation 23 by substituting $\delta = \delta_H$. Given this solution, any value of $b$ such that $0 \leq b \leq b^*$ will
maximize trading profits as $\delta = \delta_H$ is a corner solution. However, as long as there is a small (exogenous) benefit to having a larger block the unique optimum will be equal to $b^*$. 

As the lemma points out any $b \leq b^*$ would be optimal. Hence, to achieve a unique solution it would be sufficient to have any function of $V$ which is allowed to increase in $b$, say if there was also a small probability that the fund manager would sometimes engage in active monitoring. In the case that the optimal value is indeed equal to $b^*$ we can characterize the optimum and show that it is increasing in $g$. This will lead to the following corollary.

**Corollary 2** When the optimal block size is equal to $b^*$ firm value and block size can be positively correlated in the cross section. In particular, an increase in $g$ will both increase firm value and the optimal block size.

What the above corollary demonstrates is that an empirical test of the relation between institutional ownership and firm value might find a positive correlation. However, our model suggests that this positive correlation may not imply any causation. In fact, our equilibrium shows that larger ownership by mutual funds lowers firm value as it induces more complex investments which in turn deter information collection, lower the informativeness of the stock price, and lower firm value. This is, again, in contrast to previous models that argue that institutional ownership always leads to an increase in information collection and hence in firm value.

### 4 Empirical Implications

Our model demonstrates the importance of the horizon of the mutual fund manager both for the investment of the firm and the extent to which information is produced. We argue that the horizon of the large shareholder is important in relation to the horizon of the firm’s investment projects. While our model suggests that an empirical measure of the mutual fund’s horizon should look at the horizon of the manager of the fund (i.e., the turnover of
fund managers), several recent empirical papers have started analyzing related measures of mutual fund horizon and their impact on the firm.

Bushee (1998) and Wahal and McConnell (2000), for example, look at the impact of institutional investors on managerial investments and find that institutional ownership is associated with lower levels of myopic or short-term investment behavior. However, Bushee (1998) also finds that firms engage in increased manipulation of short-term prices whenever they are held by institutional investors who have a large equity stake and who have a high trading turnover (i.e., shorter horizon). This is consistent with our model as we predict that large institutional ownership will lead to both less myopic investments but also to less informative stock prices. Namely, manipulation can only occur when prices are less informative.

Bøhren, Priestley, and Ødegaard (2005) show that ownership duration appears to match the duration of the firm’s investment projects. This is a basic feature/prediction of our model.

Other recent papers have focused on measuring the holding horizon of large shareholders and seeing whether that impacts their choice of monitoring. For example, Chen, Harford, and Li (2007) show that not all institutions monitor but rather only long-term institutions with large ownership stakes. This suggests that not all institutions engage in active monitoring but rather hold large blocks for other reasons, e.g. trading profits.

Zuckerman (2009) shows that hedge fund managers with large positions in firms also worry about the horizon of their information and try to inform the market about their private information after establishing a position with the firm. This is consistent with our model that starts with the notion that the horizon of the information about firm value can be longer than the horizon of the large shareholder.

Xu (2009) analyzes the horizon of managerial contracts and shows that managers with short horizons invest less but with no impact on performance. Our model suggests that while managerial employment horizon is important, one must also control for the horizon of the large shareholders as this will impact the choice of the manager too.

Finally, Derrien, Kecskés, and Thesmar (2009) find that the presence of short-term in-
vestors is associated with shorter horizon investments for those firms that are most mispriced (under-valued). Our model suggests that these two observations are linked as the existence of short term large shareholders should lead to both less information collection and more short term projects.

5 Conclusion

In this paper, we analyze the impact of a large shareholder on a firm’s investments when the large shareholder is himself a mutual fund or hedge fund manager. We show that the large shareholder’s incentive to collect information and trade on it depends on the complexity or horizon of the firm’s investment, as measure by the time it will take for the market to understand the true value of the project. In particular, we find that more complex projects lead the fund manager to bias upward his demand for the stock. This bias is exacerbated the larger is the funds equity position in the firm. This bias in trading, in turn, provides the manager of the firm an added incentive to invest in more complex long-term projects. The resulting equilibrium is such that larger ownership by institutional investors leads firms to invest in complex long-term projects and hence to (endogenously) less informative stock prices. Unlike individual large shareholders who may monitor and increase firm value, our findings suggest that large shareholders who are agents themselves may indirectly lead to lower firm value.
References


