Informativeness of Managerial Stock Ownership and Market Reaction to Stock Repurchase Announcements

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Abstract

This paper analyzes the role of managerial stock ownership in the alleviation of information asymmetries between the firm and the market in the context of open-market stock repurchases. We develop a model of endogenous stock ownership and repurchase announcement decisions by the manager. The main prediction of the model is that higher managerial shareholdings prior to the repurchase announcement add credibility to the undervaluation signal and result in higher announcement returns. In addition, this relationship is stronger in firms that have a higher degree of information asymmetry with the market. These predictions are confirmed empirically. We find evidence that managers believe their company's stock is undervalued when they announce repurchases. Our analysis of open-market repurchase announcement data demonstrates that the fraction of the company's shares owned by the managers is a strong predictor of announcement returns. Consistent with the model, we find that managerial shareholdings are particularly informative for firms that have high information asymmetry with the market.

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1 Introduction

The announcement by a firm that it plans to repurchase some of its stock on the open market is viewed as good news by the stock market, and positive abnormal announcement returns have been documented extensively in the literature (e.g., Ikenberry, Lakonishok, and Vermaelen, 1995; Grullon and Michaely, 2002). The positive price reaction can be triggered by the repurchase announcement signal that the firm's stock is currently undervalued or by an anticipated reduction of the agency costs of free cash flow[1]. Insiders (CFOs and treasurers) who make the announcement decision[2] rank stock undervaluation as the primary reason for a firm's decision to repurchase its stock (Brav, Graham, Harvey, and Michaely, 2005). However, a firm's announcement that it plans to repurchase shares on the open market does not obligate the firm to do so, and the claim that the firm's stock is undervalued is generally unsupported by verifiable information.

The key insight of this paper is that the observed level of managerial shareholdings contains information that *complements* the information content of a share repurchase announcement. That is, the size of the share repurchase program is not by itself a sufficient statistic for the private information of managers in the firm. In particular, a high level of stock ownership by the managers prior to the announcement indicates that the managers who determine the repurchase policy are likely to believe that the stock is undervalued. Our empirical evidence indicates that high managerial shareholdings are associated with a stronger market price reaction to announcements of open-market share repurchases.

The model proposed in this paper illustrates the economic relationship between the level of managerial shareholdings, perceived stock undervaluation, and announcement returns. The main premise of the model is that the firm's management has information about the firm's value that is superior to the information available to outside investors. The manager signals the true value of the firm via a combination of two actions—choosing his optimal shareholdings at the individ-

[1] The sources of announcement returns are discussed in Vermaelen (1981), Comment and Jarrel (1991), Nohel and Tarhan (1998), Dittmar (2000), Lie (2000), Chan, Ikenberry, Lee (2004a), Grullon and Michaely (2004) among others.

[2] Although executives typically need to obtain a repurchase authorization from the board of directors, it is the executives who decide to initiate a repurchase program (Fried, 2001).

ual level and making a repurchase announcement at the company level. This idea builds on the prior literature on asymmetric information, in which firms can signal private information through managerial equity holdings (Leland and Pyle, 1977) and a stock repurchase announcement (Constantinides and Grundy, 1990; Oded, 2005).

In the model of Constantinides and Grundy (1990), a risk-neutral manager signals the true value of the firm through a stock repurchase and the issuance of a senior debt security. Their model assumes that the number of shares owned by the manager is constant and set exogenously. Oded (2005) also models the ability of stock repurchase announcements to signal information held privately by the firm. His model provides an elegant theoretical explanation for positive announcement returns, but does not consider the signaling ability of managerial stock ownership. The model developed in this paper endogenizes managerial shareholdings, thereby addressing the private incentives of the manager, which determine his decision to announce a stock repurchase.

Using the model in Oded (2005) as the starting point, we introduce a managerial trading decision prior to the announcement of the stock repurchase. With some probability, the manager receives private information about the value of the firm and trades on this information with an objective of maximizing his terminal wealth. The more favorable the information revealed to the manager, the more shares the manager buys. We also allow for the possibility that the manager does not learn the value of the firm. In this case, the manager may trade for an exogenous reason; for example, in order to increase his voting power. After reaching the optimal level of stock ownership given his private information, the manager considers whether to announce a stock repurchase. The information about the repurchase announcement complements the earlier signal from the manager's trading decision. We show that in a separating equilibrium, the firm (i.e., the manager) announces a stock repurchase if and only if the manager observes favorable information about the firm's value and, consequently, perceives the firm's stock to be currently undervalued. A repurchase announcement causes a price increase in equilibrium because the manager reveals the high firm value by making the announcement coupled with his earlier stock purchase. An important feature of the model is that the degree of perceived undervaluation (and subse-

quent price correction) is positively related to the level of managerial shareholdings because both undervaluation and managerial shareholdings increase in the level of the firm's value as it is revealed to the manager. This motivates *the first key prediction of the model that the magnitude of the price increase at the time of the announcement is greater when the managerial stock ownership is higher.* The second prediction of the model is that the price reaction to the announcement is greater in firms that have a higher degree of information asymmetry with the market. These predictions are confirmed by our empirical results.

As the first step towards understanding the market price reaction to repurchase announcements, we investigate whether managerial trading around the announcements is consistent with managers' belief that the firm's stock is undervalued. Whenever the stock price is below the equity valuation by a firm's insiders, it is reasonable to expect the insiders to reap benefits from their private information both by increasing their personal stock ownership in the firm and by repurchasing stock at the level of the firm. The literature agrees that announcements of larger repurchase programs indicate a stronger degree of undervaluation (Vermaelen, 1981; Comment and Jarrell, 1991). We establish an empirical connection between two observable outcomes of the managers' perceived undervaluation—the level of managerial shareholdings and the target repurchase amount. Our analysis shows that managers are more likely to increase their shareholdings in the announcement year when larger repurchase programs are announced. We conclude that managers' trading decisions at the firm and personal levels reflect their belief that the firm's stock is undervalued at the time they announce open-market repurchase programs.[3]

Next, we test the model's predictions by investigating whether investors incorporate the information about managerial shareholdings in forming their reaction to repurchase announcements. We explain announcement returns with managerial

[3]This result is similar to earlier findings by Lee, Mikkelson, and Partch (1992) and D'Mello and Shroff (2000), who document that managers' purchases increase and sales decrease prior to self-tender repurchase offers. However, Chan, Ikenberry and Lee (2004b) find that insiders of firms announcing open-market share repurchases both sell and buy their companies' shares more frequently than insiders of matching firms. We focus on the net outcome of insider trading and show that the shareholdings of the top five managers increase in most years when repurchase announcements take place.

shareholdings, program size, cash holdings, and a set of control variables. Consistent with the first prediction of the model, our empirical results for the full sample of announcements indicate that a high level of executive stock ownership adds credibility to the firm's message that its stock is undervalued and predicts greater announcement returns. Moreover, consistent with the second prediction of the model, we find that information on managerial shareholdings is particularly valuable to market participants when the announcing firm has a high degree of asymmetric information with the market, measured by the dispersion of analysts' earnings forecasts, number of analysts making the forecasts, market-adjusted volatility of stock returns, and firm size. This evidence may indicate that investors believe that pricing is less efficient for these companies (because analysts tend to disagree about future earnings, returns are highly volatile, small firms receive less media attention and are less transparent) and turn to additional sources of information in order to assess whether a firm's stock is undervalued. We find that for more transparent firms that have low information asymmetry with the market, outside investors rely on the repurchase program size, rather than managerial shareholdings, as the main source of information.

Managerial shareholdings are also informative when repurchase announcements are made by firms with relatively little cash, with low free cash flow, and that are highly leveraged. The agency problems of free cash flow tend to be small in these firms because their cash resources are limited or used primarily to service debt. For these firms, the primary cause of the announcement reaction is the implied undervaluation signal; this logic is substantiated by the high explanatory power of the managerial stock ownership variable in the econometric results for these firms.

We also test whether the managerial entrenchment aspect of the quality of corporate governance can affect the informativeness of managerial shareholdings. We use the managerial entrenchment index (Bebchuk, Cohen, and Ferrell, 2005) to divide the sample firms into subsamples of firms with good and poor governance and find that managerial shareholdings are equally informative regardless of the potential entrenchment issues. This can be interpreted as evidence of a similar degree of undervaluation in both groups of firms when they make repurchase announcements. An interesting side-result is that the announcement returns are sensitive to cash holdings only in firms with poor governance. These firms can

benefit from a reduction in free cash flow more than firms with good governance because shareholders in firms with poor governance have little ability to prevent inefficient uses of cash by the management. Our findings are consistent with the presence of the free cash flow (efficiency) component of announcement returns.

A positive association between the fraction of insider holdings and abnormal returns at the time of tender offer repurchase announcements has been documented by Vermaelen (1981, 1984) and by Comment and Jarrell (1991). However, tender offer share repurchases and open-market share repurchases have different informational structures. A firm conducting a tender offer repurchase typically pays the selling shareholders a premium over the firm's stock price at the announcement day. This premium informs the market about the managers' beliefs regarding the intrinsic value of the firm. In contrast, the market has no such information in the case of open-market repurchase announcements because the announcing firm does not commit itself to a specific price at which it plans to repurchase shares. Firms in the U.S. do not report either dates or prices of their open-market buyback transactions. Since over 90% of stock repurchases in the U.S. currently belong to the open-market type, the model and empirical findings in this study are of particular interest. To the best of our knowledge, this is the first study to find that managerial stock ownership can predict the magnitude of announcement returns of open market repurchase programs.

Our model and empirical results demonstrate the importance of considering the private incentives of managers as the decision makers who determine payout and, indirectly, investment policies. Besides the literature on corporate payouts and the market reaction to payout changes, this paper contributes to the literature on insider trading. The insider trading literature documents that insiders typically outperform the market in their trades (Seyhun, 1986; Lakonishok and Lee, 2001) and concludes that insider trades (particularly, purchase decisions) can be informative to outsiders. A somewhat perplexing finding in that literature is that the market is slow to incorporate information on insider trading, and the price reaction around trade reporting dates is insignificant. Our model and empirical results rationalize the market underreaction to changes in the level of managerial shareholdings. The information content of managerial trades is discounted because, from the market's perspective, these trades could have taken place for exogenous

reasons. The evidence presented in this paper supports this interpretation. Another piece of information, such as a repurchase announcement, is instrumental in informing the market about managers' beliefs regarding the intrinsic value of the firm's stock. Observing the announcement gives the market a significantly better ability to interpret earlier managerial trades and to adjust the stock price accordingly.

The paper is organized as follows. Section 2 presents the theoretical model and formulates testable hypotheses. Section 3 considers these hypotheses in the context of the existing empirical literature. Section 4 presents the data sources and defines variables used in the empirical model. Summary statistics are reported in section 5. The results of the empirical tests are discussed in section 6. The last section concludes.

2 Model

In this section, we propose a comprehensive model of the manager's decisions regarding the optimal level of his shareholdings, the repurchase announcement, and the repurchase execution. The terminal value of the firm is uncertain, and the manager can possess information about the firm's value that is superior to that of the other shareholders and the market maker. The manager is risk-neutral and maximizes his expected wealth, which is simply his expected profit from buying shares at the initial date and liquidating his shareholdings at the terminal date. The market maker, original shareholders, and outsiders (potential new shareholders) are competitive and risk neutral. Based on the manager's actions, the market maker forms posterior beliefs about the firm's value and sets market prices in each period.

Since the manager is the sole decision maker in the firm, the firm's decisions are equivalent to the manager's decisions. This means that the manager announces and conducts a stock repurchase only if it is profitable to him individually. In order to isolate the role of information on managerial shareholdings around repurchase announcements, we make several simplifications. In particular, we assume that there is no discounting, that the firm does not increase or decrease its payouts through dividends, and that events happening to other firms or securities do not

influence the price of the firm's shares.

In order to derive conditions for the sequential equilibrium, the model also incorporates the firm's decision to conduct actual repurchase activity. In equilibrium, the manager announces a repurchase program if and only if the firm's stock is undervalued according to his private information. The equilibrium number of shares he holds before the announcement directly corresponds to the degree of perceived stock undervaluation. This reflects the economic relationship between managerial shareholdings and stock undervaluation that motivates this paper.

Our model builds on the model presented by Oded (2005), whose primary objective is to explain the positive price reaction to a repurchase announcement. We take the next step and model the incentives of the agent who makes the announcement decision, namely, the manager. In order to investigate the relationship between the announcement effect and the level of managerial shareholdings, we add the managerial trading dimension to Oded's model. The manager receives information about the firm's value in two stages, while other shareholders have the same information that the market maker has. In Oded's setup, the announcement decision is made to maximize the stock value of all original shareholders. In the model here, the firm's announcement and repurchase decisions are the outcome of the manager's private profit maximization.

The timeline and notation The timeline of information flow and actions of the agents is presented in Figure 1. Initially, all agents have the same information about the value of the company:

$$\begin{aligned} V &= \theta + a \text{ with probability } q \\ V &= \theta - a \text{ with probability } 1-q \end{aligned} \tag{1}$$

where θ is the fixed value of assets in place and $a \subseteq \{a_0, a_1, a_2\}$ is a uniformly distributed state of the future cash flows from an investment project. A greater value of a corresponds to greater investment opportunities. We call $\theta + a$ and $\theta - a$ the "up" and "down" states, respectively.

Define $\overline{a}$ as the unconditional expected value of a, equal to the arithmetic mean $(a_0 + a_1 + a_2)/3$. The relative magnitudes of the firm value parameters are

$$\theta > a_2 > a_1 > \overline{a} > a_0 > 0 \tag{2}$$

The assumption that $\theta > a_i, \forall i$ guarantees that value of the firm is positive irrespective of the final state. Inequality (2) implies that a_1 and a_2 are the good states relative to the unconditional expected value $\overline{a}$ or state a_0. Assume that $q > \frac{1}{2}$. This assumption, together with (2), implies that the expected firm value $E[V] = \theta + (2q-1)\overline{a}$ increases in the expected size of the project, which is also true for the conditional expectation when a is revealed to the agent. The firm originally has N shares outstanding, and the manager holds no shares of his firm before he gets an opportunity to buy shares at date 0.

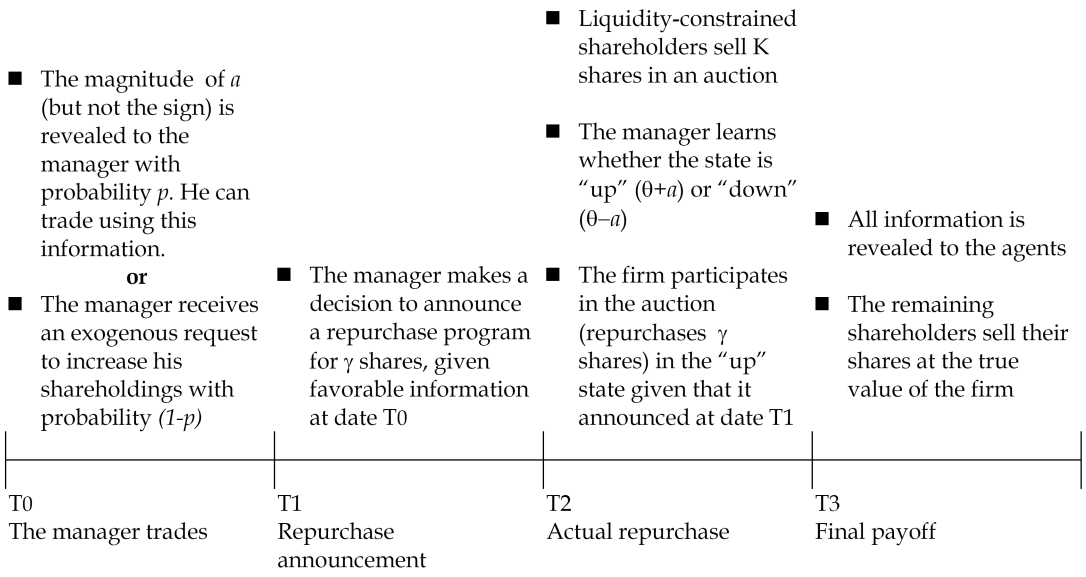

Figure 1. The timeline of information flow and actions of the agents.

Date 0 (The manager's trading date) With probability p, the manager receives precise private information about the project size a. We call the information about the firm favorable if the revealed projec size is either a_1 or a_2. The value of p is a common knowledge. The manager does not have any information yet as to whether the state will be up or down, i.e. $\theta + a$ or $\theta - a$. The manager

is allowed to trade at date 0, but cannot short the stock of his company. Since he starts with zero shares, his trades can only be nonnegative. Without a loss of generality, assume that the manager can purchase one or two shares. The actual numbers are unimportant and used only to identify whether he is in the "high shareholdings" or "low shareholdings" state. The manager may decide not to trade at all if the revealed information is unfavorable. The set of possible trades is $\{0, +1, +2\}$. The two cases of interest here are when the managerial shareholdings become "high" (the manager bought +2 shares) and "low" (the manager bought +1 shares).

The manager's optimization function at date 0 is his expected profit from buying i shares at this date and making an announcement decision s from the set $\{A, NA\}$ at date 1, where A and NA are "announce" and "do not announce" decisions, respectively. The manager chooses the size of his trade according to the following function

$$\max_{i,s\in\{A,NA\}} iE_0\left[\left(\frac{K}{N}P_2 + \left(1-\frac{K}{N}\right)P_3\right)\right] - iP_0(i) - 1_A\varepsilon \tag{3}$$

where $P_0(j)$, P_2 and P_3 are the market prices at dates 0, 2, and 3, respectively, 1_A is an indicator function equal to 1 if the manager announced a repurchase program, and ε is a very small ($\varepsilon \to 0+$) transaction cost of making the announcement. This cost is introduced solely to clarify the manager's actions when he holds zero shares after date 0 and, consequently, will earn zero future profits regardless of his actions. It is negligibly small, the same for all manager types, and, therefore, cannot be used for creating separating equilibria. When the manager is indifferent between announcing or not announcing, he chooses not to announce because of ε. This assumption is realistic (see the discussion of administrative costs associated with repurchase announcements in Fried, 2001). An alternative interpretation of the cost assumption is that when the manager has no private benefits from the optimal repurchase decision, he maximizes the firm's value for the existing shareholders.

Note that since K out of N shares are sold by the original shareholders in the date 2 auction, the probability that each of the manager's shares will have to be sold at date 2 is $\frac{K}{N}$. Thus, equation (3) illustrates that, with probability $\frac{K}{N}$, the

manager receives price P_2 for each of the shares he sells at date 2 and price P_3 for each share sold with the remaining probability $\left(1-\frac{K}{N}\right)$ at date 3.

With a complementary probability, $1-p$, the manager does not receive information about a_i at date 0. Instead, he encounters an exogenous need to increase his shareholdings by the following quantities: $\{0,+1,+2\}$, with equal probabilities $\frac{1}{3}$ for each mandatory trade. Obviously, the zero trade means no trade is required. The exogenous requirement is uncorrelated with any economic variable, such as the value of the firm. Examples of the economic circumstances in which this mandatory trading can arise include: (1) the manager needs to buy stock to increase his voting power; (2) the board makes a new rule that the manager must hold the minimum number of shares; (3) the manager needs to prove his long-term commitment to the firm to suppliers or clients. When the manager encounters an exogenous reason to trade, the cost of avoiding or altering this trade strategy is prohibitively high. The consequence of the existence of states in which the manager is uninformed is that the true project state is not fully revealed to the market based only on the manager's trade and announcement decisions, that is, before the actual repurchase stage.

If the manager knows the size of the project, his optimal trading strategy is described by Lemma 1.

Lemma 1 *The manager receiving information a_i places a purchase order for i shares in equilibrium.*

Proof. See the Appendix. ■

The existence of the described separating equilibrium requires certain restrictions on the values of p in terms of other parameters (a_i, K, N, and γ) summarized in equations (27) of the Appendix.

Since the market maker is competitive and risk-neutral, the equilibrium price schedule after observing the managerial trade $i \subseteq \{0,1,2\}$ is:

$$P_0(i) = \frac{1}{N} E_0[V|Order=i] = \frac{\theta}{N} + (2q-1)\frac{pa_i + (1-p)\overline{a}}{N} \tag{4}$$

If the manager learns the realization of the project size a_i, his conditional expectation of the firm's value per share is different from the market price (4).

Conditional on observing a given a_i, the market price from the informed manager's point of view should be

$$P_0^{'}(i, a_i) = \frac{1}{N} E_0[V|a_i] = \frac{\theta}{N} + (2q - 1)\frac{a_i}{N} \tag{5}$$

Observe that $P_0^{'}(i, a_i) > P_0(i)$ only for trades $i = 1$ and $i = 2$. This means that the manager considers the stock undervalued if and only if he observes one of the two favorable values of the project (a_1 or a_2). The discussion of events at date 1 shows that a repurchase announcement can partially correct this undervaluation.

Date 1 (The announcement date) The manager has an opportunity to announce an open-market share repurchase program at date 1. The announcement gives the firm an option, but not an obligation to repurchase stock at the next date. Assume the manager cannot trade at the time of the announcement. This assumption is standard in signaling models and is needed to obtain a separating equilibrium. No new information about the true value of the firm is revealed to the manager at this date. However, the market price changes in this period because the market maker updates her expectation of the firm's value based on whether the manager announces or does not announce a repurchase.

The manager's optimization function at date 1 is to choose from the set $\{A, NA\}$, given that his trade was i at date 0. His information set at date 1 depends on whether the trade was motivated by the information about the project size or by the exogenous reason. The expected wealth function is the same in either case:

$$\max_{s \in \{A, NA\}} E_1 \left[i \left(\frac{K}{N} P_2 + \left(1 - \frac{K}{N} \right) P_3 \right) \right] - 1_A \varepsilon \tag{6}$$

We conjecture an equilibrium strategy according to which the manager announces a repurchase program if and only if he learned favorable information (a_1 or a_2) at date 1. The conjecture is formalized in Lemma 2.

Lemma 2 *In equilibrium, the manager makes a repurchase announcement at date 1 if and only if he observed states a_1 or a_2 at date 0.*

Proof. See the Appendix. ■

To summarize the two lemmas, there are five pairs (shares traded, announcement) of equilibrium decisions the manager can make and the market observes at dates 0 and 1: $(1, A)$, $(2, A)$, $(1, NA)$, $(2, NA)$, and $(0, NA)$.

For the first four combinations of the announcement action and the manager's trade, the market maker and other agents know with certainty which state of a the manager learned at date 0. For example, if the manager purchased $i = 2$ shares at date 0 and made the announcement at date 1 (pair $(2, A)$), then the market knows that a is a_2 with certainty. If the manager purchased $i = 2$ shares and did not announce (pair $(2, NA)$), then the market maker knows with certainty that the manager did not observe the magnitude of a, but traded for the exogenous reason. In this case, the market's expectation of a is $E_1[a|2, NA] = \overline{a}$. The equilibrium strategy in Lemma 2 implies that the manager does not announce if he either observed state a_0 or learned no information and did not trade at date 0 (pair $(0, NA)$). After observing event $(0, NA)$, the market maker does not know the value of a with certainty at date 1, and the expected size of the project is $E_1[a|0, NA] = pa_0 + (1 - p)\,\overline{a}$.

An important feature of the equilibrium is that the manager announces if and only if he perceives the stock to be undervalued. The announcement leads to an increase in the market price relative to the price at date 0—the central result of the model in Oded (2005). Since this result is not the focus of our model, it is illustrated mathematically in the Appendix.

Date 2 (The Repurchase Date) The structure of the actual repurchase process is modeled very similarly to the model in Oded (2005). A subset of shareholders becomes liquidity-constrained at date 2 and offers a total of K shares for sale in an auction. The buyers of these shares can be outsiders and the repurchasing firm. For simplicity, we assume the manager cannot increase his shareholdings at this date, but can be among the original shareholders who must sell at this date. Since the firm originally has N shares outstanding, the probability that each share will be sold at date 2 is K/N. This probability is known to all agents since date 0 and is constant over time.

The K shares are offered to $M \geq 2$ bidders. Each outside bidder bids for the whole quantity K. The selling price is set at the highest price at which demand

equals supply. Bids higher than the selling price are fully satisfied, and the rest are allocated equally to the bidders who bid at the clearing price.

At this date, the manager learns the second piece of information about the firm's value—that is, whether it is in the "up" state $\theta + a$ or the "down" state $\theta - a$. The manager may also know the project size a_i if he learned it at date 0. We assume that the manager who does not know the magnitude of the project from date 0, learns only the sign before a, but is still uninformed about the magnitude of a. This assumption does not affect our results in any way, but is needed for concreteness. Even if the manager does not know the magnitude of a, he still considers the "up" state favorable because it suggests a higher expected value of the firm. Thus, if the manager observes the "up" state, the firm places a bid for the full size γ of its repurchase program, where $\gamma < K$, in the auction. The firm does not participate in the auction in the "down" state. The rest of the bidders cannot observe the firm's bidding behavior and cannot infer whether the state is "up" or "down" until after date 2.

As in the model of Oded (2005), an important feature of our model is that the firm can exploit its private information by repurchasing shares. This is enabled by giving the firm an advantage in the bidding process in the auction. Since the firm knows the state precisely, it always overbids other bidders and buys the desired quantity γ in the auction. The outside bidders get only $K - \gamma$ shares in the "up" state. Since the bidders are risk-neutral and competitive, they make zero profit in equilibrium. The price at date 2 is derived from the zero-profit condition in the appendix.

Date 3 (Liquidating Payoff) At date 3, the state is revealed to all agents. The manager realizes his profit by selling his shares. The market price P_3 is equal to the true firm value less cash spent on the repurchase, if any, and divided by the number of shares outstanding (see the Appendix).

Having described all the events captured by the model, our main conclusions are stated in the following two propositions. First, we show that the announcement price effect is always positive in equilibrium, and that the price rises more when the manager holds more shares. The high and low shareholding states in our model occur when the manager traded 2 and 1 shares at date 0, respectively. The price

increase can be equivalently expressed as either a simple price difference $(P_1 - P_0)$ or the announcement return $(P_1 - P_0)/P_0$.

Proposition 1 *The equilibrium market price increases by more at the announcement date if the manager holds more shares at that date.*

Proof. See the Appendix. ■

Next, we show that the effect of managerial shareholdings on the announcement price increase and returns is stronger when uncertainty about the firm's value is greater. Uncertainty is measured by the variance of the firm's value V, which directly depends on the variance of the distribution of the project size, in particular, the spread between a_1 and a_2. This measure can also be considered to be a measure of information asymmetry between the manager and the market because only the market maker is uncertain about the project's size, while the manager who makes the announcement is perfectly informed.

Proposition 2 *The difference between announcement price effects in high managerial shareholding and low managerial shareholding states increases in the uncertainty about the firm's value.*

Proof. *See the Appendix.* ■

The next section discusses how various features of our equilibrium solution correspond to the existing literature on stock repurchases.

3 Related Literature and Formulation of Empirical Hypotheses

Observed positive abnormal returns around repurchase announcement events indicate that investors do not fully anticipate these events and revise their expectations about the prospects of the firm. The revision of expectations can arise from multiple (not necessarily mutually exclusive) sources. Dittmar (2000) provides a comprehensive overview of the literature on firms' motives to conduct stock repurchases, which include undervaluation signaling motives, distribution of excess capital in order to mitigate agency problems, preferential tax treatment,

takeover deterrence, adjustments of capital structure, bondholder wealth expropriation, earnings management, and supporting employee stock option programs. Based on the analysis of long-term post-announcement returns, Chan, Ikenberry, and Lee (2004a) rank stock undervaluation and intention to distribute free cash flow as the most important reasons for firms to initiate repurchase programs. Consequently, there are two corresponding components of the market's reaction to the announcement, which we call here for simplicity "undervaluation" and "efficiency" components. Our model focuses on how managerial shareholdings, coupled with a repurchase announcement, can signal that a stock is undervalued. The first part of this section elaborates on the economics of the undervaluation component and states the model's predictions in a form convenient for their empirical verification. In the second part of this section, we discuss the efficiency component of the announcement effect and then set out our empirical procedures.

3.1 Undervaluation Signaling

Our model shows that the managers can signal to the market that their company's stock is currently undervalued[4] by increasing their shareholdings and announcing a repurchase program. Since investors recognize that the firm's managers may possess insider information which is superior to that available to the public, they adjust their expectations of the firm's prospects upwards after observing the announcement; the share price then increases. The magnitude of the announcement return depends on the credibility of the undervaluation message conveyed by the decisions of the top management. In particular, the market believes the stock is more undervalued if the managers' stock ownership is relatively high at the time of the announcement. The intuition of our model is supported by the literature on stock repurchases, which we review in this section.

According to the results of a recent survey of corporate executives (Brav, Graham, Harvey, and Michaely, 2005), CFOs and treasurers consider stock undervaluation (defined as "our stock is a good investment relative to its true value") to be the most important reason for repurchase announcements. Second in importance is the desire to convey information about the company to investors, with

[4] One can argue about similarities and differences between the terms "mispricing" and "undervaluation". The term is used interchangeably in this paper.

84.5% of executives considering it important or very important. D'Mello and Shroff (2000) use an earnings-based model to show that 74% of firms that made tender offer repurchases during the period 1970–89 were undervalued and conclude that managers repurchased stock to reveal their private information about a firm's prospects. Since in tender offer repurchases the firm pays a premium over the current market price to the selling shareholders, it is clear that tender offers can serve as a credible signal of undervaluation before the announcement. In the case of open-market repurchases, the announcing firm can repurchase shares at any price it deems fair during the next several years before the repurchase program expires. The managers' implicit or explicit claim that the stock is undervalued at the time of the announcement is not necessarily believable, and the market searches for ways to evaluate the credibility of this claim.

The undervaluation signal would be credible either if the managers incurred costs to send the signal or if the costs of a false signal exceeded the corresponding benefits. It is conventional for the repurchase literature to consider the undervaluation signal as consisting of one piece—the announcement itself. A false undervaluation signal would mean an announcement was made when the managers do not believe the stock to be undervalued. The contribution of this paper is to view the undervaluation signal as potentially consisting of two parts: the announcement and the observable level of managerial stock ownership.

The firm's costs of making a repurchase announcement are almost negligible. If the firm makes a false repurchase announcement, it is not obligated to repurchase stock at prices higher than the intrinsic value. Only 22.5% of executives believe that there are negative consequences to reducing repurchases (Brav et al., 2005). Thus, the major cost of making a false announcement can be avoided. Fried (2001) lists two types of small announcement costs that are incurred regardless of the quality of the signal. One is a transaction cost, which involves the time required for managers, company lawyers, investment bankers, and the board to develop, discuss, and vote on a repurchase proposal. The other is the opportunity cost of not being able to make another repurchase announcement in the near future. When managers plan to sell their shares, they can benefit by boosting the stock price with a repurchase announcement and selling their shares at a higher price. By announcing a repurchase sooner, they may be losing an opportunity to capture

the benefit of an announcement price effect in the future when they need to sell another large amount of stock. The next repurchase announcement can come only after the first program has been completed or has expired. This opportunity cost is likely to be small because, if the stock is undervalued, the firm can complete its repurchase program and initiate a new one, and if the stock is overvalued the managers do not need a repurchase announcement to boost the price in order to sell their shares at favorable prices.

Since managers cannot signal undervaluation with the firm's announcement costs, they can improve its credibility through purchasing or holding a high stake in the company's shares. In such cases, a false signal occurs if the managers purchase shares (or have high shareholdings as a result of this purchase) and make a stock repurchase announcement when they do not think the stock is undervalued. Our model shows that the managers' profits are lower if they attempt to send the false signal. Therefore, the market can recognize a credible signal if the managers purchase shares of their firm or avoid excessive selling of their shares shortly before the announcement. Jenter (2005) documents a strong empirical relationship between market valuations as they are perceived by managers and managerial trading, even after controlling for rebalancing and diversification motives. This evidence is consistent with Lemma 1 of our model, which predicts that the manager buys more shares when he observes a higher undervaluation. Using data on changes in managerial shareholdings in the repurchase announcement year, we verify the connection between stock undervaluation and managerial trading as our first empirical result in section 6.1.

Managers can enhance the credibility of the undervaluation signal not only by trading and increasing their shareholdings, but also by owning a significant amount of the company's stock at the time of a repurchase announcement. This is the intuition of the first prediction of our model made in Proposition 1. This argument is valid both if the managers deliberately send a signal to the market with their private shareholdings and if the information on managerial stock ownership is used by the market without the managers' intent. Leland and Pyle (1977) also show that large managerial stock ownership is a good signal of the value of the firm in the presence of informational asymmetries. Managers with a large stock ownership benefit more from the positive price revision following the announcement if the

signal is true (Fried, 2001). In addition, managers who own a high percentage of their company's stock also demonstrate that they are willing to carry the cost of the lower liquidity and lower diversification of their portfolio, which also includes their human capital committed to the firm. This discussion motivates the first testable hypothesis which corresponds to Proposition 1 of the model:
H1: Higher managerial stock ownership before a repurchase announcement is associated with a higher degree of stock undervaluation and higher announcement returns.

The second prediction of our model, stated in Proposition 2, is that managerial stock ownership is not a uniformly useful source of information across firms. The economic intuition is the following. When pricing of the stock is highly efficient—that is, when there is little disagreement about the firm's valuation—managerial shareholdings provide little incremental information to the market. The informational value of managerial shareholdings is higher if the market is more uncertain about the firm's prospects. Given that the firm is better informed about its expected future performance than the market, the higher uncertainty is equivalent to a higher information asymmetry between the market and the firm. The intuition of this argument stands behind Proposition 2 of the model. In order to take Proposition 2 to the data, we can separately test the strength of the relationship between announcement returns and managerial shareholdings in firms with high and low information asymmetry with the market. We would expect to find a more statistically significant relationship in the high asymmetry group of firms. We formulate the described test of predictions of Proposition 2 in our second testable hypothesis:
H2: Higher managerial stock ownership is associated with higher announcement returns only for the firms that have a high degree of information asymmetry with the market.

We adopt several measures of how well the market can be informed about the firm's future prospects, such as (1) the dispersion of analysts' earnings forecasts, (2) the number of analysts making the forecasts, (3) the volatility of market-adjusted returns, and (4) the firm's size. Diether, Malloy, and Scherbina (2002) maintain that dispersion of analysts' earnings forecasts is a good proxy for differences in opinion among investors. A more informed market has less disagreement

about the firm's future earnings and exhibits a lower dispersion of forecasts. When the dispersion is high, the market lacks unequivocal information that could unify investors' opinions, and there is a higher degree of information asymmetry between the firm managers and the market. The remaining three measures (number of analysts, returns volatility, and firm size) have also been used in the literature as proxies for asymmetric information (see Corwin, 2003; and Krishnaswami and Subramaniam, 1999).

3.2 The Efficiency Component of Announcement Returns

Besides the undervaluation effect, a portion of the announcement return can be due to the anticipated efficiency gains from repurchases. The repurchase announcement can inform the market that future cash flows are likely to improve because of more efficient capital utilization by the firm. By making the announcement to repurchase stock, the managers essentially declare their intent not to waste free cash flow on personal perks or projects that divert cash away from productive uses that benefit shareholders. The disgorgement of extra cash through repurchase programs can result in future cash flow growth, provided that the firm does not miss any valuable investment opportunities. Note that the "undervaluation message" of the announcement simply speeds up imminent changes in valuation, while the "efficiency message" of the announcement triggers a change in earnings and subsequent valuation that would not have occurred otherwise.

The economic intuition of our model is that managerial shareholdings indicate the managers' beliefs about the market price relative to the intrinsic value of the firm's shares. In addition, managerial stock ownership can also be related to the severity of the firm's agency problems or the managerial entrenchment, i.e. to potential efficiency gains from stock repurchases. The relationship between managerial shareholdings and these efficiency gains is not straightforward. On the one hand, firms in which managers hold a larger percentage of stock can be more efficient than firms with a lower percentage of managerial shareholdings because the managers' incentives are better aligned with the interests of other shareholders (Jensen, 1986). Since potential efficiency gains are smaller for such firms, higher managerial shareholdings can be associated with a smaller efficiency component

of the announcement return. On the other hand, high managerial stock ownership may be the result of the board's efforts to curb observed managerial inefficiency by distributing more stock to the top managers. If these efforts prove unsuccessful, agency problems in these firms may still proliferate. High managerial stock ownership might then indicate the mere presence of agency problems, implying a greater efficiency component of the announcement return. Moreover, managerial ownership that is too high can lead to agency problems associated with managerial entrenchment. Morck, Shleifer, and Vishny (1988) argue that high managerial ownership may indicate that managers have greater power and therefore better opportunities to indulge in non-value-maximizing behavior. Following this argument, Lie (2000) designates firms in which managers hold less than 5% or more than 25% of the firm's shares as high agency cost firms. In our empirical findings, we shed light on the relationship between managerial shareholdings and the efficiency component of announcement returns using measures of the quality of corporate governance and other robustness checks.

We begin the empirical part of this study with a description of the data and then follow the order of the discussion in this section. First, we establish that the level of managerial stock ownership and managerial trading are related to stock undervaluation perceived by the managers of announcing firms. Second, we test the two hypotheses derived from the predictions of the model. Finally, we obtain additional results about the relationship between managerial shareholdings and the undervaluation and efficiency components of announcement returns.

4 Data and Variable Definitions

We collected the initial sample of all authorization announcements of open-market share repurchases that are listed in Thomson's SDC Platinum database with original announcement dates between 1996 and 2002. The Securities Data Corporation (SDC) database is known to be the most comprehensive source for share repurchase programs and contains announcements that are reported in a number of business media sources. Each announcement record contains the company's six-digit CUSIP, the date of the announcement, the dollar value of the planned repurchases (in $ mil.), and the percentage of outstanding shares sought. To avoid

confounding effects, we exclude the group of firms that announced a dividend increase[5] during the calendar year of the repurchase announcement[6]. We also exclude twenty announcements that occurred when the stock market was closed during the week following September 11, 2001, i.e., all announcements from September 11 to September 17, 2001. The number of days between the first and last days of the announcement window is greater than three days for these announcements, and this could bias the results. Like Grullon and Michaely (2004), we do not exclude financial and regulated companies. These firms represent a nonnegligible portion of our sample, but most of our results are unchanged if the announcements made by these companies are removed from the sample (only the full sample results are reported).

The balance sheet data are from Compustat, and daily returns data are from CRSP. To be included in the final sample, the firms had to be listed by Compustat two years before and one year after the fiscal year of the announcement. In order to avoid microstructure effects in returns, we delete observations with stock prices below $1 at the end of the fiscal year either before or after the announcement.

The executive compensation data are from Execucomp. Following the convention in the literature (e.g., Fenn and Liang, 2001), for each company-year we combine the holdings of shares owned by the top five executives in order to construct the managerial shareholdings variable. In each year, the top five executives are defined as the ones receiving the highest total compensation, including option grants (Execucomp TDC1 variable).

[5] We identify dividend increases by comparing consecutive dividend declarations and payments in the CRSP database.

[6] Dividend increases are commonly considered a better way than repurchases to show a firm's commitment to limit its agency problem related to potential uses of free cash flows. The most plausible motivation for a firm to increase dividends and initiate stock repurchase is to disgorge cash. Alternatively, dividends can be viewed as a mechanism to signal undervaluation. Allen, Bernardo, and Welch (2000) propose a model in which dividends signal undervaluation because they attract an institutional clientele that has a greater chance of discovering the firm's high quality. When a dividend increase and a repurchase announcement happen within a short time period, it becomes unclear what information is conveyed by each announcement. As a result, the market reaction to the repurchase announcement is difficult to interpret unambiguously. For this reason, our sample of announcements is highly appropriate for our tests. Sorting out the effects of a combination of a dividend increase and repurchase announcement on the stock price should be the subject of another study.

We use the standard deviation of analysts' earnings forecasts and the number of analysts following the stock from I/B/E/S. These data are for the annual forecasts. If the number of forecasts is missing or there is no record for a given month in I/B/E/S, we set the number of forecasts as zero and the standard deviation of forecasts as missing for that month. We calculate the dispersion of forecasts for the preceding six-month period as the square root of the weighted average of monthly variance observations with the number of forecasts minus one as the weights. Following the I/B/E/S practice of calculating monthly standard deviations, if the total number of forecasts following the stock is one or zero in the preceding six month period, we set the average standard deviation as missing. Using the detail forecast dataset, we calculate the total number of analysts that reported their annual earnings forecasts during six months before the announcement. We merge the I/B/E/S data with the repurchase data by matching the month of the I/B/E/S statistical period with the repurchase announcement month. I/B/E/S average standard deviation data for the annual forecasts were missing for 28 announcements. Our final sample contains $1,281$ announcements of open market share repurchases for 742 different firms during the seven-year period 1996-2002.

We calculate abnormal announcement returns as the sum of differences between the observed return and the return predicted by the market model for the three trading days centered on the announcement day. The parameters of the market model are estimated using daily returns and a value-weighted market index from CRSP in the estimation window beginning 252 trading days prior to and ending 44 trading days prior to the announcement day. The three-day window for the cumulative abnormal return has been used in the stock repurchase literature (see, e.g., Kahle, 2002; Comment and Jarrel, 1991; Vermaelen, 1984). It can be justified based on the evidence provided by Raad and Wu (1995), who document that statistically different from zero abnormal returns take place only on the day of the announcement and the previous day. To check our results for robustness, we also construct abnormal returns using the market model with equally weighted CRSP index, and using the three-factor Fama-French model.

About one-third of the firms did not report the percentage of outstanding shares sought, but all firms reported the maximum dollar value of repurchases.

We divide the target dollar value of repurchases by the firm's market value at the beginning of the fiscal year to create a variable that represents the size of the repurchase program—the percentage of market value sought.

Shares owned by the top five executives are the number of common and restricted shares (SHROWN). If the flag (PINCLOPT) variable indicates that SHROWN includes unexercised exercisable options (UEXNUMEX), we subtract UEXNUMEX from SHROWN. We normalize this variable by the number of common shares outstanding at the beginning of the fiscal year. Therefore, the managerial shares variable used in the model estimation is a fraction of the company's shares owned by the top five executives.

We adjust for outliers in explanatory variables by Winsorizing explanatory variables at the 1st and 99th percentile. This removes the most conspicuous reporting errors and minimizes the chances of few observations influencing the results. The qualitative and quantitative results are very similar if no variables are Winsorized.

5 Summary Statistics

In order to control for industry fixed effects, we create eleven standard industry groups based on firms' two-digit SIC code. The summary of the announcement data set by year and industry is presented in Tables 1a and 1b. The sample contains $1,281$ announcements made by 742 firms. More than half of the announcements were made by firms in the manufacturing and retail trade industries, and about 15% of all announcements were made by high-tech firms. The number of share repurchase announcements increased before 1998 and decreased steadily thereafter, with 192 announcements in 1996, 193 in 1997, 292 in 1998, 233 in 1999, 170 in 2000, 101 in 2001, and 100 in 2002, with an average (median) target fraction of shares over this period of 6.21% (4.75%).

The positive abnormal stock returns to repurchase announcements are well documented in the literature. The mean (median) abnormal announcement returns in our sample are 1.69% (1.34%), which can be seen in Table 2. The mean is statistically different from zero at 1% according to the non-parametric Wilcoxon test. The magnitude of announcement returns is similar to the ones reported

in the recent literature, e.g., in Kahle (2002) for the 1993-96 sample period, but somewhat lower than ones obtained in previous studies (e.g., Vermaelen, 1981). As can be seen in Table 2, the announcements of open-market repurchases typically follow the period of negative abnormal returns. The average magnitude of the stock price runup in the 40 days prior to announcement is -6.89%.

Table 3 reports Pearson correlation coefficients for the main variables and common controls and the results of the Fisher two-sided significance test. Pairwise correlations do not reveal causality relationships and are more useful to expose potential collinearity problems, which cause unstable parameter estimates. The stock price runup is correlated with most variables, and the inclusion of this variable in the model negatively affects the significance of the variables of interest, such as managerial shareholdings. The high level of correlation (negative) between managerial shares and firm size should also be noted.

6 Empirical Procedures and Results

The discussion in this section follows the plan laid out in section 3. In the subsection 6.1, we show that managerial trading during the announcement year is consistent with managers' beliefs that the firm's stock is undervalued. When managers believe their firm's stock is undervalued, they buy stock in their firm for their personal portfolio and indicate their intention to do the same at the firm level by initiating a repurchase program. This behavior is consistent with the equilibrium described in Lemmas 1 and 2 of the model. The subsection 6.2 tests empirical Hypotheses 1 and 2, which correspond to the predictions of the model in Propositions 1 and 2. Finally, we report additional empirical results that allow us to learn more about the predictive power of managerial shareholdings for firms with various economic characteristics. In particular, we consider measures of agency cost problems in firms and distinguish between firms whose announcement returns consist mainly of the efficiency component and those whose announcement returns are driven by the undervaluation signaling effect.

6.1 Undervaluation, Repurchase Announcements, and Insider Stock Purchases

As the previously discussed survey evidence (Brav *et al.,* 2005) suggests, the majority of managers repurchased stock because it was undervalued and because it appeared to be a good investment that would benefit long-term shareholders. If the survey responses correctly reflect reality, then we can expect the managers not only to do a stock buyback at the firm level, but also to increase their personal stock ownership around the time of repurchase announcements. This is the economic interpretation of Lemma 1 of the model. In the empirical literature on stock repurchases, announcements of larger repurchase programs are generally considered to be stronger signals of undervaluation. If the managers genuinely believe that their firm's stock is underpriced when they announce a stock repurchase, they should be more likely to buy the shares during the announcement year when the announced program size is large. The objective of this subsection is to use this conjecture in order to prove the link between stock underpricing and the level of managerial stock ownership.

We create three variables that measure the outcome of purchase decisions by the managers. First, we calculate the difference between the number of shares (adjusted for stock splits) held by the top five executives at the end and the beginning of the fiscal year of the announcement, and set the indicator of the Increase in Managerial Shareholdings to 1 if this difference is positive, and 0 if it is zero or negative. Second, we adjust the change in managerial shareholdings by the number of employee stock options exercised, so that the growth in the shareholdings is produced only by non-option-related purchases. This variable, the Increase in Managerial Shareholdings Net of Option Exercises, is equal to 1 if the number of shares (adjusted for stock splits) held by the top five executives at the end of the announcement year minus the number of shares at the beginning of the year, and minus the number of stock options exercised during the year, is positive, and is equal to 0 otherwise. The third variable is the Increase in the Fraction of Managerial Shareholdings during the announcement year. It is equal to the difference between the number of shares held by the top five executives at the end of the year and their shares at the beginning of the year, normalized by

the contemporaneous numbers of shares outstanding.

Managers' decisions to purchase and sell shares may also be affected by factors that are not directly related to stock undervaluation. When executives already hold a large fraction of the firm's stock, they have a greater diversification motive and should be more inclined to sell. To control for the diversification effect, we include the managerial stock ownership as of the beginning of the announcement year (variable SHROWN used throughout the rest of the paper). Jenter (2005) finds that managers in a firm with a high book-to-market asset ratio view their firm as undervalued and are likely to increase their holdings of the company's shares. Tobin's Q is defined similarly to the book-to-market asset ratio as the ratio of the market value of assets to the book value of assets, where the market value of assets is calculated as the book value of assets minus the book value of equity plus the market value of equity. Consequently, we include Tobin's Q in our model and expect the dependent variables to have a negative relation with Tobin's Q. We also add total stock returns during the announcement fiscal year and the year before the announcement as control variables because changes in market valuations may affect managerial trading.

Since the first two dependent variables are binary, the models in which they are the dependent variables are estimated with a logit model:

$$\begin{aligned} & \Pr\left(\text{Shareholdings Increase}_i = 1\right) \\ = \; & \text{Logit}\left(\beta_0 + \beta_1 VALSOUGHT_i + \overline{\gamma} CTRLS_i\right) + u_i \end{aligned} \tag{7}$$

where $VALSOUGHT_i$ is the percent of market value sought to be repurchased (the size of the repurchase program in dollars normalized by the firm's market value and multiplied by 100), and $CTRLS_i$ are the remaining control variables. The least squares method with heteroscedasticity-robust standard errors is used to estimate the model in which the dependent variable is the Increase in the Fraction of Managerial Shareholdings.

The estimation results presented in Table 4 allow us to conclude that managerial trading in the announcement year is consistent with the view that managers perceive their firms as underpriced by the market when they make announcements of open market share repurchases. The variable of interest is the

percent of market value sought, and its coefficient is positive and statistically significant in all columns. The economic effect of this variable is modest, with a one standard deviation increase in the announced program size resulting in an increase in the probability of a positive change in insider stock ownership from its mean of 49.7% to 53.1% and an increase in the probability of net insider purchases from 30.3% to 33.7%.[7] We also note that all control variables enter Table 4 with expected signs. Higher stock returns during the announcement year result in fewer stock purchases by insiders, consistent with Jenter's (2005) findings. Higher managerial shareholdings at the beginning of the year are associated with fewer additional purchases by managers because of a stronger diversification incentive.

We also use a matching-firms approach in order to show that managers in an announcing firm are likely to consider their firm to be undervalued and to increase their stock ownership in the firm. We compare the changes in managerial shareholdings in announcing firms with changes in managerial shareholdings in matching firms that did not make a stock repurchase announcement during the same fiscal year. The matching firms are selected for each announcing company and announcement date in a two-step procedure. First, we select a set of companies that belong to the same industry as defined by the two-digit SIC code, have market value within a 30% range of the repurchasing firm's market value, and do not make a repurchase announcement in the same fiscal year. If no firms fit these criteria, matching is performed based on the same requirements, but using the one-digit rather than the two-digit SIC code. If no potential matches are found using this scheme, then we look for matching firms regardless of their industry specifications. Second, within the preselected group of firms, we choose the matching firm with the smallest sum of absolute deviations from the announcing firm's book-to-market ratio and market capitalization. The results for each of the three measures of changes in managerial shareholdings are reported for announcing and matching

[7] Difficulty in interpreting these results can arise for announcements that happened near the beginning of the fiscal year because most managerial trading must have occured after such announcements. We estimate the same model on a subsample of announcements that happened during the last three months of the fiscal year, so that the net increase in managerial shareholdings must have occurred before such an announcement. The statistical significance of the percent sought variable increases relative to the full sample results in Table 4. This is a strong evidence in support of the conclusions of this subsection.

firms in Table 5.

The median change in fractional ownership shows that the top five managers are net buyers in more than half of announcing firms, while they are net sellers in most non-announcing firms. On average, managers tend to sell significantly more shares in the non-announcing firms, according to the t-test and non-parametric Wilcoxon signed-rank test (an exact test with Monte-Carlo simulated p-values). The subsample results in Table 5 illustrate that this relationship is stronger in firms that are more likely to be undervalued—that is, in firms with larger announced repurchase programs. All three measures of net managerial purchases are significantly higher in the repurchasing firms than in the matching firms for the largest (top trecile and quartile) repurchase programs.

6.2 The Multivariate Results of Hypotheses Testing

We test the empirical hypotheses 1 and 2 with the following econometric model:

$$CAR_i = \beta_0 + \beta_1 SHROWN_i + \beta_2 VALSOUGHT_i + \beta_3 CASH_i + \overline{\gamma} CTRLS_i + u_i \quad (8)$$

where CAR_i is the cumulative abnormal announcement return, $SHROWN_i$ is the percent of outstanding shares owned by the top five managers at the beginning of the announcement fiscal year, $VALSOUGHT_i$ is the announced percent of the firm's market value sought to be repurchased, $CASH_i$ is equal to cash and equivalents normalized by book assets[8], and $CTRLS$ are the control variables (Tobin's Q, size, stock price runup, and exercisable options). We include the industry and year dummy variables to control for the heterogeneity of announcement responses over time and across industries. Our model and empirical hypotheses predict a positive coefficient on $SHROWN_i$ variable in the full sample and in the subsample of firms having a high information asymmetry with the market.

[8] Lie (2000) argues that firms in different industries may have different risks, investment opportunities and costs of financial distress and, consequently, may have different optimal levels of cash, all else being equal. He constructs a measure of excess cash as the difference between actual cash and the estimate of required cash and finds that excess cash is strongly correlated with raw cash levels. He points out the weaknesses of the excess cash measure, such as its potential to be biased and its sensitivity to the model of "optimal cash levels." Therefore, we do not use an industry-based measure of excess cash in our paper.

The empirical model controls for factors that are documented in the literature as capable of explaining the announcement returns. We include Tobin's Q as a proxy for investment opportunities, and the logarithm of book assets at the end of the year prior to the repurchase announcement as a measure of size.[9] Lang and Litzenberger (1989) showed that the market reaction to dividend announcements is significantly higher for low-Q (overinvesting) firms, suggesting that the free cash-flow theory may be helpful in explaining the market reaction. However, Howe, He, and Kao (1992) do not find any relationship between Tobin's Q and the stock price reaction to tender offer share repurchases.

A period of negative abnormal performance (the negative stock price runup) often precedes a repurchase announcement, as documented by Vermaelen (1981). The stock price runup can affect announcement return through pseudo-market timing and tax clientele effects. Schultz (2003) argues that pseudo-market timing can affect the abnormal market returns calculated in event studies, if the managers make their decisions contingent on past price performance. In the context of share repurchases, this implies that if managers announce buyback programs following poor stock performance, the abnormal returns may be biased upwards. The stock price runup measure should control for this effect. We also estimate abnormal returns with the equally weighted market index, which Schultz considered to be less vulnerable to the upward bias problem. Lie and Lie (1999) argue that a large appreciation in stock prices prior to repurchase announcements reduces the tax advantage of repurchases relative to dividends, and thus the price runup should be negatively associated with announcement returns. As in Kahle (2002), we measure the runup as the abnormal stock return from trading day -43 to day -4 prior to the announcement, using the market model.

We use the number of unexercised exercisable options held by the top five executives to control for the firm's intent to use the repurchase to counteract the earnings per share (EPS) dilution from employee stock option exercises. The earnings management hypothesis postulates that managers often focus on consistent EPS growth, and may repurchase shares in order to boost the diluted EPS when earnings fall short of their target (Bens et al., 2003). Consistent with the

[9] The results are not sensitive to the choice of the size measure and are very similar if the logarithm of market capitalization is used instead of the log of the book value of assets.

earnings management hypothesis, Kahle (2002) documents that firms are more likely to initiate a repurchase when the number of currently exercisable employee stock options is large. The market can discount undervaluation and efficiency motives for the repurchase announcement if the firm has a large number of exercisable employee stock options, and the announcement reaction should be relatively small for such a firm. This implies that in the cross-section, the effect of the number of exercisable employee stock options on announcement returns should be negative. On the other hand, there can also be a positive relationship between the number of unexercised exercisable options and stock undervaluation. The more exercisable stock options the top five executives hold, the more confident they are that the stock will do well in the future. Thus, they postpone the trading pattern consisting of an exercise and immediate sale described by Ofek and Yermak (2000). Overall, the expected sign of the coefficient on the exercisable managerial stock options is ambiguous. We define exercisable options as the number of unexercised exercisable stock options held by top management normalized by the number of shares outstanding at the beginning of the announcement year.

The model is linear, but the OLS standard errors cannot be used for statistical inference because tests show a high degree of heteroscedasticity. In order to obtain correct standard errors and coefficient significance results, we employ the MacKinnon and White (1985) heteroscedastic consistent-covariance matrix estimator with the weights adjusted for the number of explanatory variables. Qualitatively similar results were obtained when robust standard errors were estimated by clustering announcing companies in order to account for multiple repurchase announcements by some firms.

6.2.1 Test of Hypothesis 1: Full Sample Results

The empirical model in (8) allows us to test the first prediction of our theoretical model that higher managerial shareholdings are associated with higher announcement returns. We begin by estimating model (8) using value-weighted abnormal returns as the dependent variable without any control variables on the full sample of announcements (column 1 of Table 6). The coefficients on the managerial shareholdings variable is positive and significant both statistically and economically. A

one standard deviation increase in managerial shareholdings results in a 0.50% increase in abnormal announcement returns, while mean announcement returns have a comparable magnitude of 1.73%. Next, we add control variables, and year and industry dummies. The significance of the managerial shareholdings variable remains, as shown in column 2 of Table 6. These results confirm the positive economic relationship between managerial shareholdings and announcement returns, as predicted in Hypothesis 1 and derived in Proposition 1.

Columns 4 and 5 of Table 6 use two alternative models to calculate abnormal announcement returns. Column 4 uses the equally-weighted market index to estimate abnormal returns. Column 5 uses the three-factor Fama-French model. The results are very similar to those with cumulative returns obtained by the value-weighted market model. The robustness of results to the use of equally weighted returns is important because it addresses the concern expressed in Schultz (2003) that abnormal returns calculated with the value-weighted index are biased upwards. In addition, the coefficient on the stock price runup prior to the announcement, which controls for the pseudo market timing effect detailed by Schultz, is statistically significant in column 5 and has the anticipated negative sign.

6.2.2 Test of Hypothesis 2: Results Based on Variation in Information Asymmetry

In order to test Hypothesis 2 (and Proposition 2 of the model), we consider four measures of information asymmetry between the market and firm management. Following Diether, Malloy, and Scherbina (2002) and Krishnaswami and Subramaniam (1999), we use the dispersion of analysts' forecasts as our first and primary measure of information asymmetry.[10] We posit that when the dispersion of analysts' forecasts is high, it is more difficult for the market to gauge the firm's prospects; the result is high information asymmetry between the firm and the market. The second proxy for information asymmetry is the number of analysts making the forecasts. When more analysts follow the firm, the market should be better informed about the firm's prospects. Our results with this proxy are

[10] In the literature, the dispersion variable is sometimes normalized by the mean earnings forecast. Our results do not change when we use this definition of the dispersion variable.

qualitatively similar to the results with the dispersion of analysts' forecasts and are not reported.

As our third proxy for information asymmetry, we use the volatility of daily market-adjusted returns in the year prior to the announcement. The volatility of market-adjusted returns represents the idiosyncratic risk of the firm, and we conjecture that information asymmetry should be higher when the returns are more volatile. This asymmetric information measure has been employed by Krishnaswami and Subramaniam (1999). When studying seasoned equity offerings, Corwin (2003) uses a similar measure, the volatility of firm stock returns, which is highly correlated with the market-adjusted returns volatility (a correlation coefficient of 0.98). The estimation results are very similar for these two measures, and we report them only for the market-adjusted volatility. We calculate the volatility of daily market-adjusted return over the time period from trading day -252 to trading day -4 relative to the announcement, using the value-weighted CRSP index as a proxy for market returns.

Our fourth proxy for information asymmetry is firm size, which is also used by Jenter (2005) and Vermaelen (1981). Large firms are under greater scrutiny by the market than small firms because, among other reasons, large firms are followed by more analysts and have broader media coverage. Seyhun (1986) shows that insiders are able to predict returns for small companies. In addition, Lakonishok and Lee (2001) find that large companies are priced more efficiently than small companies and conclude that the biggest potential gain of exploiting insider trading activity is in smaller companies. According to the literature, information asymmetry should be greater for companies with smaller market capitalization prior to a stock repurchase announcement. The results with this measure of size are qualitatively identical to the results relying on other measures of size, such as the book value of assets, or book debt plus market equity.

Each pair of columns in Table 7 reports the estimation results on two equally sized subsamples of announcements. The first column in each subsample shows estimation results for announcements by firms whose measure of information asymmetry with the market is above the median. In the interest of space, we report only the results when abnormal returns are calculated using the market model estimated with the value-weighted index.

We observe that the level of managerial stock ownership is a very important source of information about the credibility of the undervaluation signal by the less transparent firms.[11] This confirms the model's prediction that information about managerial shareholdings is more useful for firms that have high information asymmetry and may be undervalued by the market. The economic significance of managerial shareholdings in the opaque firms is twice that of the full sample of firms (see column 3 of Table 6). We conclude that Proposition 2 and Hypothesis 2 are supported by the data.

6.3 Undervaluation and Efficiency Components of Announcement Returns

The previous two subsections successfully verified the model's hypotheses regarding the relationship between managerial shareholdings and announcement returns. We begin this subsection by considering whether other economic variables, e.g., the repurchase program size and cash, can explain announcement returns. In the full sample estimation results in Table 6, we observe that the coefficients on the announced program size and cash are positive and statistically significant. This is consistent with the presence of the efficiency component in the market reaction to the announcement. The positive coefficient on cash level supports the argument in section 3 that firms with a lot of cash are more likely to overinvest and that the market thinks their performance should benefit from a reduction in agency costs.

The empirical model introduces a cross-term between managerial shares and cash in order to investigate a potential tradeoff between the undervaluation and cash disgorgement motives for repurchase. The cross-term also allows us to observe whether managerial shareholdings are equally informative for firms with high cash and low cash holdings. The coefficient on the cross-term is statistically significant in most cases (e.g., see column 3 of Table 6). The negative sign indicates that the informativeness of managerial shareholdings decreases as the firm's

[11] As an alternative to splitting the sample into two parts, we also created a dummy variable for each announcement, which is equal to one if the analyst forecast dispersion for this firm is above the median and zero if it is below the median. We interacted this variable with stock ownership by top five executives and used this variable along with ownership and the dummy for high dispersion of analyst forecasts in the regressions. The results were consistent with the split sample results in the first two columns of Table 5.

agency problems and cash disgorgement motive for repurchase increase due to high cash holdings. It can also indicate the substitution between undervaluation and efficiency motives for repurchase announcements in the eyes of the market. Both the statistical and economic significance of managerial shares are unaffected by the presence of the cross-term. For a firm with mean cash holdings (13.04%), the combined coefficient of the managerial shares is 0.077 in column 3. Therefore, the economic effect of a one standard deviation increase in managerial shares in such a firm, *ceteris paribus*, translates into a 0.61% increase in abnormal returns in column 3 (similar to 0.5% in columns 1 and 2). We conclude that managerial shareholdings, announced program size, and cash provide valuable information to the market and can predict announcement returns in the full sample.

Next, we compare the informational content of the last two economic variables by grouping firms based on the degree of their asymmetric information and uncertainty. While the previous subsection showed that managerial shareholdings are more informative for opaque firms, our results also reveal that the market substitutes the target repurchase amount for managerial shareholdings to evaluate announcements by transparent firms (see Table 7, columns 2, 4, and 6). In the transparent firms, the market evaluates the undervaluation claim without relying on executive stock ownership. The amount of cash reserves is significantly informative in all subsamples. Taken together, these two findings imply that: (1) the severity of the internal agency problems indicated by the size of cash reserves does not depend on the information asymmetry between the managers and the market, and (2) information about a reduction in the free cash flow problem is relatively more important in announcements by transparent firms than by opaque firms. The cross-term between managerial shares and cash is not statistically significant for transparent firms, which means that the overall effect of managerial shares on the announcement return is small and insignificant for these firms.

In the rest of this subsection, we further investigate the explanatory power of managerial shareholdings, as well as other variables of the empirical model (8). We differentiate firms into those with a large efficiency component of announcement returns—that is, firms with potentially high agency cost problems, and firms with a relatively small efficiency component of announcement returns. The potential for agency cost problems is proxied by the magnitude of free cash

flows, the index of the quality of corporate governance, Tobin's Q, and leverage. However, Tobin's Q can also be related to the managers' perceived valuation of their firms. We investigate which economic variables, including managerial shareholdings, can explain announcement returns better in each group of firms. Finally, we check the robustness of our tests of the model's predictions.

6.3.1 Results Based on Variation in Agency Costs

We use three proxies to measure the extent of agency problems across firms. Firms that have accumulated large amounts of cash are likely to have agency problems because managers can relatively easily divert resources to personal perks and use cash to invest in negative NPV projects. Thus, as our first proxy for the magnitude of agency problems, we use the ratio of cash and equivalents to the book value of assets. We expect that the more cash a company has, the more significant are the benefits from the alleviation of agency problems, so that the informational importance of the announced program size to the market is greater. Firms with little extra cash are not likely to experience a significant reduction in agency problems from repurchases and may even encounter solvency problems if too much cash is distributed. Consequently, when repurchase announcements are made by firms with little cash, the market looks at them mainly through the undervaluation prism, whereas undervaluation is less likely for firms with a lot of cash. The market perceives the motive of the cash-rich firms as the intent to return excess cash to the shareholders. Since the level of managerial shareholdings provides information to the market about the credibility of the undervaluation claim, we conjecture that managerial shareholdings should be a more important source of information about firms with less cash.

Companies with high free cash flows ("cash cows") are highly prone to agency problems because they need to find productive uses for their abundant funds in each period. Following Fenn and Liang (2001), our second proxy for free cash flow is net operating cash flows less capital expenditures at the fiscal year-end prior to the announcement, normalized by the book assets. Using the sample median as a divider, we separate firms into those that have high and low free cash flows. Our conjecture is that repurchase announcements by firms with high free

cash flows convey primarily information about the reduction of agency problems in the firm. For firms with low free cash flows, most of the announcement return is due to the undervaluation signal, and we expect managerial shareholdings to be significant in the subsample of these firms.

Finally, we use the quality of corporate governance in the firm as a proxy for the extent of agency problems. Several studies, e.g., Yermack (2006), use measures of corporate governance based on the broad index of 24 IRRC provisions, created by Gompers, Ishii, and Metrick (2003). Bebchuk, Cohen, and Ferrell (2005) reexamine these provisions and create an improved measure by choosing six provisions that matter the most for corporate governance. Four of these provisions set the constitutional limits on shareholder voting power (staggered boards, limits to shareholder amendments of the bylaws, supermajority requirements for mergers, and supermajority requirements for charter amendments) and limit the extent to which shareholders can impose their will on management. Two other provisions are "poison pills" and "golden parachutes," which protect incumbent management from removal or its consequences. Each provision receives equal weight, with the Entrenchment Index having values from 0 to 6.

Using the Bebchuk, Cohen, and Ferrell (2005) Entrenchment Index, we separate firms into two groups at the median value, which is equal to 2. Firms whose index value is 2 or less are classified as firms with Good Governance, and firms with Entrenchment Index values of 3 to 6 are classified as firms with Bad Governance. We expect that undervaluation effects are present for firms of both types. However, the reduction in agency costs should be more important for the Bad Governance firms, especially when these firms have a lot of cash.

Our results for subsamples of announcements based on the agency cost measures are presented in Table 8. First, we use cash-to-assets ratio as the sole determinant of the potential agency problems. We separate the firms into those that have high and low cash using the median as the divider. The estimation results for each of the two subsamples are in the first two columns of Table 8. In the subsample of firms with low cash reserves, the coefficient on managerial shareholdings is positive and significant. This is consistent with the market reacting primarily to the undervaluation message by these firms. A one standard deviation increase in managerial stock ownership in these firms is associated with a 1.30%

increase in the announcement returns, while the mean announcement returns are equal to 1.31% in this subsample. In contrast to managerial shareholdings, the percent of the market value sought is more important in explaining the magnitude of announcement returns for firms with high cash reserves. This is consistent with our intuition that the larger the announced repurchase program the larger the actual repurchases will be, and that firms with more severe agency problems should benefit more from a reduction in extra cash.

Next, we divide the sample into announcements made by firms with high operating cash flow and low operating cash flow. The results presented in columns 3 and 4 of Table 8 confirm our argument that the undervaluation component of returns is smaller for firms that are more likely to announce in order to return unnecessary funds to investors—that is, for firms with high free cash flows. In these firms, managerial shareholdings are uninformative to the market, and the size of the announced repurchase program captures all information. At the same time, the announcement returns in firms with low free cash flow are more likely to be caused by the undervaluation signal, and the market uses the data on managerial share ownership in those firms to evaluate the credibility of the undervaluation claim. These findings are consistent with the undervaluation-efficiency substitution interpretation of the cross-term in Table 6.

The last two columns of Table 8 present the estimation results for subsamples of firms that differ in the quality of corporate governance. Column 5 shows that among the poorly governed firms, the announcement returns are positively related to the amount of excess cash in the firm. The size of the repurchase program is also significant at 10% for these firms. A one standard deviation increase in cash is associated with a 1.68% increase in abnormal returns, which is an economically significant effect. This finding means that the benefits from a reduction in agency costs are higher among the poorly governed firms. This is not surprising because in such firms, shareholders have more difficulty with either removing the inefficient management or imposing shareholders' will on managers through voting.

Next, consider firms with good corporate governance in Column 6. The mere fact that a well-governed firm has large cash holdings does not imply the existence of high agency problems because shareholders in this firm are in control and

can force the managers to do what is best for the shareholders. Therefore, neither cash nor the target repurchase amount is significant in that column. Managerial shareholdings explain a portion of announcement returns in both subsamples. This may imply that firms with different qualities of governance are equally likely to be undervalued when their managers announce repurchases. Alternatively, we may need to use other measures of the quality of corporate governance that are more closely related to the repurchase decision. One example of such a measure is the amount of wealth transferred from the selling shareholders to the firm associated with the firm's repurchase activity (Vedrashko, 2006). A large portion of this wealth transfer is captured by the managers and gives them an incentive to announce and conduct stock repurchases. Managerial opportunism and wealth transfers associated with repurchases are also addressed by Fried (2001) and by Brennan and Thakor (1990).

6.3.2 Value Firms versus Growth Firms

In addition to cash and governance measures of agency costs, we can use the theoretical insight of Lang and Litzenberger (1989) that Tobin's Q is associated with agency cost problems in firms. We report estimation results for subsamples of announcements based on Tobin's Q in Table 9. We designate firms whose Tobin's Q is below and above the median (which is equal to 1.84)[12] as the value and growth firms, respectively. The literature considers value companies (firms with a low Tobin's Q ratio) both as undervalued and as having high agency problems, depending on the application. We are interested in managers' perception of their firms' stock. Jenter (2005) shows that firms with a high book-to-market valuation ("value firms") are regarded as undervalued by their own managers, who actively purchase additional shares for their private accounts in such firms. Managers in growth firms (those with a high market valuation) tend to sell shares of their company. Ikenberry, Lakonishok, and Vermaelen (1995, 2000) also classify high book-to-market (low Tobin's Q) firms as undervalued. Dittmar (2000) uses the book-to-market equity ratio as a proxy for undervaluation. In addition, value firms should experience large efficiency gains from stock repurchases because they have

[12] We also built the subsamples based on Tobin's Q equal to 1, and the results were qualitatively the same.

limited investment opportunities to productively spend their free cash flows, and, consequently agency problems are significant in these firms (Nohel and Tarhan, 1998; Grullon and Michaely, 2004; Lang and Litzenberger, 1989). Therefore, when we divide our sample by the market-to-book ratio, we interpret our results with caution because Tobin's Q can be related both to undervaluation and to efficiency causes of the announcement effect. Nohel and Tarhan (1998) express the same reservations about using Tobin's Q in the context of tender offer repurchases.

An implication of the equilibrium solution to our model is that the relationship between managerial shareholdings and announcement returns can be observed only in firms that are regarded as undervalued by their own managers. Therefore, we expect to find empirically that the relationship between managerial shareholdings and abnormal returns around the announcements is stronger for the "value firms" (where undervaluation motives are more likely according to Jenter, 2005). The results in columns 1 and 2 of Table 9 are consistent with our theoretical argument. Information about the level of managerial shareholdings matters for announcement returns in value companies. A plausible interpretation of the lack of significance of managerial shareholdings in growth firms is that the market discounts the undervaluation motive for these firms.

The significance of the cash variable in the value firms reflects the agency component of announcement returns. We find no significance for the cash or target repurchase amount in growth firms, which is consistent with the lack of free cash flow problems in these firms. The weakness of the undervaluation and efficiency components of the announcement effect in growth firms is further confirmed in a significantly lower cumulative abnormal return (1.43%) in growth firms than in value firms (2.0%). These results indicate that the market considers value firms both to be more undervalued and to have higher agency costs. We conclude that grouping firms into growth and value categories using Tobin's Q is not a fruitful way of distinguishing between agency and undervaluation explanations of announcement returns.

6.3.3 Results Based on Variation in Leverage

The last two columns of Table 9 present results for firms with low and high leverage. We measure leverage as the ratio of long-term debt to assets.[13] The firms that have a ratio of debt to assets below the sample median of 0.14 are classified as firms with low leverage, while others are classified as firms with high leverage. A portion of the market's reaction to a repurchase announcement can be explained by the firm's motive to use repurchases to increase their leverage ratio and achieve the optimal leverage level. Dittmar (2000) finds that, between 1987 and 1996, firms in her sample used repurchases for this purpose. Leverage as an explanatory variable is not statistically significant in our multivariate model, but the higher mean abnormal returns in the low leverage firms can support the both the leverage and efficiency explanations for repurchases.

Jensen (1986) argues that high leverage helps to mitigate free cash flow problems because each year a large part of cash flow is directed toward the payment of debt coupons. Since nonpayment on obligations to bondholders has severe consequences and may even throw the firm into bankruptcy (and force top executives out of office), managers in highly leveraged firms are committed to making periodic coupon payments to bondholders. Increasing dividends or repurchasing shares also helps mitigate agency problems, but the alleviation may be more temporary than that achieved through increasing leverage because it is possible to cut dividends in the future or scale down and even cancel repurchase programs. Hart and Moore (1995) develop a formal model in which they show that long term debt can curb investment in unprofitable projects by self-interested managers by limiting their ability to borrow against future earnings. To summarize, highly leveraged firms are less vulnerable to agency problems and should experience a smaller market reaction to the announcement about a coming reduction in agency costs.

In firms with high leverage and with correspondingly large cash outflows, managers have less incentive to announce a repurchase program in order to return cash to investors or to increase leverage. This leaves undervaluation signaling

[13] The results are robust to defining leverage as the short term debt (item #34) plus long term debt (item #9) over book assets (item #6), or as the short term debt plus long term debt over the market value of equity plus book value of debt.

as the most likely explanation for the repurchase announcement return in high leverage firms. According to the predictions of Proposition 1 for undervalued firms, managerial stock ownership should play an important explanatory role for announcement returns in firms with high leverage. This prediction is confirmed in the data; the results in columns 3 and 4 of Table 9 show that managerial stock ownership is significant only for highly leveraged firms.

The coefficient on the cash variable is significant only for firms with zero or low leverage, further supporting the argument that for firms with low leverage, the prospective reduction in free cash flow is responsible for the announcement effect. The percent sought variable is not significant for either subsample of firms. We can relate this result to the findings by Maxwell and Stephens (2003) that since share repurchases distribute cash to shareholders, they reduce the value available to current bondholders. According to this argument, the market reaction to the repurchase announcement can be partially explained by an expected wealth transfer from bondholders to shareholders that occurs if the firm repurchases shares in the future. This effect should be more pronounced in highly leveraged firms, particularly when the size of the repurchase program is large and can lead to a bigger wealth transfer. We do not find evidence supporting the bondholders' wealth expropriation hypothesis; the repurchase program size is not significant for either high or low leverage firms.

6.3.4 Robustness to the Agency Interpretation of Managerial Shareholdings

The efficiency explanation of announcement returns states that the announcement informs the market about potential alleviation of the agency costs of free cash flow in the firm. A relationship between managerial shareholdings and agency costs can strongly influence our empirical results regarding the significance of the managerial shareholdings variable. Generally, firms in which managers have a high level of managerial stock ownership have either relatively mild agency problems (because the high ownership helps to align the interests of managers with those of other shareholders) or relatively severe agency problems (because the high ownership entrenches managers). According to the alignment argument, suggested by Jensen

and Meckling (1976), firms with higher managerial shareholdings should have lower agency problems and lower benefits associated with a reduction in the free cash flow available to managers. Therefore, the alignment argument predicts a negative relation between managerial ownership and announcement returns.

On the other hand, Demsetz (1983), Fama and Jensen (1983), and Morck, Shleifer, and Vishny (1988) point out that high managerial ownership can lead to managerial entrenchment by making the market for corporate control less efficient (with fewer takeovers) or by increasing the managerial power to secure the job (managerial turnover becomes less sensitive to performance, see, for example, Denis, Denis, and Sarin, 1997). Entrenched managers are more likely to engage in non-value-maximizing behavior. Thus, high managerial ownership can be associated with larger agency costs of free cash flow and greater performance benefits from paying out the extra cash through a stock repurchase. The entrenchment argument predicts a positive relation between the level of managerial ownership and announcement returns. The results in this section show that agency arguments (alignment or entrenchment) do not drive the results shown in Tables 6 through 8.

First, we note that the entrenchment argument is not consistent with the results presented in Tables 7 and 8. If low dispersion of earnings forecasts, low volatility of returns, or large firm size were associated with fewer investment opportunities, and if high managerial ownership implied high entrenchment, then we would observe a strong positive coefficient on the managerial ownership in columns 2, 4, and 6 and a weak positive coefficient in columns 1, 3, and 5 of Table 7. However, we see the opposite relation, i.e. the entrenchment explanation contradicts the results in Table 7. We arrive at the same conclusion for the results in Table 8. The cash-rich firms or firms with poor governance in columns 1, 3, and 5 have potentially high agency costs, and managerial entrenchment in the firms with high managerial shareholdings would make the agency problem even worse. The entrenchment story predicts a strong positive coefficient on managerial shareholdings in these columns and a weaker positive coefficient in columns 2, 4, and 6. The results presented in Table 8 are the opposite of this prediction and refute the entrenchment version of the agency explanation for announcement returns in this table.

The entrenchment explanation is consistent with the positive coefficients on the managerial shareholdings shown in Table 6. In order to complete the proof that high managerial ownership does not proxy for managerial entrenchment in our sample (and does not the drive results in Table 6 in particular), we perform a series of statistical tests. We define three variables—the size of the board of directors, CEO as the sole insider on the board, and the concentration of titles in the hands of the CEO—that measure the quality of internal corporate governance. Board size is the number of directors serving on the board (a log of this variable leads to almost identical results). A larger number of directors makes it more difficult to pass decisions that constrain the power of executives. The last two variables are defined as in Adams, Almeida, and Ferreira (2005). The sole insider variable is an indicator that the CEO is the sole insider on the board. It is equal to 1 if the CEO is a director and none of the other executives mentioned on the proxy statement is a director, and is equal to 0 otherwise. Concentration of titles in the hands of the CEO is equal to 1 if the CEO is both the president and the chairman, and 0 otherwise. If the CEO is the only insider on the board or holds other top titles in the corporation, he or she is more likely to have more power to take unbalanced decisions and be entrenched.

We test the relationship between managerial shareholdings and these three measures of internal corporate governance. In addition, we test the relationship between managerial shareholdings and two indices that measure the quality of external corporate governance (Bebchuk *et al.*, 2005; Gompers *et al.*, 2003). We find that the measure of managerial shareholdings we use throughout this paper has a negative and significant correlation with all five measures of governance and managerial entrenchment. This means that firms with high managerial shareholdings are less likely to have entrenched managers than firms with low managerial shareholdings. Therefore, we conclude that managerial entrenchment cannot explain any of our results regarding the significance of the managerial stock ownership variable.

Next, we consider the alignment effect of managerial shareholdings on agency costs. It might be present throughout our results and diminish the statistical significance of the undervaluation signaling effect of managerial ownership. The alignment effect predicts a negative sign on managerial shareholdings in Table

6, and we do not have empirical means to reject its influence. However, the observed positive coefficient on managerial shareholdings in Table 6 proves that the alignment effect must be much weaker than the relationship between managerial stock ownership and announcement returns. This conclusion provides additional support for the positive outcome of our tests of Proposition 1.

In Table 8, as in Table 6, we cannot reject the presence of the alignment effect. Firms in columns 1, 3, and 5 have a high agency cost problem, and the efficiency component of the announcement return is large. According to the alignment argument, high managerial ownership should mitigate agency costs in these firms, in which case the coefficient on the managerial shareholdings should have a strong negative sign. This coefficient should have a weak negative sign in columns 2, 4, and 6 for the firms with small agency problems. The reported coefficients on managerial shareholdings in these groups of columns are not significant and positive, respectively. The interpretation of this result is either that the firms with high agency costs are unlikely to make a repurchase announcement for undervaluation reasons, or the undervaluation and alignment effects cancel each other in the firms with high agency costs.

The final robustness check concerns the sorting variables in columns of Table 7. Besides their conventional interpretation as measures of asymmetric information, they can also be interpreted as measures of agency cost problems in firms. One can argue that large firms, firms with low-volatility returns, and firms with little dispersion of analysts' forecasts are mature firms that have relatively few growth options. Such firms are more vulnerable to the overinvestment (agency) problem (Rehman, Vermaelen, and Massa, 2005). According to this view, the announcement effect in the younger firms (columns 1, 3, 5) has a very small efficiency component. The alignment effect of high managerial shareholdings must be relatively small in these firms because the observed significance of the managerial shareholdings indicates that the undervaluation effect overpowers the alignment effect. In the mature firms (columns 2, 4, 6), the alignment effect is more prominent and counteracts the undervaluation effect, resulting in the lack of significance of the managerial shareholdings variable.

We refute this argument by showing that Table 7 does not sort on firm maturity and, consequently, on agency cost measures. We use five measures of firm

maturity—declines in investment; three measures of operating performance; and R&D expenditures—as defined by Grullon and Michaely (2004) and Rehman, Vermalen, and Massa (2006)[14]. They are more direct measures of firm maturity than the alleged maturity proxies in Table 7. We show that the relation between these maturity measures and the subsample sorting proxies in Table 7 is the opposite of the maturity interpretation of the proxies.

The variables we use for our tests are the changes in ROA, ROCAA, ROE, CAPEX, and R&D between the announcement year and the pre-announcement year. Consistent with the literature, companies experience, on average, a decline in operating performance and investments before repurchase announcements. We divide the full sample of firms into subsamples as in Table 7, using the dispersion of analysts' forecasts, market-adjusted volatility, and market capitalization variables. If this sorting is by maturity, the operating performance and investment expenditures should decline more in the more mature firms. However, the results of pair-wise t-tests and nonparametric Wilcoxon tests for the subsamples strongly reject this conjecture[15]. They show that operating performance and investments decline by more in supposedly young firms: the firms with a high dispersion of forecasts, high market-adjusted volatility, and small market capitalization (although, results for subsamples based on the market cap are occasionally reversed). Thus, we can reject a possible interpretation that columns in Table 7 are sorted by firm maturity rather than by information asymmetry.

To summarize, the entrenchment effect could have been an alternative explanation for the significance of managerial shareholdings in our results. However, we showed that measures of entrenchment are negatively associated with the level of managerial shareholdings. A likely reason for this finding is that,

[14] The return on assets (ROA) is defined as operating income before depreciation scaled by the average of beginning- and ending-period book value of assets. The return on cash-adjusted assets (ROCAA) is operating income before depreciation scaled by average of beginning- and ending-period book value of cash-adjusted assets. The cash adjusted assets are equal to the book value of total assets minus cash and marketable securities. The return on equity (ROE) is operating income before depreciation scaled by the average of beginning- and ending-period book value of equity. Capital expenditures (CAPEX) and R&D expenditures are the annual Compustat items 128 and 46, respectively.

[15] These and other results of robustness checks described in this subsection are not reported here and can be provided by the authors on request.

on average, managerial shareholdings are too low in our sample firms to cause entrenchment problems. Therefore, we reject the managerial entrenchment explanation for our results. The alignment effect can be present in the data and supports the key idea presented in this paper that high managerial shareholdings are an indicator of stock undervaluation. The statistical significance of managerial shareholdings is observed despite the neutralizing influence of the alignment effect of high managerial shareholdings.

7 Conclusion

We develop a theoretical model of the relationship between firm value, managerial shareholdings, and the firm's decision to announce a stock repurchase. We find empirical support for the first prediction of the model that a firm's announcement that it plans to conduct open-market share repurchases is greeted more favorably by the market when the top managers hold many shares of their company's stock. Since announcements of open-market repurchase programs in the United States do not obligate the firm to actually repurchase shares, we argue that the stock ownership of the firm's top management is one of the few pieces of information that outside investors can use to evaluate the credibility of the "undervaluation message" sent by the announcement. The explanatory power of managerial shareholdings has not been previously documented in the literature on open-market stock repurchases.

The second theoretical prediction is that high managerial shareholdings are more strongly associated with high announcement returns in firms that have a higher degree of informational asymmetry with the market. We confirm this economic phenomenon empirically by measuring the informational asymmetry using the dispersion of analysts' earnings forecasts, the number of analysts making the forecasts, market-adjusted volatility of stock returns, and firm size. Managerial shareholdings are also informative about stock undervaluation and can predict announcement returns in firms with low cash reserves, small net operating cash flow, high leverage, and low Tobin's Q.

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8 Appendix.

8.1 Equilibrium prices

First, we derive the equilibrium prices set by the risk-neutral market maker at each date by taking the manager's strategy described in Lemmas 1 and 2 as given. The expressions for these prices will be used in all proofs in this Appendix.

The prices at date 0 are given by the expressions in (4). In equilibrium, there are five pairs of (trade, announcement) decisions the manager can make and the market can observe at dates 0 and 1: $(1, A)$, $(2, A)$, $(1, NA)$, $(2, NA)$, and $(0, NA)$. The equilibrium prices at the announcement date 1 are:

$$\begin{aligned} P_1(i, A) &= \frac{\theta + (2q-1)\, a_i}{N}, \quad i = 1, 2 \\ P_1(0, NA) &= \frac{\theta + (2q-1)\,(p a_0 + (1-p)\,\overline{a})}{N} \\ P_1(i, NA) &= \frac{\theta + (2q-1)\,\overline{a}}{N}, \quad i = 1, 2 \end{aligned} \tag{9}$$

Since the bidders are risk-neutral and competitive, in equilibrium the expected profit of the bidders is equal to zero. At date 2, the expected profit of the bidders is

$$q(K-\gamma)\left(\frac{\theta + E_2[a] - \gamma P_2}{N-\gamma} - P_2\right) + (1-q)\,K\left(\frac{\theta - E_2[a]}{N} - P_2\right) = 0 \tag{10}$$

where $E_2[a]$ is the market's expectation of a conditional on the observed stock purchase by the manager and on the fact of the announcement. The information set of $E_2[a]$ is the same as at date 1 (i.e., $E_1[a] = E_2[a]$) and has already been discussed in section 2. The first term in (10) reflects the bidders' profits in the "up" state when the firm repurchases shares. The firm's value per share is $\frac{\theta + E_2[a] - \gamma P_2}{N-\gamma}$ in this state because γP_2 of cash leaves the firm, and the number of shares is reduced to $N - \gamma$. If the state is "down", the firm does not participate in the auction and so bids 0, and the outside bidders get the full quantity K. In the "down" state, the price per share is $\frac{\theta - E_2[a]}{N}$. There is a subtle point here—the bidders already inferred the true a_i based on the manager's decisions at dates 0 and 1 and use this information when they submit their bids. Equation (10) illustrates the link between the manager's equilibrium strategy in regard to how many units to buy at date 0, whether to announce at date 1, and the future price P_2, which enters his profit function.

From equation (10), we find the market clearing price in the auction at date 2:

$$P_2 = \frac{\theta}{N} + \frac{E_2[a]}{N} \frac{\frac{qN(K-\gamma)}{N-\gamma} - K(1-q)}{K - \frac{q\gamma(N-K)}{N-\gamma}} \tag{11}$$

Thus, if the firm announced the repurchase and the manager purchased either $i = 1$ or $i = 2$ shares, the respective equilibrium prices at the time of repurchase are:

$$P_2(i, A) = \frac{\theta}{N} + \frac{a_i}{N} \frac{\frac{q(K-\gamma)N}{N-\gamma} - K(1-q)}{K - \frac{q\gamma(N-K)}{N-\gamma}}, \quad i = 1, 2 \tag{12}$$

If the firm did not announce the repurchase at date 1, it does not have an option to buy back shares regardless of what was revealed to the manager at date 2. No new information is delivered to the market, and the date 2 equilibrium prices remain what they were at date 1.

$$\begin{aligned} P_2(0, NA) &= \frac{\theta + (2q-1)(pa_0 + (1-p)\overline{a})}{N} \\ P_2(i, NA) &= \frac{\theta + (2q-1)\overline{a}}{N}, \quad i = 1, 2 \end{aligned} \tag{13}$$

Note that prices in (12) and (13) reflect the market's ability to infer (as early as at date 1) whether the manager observed a at date 0.

At date 3, the prices are equal to the true firm value divided by the number of shares outstanding, both of which are determined by the firm's repurchase activity at date 2. If the firm made the repurchase announcement and used its option to repurchase when the manager observed the "up" state the date 3 prices for the (i, A) event are:

$$P_3(i, A, u) = \frac{\theta + a_i - \gamma P_2(i, A)}{N - \gamma}, \quad i = 1, 2 \tag{14}$$

where the third parameter in P_3 means "up" (u) or "down" (d) state. This price is expected to occur with a prior probability q from the perspective of date 0 and date 1. If the manager announced, but learned the "down" state at date 2, the firm will not repurchase. The terminal price for trades $i = 1$ and $i = 2$ (with a prior probability $1 - q$) is

$$P_3(i, A, d) = \frac{\theta - a_i}{N}, \quad i = 1, 2 \tag{15}$$

If the firm did not announce the repurchase, then it does not repurchase at date 2, and

the equilibrium prices for trades $i \subseteq \{0, 1, 2\}$ are

$$\begin{aligned} P_3(i, NA, u) &= \frac{\theta + a_i}{N}, \quad i = 0, 1, 2 \\ P_3(i, NA, d) &= \frac{\theta - a_i}{N}, \quad i = 0, 1, 2 \end{aligned} \tag{16}$$

with prior probabilities q and $1 - q$, respectively.

Having derived the prices at dates 2 and 3, the proof of the equilibrium repurchase strategy at date 2 becomes straightforward. Given the bidders' equilibrium belief that the firm repurchases if and only if the manager observes the "up" state, the manager takes P_2 as given and optimizes over P_3. We need to show that the equilibrium $P_3(i, A, u)$ in (14) is greater than the off-equilibrium price in the (i, A, u) state when the manager deviates from the equilibrium strategy and does not repurchase at date 2, i.e. that $P_3(i, A, u) > \frac{\theta + a_i}{N}, \quad i = 1, 2$. Similarly, we need to show that price $P_3(i, A, d)$ in (15), which arises if the firm does not repurchase in equilibrium, is greater than the date 3 off-equilibrium price in the (i, A, d) state if the firm repurchased at date 2, i.e. that $P_3(i, A, d) > \frac{\theta - a_i - \gamma P_2(i,A)}{N - \gamma}$, $i = 1, 2$. This becomes a simple algebraic exercise of applying the expression for $P_2(i, A)$ from equation (12). The intermediate step is to verify that the denominator in (12) is always positive. The only caveat here is the situation in which the manager sells all his shares at date 2, so that his profit does not depend on P_3. In this situation, we assume that he maximizes the liquidation price for the remaining shareholders. Thus, the manager (the firm) conducts the repurchase activity only in the "up" state according to his equilibrium strategy at date 2.

8.2 Proof of Lemma 2.

Now that we conjectured the equilibrium strategy for date 1 in Lemma 2 and determined the prices the market maker sets under this strategy, the following proof verifies that the strategy is the equilibrium one.

The proof of the equilibrium strategies in Lemmas 1 and 2 follows the standard procedure. First, we calculate the equilibrium prices in (9) - (16) which the market maker sets in anticipation of the manager's actions and after performing Bayesian updating of the expected firm value at each date. Next, we show that the manager finds it optimal to follow his equilibrium strategy by taking these prices as given. In this subsection we verify that, given that the manager places orders at date 0 according to the conjecture in Lemma 1, he does not want to deviate from the equilibrium announcing strategy defined in Lemma 2. In the next subsection, we show that, given his information at date 0, he optimally purchases shares according to the conjecture in Lemma 1.

Denote the manager's expected wealth given his information at date 1 as W_1(observed a, Trade at date 0, Announcement Decision). For example, $W_1(a_1, 1, A)$ is the manager's

wealth if he observed a_1, traded 1 at date 0, and made a repurchase announcement. If the manager did not observe a at date 0, we denote the first parameter in W_1 as $\overline{a}$.

The manager's expected wealth function at date 1 is the same as in equation (6)

$$\max_{D\in\{A,NA\}} W_1(a,i,D) = E_1\left[i\left(\frac{K}{N}P_2+(1-\frac{K}{N})P_3\right)\right]-1_A\varepsilon$$

There are six information states at date 1 in equilibrium, and there are six corresponding ways to deviate from the equilibrium strategy. The equilibrium announcement strategy at date 1 is the following:

1) if the manager observes a_1, holds 1 share, then he decides to announce $(a_1,1,A)$
2) if the manager observes a_2, holds 2 shares, then he decides to announce $(a_2,2,A)$
3) if the manager observes a_0, holds 0 shares, then he decides NOT to announce $(a_0,0,NA)$
4) if the manager does not observe a, holds 0 shares, then he decides NOT to announce $(\overline{a},0,NA)$
5) if the manager does not observe a, holds 1 share, then he decides NOT to announce $(\overline{a},1,NA)$
6) if the manager does not observe a, holds 2 shares, then he decides NOT to announce $(\overline{a},2,NA)$

Next, we compare the equilibrium expected wealth for each of the strategies 1)-6) to the wealth if the manager deviates and makes a different announcement decision than they prescribe.

The manager's expected wealth by following the equilibrium strategy in cases 1) and 2) is

$$\begin{aligned} & W_1(a_i,i,A) = \frac{i}{N}\left(KP_2(i,A)+(N-K)E[P_3|a_i,i,A]\right)-\varepsilon \\ = \quad & \frac{i}{N}\left(\theta+a_i(2q-1)\right)-\varepsilon, \quad i=1,2 \end{aligned}$$

The prices in (12)-(14) were used to obtain the last expression. If the manager deviates and does not announce, his expected wealth is

$$\begin{aligned} & W_1(a_i,i,NA) = \frac{i}{N}\left(KP_2(i,NA)+(N-K)E[P_3|a_i,i,NA]\right) \\ = \quad & \frac{i}{N}\left(\theta+(2q-1)a_i+(2q-1)\frac{K(\overline{a}-a_i)}{N}\right), \quad i=1,2 \end{aligned}$$

For $i=1,2$, we have $\overline{a}-a_i<0$. Thus, $W_1(a_i,i,NA)<W_1(a_i,i,A)$ provided that the personal cost from announcing ε is miniscule. It is optimal for the manager to follow the equilibrium strategy in cases 1) and 2), i.e. $(a_1,1,A)$ and $(a_2,2,A)$ is the equilibrium.

If the manager holds zero shares (cases 3) and 4)), his wealth $W_1(a_0,0,NA)$

and $W_1(\overline{a}, 0, NA)$ are zero if he does not announce in equilibrium. If he announces, his wealth would be $W_1(a_0, 0, A) = W_1(\overline{a}, 0, A) = -\varepsilon$. Therefore, the manager does not deviate from the equilibrium strategies 3) and 4).

Now, consider the expected wealth of the manager who did not learn the value of a and purchased $i \subset \{1, 2\}$ units because of the exogenous demand shock. Even though he could not control the purchase decision, he still has a flexibility to maximize the future value of his shareholdings by announcing or not announcing a repurchase. The manager can only form an expectation about the value a. Consequently, the expected prices at date 3 are $E_1[P_3(i, NA, u)] = (\theta + \overline{a})/N$ and $E_1[P_3(i, NA, d)] = (\theta - \overline{a})/N$ if he does not announce (i.e., the equilibrium strategies 5) and 6)), and $E_1[P_3(i, NA, u)] = \frac{\theta + \overline{a} - \gamma P_2(i, A)}{N - \gamma}$ and $E_1[P_3(i, NA, d)] = (\theta - \overline{a})/N$ if he announces. The expected wealth in equilibrium is

$$\begin{aligned} W(\overline{a}, i, NA) &= \frac{i}{N}[KP_2(i, NA) + q(N - K)\frac{\theta + \overline{a}}{N} \\ &\quad + (1 - q)(N - K)\frac{\theta - \overline{a}}{N}] \\ &= \frac{i}{N}(\theta + (2q - 1)\overline{a}) \end{aligned} \tag{17}$$

where $i = 1, 2$. The manager's wealth if he deviates and announces is

$$\begin{aligned} W(\overline{a}, i, A) &= \frac{i}{N}[KP_2(i, A) + q(N - K)\frac{\theta + \overline{a} - \gamma P_2(i, A)}{N - \gamma} \\ &\quad + (1 - q)(N - K)\frac{\theta - \overline{a}}{N}] - \varepsilon \\ &= \frac{i}{N}[\theta + \frac{a_i}{N}\left(\frac{q(K - \gamma)N}{N - \gamma} - K(1 - q)\right) \\ &\quad + (N - K)\overline{a}\left(\frac{q}{N - \gamma} - \frac{1 - q}{N}\right)] - \varepsilon \end{aligned} \tag{18}$$

where $i = 1, 2$. The inequality $W(\overline{a}, i, NA) > W(\overline{a}, i, A)$ has to be valid for each $i = 1, 2$ in order for the equilibrium to hold. Since ε is negligibly small, both inequalities simplify to the same expression

$$\gamma > \frac{K}{1 + \frac{(N-K)(1-q)}{N(2q-1)}} \tag{19}$$

Note that this parameter restriction is the same as in Oded (2005). Having considered all possible announcement strategies of the manager at date 1, we conclude that the manager optimally announces the stock repurchase according to the strategy in Lemma 2. Q.E.D.

8.3 Proof of Lemma 1.

In this subsection, we analyze the equilibrium strategies for the manager's purchase decision at date 0. In order to make the purchase decision, the manager considers what announcement decision is optimal at date 1. As of date 0, the manager's possible set of actions is

$$(0, A), (1, A), (2, A), (0, NA), (1, NA), (2, NA)$$

In order to prove that the trading strategy in Lemma 1 is an equilibrium, we check which strategy among these six strategies is the optimal one for the manager who observed a particular realization of a. We do this by comparing the manager's expected profits from these strategies for each a_i, $i = 0, 1, 2$. Note that the manager has a choice of date 0 strategy only if he receives information about the project value a. Therefore, this proof does not need to consider the states when the manager does not learn the value of a. Due to this simplification, the proof of Lemma 2 is not redundant because it considers announcement strategies for both informed and uninformed trades, but this lemma considers only informed trades.

Denote the expected profit of the manager given his information at date 0 as π_0(observed a, date 0 trade, Announcement Decision). For example, $\pi_0(a_1, 1, A)$ is the expected profit if the manager observed a_1, traded $+1$ shares at date 0, and made the repurchase announcement. Having observed some value a_i, the manager maximizes his profits by choosing trade $j = 0, 1, 2$ at date 0 and the announcement decision $D \in \{A, NA\}$ at date 1.

$$\max_{j, D \in \{A, NA\}} \pi_0(a_i, j, D) = jE_0\left[\left(\frac{K}{N}P_2 + \left(1 - \frac{K}{N}\right)P_3\right)\right] - jP_0(j) - 1_A\varepsilon$$

From the perspective of the manager who knows a_i at date 0, price P_2 is not random, but is a function of his actions, while P_3 is random because the manager does not know the sign before a in equation (1). Denote prices at date 3 for observed a_i, trade j, announcement decision $D \in \{A, NA\}$, and state $s \in \{u, d\}$ as $P_3(a_i, j, D, s)$. The equilibrium prices P_3 in equations (14)-(16) rely on the strategy "observe a_i, trade i". In this proof, we also consider off-equilibrium prices P_3, where trade j does not correspond to the observed a_i

as described in Lemma 1. Equations (14)-(16) can be generalized as

$$P_3(a_i, j, A, u) = \frac{\theta + a_i - \gamma P_2(j, A)}{N - \gamma}, \quad i = 1, 2 \tag{20}$$
$$P_3(a_i, j, A, d) = \frac{\theta - a_i}{N}, \quad i = 1, 2$$
$$P_3(a_i, j, NA, u) = \frac{\theta + a_i}{N}, \quad i = 0, 1, 2$$
$$P_3(a_i, j, NA, d) = \frac{\theta - a_i}{N}, \quad i = 0, 1, 2$$

The next three subsections compare the expected profits from the six strategies given that the manager observed a_0, a_1, and a_2, respectively.

8.3.1 The manager observes a_0

Lemma 1 states that $(0, NA)$ is optimal given the manager's information a_0. We have already checked that $(0, NA) \succ (0, A)$ in the proof of Lemma 2. We need to establish the following conditions: a) $(0, NA) \succ (1, A)$, b) $(0, NA) \succ (2, A)$, c) $(0, NA) \succ (1, NA)$ d) $(0, NA) \succ (2, NA)$. The expected profit under the manager's equilibrium strategy is

$$\pi_0(a_0, 0, NA) = 0 \left[E\left(\frac{K}{N} P_2 + \left(1 - \frac{K}{N}\right) P_3 \right) - P_0(0) \right] = 0$$

The strategy $(1, A)$ yields

$$\begin{aligned} \pi(a_0, 1, A) &= \frac{K}{N} P_2(1, A) + \left(1 - \frac{K}{N}\right) E[P_3 | a_0, 1, A] - P_0(1) - \varepsilon \\ = \quad & \frac{a_1(2q-1)}{N} - \frac{(N-K)(a_1 - a_0)}{N} \left(\frac{q}{N-\gamma} - \frac{1-q}{N} \right) - \frac{(2q-1)(pa_1 + (1-p)\overline{a})}{N} - \varepsilon \end{aligned}$$

Condition a) requires $\pi(a_0, 1, A) < \pi(a_0, 0, NA)$, which, after dropping the negligibly small ε, simplifies to

$$p > 1 - \left(\frac{q(N-K)}{N-\gamma} - \frac{(1-q)(N-K)}{N} \right) \frac{(a_1 - a_0)}{(2q-1)(a_1 - \overline{a})} \tag{21}$$

The strategy $(2, A)$ yields

$$\pi(a_0, 2, A) = 2\left(\frac{K}{N}P_2(2, A) + \left(1 - \frac{K}{N}\right)E[P_3|a_0, 2, A] - P_0(2)\right) - \varepsilon =$$
$$= 2\left(\frac{a_2(2q-1)}{N} - \frac{(N-K)(a_2 - a_0)}{N}\left(\frac{q}{N-\gamma} - \frac{(1-q)}{N}\right) - (2q-1)\frac{pa_2 + (1-p)\overline{a}}{N}\right) - \varepsilon$$

Condition b) requires $\pi(a_0, 2, A) < \pi(a_0, 0, NA)$, which, after dropping the negligibly small ε, simplifies to

$$p > 1 - \left(\frac{q(N-K)}{N-\gamma} - \frac{(1-q)(N-K)}{N}\right)\frac{(a_2 - a_0)}{(2q-1)(a_2 - \overline{a})} \tag{22}$$

Condition (22) is always satisfied if condition (21) holds. The strategy $(1, NA)$ yields

$$\pi(a_0, 1, NA) = 1\left(\frac{K}{N}P_2(1, NA) + \left(1 - \frac{K}{N}\right)E[P_3|a_0, 1, NA] - P_0(1)\right) =$$
$$= \frac{(2q-1)}{N}\left(\frac{K}{N}\overline{a} + \left(1 - \frac{K}{N}\right)a_0 - pa_1 - (1-p)\overline{a}\right) < 0$$

Condition c) requires $\pi(a_0, 1, NA) < \pi(a_0, 0, NA)$. It is satisfied for all parameter values in the initial assumption (2). The strategy $(2, NA)$ yields the manager's profit:

$$\pi(a_0, 2, NA) = 2\left(\frac{K}{N}P_2(2, NA) + \left(1 - \frac{K}{N}\right)E\left[\widetilde{P}_3|a_0, 2, NA\right] - P_0(2)\right)$$
$$= \frac{(2q-1)}{N}\left(\frac{K}{N}\overline{a} + \left(1 - \frac{K}{N}\right)a_0 - pa_2 - (1-p)\overline{a}\right) < 0$$

Condition d) requires $\pi(a_0, 2, NA) < \pi(a_0, 0, NA)$. It is satisfied for all parameter values in the initial assumption (2).

8.3.2 The manager observes a_1

Lemma 1 states that $(1, A)$ is optimal given the manager's information a_1. We have already checked that $(1, A) \succ (1, NA)$ in the proof of Lemma 2. We need to establish the following conditions: a) $(1, A) \succ (0, A)$, b) $(1, A) \succ (2, A)$, c) $(1, A) \succ (0, NA)$ d) $(1, A) \succ (2, NA)$. The expected profit under the manager's equilibrium strategy is

$$\pi(a_1, 1, A) = \frac{K}{N}P_2(1, A) + \left(1 - \frac{K}{N}\right)E[P_3|a_1, 1, A] - P_0(1) - \varepsilon$$
$$= \frac{(2q-1)}{N}(1-p)(a_1 - \overline{a}) - \varepsilon > 0$$

The strategy $(0, A)$ yields

$$\pi(0, A, a_1) = 0 - \varepsilon < 0$$

Condition a) that $\pi(a_1, 0, A) < \pi(a_1, 1, A)$ is always satisfied. The strategy $(2, A)$ yields

$$\begin{aligned} & \pi(a_1, 2, A) = 2\left(\frac{K}{N}P_2(2, A) + \left(1 - \frac{K}{N}\right) E\left[P_3 | a_1, 2, A\right] - P_0\left(2\right)\right) - \varepsilon \\ = \; & 2\frac{(2q-1)}{N}\left(\left(1-p\right)\left(a_2 - \overline{a}\right) - \left(a_2 - a_1\right)\frac{(N-K)}{(2q-1)}\left(\frac{q}{N-\gamma} - \frac{1-q}{N}\right)\right) - \varepsilon \end{aligned}$$

Condition b) requires $\pi(a_1, 2, A) < \pi(a_1, 1, A)$, which simplifies to

$$p > 1 - \frac{2\left(a_2 - a_1\right)(N-K)}{(2q-1)\left(2a_2 - a_1 - \overline{a}\right)}\left(\frac{q}{N-\gamma} - \frac{(1-q)}{N}\right) \tag{23}$$

Condition (23) makes conditions (22) and (21) redundant because if (23) holds, conditions (22) and (21) are always satisfied. The strategy $(0, NA)$ yields

$$\pi(0, NA, a_1) = 0$$

Condition c) that $\pi(a_1, 0, A) < \pi(a_1, 1, A)$ is always satisfied. The strategy $(2, NA)$ yields

$$\begin{aligned} & \pi(a_1, 2, NA) = 2\left(\frac{K}{N}P_2(2, NA) + \left(1 - \frac{K}{N}\right) E\left[P_3 | a_1, 2, NA\right] - P_0\left(2\right)\right) \\ = \; & 2\frac{(2q-1)}{N}\left(\frac{K}{N}\overline{a} - \left(1-p\right)\overline{a} + \left(1 - \frac{K}{N}\right)a_1 - pa_2\right) \end{aligned}$$

Condition b) requires $\pi(a_1, 2, NA) < \pi(a_1, 1, A)$, which simplifies to

$$p > \left(\frac{2K}{N} - 1\right)\frac{\overline{a} - a_1}{2a_2 - a_1 - \overline{a}} \tag{24}$$

8.3.3 The manager observes a_2

Lemma 1 states that $(2, A)$ is optimal given the manager's information a_2. We have already checked that $(2, A) \succ (2, NA)$ in the proof of Lemma 2. We need to establish the following conditions: a) $(2, A) \succ (0, A)$, b) $(2, A) \succ (1, A)$, c) $(2, A) \succ (0, NA)$

d) $(2, A) \succ (1, NA)$. The expected profit under the manager's equilibrium strategy is

$$\begin{aligned} & \pi(a_2, 2, A) = 2\left(\frac{K}{N}P_2(2, A) + \left(1 - \frac{K}{N}\right) E\left[P_3 | a_2, 2, A\right] - P_0\left(2\right)\right) - \varepsilon \\ = \; & 2\frac{(2q-1)}{N}\left(1-p\right)\left(a_2 - \overline{a}\right) - \varepsilon > 0 \end{aligned}$$

The strategies $(0, A)$ and $(0, NA)$ yield, respectively,

$$\begin{aligned} \pi(a_2, 0, A) &= 0 - \varepsilon < 0 \\ \pi(a_2, 0, NA) &= 0 \end{aligned}$$

Thus, conditions a) and c) are always satisfied. The strategy $(1, A)$ yields

$$\begin{aligned} & \pi(a_2, 1, A) = \frac{K}{N}P_2(1, A) + \left(1 - \frac{K}{N}\right) E\left[P_3 | a_2, 1, A\right] - P_0\left(1\right) - \varepsilon \\ = \; & \frac{a_1\left(2q-1\right)}{N} + \frac{\left(N-K\right)\left(a_2 - a_1\right)}{N}\left(\frac{q}{N-\gamma} - \frac{1-q}{N}\right) - \left(2q-1\right)\frac{pa_1 + \left(1-p\right)\overline{a}}{N} - \varepsilon \end{aligned}$$

Condition b) requires $\pi(a_2, 1, A) < \pi(a_2, 2, A)$, which simplifies to

$$p < 1 - \frac{\left(a_2 - a_1\right)\left(N-K\right)}{\left(2q-1\right)\left(2a_2 - \overline{a} - a_1\right)}\left(\frac{q}{N-\gamma} - \frac{1-q}{N}\right) \tag{25}$$

The strategy $(1, NA)$ yields

$$\begin{aligned} & \pi(a_2, 1, NA) = \frac{K}{N}P_2(1, NA) + \left(1 - \frac{K}{N}\right) E\left[P_3 | a_2, 1, NA\right] - P_0\left(1\right) \\ = \; & \frac{(2q-1)}{N}\left(\frac{K}{N}\overline{a} + \left(1 - \frac{K}{N}\right)a_2 - pa_1 - \left(1-p\right)\overline{a}\right) \end{aligned}$$

Condition d) requires $\pi(a_2, 1, NA) < \pi(a_2, 2, A)$, which, after dropping the negligibly small ε, simplifies to

$$p < \frac{\left(a_2 - \overline{a}\right)}{\left(2a_2 - \overline{a} - a_1\right)}\left(1 + \frac{K}{N}\right) \tag{26}$$

From the non-redundant solutions, the summary of parameter restrictions for the sepa-

rating equilibrium is

$$\begin{aligned} p &< 1-\frac{(a_2-a_1)(N-K)\left(\frac{q}{N-\gamma}-\frac{1-q}{N}\right)}{(2q-1)(2a_2-a_1-\overline{a})} \\ p &> \max\left\{\frac{(a_1-\overline{a})\left(1-\frac{2K}{N}\right)}{2a_2-a_1-\overline{a}}, 1-\frac{2(a_2-a_1)(N-K)\left(\frac{q}{N-\gamma}-\frac{(1-q)}{N}\right)}{(2q-1)(2a_2-a_1-\overline{a})}\right\} \\ \gamma &> \frac{K}{1+\frac{(N-K)(1-q)}{N(2q-1)}} \end{aligned} \tag{27}$$

We have considered all strategies the manager can adopt once he has observed each of the three possible project values and derived the equilibrium conditions (27). Q.E.D.

In order to illustrate the equilibrium conditions, we present a numerical example. Let $a_0 = 1, a_1 = 5, a_2 = 6$, so that $\overline{a} = \frac{1}{3}(1+5+6) = 4$. Let $K = \frac{N}{4}$ and $q = \frac{3}{5}$. Then, the repurchase target must be between 10% and 25% of the outstanding shares, e.g. $\gamma = \frac{N}{5}$. The equilibrium condition is $\frac{9}{16} > p > \frac{1}{6}$.

8.4 Proof of Proposition 1.

If the manager purchased 1 share at date 0, the price change from the date 0 equilibrium price to the post-announcement price at date 1 is

$$P_1(1,A) - P_0(1) = \frac{(2q-1)}{N}(1-p)(a_1-\overline{a})$$

The corresponding price change in the case of the high managerial shareholdings, i.e. the purchase of 2 shares at date 0, is

$$P_1(2,A) - P_0(2) = \frac{(2q-1)}{N}(1-p)(a_2-\overline{a})$$

Note that both $P_1(1,A) - P_0(1)$ and $P_1(2,A) - P_0(2)$ are strictly positive based on the model setup, i.e. $q > \frac{1}{2}$ and inequality (2) holds. From the latter inequality, $a_2 > a_1$, it is clear that $P_1(2,A) - P_0(2) > P_1(1,A) - P_0(1)$. The orders 1 and 2 correspond to the lower and higher managerial shareholdings, respectively. This proves the first part of Proposition 1. The announcement returns for the low and high managerial stock

ownership are, respectively,

$$\begin{aligned} R(1,A) &\equiv \frac{P_1(1,A)-P_0(1)}{P_0(1)} = \frac{\frac{(2q-1)}{N}(1-p)(a_1-\overline{a})}{\frac{\theta}{N}+(2q-1)\frac{pa_1+(1-p)\overline{a}}{N}} \\ R(2,A) &\equiv \frac{P_1(2,A)-P_0(2)}{P_0(2)} = \frac{\frac{(2q-1)}{N}(1-p)(a_2-\overline{a})}{\frac{\theta}{N}+(2q-1)\frac{pa_2+(1-p)\overline{a}}{N}} \end{aligned}$$

It is easy to show that the numerator of $R(2,A)-R(1,A)$ is $(a_2-a_1)(2q-1)(1-p)\cdot(\theta+\overline{a}(2q-1))>0$ and the denominator is the product of two prices which are positive. Therefore, $R(2,A)-R(1,A)>0$, i.e. the announcement returns are higher when the manager's stock ownership at the announcement date is higher. Q.E.D.

8.5 Proof of Proposition 2.

The variance of the firm value increases in the spread of project values, in particular in the spread between a_2 and a_1. The difference between price increases for the high and low managerial ownership is

$$(P_1(2,A)-P_0(2))-(P_1(1,A)-P_0(1)) = \frac{(2q-1)(1-p)(a_2-a_1)}{N}$$

Clearly, the price reaction to the announcement increases in the spread between the two states of the project value a. It is easy to show that the difference between announcement returns $R(2,A)$ and $R(1,A)$, the expressions for which were derived in the proof of Proposition 1, is also proportional to a_2-a_1. Therefore, a higher variance of the firm value corresponds to a greater price increase at the repurchase announcement. Q.E.D.

8.6 Appendix: Tables

Table 1a. Repurchase Announcement Data by Industry.
Firms are classified into industries according to their two-digit SIC codes, with an exception of the high-tech industry, which is defined by 4-digit SIC codes 3571, 3572, 3575, 3578, 3671, 3672, 3674-3677, 3661, 3678, 3679, 3875, 7371-7376, 7379. The second column lists 2-digit SIC codes, the fourth and fifth columns contain the number of observations and the number of sample firms within each industry that announced an open-market share repurchase during 1996-2002.

2-digit SIC code	Industry name	Number of Observations	Number of Firms
01-09	Agriculture, forestry, and fishing	5	3
10-14	Mining	31	21
15-17	Construction	28	16
20-39	Manufacturing (excluding High-Tech)	508	309
40-49	Transportation, communication, utilities	97	58
50-51	Wholesale trade	55	29
52-59	Retail trade	161	78
60-67	Finance and Insurance	80	50
70-89	Services (excluding High-Tech)	122	70
91-99	Public administration	3	2
Other	High-Tech	191	106
	Total	1,281	742

Table 1b. Repurchase Announcements by Year

2-digit SIC code	1996	1997	1998	1999	2000	2001	2002
01-09	1	1	0	2	1	0	0
10-14	4	6	11	1	3	5	1
15-17	8	5	4	4	2	3	2
20-39	88	86	125	91	62	27	29
40-49	20	12	23	21	6	5	10
50-51	11	7	12	14	8	2	1
52-59	13	17	40	35	27	14	15
60-67	14	5	12	17	13	10	9
70-89	8	21	25	26	17	8	17
91-99	0	1	0	0	1	1	0
Other	25	32	40	22	30	26	16
Total	192	193	292	233	170	101	100

Table 2. Summary statistics of main variables for firms announcing open market share repurchases. Value-weighted (equally-weighted) abnormal return is the cumulative abnormal stock return over the (-1,+1) announcement window in percentage terms, calculated using the market model with the value-weighted (equally-weighted) CRSP index. Fama-French three-factor abnormal return is the cumulative abnormal stock return over the (-1,+1) announcement window in percentage terms, calculated using the Fama-French three-factor model. Stock Price Runup is calculated as the abnormal stock price return in percentage terms from trading day -43 to day -4 prior to the announcement. The parameters of the market model are estimated over a period beginning from trading day -252 and ending at day -44 prior to the announcement. Managerial Shares (Exercisable Options) is the number of shares (exercisable options) held by the top five executives at the end of the fiscal year prior to the announcement normalized by the number of outstanding shares, multiplied by 100. Cash is cash and equivalents divided by book assets, multiplied by 100. Tobin's Q is defined as the ratio of market value of assets to book value of assets, where market value of assets is calculated as book assets plus market equity and minus book value of equity. All Compustat variables are taken at the fiscal year-end prior to the announcement. The last column reports t-test statistics for a two-sided test to determine whether Mean=0. Significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

Variable	Mean	Median	Min	Max	StdDev	T-test
Value-weighted abnormal return (%)	1.69	1.34	-48.78	43.19	7.38	8.20^{***}
Equally-weighted abnormal return (%)	1.86	1.53	-47.54	38.52	7.35	9.08^{***}
Fama-French 3-factor abnormal return (%)	1.68	1.42	-47.98	40.32	7.22	8.34^{***}
Managerial Shares (%)	4.30	0.87	0.01	39.48	7.87	-
Percent of Market Value Sought (%)	6.21	4.75	0.16	30.64	5.63	-
Cash (%)	13.04	5.79	0.03	67.99	15.53	-
Managerial Exercisable Options (%)	1.40	0.92	0.00	8.30	1.53	-
Stock Price Runup in prior 40 days (%)	-6.89	-6.22	-65.80	44.90	19.16	-12.88^{***}
Firm book assets (mil)	8789	1283	29	1337282	56715	-
Tobin's Q	2.61	1.84	0.89	11.50	2.00	-

Table 3. Correlation Matrix of the Main Variables and Controls
Managerial Shares (Exercisable Options) is the number of shares (exercisable options) held by the top five executives at the end of the fiscal year prior to the announcement normalized by the number of outstanding shares, multiplied by 100. Stock Price Runup is calculated as the abnormal stock price return in percentage terms from trading day -43 to day -4 prior to the announcement. The parameters of the market model are estimated from trading day -252 to -44. Cash is cash and equivalents divided by book assets, multiplied by 100. Tobin's Q is defined as the ratio of market value of assets to book value of assets, where market value of assets is calculated as book assets plus market equity and minus book value of equity. Significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

Variable	Managerial Shares (%)	Percent Sought (%)	Exercisable Options (%)	Stock Price Runup (%)	Firm Size	Tobin's Q	Cash
Managerial Shares (%)	100.00%	-3.55%	0.21%	-7.1%**	-23.26%***	1.72%	8.27%***
Percent Sought (%)		100.00%	5.99%**	7.72%***	-11.06%***	-28.71%***	4.35%
Exercisable Options (%)			100.00%	-5.21%*	-29.69***	0.50%	7.40%***
Stock Price Runup (%)				100.00%	11.41***	-9.58%***	-8.83%***
Firm Size					100.00%	-7.66%***	-23.21%***
Tobin's Q						100.00%	34.9%***
Cash							100.00%

Table 4. Explaining Changes in Managerial Shareholdings during the Year of Repurchase Announcement
The dependent variable in column 1 is the indicator of stock increases, equal to 1 if the number of shares held by the top five executives (adjusted for stock splits) has increased during the fiscal year of the repurchase announcement, and equal to 0 otherwise. The dependent variable in column 2 is the indicator of stock increases net of options exercised, equal to 1 if the number of shares held by the top five executives at the end of the announcement year (adjusted for stock splits) minus the number of shares at the beginning of the year, and minus the number of options exercised during the year, is positive, and equal to 0 otherwise. The dependent variable in column 3 is the percent change in stock ownership of the top five executives during the announcement year. Percent Sought is the percentage of equity that the firm plans to repurchase according to the announcement. Managerial Shares is the number of shares held by the top five executives at the fiscal year-end prior to the announcement normalized by the number of outstanding shares. Tobin's Q is the ratio of market to book value of assets. Past (Contemporaneous) Stock Returns are returns during the fiscal year prior to (year of) the announcement. Models in columns 1-2 and column 3 are estimated with logit and OLS, respectively. For each regressor, the first and second entries are the coefficient and t-statistic (corrected for heteroscedasticity), respectively, and the third entry is the change in the probability that the dependent variable is equal to 1 (or the increment in the change in managerial ownership for column 3) when the explanatory variable increases by one standard deviation. Significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

Variable	ΔStock>0	Δ(Stock-Opt)>0	ΔOwnership
Intercept	0.757	0.692	-1.319
	(0.78)	(0.71)	(-1.27)
Percent Sought (%)	0.027**	0.034***	0.017**
	(2.39)	(2.93)	(2.03)
	0.034	0.039	0.096
Managerial Shares (%)	-0.052***	-0.028***	
	(-5.90)	(-2.92)	
	-0.094	-0.039	
Tobin's Q	-0.080**	-0.157***	-0.009
	(-2.26)	(-3.38)	(-0.49)
	-0.036	-0.060	
Past Stock Returns (%)	0.001	0.000	-0.002*
	(0.86)	(0.09)	(-1.94)
			-0.125
Contemporaneous Stock Returns (%)	-0.003**	-0.001	-0.002*
	(-2.45)	(0.33)	(-1.72)
	-0.046		-0.093
Year, Industry Dummies	Yes	Yes	Yes
Observations	1,224	1,224	1,224
Dependent Var. Mean	0.493	0.297	-0.163

Table 5. Analyzing managerial stock purchases for announcing and matching firms.
Top Half, Trecile, and Quartile are subsamples of data with the announced program sizes in the top half, trecile and quartile of the sample, respectively. The indicator of stock increases is equal to 1 if the number of shares held by the top five executives (adjusted for stock splits) has increased during the fiscal year of the repurchase announcement, and is equal to 0 otherwise. Indicator of Stock Increases Net of Options is equal to 1 if the number of shares held by the top five executives at the end of the announcement year (adjusted for stock splits) minus the number of shares at the beginning of the year, and minus the number of options exercised during the year, is positive, and equal to 0 otherwise. The Change in Fractional Ownership is equal to the number of shares held by the top five executives at the end of the fiscal year of the announcement normalized by the number of outstanding shares minus the number of shares held at the beginning of fiscal year of announcement normalized by the number of outstanding shares, multiplied by 100. The two-sample t-test statistic and the Wilcoxon test statistic for the difference in means are presented in the last two columns, respectively. The matching firms are firms that do not make repurchase announcements in the same fiscal year, and are matched with announcing firms on industry, size and book-to-market. Significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

	Announcing Firms	Matching Firms	Two-Sample T-Test	Two-Sample Wilcoxon
Full Sample (1,199 obs.)				
Change in Fractional Ownership (Mean)	-0.154%	-0.586%	5.36^{***}	5.78^{***}
Change in Fractional Ownership (Median)	0.010%	-0.010%		
Indicator of Stock Increases (Mean)	0.496	0.470	1.31	
Indicator of Stock Increases net of Options (Mean)	0.304	0.299	0.22	
Top Half (599 obs.)				
Change in Fractional Ownership (Mean)	-0.094%	-0.620%	4.35^{***}	4.01^{***}
Change in Fractional Ownership (Median)	0.016%	-0.006%		
Indicator of Stock Increases (Mean)	0.521	0.489	1.13	
Indicator of Stock Increases net of Options (Mean)	0.337	0.315	0.88	
Top Trecile (400 obs.)				
Change in Fractional Ownership (Mean)	-0.016%	-0.695%	4.67^{***}	5.12^{***}
Change in Fractional Ownership (Median)	0.033%	-0.012%		
Indicator of Stock Increases (Mean)	0.555	0.483	2.12^{**}	
Indicator of Stock Increases net of Options (Mean)	0.363	0.303	1.81^{*}	
Top Quartile (300 obs.)				
Change in Fractional Ownership (Mean)	0.019%	-0.748%	4.35^{***}	5.57^{***}
Change in Fractional Ownership (Median)	0.037%	-0.015%		
Indicator of Stock Increases (Mean)	0.573	0.467	2.68^{***}	
Indicator of Stock Increases net of Options (Mean)	0.403	0.300	2.70^{***}	

Table 6. Explaining Announcement Returns in Full Sample.

The dependent variable in columns 1-3 is the cumulative abnormal return (CAR) in the (-1,+1) announcement window, calculated using the market model with the value-weighted CRSP index. The dependent variables in columns 4 and 5 are the CAR in the (-1,+1) announcement window, obtained from the market model with the equally-weighted CRSP index and from the Fama-French three-factor model, respectively. Stock Price Runup is the abnormal return from trading day -43 to -4 prior to the announcement. The parameters of the market model are estimated from trading day -252 to -44. Managerial Shares (Exercisable Options) is the number of shares (exercisable options) held by the top five executives at the fiscal year-end prior to the announcement normalized by the number of outstanding shares. Cash is cash and equivalents divided by book assets. Tobin's Q is the ratio of market to book value of assets. Heteroscedasticity-consistent t-statistics are in parentheses below each coefficient. The third entry is the percentage by which the abnormal return changes when the explanatory variable increases by one standard deviation. Significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

Variable	VW (1)	VW (2)	VW (3)	EW (1)	FF (1)
Intercept	0.319	-1.842	-2.405	-1.027	-1.399
	(0.87)	(-0.78)	(-0.98)	(-0.39)	(-0.57)
Managerial Shares (%)	0.063^{**}	0.063^{**}	0.129^{***}	0.112^{**}	0.121^{***}
	(2.07)	(1.97)	(2.68)	(2.33)	(2.59)
	0.50%	0.50%	1.02%	0.88%	0.95%
Percent Sought (%)	0.083^{**}	0.077^{**}	0.077^{**}	0.063^{*}	0.085^{**}
	(2.23)	(2.01)	(2.01)	(1.69)	(2.28)
	0.47%	0.43%	0.43%	0.35%	0.48%
Cash (%)	0.048^{***}	0.051^{**}	0.069^{**}	0.077^{***}	0.064^{***}
	(2.93)	(2.47)	(3.05)	(3.43)	(2.93)
	0.75%	0.79%	1.07%	1.20%	0.99%
Managerial Shares*Cash			-0.004^{**}	-0.003	-0.004^{*}
			(-2.01)	(-1.63)	(-1.81)
Stock Price Runup (%)		-0.022	-0.023	-0.013	-0.024^{*}
		(-1.48)	(-1.58)	(-0.96)	(-1.70)
Exercisable Options (%)		-0.076	-0.097	-0.066	-0.091
		(-0.46)	(-0.58)	(-0.40)	(-0.56)
Tobin's Q		-0.094	-0.080	-0.145	-0.104
		(-0.77)	(-0.66)	(-1.20)	(-0.88)
Firm Size		-0.056	-0.040	-0.071	-0.094
		(-0.36)	(-0.25)	(-0.45)	(-0.61)
Year Dummies	No	Yes	Yes	Yes	Yes
Industry Dummies	No	Yes	Yes	Yes	Yes
Observations	1,266	1,260	1,260	1,260	1,260
Mean CAR	1.73%	1.72%	1.72%	1.89%	1.71%

Table 7. Explaining Announcement Returns in Asymmetric Information Subsamples.
The dependent variable is CAR in the (-1,+1) announcement window. Stock Price Runup is the abnormal return from trading day -43 to -4. Managerial Shares (Exercisable Options) is the number of shares (exercisable options) held by the top five executives at the fiscal year-end prior to the announcement normalized by the number of outstanding shares. Cash is cash and equivalents divided by book assets. Tobin's Q is the ratio of market to book value of assets. High (low) analyst uncertainty firms are firms with the dispersion of analysts' earnings forecasts above (below) the sample median. High (low) returns volatility firms are firms with volatility of market-adjusted returns above (below) the sample median. Heteroscedasticity-consistent t-statistics are in parentheses below each coefficient. The third entry is the percentage by which the abnormal return changes when the explanatory variable increases by one standard deviation. Significance at the 1%, 5%, and 10% is denoted by ***, **, and *, respectively.

Variable	High Analyst Uncertainty	Low Analyst Uncertainty	High Returns Volatility	Low Returns Volatility	Small Market Cap	Large Market Cap
Intercept	-0.725	-1.066	0.721	-1.825	0.790	-0.998
	(-0.31)	(-0.41)	(0.29)	(-1.00)	(0.50)	(-1.11)
Managerial Shares (%)	0.267***	0.028	0.215***	0.029	0.142**	0.041
	(3.42)	(0.50)	(2.78)	(0.75)	(2.48)	(0.45)
	2.10%		1.69%		1.12%	
Percent Sought (%)	0.032	0.102*	0.023	0.128***	0.015	0.172***
	(0.60)	(1.82)	(0.34)	(3.34)	(0.28)	(3.32)
		0.57%		0.72%		1.15%
Cash (%)	0.065*	0.078**	0.062**	0.064*	0.064**	0.074**
	(1.85)	(2.50)	(2.11)	(1.86)	(2.01)	(2.36)
	1.01%	1.21%	0.96%	0.99%	0.99%	1.06%
Managerial Shares*Cash	-0.006*	-0.002	-0.006*	-0.002	-0.004	-0.001
	(-1.87)	(-0.78)	(-1.92)	(-1.12)	(-1.60)	(-0.45)
Stock Price Runup (%)	-0.030	-0.013	-0.023	-0.016	-0.037*	-0.012
	(-1.63)	(-0.52)	(-1.23)	(-0.76)	(-1.81)	(-0.59)
Exercisable Options (%)	-0.051	-0.077	0.030	-0.336*	-0.119	0.039
	(-0.26)	(-0.29)	(0.13)	(-1.81)	(-0.50)	(0.21)
Tobin's Q	0.062	-0.077	-0.087	-0.012	-0.810**	0.184
	(0.25)	(-0.52)	(-0.52)	(-0.07)	(-2.40)	(0.83)
Firm Size	-0.022	0.056	-0.174	0.168		
	(-0.11)	(0.20)	(-0.67)	(0.93)		
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	616	616	630	630	630	630
Mean CAR	1.91%	1.42%	2.46%	0.97%	1.94%	1.49%

Table 8. Explaining Announcement Returns Based on Agency Cost Measures.

The dependent variable is the CAR in the (-1,+1) announcement window, calculated using the market model with the value-weighted index. Stock Price Runup is the abnormal return from trading day -43 to -4 prior to the announcement. The parameters of the market model are estimated from day -252 to -44. Managerial Shares (Exercisable Options) is the number of shares (exercisable options) held by the top five executives at the fiscal year-end prior to the announcement normalized by the number of outstanding shares. Cash is cash and equivalents to book assets. Tobin's Q is defined as the ratio of market value of assets to book value of assets. Free cash flow is equal to EBITDA less capital expenditures, scaled by assets. High (low) cash firms are firms with cash above (below) the sample median. High (low) free cash flow firms are firms with free cash flow above (below) the sample median. Bad (good) governance firms are firms with entrenchment index (Bebchuk, Cohen, and Ferrell, 2005) values of 3-6 (0-2). Heteroscedasticity-consistent t-statistics are in parentheses below each coefficient. The third entry is the percentage by which the abnormal return changes when the explanatory variable increases by one standard deviation. Significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

Variable	High Cash	Low Cash	High Free CF	Low Free CF	Bad Governance	Good Governance
Intercept	2.833	-0.630	-4.294	-0.723	0.015	-2.990
	(1.37)	(-0.26)	(-1.52)	(-0.16)	(0.00)	(-0.94)
Managerial Shares (%)	-0.009	0.165***	0.051	0.115**	0.104*	0.072*
	(-0.24)	(2.74)	(1.27)	(2.09)	(1.78)	(1.92)
		1.30%		0.91%	0.82%	0.57%
Percent Sought (%)	0.119**	0.025	0.160**	0.040	0.098*	0.060
	(1.97)	(0.51)	(2.44)	(0.77)	(1.74)	(1.31)
	0.67%		0.90%		0.55%	
Cash (%)					0.108***	0.006
					(3.32)	(0.22)
					1.68%	
Stock Price Runup (%)	-0.049**	0.019	-0.020	-0.008	-0.003	-0.026
	(-2.43)	(0.85)	(-0.91)	(-0.40)	(-0.15)	(-1.30)
Exercisable Options (%)	-0.103	-0.096	-0.070	-0.013	-0.046	-0.018
	(-0.48)	(-0.36)	(-0.29)	(-0.05)	(-0.20)	(-0.08)
Tobin's Q	0.027	-0.130	-0.084	0.416	-0.012	-0.303*
	(0.17)	(-0.79)	(-0.62)	(1.29)	(-0.07)	(-1.82)
Firm Size	-0.277	0.123	0.098	-0.264	-0.259	0.090
	(-1.40)	(0.47)	(0.38)	(-1.23)	(-0.89)	(0.049)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	630	630	609	608	539	705
Mean CAR	2.12%	1.31%	1.62%	1.66%	1.36%	2.02%

Table 9. Explaining Announcement Returns Based on Other Measures.

The dependent variable is the CAR in the (-1,+1) announcement window, calculated using the market model with the value-weighted index. Stock Price Runup is the abnormal return from trading day -43 to -4 prior to the announcement. The parameters of the market model are estimated from trading day -252 to -44. Managerial Shares (Exercisable Options) is the number of shares (exercisable options) held by the top five executives at the fiscal year-end prior to the announcement normalized by the number of outstanding shares. Cash is cash and equivalents divided by book assets. Tobin's Q is defined as the ratio of market value of assets to book value of assets. Leverage is defined as the ratio of long term debt to assets. High (low) Tobin's Q firms are firms with Tobin's Q (below) the sample median. High (low) leverage firms are firms with leverage ratios above (below) the sample median. Heteroscedasticity-consistent t-statistics are in parentheses below each coefficient. The third entry is the percentage by which the abnormal return changes when the explanatory variable increases by one standard deviation. Significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

Variable	High Tobin's Q	Low Tobin's Q	High Leverage	Low Leverage
Intercept	-2.058	-1.115	2.383	-1.082
	(-0.68)	(-0.39)	(0.97)	(-0.53)
Managerial Shares (%)	-0.012	0.122***	0.137**	0.022
	(-0.29)	(2.61)	(2.45)	(0.56)
		0.96%	1.08%	
Percent Sought (%)	0.042	0.077	0.071	0.065
	(0.63)	(1.62)	(1.43)	(1.11)
Cash (%)	0.039	0.072**	0.054	0.057**
	(1.48)	(2.31)	(1.23)	(2.23)
		1.12%		0.89%
Stock Price Runup (%)	-0.042*	0.000	0.001	-0.039*
	(-1.94)	(0.02)	(0.05)	(-1.86)
Exercisable Options (%)	-0.088	-0.105	-0.055	-0.063
	(-0.36)	(-0.44)	(-0.25)	(-0.26)
Tobin's Q			-0.057	-0.159
			(-0.29)	(-1.01)
Firm Size	0.085	-0.165	-0.230	0.061
	(0.35)	(-0.78)	(-0.96)	(0.29)
Year Dummies	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes
Observations	630	630	629	628
Mean CAR	1.43%	2.00%	1.48%	1.95%