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Stock repurchases: How firms choose between a self tender offer and an open-market program

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ABSTRACT

In practice, open-market stock repurchase programs outnumber self tender offers by approximately 10–1. This evidence is puzzling given that tender offers are more efficient in disbursing free cash and in signaling undervaluation – the two main motivations suggested in the literature for repurchasing shares. We provide a theoretical model to explore this puzzle. In the model, tender offers disburse free cash quickly but induce information asymmetry and hence require a price premium. Open-market programs disburse free cash slowly, and hence do not require a price premium, but because they are slow, result in partial free cash waste. The model predicts that the likelihood that a tender offer will be chosen over an open-market program increases with the agency costs of free cash and decreases with uncertainty (risk), information asymmetry, ownership concentration, and liquidity. These predictions are generally consistent with the empirical evidence.

1. Introduction

Stock repurchases are generally performed either with an open-market repurchase program (henceforth "an open-market program") or a self-tender offer repurchase (henceforth "a tender offer"). With an open-market program, the firm announces its intention to buy back shares and then starts repurchasing shares in the open market over a long period of time (generally 1–2 years). With a tender offer, the firm offers its existing shareholders the opportunity to sell their shares back directly to the firm within a short period of time from the offer date (generally 1 month).[1]

During the last three decades, stock repurchases have experienced dramatic growth.[2] This growth has stimulated numerous empirical studies which report that open-market programs outnumber tender offers by about 10–1.[3] While the literature tends to consider the growth in repurchase activity as "the growth in open-market programs," a careful review of the earlier empirical literature suggests that open-market programs accounted for the majority of stock repurchase activity even before the recent growth.[4]

Why are tender offers less popular than open-market programs? The commonly suggested motivations for repurchasing shares are signaling and reducing agency costs of free cash. Empirical evidence indicates that the average announcement return is significantly higher for tender offers relative to open-market programs (15% versus 3%, respectively), implying that tender offers have favorable signaling capability.[5] Alternatively,

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[1] For a detailed description of the stock repurchase institution see, Johnson and McLaughlin (2010).

[2] See, Grullon and Michaely (2002), and more recently, Chan et al. (2007).

[3] Comment and Jarrell (1991) document this ratio over the period 1985–1988. Peyer and Vermaelen (2005) report a higher ratio for the period 1984–2001, and Banyi et al. (2008) report a higher ratio for the period 1996–2003.

[4] Vermaelen (1981) finds 198 open-market program announcements during the period 1970–1978, and only 131 tender offers during 1962–1977, a period of double the duration. Dann (1981) investigates only tender offers, but mentions that open-market programs occur more frequently. Barclay and Smith (1988) document a ratio of 14:1 between open-market programs and tender offers for the period 1983–1986 for NYSE firms.

[5] See, Vermaelen (1981), Comment and Jarrell (1991), and Peyer and Vermaelen (2009). The announcement return is higher for tender offers even after controlling for the repurchase size, which is larger on average for tender offers. Moreover, studies find that the announcement return on open-market programs has decreased over the years (e.g., Ikenberry et al., 1995; Grullon and Michaely, 2004) whereas there are no such findings documented for tender offers.

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if firms repurchase stock in order to reduce agency costs of free cash flow, then it would appear that tender offers are more efficient than open-market programs because the sooner the cash is distributed, the better. Taxes are commonly suggested as other frictions that affect a firm's payout policy.[6] Taxes, however, are not likely to affect the choice of the stock repurchase method because both open-market programs and tender offers are taxed as capital gains.

The purpose of this study is to investigate how firms choose between tender offers and open-market programs. In particular, we would like to explain the prevalence of open-market programs. Our approach is theoretical. Earlier theoretical studies of repurchase activity have focused on the choice between alternative tender offer mechanisms or on the choice between repurchases and dividends. Interestingly, the question of how firms choose between open-market programs and tender offers has been largely ignored. Our goal is to fill this gap.

We consider a firm that has free (excess) cash for which it does not have good investment opportunities. If kept in the firm, this free cash will gradually decrease in value (e.g., because it will be invested in negative NPV projects). The firm can prevent the waste of this free cash by distributing it back to the shareholders either with a tender offer or with an open-market program. If it chooses a tender offer, the cash is distributed immediately and therefore the waste is completely prevented. However, because a huge number of shares are repurchased in a short time, the repurchase has significant wealth effects on the shareholders. Namely, if the repurchase price underestimates the value, tendering shareholders loose and nontendering shareholders gain whereas if the repurchase price overestimates the value, the situation is reversed. We show that this stimulates costly information gathering (e.g., firm and market analysis) among a subset of the shareholders. The resulting information asymmetry induces adverse selection, and requires the firm to offer a premium in order to make sure that the tender offer succeeds. This tender premium, in turn, reduces the value of the remaining shares. In contrast, an open-market program is gradual. Hence it does not stimulate information gathering, and no tender premium is required. However, because the cash distribution is gradual, with an open-market program, some free cash is carried with the firm for a longer time, and hence part of it is wasted.[7] The trade off between the decrease in share value incurred in a tender offer and the waste of free cash incurred in an open-market program determines the resultant repurchase method.

In sum, the model suggests that tender offers efficiently prevent the waste of free cash but induce costly and dissipative information gathering, and result in wealth transfers among the shareholders. Open-market programs are less efficient in preventing the waste of free cash because they are slow in distributing it. However, the slow pace of cash distribution is also advantageous as it avoids negative information effects. In light of the empirical evidence that open-market programs prevail, our interpretation is that, in general, the expected loss from slowing the cash distribution with an open-market program is smaller than the expected loss from paying a premium with a tender offer.

The model makes two key assumptions. The first is that the manager-shareholder in charge who chooses the repurchase method cannot participate in the tender offer.[8] Because he cannot participate, a tender premium reduces the value of his shares.[9] We show that, in our model, this induces a socially effective mechanism: a tender offer and the wealth expropriations associated with it are the equilibrium outcome only if they represent the best alternative for all shareholders. The second important assumption that we make is that the daily trade is small relative to the payout size and that the quantity the firm can purchase every day in an open-market program is even smaller.[10] As a result, an open-market program does not stimulate information gathering (and hence has no price or wealth expropriation effects); however, it slows the cash distribution. Indeed, empirically, in comparison to tender offers, open-market programs hardly generate an announcement return and take years to complete. In fact, many open-market programs are not completed (Stephens and Weisbach, 1998), suggesting they are only partially effective in preventing the waste of free cash.

The model generates several new predictions about the choice between the repurchase methods. In the model, the tender premium in a tender offer represents compensation to uninformed shareholders for adverse selection they face, and hence increases with risk and information asymmetry. Open-market programs are not associated with adverse selection but rather with waste of free cash. Accordingly, the model predicts that, given a repurchase, higher risk and information asymmetry increase the likelihood of an open-market program whereas higher free cash waste increases the likelihood of a tender offer. The model also predicts that ownership concentration will increase the likelihood of an open-market program over a tender offer. This is because in a tender offer, only large shareholders can afford the information costs. Consequently, the larger the number of shares held by large shareholders, the higher the level of adverse selection, and hence, the higher the tender premium required to assure a successful tender offer. In contrast, the cost of an open-market program does not depend on ownership concentration. Similarly, market liquidity increases the likelihood of an open-market program over a tender offer because it allows the firm to execute open-market programs more quickly, whereas tender offers do not involve the secondary market.

The focus of this paper is on the trade-off between repurchase methods, and we thus abstract from other means of free cash disbursement mechanisms such as dividends and interest payments. Dividends distribute free cash immediately and do not require a premium. However, they are tax disadvantageous and informally commit the firm to future dividends. Furthermore, empirical evidence suggests that dividends and repurchases serve to distribute cash flows of different nature.[11]

[6] See, for example, Allen and Michaely (2003); Gottesman and Jacoby (2006).

[7] While the execution of open-market programs may start immediately (see, Gong et al., 2008), they generally take several years to complete (see, Stephens and Weisbach, 1998). In contrast, tender offers are generally completed within a few weeks after their initial announcement (see, Johnson and McLaughlin, 2010).

[8] Most earlier theoretical investigations of repurchases make this assumption. See, for example, Vermaelen (1984) and Ofer and Thakor (1987). Supporting empirical evidence that managers do not sell their shares in tender offers is in Vermaelen (1981) and in Comment and Jarrell (1991). In practice, managers often own shares that they are not allowed to sell, or they only own options or a commitment for shares. Tendering could also expose them to lawsuits about use of private information or stock price manipulation.

[9] While managers may benefit from the announcement return, empirically, this return is substantially lower than the tender premium (see, Lakonishok and Vermaelen, 1990; McNally, 2001). Hence, the loss from not being able to participate is substantial even after taking into account the announcement effect.

[10] In the US, Rule 18-10b in the Safe Harbor Act (1982) limits the firm's ability to trade in an open-market program (see, also Footnote 26). Outside the US, restrictions on actual repurchase trade are more severe.

[11] Jagannathan et al. (2000) and Guay and Harford (2000) find that firms distribute relatively permanent free cash flows with dividends and relatively transient free cash flows with stock repurchases. Dividends could be incorporated into the model based on their tax disadvantage without affecting the qualitative results on the choice between tender offers and open-market programs.

Most earlier theoretical investigations in payout policy build on taxes and signaling motivation. As described above we abstract from these motivations and instead build on the agency costs of free cash flow. Increasing empirical evidence suggests that firms repurchase stock in order to distribute free cash (see, for example, Grullon and Michaely, 2004; Oswald and Young, 2008). The agency costs we introduce are minimal. Namely, the manager is not better informed, he does not have compensation contracts that depend on interim stock prices (Kahle, 2002), and he does not benefit from cash waste.[12] Other things we abstract from, and which have been suggested to affect repurchase activity, are the nonperfect elasticity of stock supply (Hodrick, 1999), control conflicts (Shleifer and Vishney, 1986; Harris and Glegg, 2009), managerial entrenchment (Hu and Kumar, 2004), transaction costs (McNally and Smith, 2007), the flexibility inherent in open-market programs with respect to the timing and quantity of actual repurchases (Stephens and Weisbach, 1998; Oded, 2005), and earning management (Gong et al., 2008; Michel et al., 2010). We acknowledge these issues are also important but we do not consider them in this paper.

The existing theoretical studies on stock repurchases focus on the choice between tender offer mechanisms or between repurchases and dividends.[13] Interestingly, the choice between self tender offers and open-market programs is largely ignored. Papers closely related to this paper are Vermaelen (1984), Ofer and Thakor (1987), Chowdhry and Nanda (1994), Lucas and McDonald (1998), and Brennan and Thakor (1990). All build on the wealth redistribution properties of stock repurchases under asymmetric information. The first four papers deliver very interesting insights, but the repurchase they consider is essentially a tender offer, and they do not address the differences between a tender offer and an open-market program. Our paper is closest to Brennan and Thakor (1990). In their model, large investors use the wealth redistribution properties of stock repurchases to expropriate wealth from small investors, as it is relatively cheaper for large investors to learn the true stock value. Their choice between an open-market program and a tender offer is determined as a trade-off between wealth expropriations and taxes. Specifically, tender offers provide large shareholders with higher wealth transfers from small shareholders but result in higher effective taxes (because unlike open-market programs, tender offers might be regarded and taxed as dividends).[14] In contrast, in our model the wealth transfers to large shareholders associated with tender offers represent a cost to insiders which is traded off against free cash waste with open-market programs. The predictions are also different. For example, Brennan and Thakor predict that ownership concentration increases the likelihood of a tender offer over an open-market program while our model predicts the opposite.

Brennan and Thakor's model and ours are both structurally similar to that of Rock (1986) who investigates the underpricing of new stock issues (IPOs). All three models assume that managers are not inherently better informed than outsiders, and that asymmetric information among outsiders necessitates compensation to uninformed shareholders (premium in a tender offer, discount in an IPO). The tensions in Rock's model, however, are different, because in IPOs investors can avoid adverse selection by not participating, whereas in tender offers, all shareholders are affected whether they participate or not. Namely, unlike in the case of an IPO, in a tender offer uninformed shareholders cannot avoid adverse wealth effects by choosing not to participate.

The remainder of this paper is organized as follows. Section 2 develops a model of tender offers, abstracting from the motivation for the repurchase. Section 3 introduces open-market programs and free cash flow waste as the motivation for repurchasing into the model, and characterizes the choice between a tender offer and an open-market program. Section 4 compares the model predictions to the empirical evidence, and Section 5 concludes.

2. A model of tender offers

This section develops a two-period model of tender offers. We investigate the offer's wealth redistribution effects and characterize an equilibrium in which investors incur information costs.

2.1. Notation and assumptions

Consider an economy with an interest rate of zero. All agents are risk neutral, there are no taxes and no transaction costs. Assume two dates, $t \in \{0,1\}$. At $t = 0$, an equity-financed firm has N shares outstanding and is owned by J investors (shareholders). Each investor $j \in \{1,\ldots,J\}$ holds n_j shares, where $\sum_j n_j = N$. One investor manages the firm (henceforth "the manager"). All investors including the manager maximize the expected value of their holdings. The intrinsic value of the firm's assets in place, V_t, follows an exogenous random process in which $V_1 = V_0(1+x)$ or $V_1 = V_0(1-x)$ with equal probability, and where $x \in (0,1)$ is a parameter. Let v_0, v_1 denote the normalization of V_0, V_1 by N, respectively.

At $t = 1$, the manager needs to distribute an exogenous amount of cash $C < V_0(1-x)$ to the firm's investors in a tender offer. The tender offer mechanism is a fixed-price auction, held among current investors as follows.[15] The manager announces a price $P_R \in R^+$ at which the firm offers to buy $N_R = \frac{C}{P_R}$ shares. Each investor then submits a bid $b_j \in [0, n_j]$. The manager, however, is not allowed to participate in the auction (always bids 0). Assume also, that when investors are indifferent between tendering and not tendering, they bid all their shares. If the auction is oversubscribed, there is pro-rata rationing. We assume that the manager must make sure that the tender offer does not fail (i.e., is not undersubscribed).[16]

Public information in the economy evolves as follows. At $t = 0$, the value process and its parameters are known. At $t = 1$, first C is publicly observed and the manager announces a tender offer. Then V_1 is realized, and investors place their bids. Only after the completion of the tender offer is the realization of V_1 publicly observed.[17]

Let $B \equiv \Sigma_j b_j$, and let Γ_j denote investor j's expected gain per share from the tender offer, based on his information I_j. Appendix A reviews the wealth redistribution properties of stock repurchases. It is shown there that

[12] Abstracting from private benefits to managers from the waste is common in free-cash-based models in payout policy (e.g., Chowdhry and Nanda, 1994; Lucas and McDonald, 1998). The purpose is to focus on the implications for repurchase methods rather than on the principle-agent problem. In our model, limited private benefits from waste will not have a significant impact on the qualitative results.

[13] On alternative tender offer mechanisms, see, for example, Gay et al. (1991), and Hausch and Seward (1998); For a review of the theoretical literature on the choice between dividends and repurchases, see, Allen and Michaely (2003).

[14] Repurchases are generally taxed at a lower rate than dividends. Repurchases are tax advantageous relative to dividends even if the tax rate is the same because with a repurchase only the capital gain is taxed. On the magnitude of this tax advantage see, for example, Green and Hollifield (2003).

[15] Tender offers are generally executed either at a fixed-price or using a Dutch auction. We utilize a fixed-price tender offer because it is more theoretically tractable. When utilizing a Dutch auction instead, it is possible to indicate bounds on the equilibrium outcome that imply similar qualitative results.

[16] In practice a failure results in reputational costs and the costs associated with initiating a tender offer (sending letters to shareholders, management time, investment bank fees) are also lost. In fact, some firms use a Dutch auction instead of a fixed price tender offer in order to avoid the risk of undersubscription (see, McNally, 2001). Alternatively, it can simply be assumed that if the tender offer fails, the cash is lost.

[17] The assumption that V_1 is realized only after the manager announces a tender offer is not necessary for the tender offer model. If the order is reversed, all results in this section still hold. The order is important for the general model (Section 3), where we do not want the manager to be able to verify the value before he chooses between a tender offer and an open-market program.

$$\Gamma_j = \frac{N_R}{N - N_R} E\left[\left(\frac{N}{n_j}\frac{b_j}{B} - 1\right)(P_R - v_1)|I_j\right]. \quad (1)$$

The important insights in (1) are that the repurchase does not redistribute wealth (i.e., $\Gamma_j = 0$ all j) either if it is pro-rata ($\frac{b_j}{B} = \frac{n_j}{N}$ all j) or if it is performed at true value ($P_R = v_1$). In all other cases it does. Each investor's objective function is

$$\max\{\Gamma_j\}. \quad (2)$$

The manager maximizes his expected wealth through his choice of P_R (his bid is fixed to 0), and the rest of the investors maximize their expected wealth through their choice of b_j. The superscript * will be used to denote equilibrium values.

Definition 1. An equilibrium in the tender offer game is a price P_R^* set by the manager and a bid profile $\{b_j^*\}$ chosen by all investors given P_R^*, such that all investors (including the manager) maximize their expected wealth given the information they have.[18]

Given P_R, suppose investor j adopts the strategy of always bidding 0. Then by substituting $b_j = 0$ into (1),

$$\Gamma_j(b_j = 0) = -\frac{N_R}{N - N_R}(P_R - E[v_1|_{I_j}]) = -\frac{C(P_R - E[v_1|_{I_j}])}{NP_R - C}. \quad (3)$$

Because the manager never tenders, his expected gain per share is given in (3). This expected gain, is decreasing in P_R in the feasible range of C regardless of his information about v_1. The manager's problem is, thus, to minimize P_R subject to a successful tender offer. Intuitively, because the manager never tenders any shares, he wishes to minimize the decrease in value of the unretired shares by minimizing P_R.

It can be observed from (1) that if the manager sets $P_R \geqslant v_0(1 + x)$, the tender offer always succeeds because, regardless of the realization of v_1, bidding all shares is the dominant strategy for all investors other than the manager. Based on similar reasoning, if the manager sets $P_R < v_0(1 - x)$, the tender offer always fails. By earlier assumption, the manager is always worse off if the tender offer fails. Hence, in any equilibrium, the tender offer always succeeds, and $P_R^* \in [v_0(1-x), v_0(1+x)]$. The equilibrium outcome will be $P_R^* = v_0(1+x)$ only if the manager cannot guarantee a successful tender offer with a lower repurchase price. Next, we characterize equilibrium under different information settings.

2.2. Equilibrium: Symmetrically uninformed investors

Consider first the case where at the time the tender offer takes place all investors (including the manager) are uninformed about the realization of v_1. In this case, (1) simplifies to

$$\Gamma_j = \frac{N_R}{N - N_R}\left(\frac{N}{n_j}E\left[\frac{b_j}{B}\right] - 1\right)(P_R - v_0) \quad (4)$$

for all j, since bids b_j cannot depend on the realization of v_1, and $E[v_1] = v_0$.

Proposition 1. *When C is paid with a tender offer repurchase, and all investors are symmetrically uninformed, then in the unique equilibrium $P_R^* = v_0$.*

All proofs are in Appendix B. Substituting $P_R = v_0$ into (4), yields $\Gamma_j = 0$ for all j. Accordingly, when all investors are symmetrically uninformed, the manager can costlessly distribute the cash C with a tender offer, and a tender offer has no wealth effects.

[18] The equilibrium concept we use here is subgame-perfect equilibrium. All players know all relevant information about each other, including the payoffs that each receives from the various outcomes.

2.3. Equilibrium: Asymmetric information

We characterize equilibrium when investors can become informed (learn v_1), at a cost, at the time they place their bids in two steps. First, in Section 2.3.1, we characterize the equilibrium, given that some investors are informed. Then, in Section 2.3.2, we assume no investor is initially informed but that each investor can verify the realization of v_1 at a cost, and characterize an equilibrium with information acquisition.

Henceforth, we will use the subscripts i, u, and m to indicate an informed investor, an uninformed investor, and the manager, respectively. Also, let N_I and N_U denote the aggregate number of shares held by informed and uninformed investors, respectively, *excluding* the manager. Let n_m denote the number of shares held by the manager, regardless of whether he is informed or not. Then,

$$N_I + N_U + n_m = N. \quad (5)$$

Because the manager never tenders, and because of the linear dependency in (5), N_U summarizes the level of information asymmetry.

2.3.1. Endogenous information asymmetry

Assume that after the manager announces the tender offer some investors are informed (observe the realization of v_1) while others are not. Assume also that N_I, N_U, and n_m are publicly known at the time the tender offer is announced. Since the manager cannot participate, his problem is to minimize P_R subject to a successful tender offer, regardless of whether he is informed or not. Eq. (1) holds for both informed and uninformed investors. Under the current information setting, however, it *cannot* be simplified to Eq. (4), because informed investors will now condition their bids on the realization of v_1. Specifically, given P_R, informed investors maximize their expected gains by bidding all their shares if $P_R \geqslant v_1$ and by bidding 0 otherwise. This is their optimal strategy regardless of other investors' bids. In contrast, uninformed investors cannot condition their bids on the realization of v_1. Accordingly, for a successful tender offer, the manager will be able to set $P_R^* < v_0(1+x)$ only if the following conditions hold: (a) The uninformed investors can supply the quantity sought, implied by P_R^* (i.e., $N_R^* \leqslant N_U$); and (b) the uninformed investors always bid their shares. The first condition can be written as

$$P_R^* \geqslant \frac{C}{N_U}. \quad (6)$$

In order to make sure that (6) holds, we will first make the following assumption (we will relax it later):

$$N_U \geqslant \frac{C}{v_0(1-x)}. \quad (7)$$

Next, in Lemmas 1, 2, we establish when the second condition for a successful tender offer holds, i.e., uninformed investors always bid their shares. Let Γ_i denote the expected gain per share for an informed investor after the tender offer is announced, just before v_1 is realized. Define Γ_u and Γ_m similarly.

Lemma 1. *Suppose that all uninformed investors always bid all their shares. Then, given P_R, the expected gain per share of an informed investor is*

$$\Gamma_i = \frac{1}{2}\frac{N_R}{N - N_R}\left[\frac{N}{N - n_m}(v_0(1+x) - P_R)\right] \quad (8)$$

and the expected gain per share of an uninformed investor is

$$\Gamma_u(N_U) = -\frac{N_R}{N - N_R}(P_R - v_0) + \frac{1}{2} \times \frac{NN_R}{N - N_R}\left[\frac{(P_R - v_0(1-x))}{N - n_m} - \frac{(v_0(1+x) - P_R)}{N_U}\right]. \quad (9)$$

Observe that if all uninformed investors always bid their shares, then, given P_R, Γ_i is independent of the number of shares held by the uninformed investors, N_U. This happens because if the realization of v_1 is low, all investors, except the manager, bid their shares. If, instead, the realization of v_1 is high, the informed investors exclude themselves (bid 0), and the firm makes a fixed gain at the expense of the uninformed investors. This gain accrues evenly to the value of all *untendered* shares ($N - N_R$). In both scenarios, the gain per share of an informed investor is independent of the number of shares held by the uninformed investors. Hence, his expected gain is independent as well. In contrast, given the strategies above, Γ_u is a function of N_U. Again, this is because when uninformed investors lose, their loss as a group is fixed. Hence, the expected loss per share of an uninformed investor depends on the aggregate number of shares held by uninformed investors.

Now, consider the uninformed investors. They cannot condition their bid on the realization of v_1 but are aware that some investors are informed. Thus, the manager needs to choose P_R such that, given P_R and N_U, and given that informed investors play their optimal strategy, uninformed investors maximize their expected wealth by bidding their shares (the second condition for a successful tender offer).

Lemma 2. *Uninformed investors bid all their shares if and only if*

$$P_R \geqslant v_0\left(1 + x\frac{N - n_m - N_U}{N - n_m + N_U}\right). \tag{10}$$

The intuition for this result is as follows. Eq. (9) gives the expected gain per share of an uninformed investor if she bids her shares. The first term in (9) gives her expected gain per share if she *does not* bid her shares. Thus, she bids her shares if and only if the second term in (9) is nonnegative. This term, in turn, is nonnegative if and only if P_R is in the range given in (10). Because the repurchase fails for all values of P_R for which (10) does not hold, and because the manager maximizes his wealth by minimizing P_R such that the tender offer does not fail, the manager sets the tender offer price P_R such that (10) holds with equality. This leads to the following proposition:

Proposition 2. *Suppose that C is paid with a tender offer repurchase, that information asymmetry is exogenous, and that* $N_U \geqslant \frac{C}{v_0(1-x)}$. *Then, given* N_U, *in the unique equilibrium:*

(a) *The manager sets*

$$P_R^*(N_U) = v_0\left(1 + x\frac{N - n_m - N_U}{N - n_m + N_U}\right). \tag{11}$$

(b) *Uninformed investors always bid all their shares. Informed investors bid all their shares when* $P_R^* \geqslant v_1$ *and bid 0 otherwise. The tender offer always succeeds.*

Because P_R^* is the price at which uninformed investors are indifferent between tendering and not tendering, and because the manager never tenders, the equilibrium expected gain per share is the same for both the manager and each uninformed investor. Indeed, when (11) holds, the second term in (9) is zero, and

$$\Gamma_u^* = \Gamma_m^* = -\frac{C(P_R^* - v_0)}{NP_R^* - C}. \tag{12}$$

This result will have important welfare implications in Section 3 when we characterize the choice between tender offers and open-market programs. In equilibrium, Lemma 1 holds (because all uninformed investors always bid their shares), hence, for $P_R = P_R^*$, Eq. (8) gives the equilibrium expected gain per share of an informed investor, Γ_i^*. By substituting P_R^* from (11) into (12) and (8), one can verify the zero-sum-game condition

$$0 = N_I\Gamma_i^* + N_U\Gamma_u^* + n_m\Gamma_m^*. \tag{13}$$

Note that for $N_U < N - n_m$, (11) implies that $P_R^* > v_0$. Consequently, with asymmetric information, the manager is always in a worse position than with symmetric information.

Fig. 1 describes equilibrium with exogenous information asymmetry for all values of N_U (not only for the range where the assumption $N_U \geqslant \frac{C}{v_0(1-x)}$ holds). The bold line describes P_R^* as a function of N_U. That is, for a given number of shares held by uninformed shareholders, it describes the minimal price that the manager must set so that the tender offer will succeed. This is the minimal price such that (a) uninformed investors can provide the number of shares sought (dotted line), and (b) uninformed investors bid their shares (dashed line). These are conditions (6) and (10) respectively. Let N_{U_R} denote the value of N_U that solves the system (6), (10) with strict equalities. That is, N_{U_R} solves

$$N_U\left[v_0\left(1 + x\frac{N - n_m - N_U}{N - n_m + N_U}\right)\right] = C. \tag{14}$$

In the range $N_U \in [N_{U_R}, N - n_m]$, condition (10) is binding and determines P_R^*, whereas condition (6) is not binding. In this range Proposition 2 is robust. In the range $N_U \in \left[\frac{C}{v_0(1+x)}, N_{U_R}\right)$, there are too few shares held by the uninformed to provide N_R at the price that satisfies (10) with equality. In this range, (6) is binding and determines P_R^*. In the range $N_U < \frac{C}{v_0(1+x)}$, the only way the manager can guarantee a successful tender offer is by setting $P_R^* = v_0(1+x)$, because uninformed investors hold too few shares. In this range all investors, except the manager, always bid their shares.[19]

The analysis in this subsection suggests that with asymmetric information uninformed investors benefit most by retaining their shares, unless the offer price is sufficiently above the expected value. Because in this section we abstract from the motivation for distributing the cash, the need for a tender premium is implied even without signaling motivation. This result is in line with Brennan and Thakor (1990) and is an alternative to the common explanation that the tender premium is a signaling effect. The results are also consistent with the negative correlation documented between oversubscription and expiration return (e.g. Masulis, 1980), because only uninformed investors participate when the stock is undervalued, whereas all investors participate when the stock is overvalued.

2.3.2. Endogenously determined information asymmetry

In this subsection, we solve for equilibrium results when all investors are initially uninformed, but can choose to become informed at a cost. Assume that at the time the tender offer is announced all investors (including the manager) have only public information, but that each investor can verify v_1 at a cost M before bids are submitted. Investors cannot resell or pass this costly information to each other and choose to stay uninformed whenever indifferent. Assume also that $\{n_j\}$ (the ownership structure) is publicly known. We next generalize the definition of equilibrium to accommodate information acquisition.

Definition 2. An equilibrium in the tender offer game with costly information is a price P_R^* set by the manager, a partition of the rest of the investors to informed investors and uninformed investors given P_R^*, and a bid profile $\{b_j^*\}$ chosen by all investors, such that all investors (including the manager) maximize their expected wealth given the information they have, and where the decision to become informed is made optimally.

[19] In the range $N_U < N_{U_R}$, Eq. (12) holds only for the manager, and Γ_u^* can be calculated using (13).

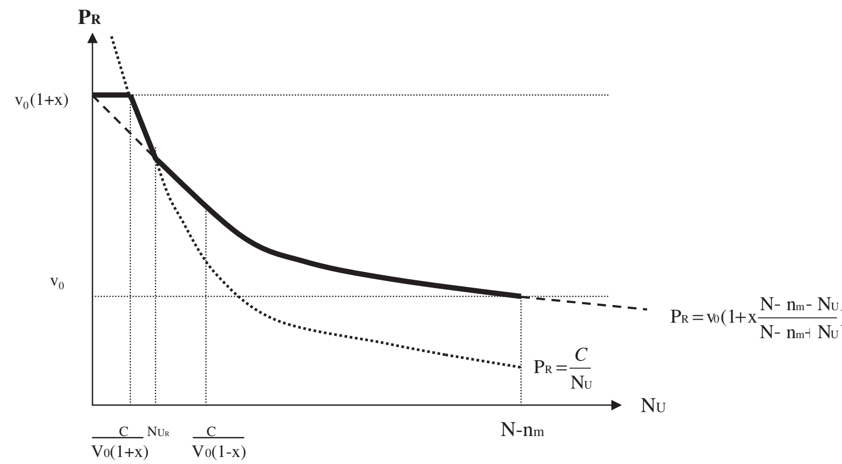

Fig. 1. Equilibrium with exogenous information asymmetry. The dotted line describes the constraint that, for a successful tender offer, uninformed investors hold enough shares. The dashed line describes the constraint that it must be optimal for uninformed investors to bid their shares. In equilibrium, both constraints must be satisfied, unless $P_R = v_0(1 + x)$, in which case all investors bid their shares. Accordingly, the bold line describes the equilibrium tender offer price, P_R^*, as a function of the number of shares held by uninformed investors, N_U.

When information acquisition is endogenously determined, the manager's choice of P_R determines the level of information acquisition. That is, the choice of P_R determines N_U. Once N_U is determined, the full extent of the preceding analysis (exogenous information asymmetry) is robust. That is, after N_U is determined, informed investors place their optimal bid, and uninformed investors decide whether to bid their shares or not according to N_U and P_R. Thus, the manager's problem is to choose the minimal P_R for which enough investors will choose to stay uninformed. The best situation for the manager is when all investors choose to stay uninformed for $P_R = v_0$, in which case Proposition 2 implies he can set $P_R^* = v_0$ and the tender offer succeeds. The following Lemma gives a sufficient condition to render this the equilibrium outcome. Let $n_{\max}$ denote the number of shares held by the largest investor, and let Γ_{i0} denote the value of Γ_i in (8) for $P_R = v_0$. That is,

$$\Gamma_{i0} = \frac{1}{2}\frac{Cxv_0}{Nv_0 - C}\left(\frac{N}{N - n_m}\right). \tag{15}$$

Lemma 3. *If*

$$M \geqslant M_c \equiv \min\left(n_{\max}, \frac{C}{v_0}\right) * \Gamma_{i0} \tag{16}$$

then $P_R^* = v_0$ *and* $N_U^* = N - n_m$.

Intuitively, if for $P_R = v_0$ there is no investor for whom the gain from becoming informed can cover the cost of the information, then the equilibrium results will equal those in an economy with symmetrically uninformed investors. In this case, the tender offer is a costless payout mechanism. Substitute (15) into (16) to get

$$M_c \equiv \min\left(n_{\max}, \frac{C}{v_0}\right) * \frac{1}{2}\frac{Cxv_0}{Nv_0 - C}\left(\frac{N}{N - n_m}\right). \tag{17}$$

The manager's ability to set $P_R = v_0$, thus, depends both on the cost of information and on the dispersion of ownership.

We now move our focus to the case where $M < M_c$. In Section 2.3.1 (Lemma 1), we showed that, given P_R, if all uninformed investors always tender their shares, then Γ_i and $\Gamma_u(N_U)$ are given by (8) and (9), respectively. Recall that the condition for uninformed investors to always bid their shares is (10), and that for the offer to succeed for $P_R < v_0(1 + x)$, (6) must be satisfied. The following proposition establishes how N_U^* and P_R^* are determined when N_U is endogenous.

Proposition 3. *Suppose C is paid with a tender offer repurchase and that investors can become informed at a cost M. Then, in the unique equilibrium: (a) Given* P_R^**, for all informed investors*

$$n_i\Gamma_i^* - M \geqslant n_i\Gamma_u^*(N_U^* + n_i) \tag{18}$$

and for all uninformed investors

$$n_u\Gamma_u^*(N_U^*) \geqslant n_u\Gamma_i^* - M \tag{19}$$

where $\Gamma_i^*, \Gamma_u^*(\bullet)$ *are determined through (8) and (9) for* $P_R = P_R^*$*, respectively. (b)* P_R^* *is the minimal tender offer price for which (6) and (10) are satisfied.*

Condition (18) requires that, in equilibrium, no informed investor can be better off by staying uninformed, and condition (19) requires that no uninformed investor can be better off by becoming informed. Condition (18) depends on $\Gamma_u^*(N_U^* + n_i)$ rather than on $\Gamma_u^*(N_U^*)$, because if an informed investor deviates and chooses not to buy information, his deviation increases the number of the "uninformed shares" and decreases the aggregate loss of uninformed investors. In contrast, given a value of P_R, the expected gain Γ_i^* is insensitive to the number of shares held by uninformed investors, as long as the repurchase succeeds (see discussion following Lemma 1 in Section 2.3.1).

The manager's problem is to minimize P_R subject to a successful tender offer. A successful tender offer, in turn, requires that (a) uninformed investors hold enough shares, and (b) uninformed investors bid their shares. For every P_R that the manager may choose, Eqs. (8) and (9), and conditions (18) and (19), dictate a partition of investors to informed and uninformed, under the assumption that uninformed investors bid their shares. This partition in turn implies a corresponding value of N_U. For the uninformed investors to have enough shares to clear the tender offer, this N_U must satisfy (6); and for uninformed investors to always bid their shares, this N_U must also satisfy (10). Accordingly, given information cost M and ownership structure $\{n_j\}$ the manager chooses the minimal P_R for which the N_U, dictated by conditions (18) and (19), and Eqs. (8) and (9), satisfies (6) and (10).

Condition (16) indicates when the manager must set P_R higher than v_0 for the repurchase to succeed. It does not indicate when investors incur information costs in equilibrium. Because only the information costs affect the social wealth, and because these costs are a dead-weight loss, we wish to investigate when these costs are incurred. For at least one investor to become informed in the equilibrium, one necessary condition is $M < M_c$. Assume

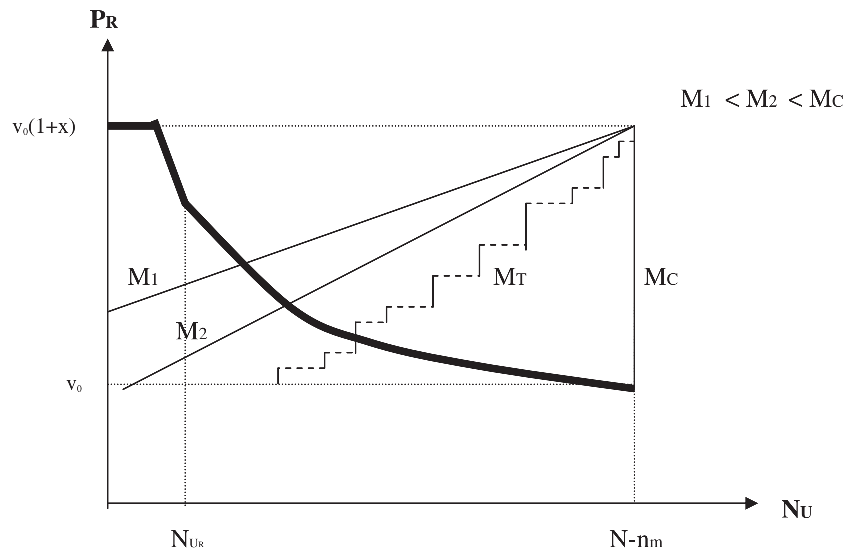

Fig. 2. Equilibrium with endogenously determined information asymmetry. The bold line now describes the minimal tender offer price, P_R, for which the tender offer succeeds as a function of the number of shares held by uninformed investors, N_U. (This is the bold line from Fig. 1). The number of shares held by uninformed investors is now endogenously determined. Each diagonal M-line represents the aggregate number of shares held by investors that choose to stay uninformed, as a function of P_R, for a given cost of information M. The line M_c corresponds to the value of M for which condition (16) holds with equality. For values of M lower than Mc, the M-line has a lower slope as in M1, M2. If $M \geqslant M_c$ the manager can set $P_R = v_0$, and all investors stay uninformed. If $M < M_c$, the manager must offer a higher price. In equilibrium, the manager chooses P_R^* at the intersection between the M-line that corresponds to the prevailing cost of information and the bold line. Because the distribution of ownership is discrete, actual M-lines (except M_c) are discontinuous as described by the line M_T, and their exact shape depends on the asymmetry in share holdings.

$M < M_c$, and let $\{n_k\}$, $k = \{1,\ldots,K\}$, be an ascending order of $\{n_j\}$. The following proposition demonstrates that with little asymmetry in shareholdings the equilibrium will involve information acquisition.

Proposition 4. *The equilibrium involves information acquisition if and only if there exists a P_R for which there exists $k' < K$ such that for $N_U = N_{Uk'} \equiv \sum_{k \leqslant k'} n_k$, conditions (6), (10), and the following conditions hold:*

$$n_{k'}\Gamma_u(N_{Uk'}) \geqslant n_{k'}\Gamma_i - M \quad (20)$$

$$n_{k'+1}\Gamma_i - M \geqslant n_{k'+1}\Gamma_u(N_{Uk'} + n_{k'+1}) \quad (21)$$

where $\Gamma_i, \Gamma_u(\bullet)$ are from (8) and (9), respectively.

As in the previous propositions, condition (6) guarantees that there are enough uninformed investors, and condition (10) guarantees that the uninformed investors bid their shares. The only purpose of conditions (20) and (21) is to impose a degree of asymmetry in ownership that will result in some information acquisition. If, for example, all investors hold the same number of shares, the latter conditions cannot hold, but they do hold with a little asymmetry in ownership: all investors who hold more than $n_{k'}$ shares buy information, and all investors with $n_{k'}$ shares, or less, stay uninformed.[20] The manager sets P_R^* to the lowest repurchase price that satisfies conditions (20) and (21).

In equilibrium, informed investors gain at the expense of uninformed investors, but information costs diminish this gain and can potentially lead to a net loss. The aggregate loss of the uninformed investors is higher than the aggregate gain of the informed investors. In fact, because no value is created in the tender offer, as a group, the firm's investors suffer a loss MI^*, where I^* is the equilibrium number of informed investors.[21]

Fig. 2 demonstrates equilibrium with information acquisition by means of a graph. The bold line describes the minimal repurchase price, P_R, that the manager must set so that the tender offer will succeed as a function of the number of shares held by uninformed investors, N_U (this is the bold line from Fig. 1). However, N_U is now endogenously determined. Each diagonal M-line represents the aggregate number of shares held by investors that choose to stay uninformed, as a function of P_R, for a given cost of information M.

The line M_c corresponds to the value of M for which condition (16) holds with equality. For values of M lower than M_c, the M-line has a lower slope as in M_1, M_2. If $M \geqslant M_c$ the manager can set $P_R = v_0$, and all investors stay uninformed. If $M < M_c$ the manager must offer a higher price. He can always set $P_R = v_0(1 + x)$, which results in $N_U = N - n_m$ for all $M > 0$. This is optimal for all investors other than the manager. If the cost of information is very low (outside our model this could happen, if, for example, investors can resell or share the information), then $P_R = v_0(1 + x)$ will be the equilibrium outcome. However, if M is not too low, then the manager can choose a lower P_R. In equilibrium, the manager chooses P_R at the intersection between the appropriate M-line and the bold line. If at the crossing point $N_U < N - n_m$, then the equilibrium is informed. The "slope" of the M - lines is determined both by the value of M and the distribution of ownership. Because the distribution of ownership is discrete, all lines (except M_c) are actually discontinuous with step jumps as depicted by the line M_T.

The above analysis leads to the following predictions. Increasing the parameter x pushes up both the bold line and the M-lines. Accordingly, P_R^* increases with the uncertainty in the firm value. P_R^* decreases in the "slope" of the M-lines, and correspondingly it decreases in the cost of information, M, and in the ownership dispersion. The greater the number of large shareholders, the higher the tender premium, whereas the equilibrium level of information acquisition depends also on the asymmetry of the ownership distribution. Although we have taken C as given throughout, the above analysis implies that changes in C have the opposite effect as changes in M, i.e., P_R^* increases with C.

In sum, the results in this section suggest that tender offers stimulate information gathering among existing shareholders,

[20] Asymmetry in shareholding is necessary for information acquisition. If $n_{k'} = n_{k'+1}$, conditions (20) and (21) will never hold simultaneously because Γ_i is invariant to N_U, whereas Γ_u is decreasing in N_U.

[21] Note that an equilibrium in which investors buy information is attained without noise traders. The No Trade theorem is not invoked, because investors are affected by the tender offer whether they buy information or not. This is a unique property of the tender offer game.

and that consequently, for the tender offer to succeed, the manager–shareholder must offer a tender premium. The information gathering is not only costly to the manager, who has to offer a tender premium, but also imposes a dead-weight loss on the social wealth. Because the manager cannot participate, his equilibrium loss per share is the same as the loss per share of the small, uninformed shareholders. The equilibrium tender offer price and the equilibrium information acquisition increase with uncertainty about the firm value, with ownership concentration, and with the size of the cash distribution, and decrease with the cost of information.

3. A general model of stock repurchases

In this section, the two-period model from Section 2 is extended to a multiperiod model, and a market and open-market programs are introduced. We also introduce a motivation for distributing the cash. It is assumed that C is a free cash flow that is wasted unless distributed. It is shown that an open-market program mitigates the incentive to buy information at the cost of slowing the cash distribution. Consequently, with an open-market program some excess cash is carried with the firm for a longer time, and part of the cash is wasted. When coming to chose a repurchase method, the manager trades off the cash waste associated with an open-market program against the loss from the tender premium in a tender offer.

3.1. Generalizations about assumptions

The two-period model from Section 2 is extended as follows. Every day $t \in \{1,2,\ldots\}$ a new (exogenous) *value* shock arrives such that $v_t = v_{t-1}(1+x)$ or $v_t = v_{t-1}(1-x)$ with equal probability, where v_t is the post-shock stock value at day t. Let H and L indicate a positive and a negative value shock, respectively. The realization of the value shock becomes part of the public information only at the end of the day.[22]

Assume further that there is an active market for the firm's stock, in which in addition to the shareholders, other agents can trade in the stock. (Henceforth, the shareholders and these agents will be referred to as "investors".) The market mechanism is based on Bernhardt et al. (1995). At the beginning of every day, shareholders receive an uninsurable *liquidity* shock, and as a result a random number $r_t \in \{l,h\}$ of the shares must be liquidated, where $0 < l < h$.[23] Assume further that the liquidity shocks $\{l,h\}$ are equally likely and independent of the value shock. Thus, there are four possible (value, liquidity) shock combinations that can occur in the economy every day: $\{(H,h), (H,l), (L,h), (L,l)\}$.

The economy has a market maker whose role is to take the opposite side in all trades. Every day, he is ready to buy/sell all demands. The market maker has all public information, and in addition observes the current order flow q_t. He then pools orders and sets a price P_t that, conditional on his information, leaves him with zero expected profits. Every day, just before the market opens for trade, all investors including the manager have the same (public) information. Each investor, however, can verify the realization of the current value shock at a cost M. We make the following assumption on the cost of information M:

$$0 \leqslant M < M_{ct} \tag{22}$$

where

$$M_{ct} = \min\left(n_{\max}, \frac{C}{v_0}\right) * \frac{1}{2}\frac{Cxv_{t-1}}{Nv_{t-1} - C}\left(\frac{N}{N-n_m}\right) \quad \textit{for all } t. \tag{23}$$

M_{ct} is simply the generalization of M_c defined in (16) in Section 2.[24]

Without loss of generality, at the beginning of $t = 1$ the manager and the market learn that the firm has excess cash C. This cash, unless immediately distributed, will be wasted at a rate of δ per day (e.g., because it is invested in negative NPV projects or lost because of inefficiencies in the firm). We also assume that this waste does not contribute to the manager's utility in any manner.[25] If the manager announces a tender offer, then at $t = 1$ a tender offer is performed as described in Section 2 in parallel to the trade in the market. If, instead, the firm announces an open-market program, the firm can buy shares in the market starting from $t = 1$. The firm is allowed to buy shares in the market only if it announces a program. If it does announce a program, then every day it is allowed to purchase only up to 25% of the average daily trade.[26] As in the case of a tender offer, the manager is not allowed to trade his own shares.[27] Assume that the manager chooses an open-market program over a tender offer whenever he is indifferent. Last, for tractability, we neglect the interaction between a tender offer and the market at $t = 1$. Empirically, daily trade is substantially smaller than the repurchase size. Furthermore, liquidity traders are not guaranteed a sale if they try to sell directly to the firm. Fig. 3 illustrates the time line for the general model.

3.2. Equilibrium in the stock market

This subsection derives the equilibrium results for regular trade with and without an open-market repurchase program.

Definition 3. An equilibrium in the market for the stock is a collection of the following at each date t:

1. A strategy for each investor that details whether he purchases information, and his stock purchases q_{tj} as a function of his information, given his conjectures about the market maker's pricing function.
2. A strategy for the manager that details the firm's purchases if he announced an open-market program.
3. A belief function $\mu:\mathbf{R} \Rightarrow [0,1]$ that gives the market maker beliefs about what the current value shock is, given the order flow.
4. A pricing function $P(\cdot)$ for the market maker that, given public information and the net order flow, determines the price P_t for which he buys/sells the stock.

[22] We assume that every day a new value shock arrives as in practice that information changes over time in the course of an open-market program (unlike in the case of a tender offer). Most of our qualitative results are unchanged under the alternative information setting in which a value shock arrives only at $t = 1$.

[23] The assumption that l,h are positive is without loss of generality. That is, our results are not affected if we allow for liquidity shocks that result in uninformed buying.

[24] If instead $M \geqslant M_{ct}$, or if $M = 0$, the dominance of tender offers is immediate, because they distribute the cash costlessly (no premium is needed). Both cases, however, are inconsistent with the empirical evidence.

[25] Private benefits from waste will increase the likelihood of open market programs but will not change the qualitative results on the choice of repurchase method. See also Footnote 12 on this assumption.

[26] Firms generally announce their repurchase program, although in the US this is not required by law or under the Safe Harbor Act. Most exchanges however require that programs be announced. In the US, Rule 18-10b in the Safe Harbor Act (1982) limits the firm's ability to trade in an open-market program. On any 1 day, the firm is not allowed to bid for more than 25% of the average daily trade. Also, the firm is not allowed to purchase shares at a price higher than the last independent bid, the last reported sell price, or in the last half hour of the trade. In any single day, it must also trade through only one broker.

[27] The model results will not change if the manager is allowed to trade his own shares, because he faces the same costs as any other investor. What we cannot allow is for the manager to coordinate the firm's repurchases with his private trade. Such behavior, however, if detected by the SEC, is likely to trigger a lawsuit, and is generally not supported by the empirical evidence (see, Ben-Rephael et al., 2011).

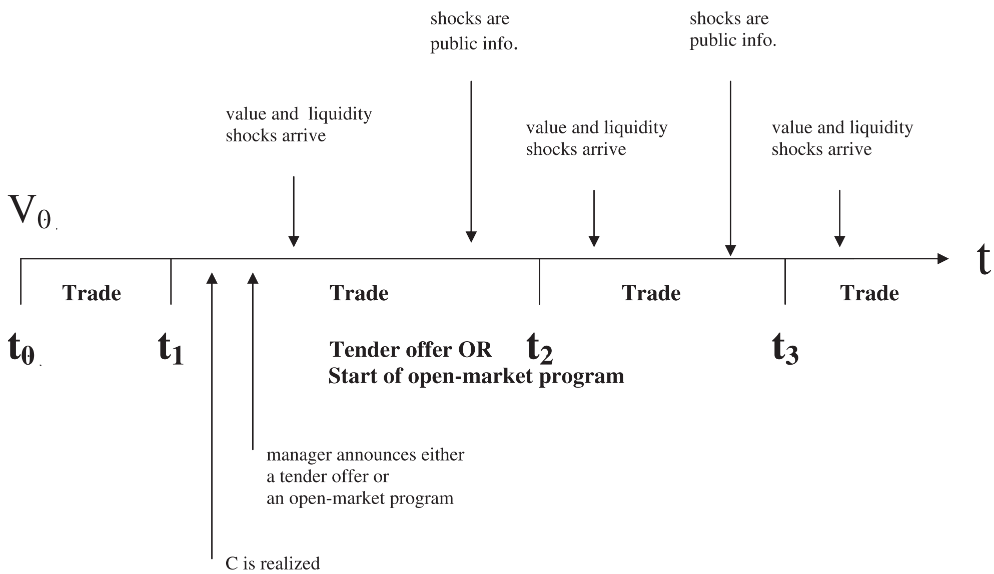

Fig. 3. General model of stock repurchases: Time line.

Such that:

1. The manager and investors maximize their expected wealth
2. The market maker sets P to earn zero expected profits conditional on all information available to him:

$$P(q_t, v_{t-1}) = E[v_t | q_t, v_{t-1}] \tag{24}$$

where expectations are taken using the market maker's beliefs defined above, and these beliefs satisfy Bayes' rule where applicable.

The following lemma establishes the bound on the expected gain of informed investors.

Lemma 4. *With or without an open-market program, in any equilibrium, the maximal aggregate expected profit for informed investors (excluding information costs) is bounded by*

$$G_t \equiv \frac{(h-l)x v_{t-1}}{4}. \tag{25}$$

The intuition for this result is as follows. First, suppose that there is only one informed investor. This informed investor observes the value shock, but not the liquidity traders' bid. To make positive profits, he buys shares if the value shock is positive and sells shares if the value shock is negative, but must choose quantities that, at least in some states, will not reveal his information. He maximizes his expected profits by setting his order such that the market maker cannot tell whether the liquidity shock is high and the informed investor is buying, or whether the liquidity shock is low and the informed investor is selling. Taking expectations of his profit across states gives the gain in (25). An open-market program does not change his expected gain because the firm's trade is accounted for by the market maker. Last, with more than one informed investor, the equilibrium is not revealing only if the pooled order of the informed investors is as above. Hence (25) is the maximal aggregate expected profit to informed investors.

Corollary 1. *If $M > G_t$ where G_t is from (25), trade in the stock market is never informed. Otherwise, trade in the stock market may involve informed trading.*

If $M > G_t$, with or without an open-market program, the equilibrium market price P_t^* is equal to the value based on public information v_{t-1}. Otherwise, there may exist equilibria in which one or more investors are informed. Since the market maker's expected profit is zero, the gain in (25) is the total expected loss of the manager and uninformed investors. This loss is incurred regardless of whether or not an open-market program is announced.

3.3. Equilibrium: The choice between a tender offer and an open-market program

Consider the manager's choice between a tender offer and an open-market program.[28] If he chooses a tender offer, all the analysis in Section 2 is robust. Accordingly, P_R^* depends on the asymmetry in share holdings, and hence is generally not tractable in a closed form. The following analysis characterizes the equilibrium choice of repurchase method, assuming that there is enough asymmetry in share holdings so that, with a tender offer, $N_U^* \in (N_{U_R}, N - n_m)$,[29] taking the implied P_R^* as given.

Proposition 5. *If*

$$\delta > \frac{(h+l)v_0}{4C} \frac{(P_R^* - v_0)}{(NP_R^* - C)} \tag{26}$$

the manager chooses a tender offer. Otherwise, he chooses an open-market program.

Eq. (26) summarizes the manager's trade-off. An open-market program may involve informed trading and hence losses to the uninformed, if the cost of information is lower than the gain in (25). However, as discussed earlier these losses will be incurred regardless of the program. Thus, the manager chooses a tender offer if and only if, with a tender offer, he and all investors who choose to stay uninformed lose less than what they would lose with an open-market program. With a tender offer, investors who become informed always end up with a smaller loss per share than investors who stay uninformed. Thus, a tender offer is the equilibrium outcome only when it dominates an open-market program for all shareholders. In other words, wealth redistribution and dissipative information costs are avoided unless they represent the best alternative for all shareholders.

[28] It is immediate to show that the strategy "do nothing" (i.e., keep the cash) is strictly dominated by an open-market program.

[29] See, Fig. 2. This assumption, requires that C and n_{max} are large enough so that $M < M_{ct}$, and that ownership structure is such that, with a tender offer, in equilibrium, condition (7) is not binding.

4. Empirical implications

In this section we consider empirical implications. In particular, we offer predictions about the manner in which the repurchase method depends on agency costs of free cash, risk, information asymmetry, ownership concentration, and liquidity. We show these predictions are generally consistent with the empirical evidence and offer several new testable predictions.

The model predicts that higher agency costs of free cash increase the likelihood of choosing a tender offer over an open-market program. This is because, in the model, a higher waste rate δ increases the costs of an open-market program whereas it does not affect the costs of a tender offer. Vafeas (1997) provides evidence consistent with this prediction. Supportive evidence for this prediction also appears in the empirical literature about leveraged recapitalizations and takeovers. In a leveraged recapitalization, the amount of free cash is clear, and hence the benefit from distributing it immediately is high. Similarly, takeover threats tend to follow inefficiencies (waste) in free cash management. For both events our model predicts that a tender offer is the preferred repurchase method. Indeed, empirically, leveraged recapitalization and takeovers are associated with tender offers (e.g., Denis and Denis, 1998), whereas a similar association has not been documented for open-market programs.

In the model, the costs of both tender offers and open-market programs increase with the payout size C (higher premium in a tender offer; more waste in an open-market program). However, if larger amounts of free cash are associated with a higher waste rate δ, the model is consistent with the empirical association of tender offers with larger cash distributions (see Footnote 5 in the introduction). Indeed, empirical evidence suggests that waste is convex in excess cash (see, for example, Harford, 1999; Dittmar and Mahrt-Smith, 2007).

One new and testable prediction of the model is that higher uncertainty and information asymmetry increase the likelihood of an open-market program over a tender offer. This is because, in the model, uncertainty (captured with the parameter x) increases the information asymmetry and tender premium in a tender offer but does not affect the costs of an open-market program. We are not aware of any systematic empirical analysis on the relation between risk and the repurchase method. The market crash of 1987, and September 11, 2001 provide anecdotal evidence consistent with this prediction. Both events triggered a "boom" of open-market programs, but not of tender offers. These events illustrate the tendency to prefer open-market programs over tender offers in periods of high uncertainty.[30]

Another new prediction is that higher presence of large shareholders increases the likelihood of an open-market program over a tender offer. This is because, in the model, higher ownership concentration results in a higher tender premium in a tender offer (see Fig. 2) whereas it does not affect the cost of an open-market program. We are not aware of any study that considers the relation between ownership concentration and the repurchase method. In recent years there has been a dramatic increase in both institutional investor holdings (Bennet et al., 2003), and the ratio of open-market programs to tender offers (Banyi et al., 2008). This evidence is consistent with the prediction that ownership concentration increases the advantage of open-market programs over tender offers.

Another prediction of the model is that liquidity increases the likelihood of an open-market program over a tender offer. This is, in turn, because given the SEC regulations, higher trading volume allows the firm to distribute the cash more quickly. We are not aware of any systematic inquiry into this prediction. Again, both the market crash of 1987 and September 11, 2001 provide anecdotal evidence consistent with this prediction. Following each of the events, the SEC temporarily eased its restrictions on the firms' repurchase trade. For example, following September 11, 2001, the SEC allowed firms to increase their purchases to 100% of average daily trade for a period of 3 weeks, instead of only 25%, suggesting regulatory restrictions do limit the firm's ability to trade in open-market programs.

In the model, only a tender offer is associated with a tender premium because only a tender offer stimulates information gathering. Consistent with this result, empirically, the announcement return is high for tender offers and low for open-market programs (see Section 1). With respect to long-run stock performance, given that a tender offer repurchaser buys back stock at a premium, ceteris paribus, the model predicts that the price will return to fair value in the long run, suggesting a reversal long-run stock performance, which contradicts the repurchase literature. Yet, a tender offer repurchaser also largely and immediately reduces the free cash flow problem. Relative to their peers, tender offer repurchasers will tend to eliminate the downside risk from overinvestment. Thus, there will be a long-run positive stock return following the tender offer repurchase if the benefit of the reduced risk outweighs the initial stock premium cost (on the positive association between stock repurchases and risk reduction, see, for example, Grullon and Michaely, 2004).

With respect to information acquisition, the model predicts that a higher cost of information M increases the likelihood of a tender offer over an open-market program. This is, in turn, because in the model the tender premium in a tender offer decreases with the cost of information, whereas, in equilibrium, there is no premium paid in open-market programs. We are not aware of studies relating the repurchase method to the cost of private information. Last, in the model, with an open-market program the firm repurchases the maximum number of shares until all the free cash is distributed. The empirical evidence, however, suggests there is no systematic pattern in the execution and that many open-market programs are not completed. (e.g. Stephens and Weisbach, 1998; Cook et al., 2004; Zhang, 2005; Ginglinger and Hamon, 2007). Yet, consistent with the model these findings suggest that open-market programs are less efficient than tender offers in preventing the waste of free cash. Outside our model, the financial flexibility associated with open-market programs (e.g., Oded, 2009) or private benefits to insiders from waste might explain the program execution patterns. These are directions for further research.

5. Conclusion

This paper considers how firms that wish to repurchase their shares choose between a self tender offer and an open-market repurchase program. The model developed suggests that a tender offer encourages information acquisition among a subset of the shareholders, inducing information asymmetry. The resulting adverse selection requires the firm to pay a tender premium. This is not only costly to a manager–shareholder who cannot participate, but also results in wealth expropriations and in a dead-weight loss. An open-market program avoids this unattractive property of tender offers at the cost of slowing free cash distribution, which in turn results in partial free cash waste. A firm's choice of repurchase method is socially efficient in the sense that a tender offer and the wealth expropriations it induces are the equilibrium outcome only if they represent the best alternative for all shareholders. The model suggests that in practice open-market programs prevail because, in general, the expected loss from the price premium of a tender

[30] See, Netter and Mitchell (1989) for the crash of 1987. In the week following September 11, 2001 alone, there were about 100 program announcements, whereas the pre-event average yearly announcement rate was about 800 per year.

offer is higher than the expected cash waste in an open-market program. The model also predicts that the likelihood that a tender offer will be chosen over an open-market program increases with agency costs of free cash and decreases with uncertainty (risk), information asymmetry, ownership concentration, and liquidity.

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Appendix A. Wealth redistribution properties of stock repurchases

This section reviews how wealth is redistributed among investors in a nondiscriminating stock repurchase (one price for all shares repurchased) given the repurchase price, the stock value, and the number of shares each investor gets to tender. These properties are, thus, robust for all common forms of stock repurchase (fixed-price and Dutch-auction tender offers, and open-market programs). It is also shown how these properties specialize in the tender-offer model used in this paper.

Consider a nondiscriminating stock repurchase held by a firm with N shares outstanding and a (pre-repurchase) share value of v_1. The firm buys back N_R shares from its investors at a price P_R. Each investor $j \in [1,\ldots J]$ holds n_j shares before the repurchase and tenders n_{Tj} in the repurchase. Let ΔW_{Rj} denote the change in investor j's wealth because of the stock repurchase, then

$$\Delta W_{Rj} = n_{Tj}(P_R - v_1) + (n_j - n_{Tj})\frac{N_R}{N - N_R}(v_1 - P_R). \tag{27}$$

In (27), the first term is the gain on the shares that investor j sells. The second is the gain (negative when $P_R > v_1$) on the shares that she keeps. Now rearrange (27) to

$$\Delta W_{Rj} = \frac{n_j N}{N - N_R} Q_j (P_R - v_1) \tag{28}$$

where

$$Q_j \equiv \frac{n_{Tj}}{n_j} - \frac{N_R}{N}. \tag{29}$$

When $Q_j = 0$, investor j tenders a pro-rata number of his shares. In this case, (28) implies that $\Delta W_{Rj} = 0$. The repurchase is pro-rata if and only if $Q_j = 0$ all j, in which case $\Delta W_{Rj} = 0$ all j. Independently, $P_R = v_1$ also implies $\Delta W_{Rj} = 0$ all j. Thus, the repurchase does not redistribute wealth either if it is pro-rata or if it is performed at true value. In all other cases it does. It is always the case that

$$\sum_j \Delta W_{Rj} = \frac{N(P_R - v_1)}{N - N_R}\sum_j n_j Q_j = 0 \tag{30}$$

where the first equality is derived by aggregating (28) over j, and where the second equality is implied by zero-sum game.

Next, we specialize the above properties to the tender offer mechanism in this paper. The allocation rule dictates that for all j

$$n_{Tj} = \frac{b_j}{B} N_R. \tag{31}$$

Substitute (31) into (29) to get

$$Q_j \equiv \frac{N_R}{N}\left(\frac{N b_j}{B n_j} - 1\right). \tag{32}$$

It can be observed from (32) that the tender offer is pro-rata, if and only if $\frac{b_j}{n_j} = \frac{B}{N}$ for all j. That is, the tender offer is pro-rata, if and only if all investors bid shares in the same proportion to their holdings. Now substitute (32) into (28) to get

$$\Delta W_{Rj} = \frac{n_j N_R}{N - N_R}\left(\frac{N}{n_j}\frac{b_j}{B} - 1\right)(P_R - v_1). \tag{33}$$

Recall that Γ_j denotes investor j's expected gain per share from the tender offer, based on his information I_j at the time he places his bid. Then, use (33) to get

$$\Gamma_j = \frac{E[\Delta W_{Rj}|I_j]}{n_j} = \frac{N_R}{N - N_R} E\left[\left(\frac{N}{n_j}\frac{b_j}{B} - 1\right)(P_R - v_1)|I_j\right] \tag{34}$$

which is (1).

Appendix B. Proofs of lemmas and propositions

Proof of Proposition 1: Consider the right hand side of (4). If $P_R < v_0$, the first term is positive and the last is negative, so the middle term determines the gain sign. Each investor maximizes his wealth by bidding 0 to minimizing the middle term by, and hence the repurchase cannot succeed. If instead $P_R = v_0$, investors make 0 expected gain, regardless of their bid. Given that they are indifferent, they will not deviate from a strategy of bidding all their shares. It can be observed from (4) that the auction succeeds for all $P_R \geqslant v_0$. Because the manager does not participate, (3) implies that he maximizes his wealth for $P_R = v_0$. □

Proof of Lemma 1: Given P_R, rewrite (1) as

$$\begin{aligned}\Gamma_j = {} & \Pr(v_1 \geqslant P_R)\frac{N_R}{N - N_R} E\left[\left(\frac{b_j}{B}\frac{N}{n_j} - 1\right)(P_R - v_1)|_{v_1 \geqslant P_R}\right] \\ & + \Pr(v_1 < P_R)\frac{N_R}{N - N_R} E\left[\left(\frac{b_j}{B}\frac{N}{n_j} - 1\right)(P_R - v_1)|_{v_1 < P_R}\right].\end{aligned} \tag{35}$$

Assume that $P_R > v_0(1 - x)$. Then, based on public information at the time the tender offer is announced, given P_R:

$$\Pr(v_1 < P_R) = \Pr(v_1 \geqslant P_R) = \frac{1}{2} \tag{36}$$

$$E[(P_R - v_1)|_{v_1 < P_R}] = [P_R - v_0(1 - x)] \tag{37}$$

$$E[(v_1 - P_R)|_{v_1 \geqslant P_R}] = [v_0(1 + x) - P_R]. \tag{38}$$

Substitute (36)–(38) into (35) to get

$$\begin{aligned}\Gamma_j = {} & \frac{1}{2}\frac{N_R}{N - N_R} E\left[\left(\frac{b_j}{B}\frac{N}{n_j} - 1\right)\Big|_{v_1 \geqslant P_R}\right](P_R - v_0(1 + x)) \\ & + \frac{1}{2}\frac{N_R}{N - N_R} E\left[\left(\frac{b_j}{B}\frac{N}{n_j} - 1\right)\Big|_{v_1 < P_R}\right](P_R - v_0(1 - x)).\end{aligned} \tag{39}$$

It can be shown that (39) holds also for $P_R = v_0(1 - x)$.

Consider an *informed* investor. He knows the realization of v_1. It can be observed from (39) that, given P_R, he maximizes his expected gain by bidding $b_j = n_j$ when $P_R \geqslant v_1$ and bidding $b_j = 0$ otherwise. This is his optimal strategy regardless of the other investors' bids. In contrast, uninformed investors' bids cannot depend on the realization of v_1. Suppose all uninformed investors always bid all their shares, and that informed investors play their optimal strategies. Then from (39), the expected gain per share for an informed investor at the time the tender offer is announced, based on public information, is given by

$$\Gamma_i = -\frac{1}{2}\frac{N_R}{N-N_R}(P_R - v_0(1+x)) + \frac{1}{2}\frac{N_R}{N-N_R}\left(\frac{N}{N_U+N_I}-1\right)(P_R - v_0(1-x)). \quad (40)$$

Substitute $N_U + N_I = N - n_m$ and rearrange to get

$$\Gamma_i = \frac{1}{2}\frac{N_R}{N-N_R}\left[\frac{N}{N-n_m}(v_0(1+x) - P_R)\right]. \quad (41)$$

Next, consider an *uninformed* investor, and suppose all other uninformed investors bid their shares. Given P_R, his expected gain per share as a function of his bid b_u based on his information, can be written based on (39) as

$$\Gamma_u(b_u, N_U) = \frac{1}{2}\frac{N_R}{N-N_R}\left[\left(\frac{N}{(N_U-n_u)+b_u}\frac{b_u}{n_u}-1\right)(P_R - v_0(1+x)) + \left(\frac{N}{N_I+(N_U-n_u)+b_u}\frac{b_u}{n_u}-1\right)(P_R - v_0(1-x))\right]. \quad (42)$$

Because an uninformed investor cannot condition his bid on the realization of v_1, then, given that all other uninformed investors bid their shares and that informed investors play their optimal strategy, his expected gain per share depends not only on the number of shares held by uninformed investors, but also on his bid. Using (5), rewrite (42) as

$$\Gamma_u(b_u, N_U) = -\frac{N_R}{N-N_R}(P_R - v_0) + \frac{1}{2}\frac{NN_R}{N-N_R} \times \frac{b_u}{n_u}\left[\frac{(P_R - v_0(1-x))}{N-n_m-n_u+b_u} - \frac{(v_0(1+x)-P_R)}{N_U-n_u+b_u}\right]. \quad (43)$$

Now substitute $b_u = n_u$ into (43) to get (9). □

Proof of Lemma 2: Suppose all uninformed investors bid all their shares and that informed investors play their optimal strategy. Consider an uninformed investor who deviates from the strategy of bidding all his shares. His expected gain per share as a function of his bid, $\Gamma_u(b_u)$, is given by (43). First, note that if he bids $b_u = 0$, then (43) reduces to

$$\Gamma_u(b_u = 0) = -\frac{N_R}{N-N_R}(P_R - v_0). \quad (44)$$

Observe that, given P_R, this expected gain does not depend on N_U. (In equilibrium, however, it will depend on N_U through P_R^*.) Next, suppose that the uninformed investor bids all his shares, then his expected gain per share is given by

$$\Gamma_u(b_u = n_u, N_U) = -\frac{N_R}{N-N_R}(P_R - v_0) + \frac{1}{2}\frac{NN_R}{N-N_R}\left[\frac{(P_R - v_0(1-x))}{N-n_m} - \frac{(v_0(1+x)-P_R)}{N_U}\right] \quad (45)$$

which is (9).

For an uninformed investor to bid his shares, his expected gain per share must be at least the gain in (44). This is because given P_R, he can always secure the expected gain per share in (44) by bidding 0. Suppose that the manager sets P_R such that

$$\frac{(P_R - v_0(1-x))}{N-n_m} - \frac{(v_0(1+x)-P_R)}{N_U} = 0. \quad (46)$$

Then the second term in (43) is equal to zero for $b_u = n_u$ and for $b_u = 0$, and is negative for all values $b_u \in (0, n_u)$. Accordingly, if the manager chooses the P_R implied by (46), then

$$\Gamma_u(b_u = n_u) = \Gamma_u(b_u = 0) = -\frac{N_R}{N-N_R}(P_R - v_0) \quad (47)$$

and no uninformed investor will deviate from a strategy of bidding all his shares. This is because each uninformed investor is indifferent between bidding all his shares and bidding none of his shares and is worse off by bidding part of his shares; hence (by earlier assumption) he bids all his shares. Given P_R as in (46), if an uninformed investor bids only part of his shares, he is worse off, since the term in the square brackets in (43) is always negative for $b_u \in (0, n_u)$. Intuitively, a deviation increases the loss on the shares that he gets to tender, without changing the loss per share on the shares that he does not tender. This is because if he deviates, informed investors get to tender more of their shares when the value realization is high, and hence utilize the information better at the expense of uninformed shareholders that always tender. Hence, if the manager sets P_R as above, uninformed investors would not deviate from the strategy of bidding all their shares. Denote the repurchase price implied by (46) with P_{R0} and rearrange (46) to get

$$P_{R0} = v_0\left(1 + x\frac{N-n_m-N_U}{N-n_m+N_U}\right). \quad (48)$$

Next, it can be observed from (43) that for values of P_R lower than P_{R0}, the second term on the right hand side of (43) is negative for all $b_u > 0$, so that an uninformed investor will always deviate and bid 0. In any equilibrium, therefore, $P_R^* \geqslant P_{R0}$. On the other hand, for all $P_R > P_{R0}$, the second term in (43) is maximized for $b_u = n_u$, so that an uninformed investor will not deviate. Hence, the uninformed always bid their shares if and only if $P_R \geqslant P_{R0}$. □

Proof of Proposition 2: Because the manager maximizes his wealth by choosing the minimal repurchase price for which the repurchase succeeds, he sets $P_R^* = P_{R0}$, which is the price in (11). The unique strategy of informed investors has been demonstrated in Lemma 1, and it is only left to show that the only equilibrium strategy of uninformed investors is to bid all their shares. Suppose not all uninformed investors bid all their shares. Rewrite the expected gain per share for the uninformed investor as a function of his bid as

$$\Gamma_u(b_u) = -\frac{N_R}{N-N_R}(P_R - v_0) + \frac{1}{2}\frac{NN_R}{N-N_R} \times \frac{b_u}{n_u}\left[\frac{(P_R - v_0(1-x))}{N_I+B_U} - \frac{(v_0(1+x)-P_R)}{B_U}\right] \quad (49)$$

where B_U is the aggregate number of shares bid by all uninformed investors. The first term is the gain when investor u bids 0. The other uninformed investors will not deviate from the given strategy that yields B_U only if the term in the square brackets is set at 0 by the choice of P_R, but for any $B_U < N_U$ this P_R is higher than in (48), so that in this case the manager is worse off. Hence, in the unique equilibrium, uninformed investors bid all their shares. □

Proof of Lemma 3: Γ_i is decreasing in P_R and P_R can never be set at a price lower than v_0. Hence Γ_i is maximized at $P_R = v_0$. If the manager sets $P_R = v_0$ and all investors always bid their shares, then the maximum gain to a single investor from deviating and becoming informed is $\min(n_{max}, N_R) * \Gamma_{i0}$. Accordingly, if (16) is satisfied no investor will deviate. □

Proof of Proposition 3: Γ_i^* is decreasing in P_R and Γ_u^* is increasing in P_R, hence (18), (19), (8), and (9) dictate that N_U is increasing in P_R. The N_U, for which each of the constraints (6) and (10) is binding, is continuous and decreasing in P_R. Constraints (6) and (10) are not binding for $P_R = v_0(1 + x)$ in which case nobody becomes informed and the repurchase succeeds. Because the manager maximizes his wealth for the minimal P_R for which the tender offer succeeds, he sets the tender offer price at the minimal P_R for which (18), (19), (8), and (9) dictate N_U for which one of the constraints (6) and (10) is binding. □

Proof of Proposition 4: Given P_R, if (20) holds for investor k' it holds for all investors $k \leqslant k'$. Given that (21) holds for investor $k' + 1$ it holds for all investors $k > k'$. Accordingly, given P_R, all investors $k \leqslant k'$ choose to stay uninformed and all investors $k > k'$ choose to become informed. Because (10) holds, all uninformed investors always bid all their shares, and, because (6) holds, the tender offer succeeds. Because $N_{Uk'} < N - n_m$, it must be that $P_R < v_0(1 + x)$. The manager will not set the price higher than this value of P_R because it reduces his wealth. Because Γ_i increases with P_R (see (8)), and $\Gamma_u(N_{Uk'} + n_{k'+1})$ decreases in P_R (this is hard to observe from (9), but is implied by zero-sum game), then for any lower P_R the manager might choose for which (6) still holds, condition (21) will be satisfied. Hence, in any equilibrium there will be informed investors and the equilibrium will be costly. □

Proof of Lemma 4: The proof consists of three steps: (a) We first show that in regular trade (without an open-market program) and with one informed investor, in any equilibrium, the highest expected gain of this informed investor is the gain in (25). (b) Next, we show that in any equilibrium, an open-market repurchase program does not affect this gain. (c) Last, we show that in all equilibria with more than one informed investor, the aggregate expected profit of all informed investors cannot be higher than the gain of one informed investor.

(a) Suppose there is one informed investor. We first show that this informed investor must earn positive expected profit in any equilibrium. Since the market maker earns zero expected profits for any given net order flow, then

$$v_{t-1}(1-x) \leqslant P(q_t) \leqslant v_{t-1}(1+x). \tag{50}$$

This follows because, were the price outside these bounds, the market maker would buy/sell the stock at a price greater or less than the value in any possible state, violating the zero-expected-profit condition. In any fully revealing equilibrium, the expected profits of the informed investor must be zero state by state, because the price must equal the expected value of the asset conditional on his private information. Since the price is between $v_{t-1}(1 - x)$ and $v_{t-1}(1 + x)$, the informed investor can earn positive expected profits in at least one state; hence the equilibrium cannot be fully revealing. This further implies that, aside from the informed investor, only liquidity traders participate (uninformed investors suffer expected loss). Denote the informed investor with subscript i; then $q_{tj} = 0$ for all $j \neq i$.
Consider state H. For any order submitted by the informed investor, q_{ti}, his expected profit is

$$q_{ti}\left[v_{t-1}(1+x) - \frac{1}{2}(P(q_{ti}-h) + P(q_{ti}-l))\right]. \tag{51}$$

For this to be nonpositive, it must follow that, for $q_t > -h$,

$$\frac{1}{2}[P(q_t) + P(q_t + h - l)] \geqslant v_{t-1}(1+x). \tag{52}$$

Similarly, in the state L, the expected profits for the informed investor are

$$q_{ti}\left[v_{t-1}(1-x) - \frac{1}{2}(P(q_{ti}-h) + P(q_{ti}-l))\right] \tag{53}$$

and it must follow that, for $q_t < -l$,

$$\frac{1}{2}[P(q_t) + P(q_t + l - h)] \leqslant v_{t-1}(1-x). \tag{54}$$

Let $-h < q_t < -l$. To satisfy (52), we must have $P(q_t) = v_{t-1}(1 + x)$. But to satisfy (54), we must have that $P(q_t) = v_{t-1}(1 - x)$. Hence the informed investor must always earn positive expected profit in any equilibrium.
Next, suppose the informed investor sets q_{ti} such that

$$q_{ti}(H) - h = q_{ti}(L) - l \tag{55}$$

so that the market maker cannot determine the value shock in the states, $\{H,h\}$ and $\{L,l\}$. Substituting the market maker's zero-expected-profit condition (24) for equilibrium prices into (51) and into (53) and using Bayes' rule, the equilibrium expected profits for the informed investor in states H and L are given by:

$$H: \quad \frac{1}{2}q_{ti}(H)v_{t-1}x \tag{56}$$

$$L: \quad -\frac{1}{2}[q_{ti}(H) - (h-l)]v_{t-1}x \tag{57}$$

respectively. These are both nonnegative if and only if

$$0 \leqslant q_{ti}(H) \leqslant (h-l). \tag{58}$$

Inspection reveals that the only other ways to induce adverse selection are either to set $q_{ti}(H) = q_{ti}(L)$, or to set $q_{ti}(H) - l = q_{ti}(L) - h$. These trades, however, cannot generate nonnegative expected profits in both states H and L. Therefore, set the informed investor's trades to $\alpha(h - l)$ in state H and to $(\alpha - 1)(h - l)$ in state L where $0 < \alpha < 1$. Substituting these expressions into (56) and (57) and taking expectations gives the expected profit in (25), which does not depend on α and is strictly greater than 0.

(b) Suppose the manager announces an open-market program. He maximizes his wealth and that of all other shareholders by distributing the cash as fast as possible. Thus his optimal strategy is to buy the maximal allowed number of shares every day (25% of the average daily trade, $\frac{h+l}{2}$). Accordingly, the analysis is the same as in (a) with $q_t - \frac{h+l}{8}$ replacing q_t. The expected gain for the informed investor is unchanged.

(c) Suppose there is more than one informed investor. Suppose they place an aggregate order as in (a). Then each informed investor's expected profit cannot be higher than the gain in (25). Any deviation by one of the informed investors to increase his expected profit from such a strategy will adversely affect the market maker's beliefs; hence, the aggregate expected gain cannot be higher that the gain in (25). Thus, each informed investor's gain cannot be higher than the expected gain in (25).

Proof of Proposition 5: With a tender offer, the manager's expected loss per share is $\frac{C(P_R^* - v_0)}{NP_R^* - C}$ (see (12)). The manager can avoid the costs of a tender offer by distributing the cash with an open-market program, at the cost of a partial loss of cash. Losses to informed investors in case of an open-market program are irrelevant since they will be incurred regardless of the program. With an open-market program, the manager minimizes the waste by buying the maximal allowed quantity under the Safe Harbor Act: $\frac{h+l}{8}$ per day. The expected time until program completion is $\frac{8C}{v_0(h+l)}$, which implies that the expected erosion in value per share is $\frac{4\delta C^2}{N(h+l)v_0}$. Thus the manager chooses a tender offer whenever

$$\frac{C(P_R^* - v_0)}{NP_R^* - C} < \frac{4\delta C^2}{N(h+l)v_0}. \tag{59}$$

Otherwise, he chooses an open-market program. Rearrange (59) to get (26). □

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