ELSEVIER Journal of Corporate Finance 3 (1997) 221–249

Journal of CORPORATE FINANCE

Heterogeneous shareholders and signaling with share repurchases [1]

John C. Persons

Ohio State University, Fisher College of Business, 1775 College Road, Columbus, OH 43210, USA

Abstract

This paper presents an asymmetric information model of share repurchases when shareholders have heterogeneous reservation values. Consistent with empirical evidence, managers in the model repurchase shares at a premium above the post-repurchase share value — transferring wealth from shareholders who do not tender to those who do — in order to signal that the firm is undervalued. Such dilutive repurchases would not occur under the classical assumption of perfectly elastic share supply; they depend critically on shareholder heterogeneity. It is also shown that repurchases are more efficient signals than other strategies like dividends and 'burning money'. The model's implications are consistent with much empirical evidence regarding announcement returns, repurchase size, repurchase premiums and expiration-day price drops.

JEL classification: G32; G35

Keywords: Repurchase; Dividend; Signaling; Heterogeneous shareholders

1. Introduction

Corporate tender offers to repurchase shares tend to be very large transactions that produce significant increases in the firm's stock price. Management often claims to be repurchasing shares because the shares are 'undervalued' or a 'good

[1] This paper is adapted from my dissertation at the University of Chicago.

PII S0929-1199(96)00012-0

investment'. This suggests an asymmetric information story: that managers of the firm have superior ability to determine firm value. Given their access to proprietary information, this is quite plausible. Furthermore, much of the empirical evidence concerning share repurchases is consistent with repurchases serving as a 'signal' of undervalued shares [2].

Empirical evidence (Bagwell, 1992) also shows that, contrary to the classical assumption of a perfectly elastic supply curve for a firm's shares, there is significant dispersion in shareholder reservation values. This has important implications for the signaling characteristics of share repurchases. This paper develops a signaling model that explicitly incorporates heterogeneous shareholder reservation values [3]. Heterogeneity proves important in understanding why firms pay more than 'fair value' for their shares, i.e., why they offer a repurchase price significantly higher than the post-repurchase stock price. The model produces comparative statics that are consistent with some existing empirical evidence. It also produces an explanation for the changes in average repurchase size and average repurchase premium during the 1980's; namely, more elastic share supply curves due to increased institutional ownership. Changing elasticity also offers a consistent explanation for the difference in market reaction to repurchase tender offers during the 1980's.

I show that repurchases have advantages over other possible signals like dividends, corporate philanthropy, advertising or 'burning money'. One might think that the firm would avoid repurchases if it faces a very steep supply curve for its shares, because a steep supply curve necessitates paying a large premium. However, regardless of the steepness of the firm's supply curve, repurchases are always better signaling devices *at the margin* — a small increase in shares repurchased is more costly for a low-value firm to imitate than a small increase in these alternative signals. Therefore, in the absence of fixed costs of repurchasing, firms always signal with a repurchase tender offer rather than with an increased dividend (or other alternative). When tender offers carry fixed costs, dividends are used to signal small differences in value while repurchases are used to signal large differences. As a result, tender offers cause larger stock price reactions than dividend increases, consistent with existing evidence [4].

Dann (1981), Vermaelen (1981) and Masulis (1980) document that the average purchase price in tender offer repurchases is 22–23% above the market price prior to the announcement of the tender offer, while the post-repurchase stock price (60

[2] See Masulis (1980), Dann (1981), Vermaelen (1981), Vermaelen (1984), Dann et al. (1991) and Comment and Jarrell (1991).

[3] The corporate control implications of an upward-sloping supply curve have been examined by Stulz (1988), Bradley et al. (1988), Brown (1988), and Bagwell (1991a).

[4] See Barclay and Smith (1988) for a summary of the evidence.

days following offer expiration) is only 13% above the pre-offer price. Thus, firms that execute tender offer repurchases seem to be significantly 'overpaying' for their shares. Such a policy benefits tendering shareholders at the expense of non-tendering shareholders (and perhaps other security holders), since it is the remaining claimants who bear the premium that is paid to the tendering shareholders [5]. This is surprising for two reasons. First, it is these remaining shareholders whom management must satisfy in the future, so it seems unlikely that management would take actions that hurt them and help tendering shareholders (to whom they will have no future obligation). Second, managers usually commit not to tender any shares held personally, so their personal portfolio values are diluted by the overpayment.

One possible explanation of this overpayment is that it is more efficient to signal by repurchasing shares at a higher price, because this reduces the number of shares the firm must buy to make the signal credible. Therefore allow the manager to choose both the tender price and the number of shares the firm offers to repurchase. This explanation for dilutive repurchases does not hold up — it turns out to be more efficient to signal by repurchasing more shares at a lower price than by repurchasing fewer shares at a higher price. The only reason firms pay such high premiums in the model is because of heterogeneous shareholder reservation prices — the firm faces an upward-sloping supply curve for its shares, and is 'forced' to overpay. The model points to heterogeneous shareholders as an important factor in understanding repurchase behavior.

Other models of share repurchases based on private information possessed by management include Vermaelen (1984), Ofer and Thakor (1987), Constantinides and Grundy (1989), Bagnoli et al. (1989) and Hausch and Seward (1993). Of these, only Hausch and Seward (1993) includes the possibility of shareholders having different reservation values; all others assume, at least implicitly, that the firm can purchase as many shares as desired at the 'fair' price, so they have nothing to say about how differences in share elasticity affect repurchase behavior [6].

[5] More recent evidence is similar. Comment and Jarrell (1991) and Kamma et al. (1992) have samples from the middle and late 1980's. For fixed price tender offers, Comment and Jarrell find an average tender premium of 20.6%, while Kamma, Kanatas and Raymar find an average premium of 19.2%. These premiums are substantially higher than the average post-expiration market price. The cumulative average residual from just before the offer is announced until the end of the event window is about 10% for Comment and Jarrell (event window ends 50 days after announcement) and about 5% for Kamma, Kanatas and Raymar (event window ends 60 days after announcement). For Dutch auctions, the average premium is smaller (about 13% in both cases) and the CAR is similar — about 11% for Comment and Jarrell and about 7% for Kamma, Kanatas and Raymar.

[6] The tender price is exogenous in Vermaelen's model, and he assumes that it is higher than the fair price. Here the tender price is determined endogenously. Furthermore, Vermaelen implicitly assumes that the firm can buy as many outside shares as desired at the given tender price.

Since Hausch and Seward (1993) include heterogeneous reservation prices in their model, it is important to highlight the fundamental differences between their model and this one. The first important difference has been mentioned already — I allow the manager to choose both the tender price and the number of shares the firm offers to repurchase. Hausch and Seward allow the manager to choose the number of shares, and the purchase price is then determined by an auction. That approach does not allow the possibility that the manager prefers to purchase fewer shares, and offer a higher price to make the signal credible. Second, managers in their model have private information about the amount of *current cash*, which obviously must be unobservable; in this model they have private information about the firm's *future* cash flows. Third, the effect of financial signals (dividends and repurchases) in Hausch and Seward (1993) arises because they distort *investment* policy; higher dividends and repurchases reduce the (unobservable) amount invested in production. For this reason, the properties of the firm's production function play a prominent role in their analysis. In contrast, dividends and repurchases in this model are *purely financial* signals. Since investment is held fixed in the analysis, payouts cause no social loss from distorted investment policy. Finally, the key distinction between dividends and repurchases in Hausch and Seward (1993) is that dividends are deterministic and repurchases are stochastic, so dividends produce a deterministic distortion in investment and repurchases produce a stochastic distortion. In their model, dividends and repurchases would be interchangeable if they were both deterministic. In my setting, repurchases and dividends have quite different signaling properties even though they are both deterministic — the model highlights a very different facet of the repurchase/dividend choice than Hausch and Seward's model.

The essentials of the model are as follows. There are two types of firms, distinguished by the size of the firm's terminal cash flow. The manager of the firm learns the cash flow prior to its realization, and may choose to repurchase some shares (and in Section 4, pay a dividend). The manager's utility depends on the market price of the stock — hence the incentive to signal when the stock is undervalued. I do not impose a functional form on management preferences, but allow general increasing and (weakly) concave preferences. Shareholders agree on the price they would pay for additional shares, but they have heterogeneous asking prices, because (say) they face different transaction costs and capital gains taxes. Repurchases are costly because the firm must pay a premium to buy the shares; dividends are costly because cash received as dividends is taxed more severely than cash received via repurchases [7]. Any repurchase or dividend is financed by

[7] Not only is the tax rate on dividends higher than on capital gains (for individuals in the upper brackets), but the amount that gets taxed is greater. If a shareholder receives a $100 dividend, the entire $100 distribution is taxed. If the shareholder receives $100 by selling shares to the firm, only the profit from the sale is taxed; repurchases allow shareholders to delay the recognition of taxable income.

borrowing, so the firm's investment policy and terminal cash flow are unchanged by the financing decision.

Section 2 presents the repurchase model in detail. Section 3 analyzes equilibrium in the model. There is a unique separating equilibrium that survives a mild refinement based on eliminating strictly dominated strategies. This equilibrium yields testable comparative statics that are compared with existing empirical evidence. The equilibrium is dilutive in that the firm repurchases shares at a price higher than the post-repurchase value. I show that this result depends crucially on heterogeneous shareholders — there are no plausible dilutive equilibria when the supply curve is perfectly elastic. Section 4 extends the model to include dividends, and demonstrates that repurchases have signaling properties superior to dividends (or burning money, corporate philanthropy, excess advertising, or other possible signals) because they impose relatively greater costs on a potential imitator. When there are fixed costs involved in executing a tender offer, repurchases are chosen when the firm's shares are severely underpriced and dividends are chosen when the shares are slightly underpriced. Section 5 offers a brief conclusion. Proofs are contained in Appendix B, which is available from the author.

2. A model of repurchase tender offers

2.1. *Description of the model*

I model share repurchases as a simple game in which the manager of a firm chooses a repurchase strategy and a risk-neutral 'market' tries to infer the value of the firm based on the strategy chosen. There are three dates — 0, 1, and 2 — and there is no time preference. The firm's projects will produce a cash flow v at date 2, where v is either low or high, $v \in \{L, H\}$. Date 0 is merely a starting point at which information is symmetric. Between dates 0 and 1, the manager learns the realization v of the future cash flow and chooses a repurchase strategy. If the manager chooses to repurchase shares, a tender offer is executed. The market makes an inference about firm value based on the repurchase announcement, and the firm's stock price adjusts. At time 1, there is probability π that the size of the future cash flow becomes *public* information; if so, the prices of the firm's securities adjust so that firm value equals the known realization [8]. This represents the possibility that firm type is revealed by the firm's production decisions, public disclosure through financial reports, information leakage, actions of competitors, and so forth. At the final date, $t = 2$, the cash flow is realized. The firm is initially all equity, with one share outstanding (divided among many investors).

[8] This is the approach taken by Welch (1989) in his model of IPO signaling.

The manager maximizes expected utility $E[u(p^1)]$, which depends on the market price of the stock at the interim date, p^1 [9]. The manager therefore 'cares' about the post-repurchase stock price — his or her interests are aligned with long-term shareholders who do not sell their shares, perhaps because the manager owns restricted shares or because management commits not to tender its shares (Vermaelen, 1981). The utility function $u(\cdot)$ is strictly increasing, weakly concave, twice continuously differentiable, and has $u(0) = -\infty$. The manager's strategy (I consider only pure strategies) gives the repurchase tender offer that will be made when the manager learns firm value v. It thus specifies a choice of tender offer for each firm type $v \in \{L, H\}$. A tender offer (α, p) is an offer to buy a maximum of α shares, $0 < \alpha < 1$, at the price p per share [10]. The choice to make no tender offer will be denoted $(0, \cdot)$, since the number of shares sought is $\alpha = 0$. I sometimes use $\sigma(v)$ to denote the tender offer of firm type v, i.e., $\sigma(v)$ is some ordered pair (α, π).

The prior probability that $v = H$ is denoted ϕ, so the market's initial estimate of firm value is $E[v] = \phi H + (1 - \phi)L$. When the firm announces the tender offer, the market updates this estimate. The new estimate is denoted $v^{M}(\alpha, p)$ (where the M stands for market), with $L \le v^{M}(\alpha, p) \le H$ [11]. I assume that there is complete agreement among investors about firm value, i.e., all investors would pay the same amount to buy additional shares. This is a natural assumption if the stock has close substitutes in the capital market — the market price of the stock cannot differ from the market price of the substitutes. The heterogeneous asking prices of current shareholders are thus not due to differences of opinion, but due to frictions like capital gains taxes or transaction costs.

The fact that a firm offers to purchase α shares at price p does not mean that the firm will end up purchasing α shares. Whether the firm succeeds in purchas-

[9] Allowing the manager's utility to depend on the price at date 2 as well as date 1 would merely require a redefinition, assuming preferences are time-additive and stationary. If we define $\hat{\pi} = \pi/2$ and replace π with $\hat{\pi}$ in what follows, everything goes through.

[10] Tender offer repurchases in the model are the traditional type of offer in which the firm specifies the repurchase price and the maximum number of shares to be repurchased. A new method, the so-called 'Dutch auction' repurchase, was introduced in the 1980's. Under a Dutch auction repurchase, shareholders specify the price at which they are willing to sell to the firm, and the firm then determines what price it must pay to repurchase the desired number of shares. (See Gay et al. (1990), Bagwell (1992), Comment and Jarrell (1991) and Persons (1994).) Nothing would change in this setting if repurchases were executed via Dutch auction, because there is no uncertainty about shareholder tendering behavior. Persons (1994) analyzes the choice between the two methods when shareholder tendering is uncertain.

[11] Note that there is a one-to-one correspondence between the market's estimate v^{M} of firm value and the posterior distribution over firm types. If we let ϕ^{M} denote the market's posterior probability that $v = H$, then $v^{M} = \phi^{M} H + (1 - \phi^{M})L$, or $\phi^{M} = (v^{M} - L)/(H - L)$. The posterior probability that $v = L$ is then $1 - \phi^{M} = (H - v^{M})/(H - L)$.

ing α shares depends on whether shareholders tender this many shares, which in turn depends on what they infer about the true value of the firm. Let $\alpha^{M}(\alpha, p|v^{M})$ denote the number of shares actually purchased when the firm makes the offer (α, p) and investors infer that the firm is worth v^{M}. Then $\alpha^{M}(\alpha, p|v^{M}) = \min[\alpha, \alpha^{T}(\alpha, p|v^{M})]$, where α^{T} represents the number of shares tendered [12]. Since α^{M} is the actual size of the repurchase, I refer to the pair $(\alpha^{M}[\alpha, p|v^{M}(\alpha, p)], p)$ as the *effective tender offer*. The function α^{T}, and hence α^{M}, is common knowledge; I abstract from uncertain tendering behavior.

I assume throughout that the firm does not change its investment projects as a result of a repurchase, so the terminal cash flow remains v. A tender offer therefore has no effect on the true value of the firm, but it will change the market value of the firm if it changes investors' perception of firm value. Since shares are repurchased without altering investment policy, external financing must be used, and I assume the funds are raised by borrowing [13]. A tender offer (α, p) requires a cash outlay of $\alpha^{M}p$, and no lender will lend the firm more than the perceived value of the firm's cashflows, so the tender offer (α, p) is feasible if

$$v^{M}(\alpha, p) \geq \alpha^{M}\left[\alpha, p|v^{M}(\alpha, p)\right]p. \tag{1}$$

To abstract from possible signaling by choice of debt contract, I assume that the firm issues debt that matures at date 2 and has the minimum face value that will raise $\alpha^{M}p$. If the amount borrowed $\alpha^{M}p$ is L or less, the loan is riskless, so the face value is just $\alpha^{M}p$. Otherwise, the market assesses a default probability of $(H - v^{M})/(H - L)$, the posterior probability that the firm is worth L (see Footnote 10). In order to raise $\alpha^{M}p$, the firm must issue debt with face value

$$F(\alpha, p|v^{M}) = \begin{cases} \alpha^{M}p & \text{if } \alpha^{M}p \leq L \\ \alpha^{M}p + \left(\dfrac{H - v^{M}}{v^{M} - L}\right)(\alpha^{M}p - L) & \text{if } \alpha^{M}p > L, \end{cases} \tag{2}$$

where α^{M} means $\alpha^{M}(\alpha, p|v^{M})$.

[12] In cases where an offer is oversubscribed, i.e. $\alpha^{T} > \alpha$, I assume that the firm honors its original limit α on the number of shares repurchased. In practice, firms sometimes do so (and repurchase shares on a pro rata basis), and sometimes they exceed their initial offer and repurchase all tendered shares.

[13] Since I assume that true firm value is independent of the amount of borrowing, I obviously abstract from real capital structure effects such as interest tax shields and costs of financial distress. I also ignore as negligible the effect of the manager's compensation on the value of the firm. The choice of debt as the vehicle for financing repurchases is not crucial in any way. One could as easily assume that the repurchase is financed by issuing new shares. This would yield the same results and save the minor complication of dealing with default. It would seem strange to discuss a firm issuing equity in order to repurchase equity, but this would also make the idea of a dilutive repurchase transparent — the shareholders who do not tender would own a smaller fraction of the equity after the repurchase than before, and nothing else about the firm would have changed.

When the firm executes the repurchase between dates 0 and 1, the number of shares outstanding decreases from 1 to $1-\alpha^{\mathrm{M}}$. Since the new debt has market value $\alpha^{\mathrm{M}}p$, the market value of equity is $v^{\mathrm{M}}-\alpha^{\mathrm{M}}p$ and the share price is $(v^{\mathrm{M}}-\alpha^{\mathrm{M}}p)/(1-\alpha^{\mathrm{M}})$. If true firm value is not revealed publicly at time 1, this is also the time-1 stock price.

If true firm value is revealed at time 1 (this happens with probability π), the previous market estimate v^{M} becomes irrelevant — the stock price is based on the publicly known firm value v. The future cash flow is now public information, so the market value of debt becomes $\min[F, v]$, and equity value is $\max[v-F, 0]$ when the firm's type is revealed. The stock price at time 1 is thus

$$p^{1}(\alpha, p|v^{\mathrm{M}}) = \begin{cases} (v^{\mathrm{M}}-\alpha^{\mathrm{M}}p)/(1-\alpha^{\mathrm{M}}) & \text{if firm type is not revealed} \\ \max\left[v-F(\alpha, p|v^{\mathrm{M}}), 0\right]/(1-\alpha^{\mathrm{M}}) & \text{if firm type is revealed,} \end{cases} \tag{3}$$

where α^{M} means $\alpha^{\mathrm{M}}(\alpha, p|v^{\mathrm{M}})$. Default can safely be ignored due to the assumption that $u(0)=-\infty$; the manager will never issue debt with face value greater than v because default is too costly to him [14].Therefore, to simplify notation, I will write the stock price when firm type is revealed as $(v-F)/(1-\alpha^{\mathrm{M}})$.

2.2. Equilibrium

In equilibrium, the manager's tender offer choice maximizes his or her expected utility, and the market's inference function $v^{\mathrm{M}}(\cdot)$ provides unbiased estimates of firm value, conditional on public information. For a given firm type v and market inference function $v^{\mathrm{M}}(\cdot)$, let $U_{v^{\mathrm{M}}}(\alpha, p|v)$ denote the manager's expected utility from making a feasible tender offer (α, p):

$$U_{v^{\mathrm{M}}}(\alpha, p|v) = (1-\pi)u\left(\frac{v^{\mathrm{M}}(\alpha, p)-\alpha^{\mathrm{M}}p}{1-\alpha^{\mathrm{M}}}\right) + \pi u\left(\frac{v-F(\alpha, p|v^{\mathrm{M}}(\alpha, p))}{1-\alpha^{\mathrm{M}}}\right), \tag{4}$$

where α^{M} means $\alpha^{\mathrm{M}}(\alpha, p|v^{\mathrm{M}}(\alpha, p))$. As in the signaling models of Miller and Rock (1985) and others, the manager places some weight on true value and some

[14] When dividends are introduced in Section 4, we will no longer be able to ignore the possibility of default.

Table 1
Summary of notation

Symbol	Description
$v \in \{L, H\}$	true firm value, $L < H$
ϕ	probability that a firm is high-value ($v = H$)
π	probability that firm value is revealed at time 1
$\sigma(v)$	strategy chosen by manager of a type-v firm, often written as (α, p) or (α, p, D)
α	number of shares sought in a tender offer
$\alpha^{T}(\sigma(v)\|v^{M})$	number of shares tendered in response to the strategy $\sigma(v)$, given that the market'sinference about firm value is v^{M}
$\alpha^{M}(\sigma(v)\|v^{M})$	number of shares actually purchased via the strategy $\sigma(v)$, given that the market's inference about firm value is v^{M}
p	tender price
p^{0}	stock price at date 0
p^{1}	stock price at date 1
$v^{M}(\sigma(v))$	market's inference from the strategy $\sigma(v)$ about firm value v
$p^{S}(\alpha\|v^{M})$	minimum tender price at which the firm can purchase α shares, given that the market's inference about firm value is v^{M}
D	cash spent on dividends
$b(D)$	personal benefit shareholders receive when the firm spends D on dividends
$u(p^{1} + b(D))$	manager's utility when the firm spends D on dividends and the stock price at time 1 is p^{1}
$U_{v^{M}}(\sigma(v)\|v)$	expected utility of the manager of a type-v firm when following the strategy $\sigma(v)$, given that the market's inference function is $v^{M}(\cdot)$

on market value. The weight placed on true value is π, the probability that this true value is revealed publicly by date 1. Please refer to Table 1 for a summary of the notation, including some to be introduced later.

A pair of functions (σ, v^{M}) is an equilibrium if the manager's strategy σ maximizes his or her expected utility and the market's strategy v^{M} produces unbiased inferences.

Definition 1. *(σ, v^{M}) is an equilibrium if, for $v \in \{L, H\}$,*

1. $\sigma(v) \in \arg\max U_{v^{M}}(\alpha, p|v)$
2. $v^{M}(\sigma(v)) = E[v|\sigma(v)]$,

where the maximization in part 1 is over tender offers that are feasible under v^{M} (see Eq. (1)). In a separating equilibrium, part 2 requires that the equilibrium be fully revealing: $v^{M}(\sigma(v)) = v$. In a pooling equilibrium, the inferred value must be the unconditional mean value: $v^{M}(\sigma(v)) = E[v] = \phi H + (1 - \phi)L$.

I rely on the concept of dominated strategies to eliminate equilibria that depend on unreasonable beliefs [15]. Dominance is the weakest refinement of Nash equilibrium, yet it proves quite powerful in this setting. One tender offer dominates

[15] Cho and Kreps (1986) discuss several ways to refine equilibria in signaling games by restricting the beliefs of the uninformed player. See also Milgrom and Roberts (1986).

another if it yields strictly higher utility for *every possible* market inference function v^{M} (which certainly requires that it be *feasible* for every v^{M}). A tender offer is dominated if such a dominating tender offer exists.

Definition 2. *The tender offer (α, p) is dominated by the tender offer $(\hat{\alpha}, \hat{p})$ for firm type v if $(\hat{\alpha}, \hat{p})$ is always feasible and $U_{v^M}(\hat{\alpha}, \hat{p}|v) > U_{v^M}(\alpha, p|v)$ whenever $v^M(\cdot)$ makes (α, p) feasible. The tender offer (α, p) is dominated for firm type v if such a tender offer $(\hat{\alpha}, \hat{p})$ exists.*

The manager will never use a dominated strategy, and the market should realize that the manager will never do so. Therefore, if a particular tender offer (α, p) is dominated for a low-value firm but not for a high-value firm, the market should never interpret the offer (α, p) as evidence of a low-value firm — it should set $v^{\mathrm{M}}(\alpha, p) = H$. If the roles are reversed, $v^{\mathrm{M}}(\alpha, p) = L$ is the only reasonable inference. An equilibrium that fails this mild test of reasonableness is said to fail the dominance criterion. An equilibrium that passes this test survives the dominance criterion.

Definition 3. *An equilibrium (σ, v^M) survives the dominance criterion if $v^M(\alpha, p) = L$ for any tender offer (α, p) that is dominated for the high-value firm but not for the low-value firm and $v^M(\alpha, p) = H$ for any tender offer (α, p) that is dominated for the low-value firm but not for the high-value firm.*

2.3. Tendering behavior of shareholders

Recall that $\alpha^{\mathrm{T}}(\alpha, p|v^{\mathrm{M}})$ is the number of shares tendered when the firm makes the offer (α, p) and the market concludes the firm is worth v^{M}. The number of shares purchased is $\alpha^{\mathrm{M}} = \min\{\alpha, \alpha^{\mathrm{T}}\}$. One might think that, as long as there is consensus about share value, all shareholders would tender if $p > v^{\mathrm{M}}$. This is not so when there are transaction costs associated with portfolio rebalancing or when capital gains are taxed only upon realization. Both of these inhibit shareholders from tendering at a price of only v^{M}, and lead to shareholders having different reservation values for their shares, even when there is complete agreement about share value (i.e., even when all investors are willing to pay the same price for additional shares) [16].

I assume that the firm's shareholders have heterogeneous reservation prices. Appendix A explains in detail the assumptions made about the tendering function

[16] See, for example, Constantinides and Scholes (1980), Constantinides (1983), Bradley et al. (1988), Stulz (1988), Brown (1988), Brown and Ryngaert (1992), and Bagwell (1991a), Bagwell (1991b).

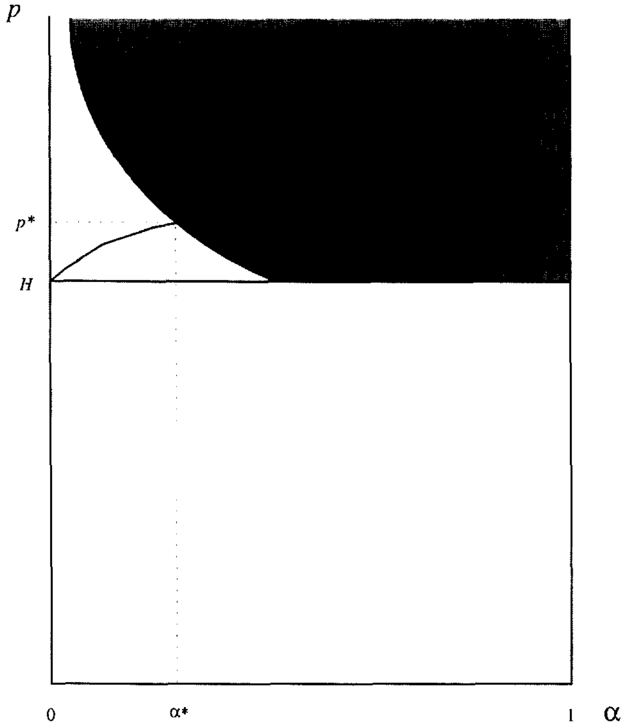

Fig. 1. The number of shares repurchased is on the horizontal axis and the purchase price per share is on the vertical axis. The shaded area is the incentive compatible set — those repurchases a low-value firm would not be willing to make to imitate a high-value firm. The upward-sloping curve is the supply curve faced by the firm when repurchasing its shares. In any plausible separating equilibrium, a high-value firm repurchases α^* shares for p^* per share.

α^{T}. The most important assumptions concern monotonicity: $\alpha^{\mathrm{T}}(\alpha, p|v^{\mathrm{M}})$ is nondecreasing in α and p (larger offers elicit larger responses) and nonincreasing in v^{M} (fewer shares are tendered at a given price when investors think the shares are more valuable). Under the assumptions given in the appendix, one can define a function $p^{\mathrm{S}}(\alpha|v^{\mathrm{M}})$, which I refer to as the supply curve for shares. For any α strictly between 0 and 1, $p^{\mathrm{S}}(\alpha|v^{\mathrm{M}})$ gives the minimum price at which the firm can repurchase α shares, given that the market imputes value v^{M} to the firm. As illustrated in Fig. 1, this supply curve $p^{\mathrm{S}}(\cdot|v^{\mathrm{M}})$ is continuous and strictly increasing, with $\lim_{\alpha \downarrow 0} p^{\mathrm{S}}(\alpha|v^{\mathrm{M}}) = v^{\mathrm{M}}$ (*some* shares are tendered even when the premium is very small). By the very definition of p^{S}, it is impossible for the firm to make a tender offer that is effectively below the supply curve — the price offered is not high enough to attract the desired number of shares. If $v^{\mathrm{M}}(\alpha, p) = H$, as in Fig. 1, then the effective tender offer $(\alpha^{\mathrm{M}}(\alpha, p|H), p)$ must be on or above the supply curve $p^{\mathrm{S}}(\cdot|H)$.

3. Analysis of the model

3.1. Incentive compatibility conditions

Equilibrium requires that all players be willing to follow their prescribed strategies. This section derives 'incentive compatibility' conditions for a separating equilibrium that guarantee this is the case [17].

Lemma 1 in Appendix B shows that low-value firms do not repurchase shares in a separating equilibrium. Since investors correctly infer firm value in a separating equilibrium, the stock price falls to L, and the manager's payoff is $u(L)$. To prevent a type-L manager from mimicking the strategy chosen a type-H manager — thereby fooling investors into thinking the firm is worth H rather than L — the equilibrium repurchase of a high-value firm must not yield a payoff greater than $u(L)$ to a potential imitator. Let Ω, illustrated in Fig. 1, denote the set of incentive compatible repurchases: pairs (α^{M}, p) with $p \geq H$ that satisfy

$$u(L) \geq (1-\pi) u\left(\frac{H-\alpha^{\mathrm{M}} p}{1-\alpha^{\mathrm{M}}}\right)+\pi u\left(\frac{L-\alpha^{\mathrm{M}} p}{1-\alpha^{\mathrm{M}}}\right). \tag{5}$$

Along the left boundary of Ω, Eq. (5) holds with equality. This curve $c(\alpha^{\mathrm{M}})$ is the indifference curve for a potential impostor that yields a payoff equal to his or her equilibrium payoff, $u(L)$.

The separating equilibrium repurchase of a high-value firm must be in the set Ω to deter imitation. Of course, it must also be on or above the supply curve $p^{\mathrm{S}}(\cdot|H)$, since repurchases below this curve are impossible to make. Referring to Fig. 1, the possible separating equilibrium repurchases are in that portion of the shaded region that lies above the upward-sloped supply curve. Within this set, the repurchases along the left boundary of Ω are the most attractive to a signaling manager because, fixing any repurchase price, the manager would like to repurchase as few shares as possible to minimize the wealth transfer to tendering shareholders. But which of the boundary repurchases is best? Would the manager rather signal by repurchasing more shares at a lower price or fewer shares at a higher price? The answer is that the manager prefers to move as far down the boundary as possible, to the point (α^*, p^*), where the two curves intersect. To understand why, recall that the boundary $c(\alpha^{\mathrm{M}})$ is an indifference curve for the type-L manager (with the preferred set to the southwest), who would be paying a premium of $p-L$ over *true* share value. A type-H manager suffers less from purchasing additional shares because the premium paid is only $p-H$ (his or her

[17] I focus primarily on separating equilibria because signaling is the common explanation for tender offer repurchases. Furthermore, no pooling equilibrium survives the 'intuitive criterion' of Cho and Kreps (1986).

indifference curve is flatter), so the manager's payoff increases as we move down the curve $c(\alpha^{M})$. The highest possible separating equilibrium payoff for a type-H manager therefore occurs at this intersection: it is $u((H-\alpha^{*}p^{*})/(1-\alpha^{*}))$. This is proved as Lemma 2 in Appendix B. The appendix also shows that this is *exactly* the manager's payoff in any plausible separating equilibrium, i.e., any separating equilibrium that survives the dominance criterion. This is because all offers effectively in the interior of Ω are dominated for a low-value firm.

We also have to worry about a high-value firm imitating a low-value firm by making an offer $(\alpha,\ p)$ that has $v^{M}(\alpha,\ p)=L$. It might seem strange that a type-H manager would choose to imitate a type-L manager, but he or she might do so in order to buy shares at less than their true worth. If the firm's true value is then revealed at time 1, the share price is inflated because of the shares that were bought 'on the cheap'. This effect may be enough to compensate for the lower share price when revelation does not occur. In most signaling models, the incentive compatibility constraints are unidirectional — low-productivity workers have an incentive to imitate high-productivity workers, weak bargainers have an incentive to imitate strong bargainers, etc. Here the incentive compatibility constraints are bidirectional [18].

If a high-value firm were to masquerade as a low-value firm in order to repurchase bargain-priced shares, the most tempting repurchases would be those on the supply curve $p^{S}(\cdot|L)$ — fixing the number of shares repurchased, the firm would like to pay the lowest possible price. If we have

$$u\left(\frac{H-\alpha^{*}p^{*}}{1-\alpha^{*}}\right)\geq(1-\pi)u\left(\frac{L-\alpha p^{S}(\alpha|L)}{1-\alpha}\right)+\pi u\left(\frac{H-\alpha p^{S}(\alpha|L)}{1-\alpha}\right) \tag{6}$$

for all $\alpha\in(0,\ L/p^{S}(\alpha|L))$ (all feasible repurchases on the supply curve), a type-H manager willingly repurchases α^{*} shares for p^{*} per share rather than imitating a low-value firm. It is easy to show that Eq. (6) is not vacuous — there are many examples for which it is satisfied.

3.2. Separating equilibrium

When condition Eq. (6) holds, so buying on the cheap is not too tempting to high-value firms, it is straightforward to prove the existence of a separating

[18] There is a second reason a type-H manager might, in principle, choose to imitate a type-L manager. It is conceivable that the necessary signal $(\alpha^{*},\ p^{*})$ is so big that the manager would rather make no offer, and accept a payoff $u(L)$ with probability $1-\pi$ and $u(H)$ with probability π. However, it is easy to show that this is not the case — the payoff $u((H-\alpha^{*}p^{*})/(1-\alpha^{*}))$ is greater than $(1-\pi)u(L)+\pi u(H)$. (This is part of the proof of Theorem 1 in Appendix B.)

equilibrium in which the high-value firm repurchases α^* shares for p^* per share, the low-value firm makes no repurchase, and the market's inference function is

$$v^{\mathrm{M}}(\alpha, p) = \begin{cases} H & \text{if } (\alpha^{\mathrm{M}}(\alpha, p|H), p) \in \Omega \\ L & \text{otherwise.} \end{cases}$$

Tender offers that are effectively in Ω (when $v^{\mathrm{M}} = H$) are interpreted as evidence of high value, and other tender offers are interpreted as evidence of low value. There are also (generally) separating equilibria in which a high-value firm repurchases shares at prices higher than p^*, but these equilibria depend on unreasonable investor beliefs. In any separating equilibrium that passes the mild test of the dominance criterion, the type-H firm buys α^* shares for p^* per share.

Theorem 1. *If Eq. (6) holds, there exists an equilibrium in which the low-value firm makes no tender offer and the high-value firm repurchases α^* shares for p^* per share. Furthermore, $(0, \cdot)$ and (α^*, p^*) are the effective tender offers in any separating equilibrium that survives the dominance criterion.*

One of the empirical facts discussed in the introduction was that, on average, the tender price is significantly higher than the post-repurchase stock price, diluting the value of the remaining shares. Since $p^* > H$, the equilibrium of Theorem 1 is dilutive. Furthermore, a significant premium requires that the supply curve have significant inelasticity, because the firm never makes a tender offer that is *above* the supply curve in any plausible equilibrium. The next section shows that the upward-sloping supply curve that results from heterogeneous shareholder reservation values is absolutely necessary to producing dilutive equilibria — with perfectly elastic supply, no dilutive equilibrium (separating or pooling) survives the dominance criterion.

Since the separating equilibrium repurchases are determined uniquely, one can calculate the initial stock price p^0, the percentage tender premium $(p^* - p^0)/p^0$, and the percentage price drop at the tender offer expiration date $(p^* - p^1)/p^*$ [19]. The next theorem describes how the tender premium, the number of shares

[19] To determine p^0, note that an investor could purchase shares at time 0 and then tender them at p^* if the firm turns out to be high-value. If the firm turns out to be low-value, the shares are worth L. Since the ex ante probability that the firm is high-value is ϕ, the initial stock price will be bid up to $p^0 = \phi p^* + (1-\phi)L$ to ensure that such a strategy yields zero expected return. Thus the tender premium reduces to $(1-\phi)(p^* - L)/[\phi p^* + (1-\phi)L]$.
In calculating p^0, I am assuming that shares cannot be sold short. If short selling is allowed, then there is no initial price p^0 that will prevent abnormal expected returns. To see this, let $\tilde{p} = \dfrac{H - \alpha^* p^*}{1 - \alpha^*} < H < p^*$. The strategy of purchasing at time 0 and tendering if an offer is made will produce abnormal expected returns unless $p^0 \geq \phi p^* + (1-\phi)L$. The strategy of selling short at time 0 and covering the short position after any tender offer is completed will produce abnormal expected returns unless $p^0 \leq \phi \tilde{p} + (1-\phi)L$. Since $\tilde{p} < p^*$, the two requirements are incompatible.

purchased, and the price drop at offer expiration respond to a change in the probability of revelation, a shift in the supply curve, and a change in the value of a type-H firm.

Theorem 2. *In any separating equilibrium that survives the dominance criterion, the effective tender offer of a high-value firm responds as follows to exogenous changes.*

1. *An increase in π causes the number of shares purchased and the tender premium to decrease, and produces a smaller expiration-day price drop.*
2. *An increase in $p^S(\alpha^* | H)$ (upward shift in the supply curve) causes the number of shares purchased to decrease and the tender premium to increase, and produces a larger expiration-day price drop.*
3. *An increase in H causes the tender premium to increase.*

Since the effective tender offer of a high-value firm is given by the intersection of the left boundary of Ω and the supply curve $p^S(\cdot | H)$, the proof of the theorem involves examining the effects of the exogenous changes on these two curves.

3.2.1. Testable implications

The results of Theorem 2 are testable if one can come up with reasonable proxies for the exogenous variables. The challenge is finding reasonable proxies. Firm size might serve as a proxy for the probability of revelation π because large firms make more extensive disclosure and are followed more closely by analysts and competitors. Part 1 of the theorem then predicts that, when repurchasing their shares, larger firms pay a smaller premium and repurchase a smaller fraction of shares than smaller firms. Small firms have to send a stronger signal because there is less chance they will be 'found out' if they are signaling falsely. There is evidence that this is in fact the case. Vermaelen (1981) divides his sample into quintiles by firm size. Both premium and target fraction decrease monotonically with firm size. The mean values for the smallest quintile are a 35.9% premium and 20.8% of the outstanding shares sought; for the largest quintile, a 15.3% premium and 8.9% of the outstanding shares sought. The theorem predicts a similar pattern in the average size of the expiration-day price drop.

Analyzing management compensation might also provide proxies for π. In the model, π is the probability that the manager's private information becomes public by the date at which his or her payoff is determined. One might consider firms whose managers have longer-term incentive compensation contracts to be high-π firms and firms whose managers have shorter-term incentive compensation contracts to be low-π firms, since the probability that the public becomes informed by the 'payoff date' presumably increases when this date is farther in the future. The model then predicts that longer-term incentive compensation contracts would be associated with smaller tender offers, smaller premiums, and smaller expiration-day price decreases.

Part 2 of the theorem predicts that an upward shift in the supply curve causes the number of shares purchased to decrease, the tender premium to increase, and the expiration-day price drop to increase. Suppose that capital gains taxes are a primary cause of upward-sloping supply curves. Then, ceteris paribus, a shareholder will have a higher reservation price the lower his or her tax basis. This leads to the prediction that firms whose stock has had better price performance prior to a repurchase (so that shareholders have higher unrealized capital gains) will pay a higher premium, repurchase a smaller fraction of their shares, and experience larger price drops at the expiration date. Existing evidence on this is mixed. Comment and Jarrell (1991) regress the tender premium on the return over 40 days leading to the offer announcement (among other variables), and find a negative coefficient — the opposite of what the model predicts. They do not report a similar regression for the number of shares purchased. Kadapakkam and Seth (1994) present evidence of a positive association between the size of the expiration-day price drop and their proxy for the capital gains tax lock-in, consistent with the model's prediction [20].

There are several reasons to think that institutional investors are more likely to tender their shares at a small premium. Their transaction costs are tiny, their costs of becoming informed about an offer tend to be small (especially on a per-share basis), and the capital gains tax lock-in is likely to be less severe, since many institutional investors are not taxed at all. Furthermore, Bagwell (1991c) presents direct evidence that higher institutional ownership is associated with more elastic share supply. If higher institutional ownership produces more elastic supply curves, the model predicts that, controlling for other factors, firms with higher institutional ownership will repurchase more shares at lower premiums, and experience smaller expiration-day price drops.

One could also directly estimate the slope of the supply curve from the terms and outcome of the tender offer, as in Bagwell (1991c), and use this estimated slope in empirical tests.

Considering temporal changes in institutional ownership also produces interesting implications. One of the most profound changes in U.S. markets over the last 15 years has been the increasing influence of institutional investors. If share supply curves have become more elastic over this period due to increasing institutional ownership, the model predicts a secular shift toward larger repurchases and smaller premiums. When Lakonishok and Vermaelen (1990) separate their sample into a pre-1980 subsample (1962–1979) and a 1980's subsample (1980–1986), the data support these predictions. In the early period, firms

[20] Also, Brown and Ryngaert (1992) find that tendering rates in interfirm tender offers are (negatively) related to their proxy for the capital gains tax lock-in, as one would expect if tax considerations generate heterogeneous reservation values.

repurchased an average of 15.68% of their shares at an average premium of 24.09%. In the later period, firms repurchased more shares (19.07%), but paid a *smaller* premium (18.54%) [21].The model would also predict smaller expiration-day price drops in the later period.

An increase in H can be thought of as increasing the uncertainty about firm value since it increases the dispersion of possible firm values. This suggests several proxies for testing part 3 of the theorem. One possibility is using a stock's idiosyncratic return variance as a proxy for H, because management's private information is presumably about firm-specific factors and greater uncertainty should result in more price volatility. One might also use the dispersion in analysts' earnings forecasts as a proxy for the uncertainty about true value. Another possibility would be to use estimated 'earnings response coefficients', which measure how dramatically the stock price responds to earnings announcements. One expects greater response coefficients the greater the dispersion in possible values. The model predicts a positive association between these measures and the size of the tender premium.

3.3. Heterogeneous shareholders and dilutive equilibria

The model produces dilutive separating equilibria — equilibria in which firms repurchase shares at a price that is above the post-repurchase stock price. This 'overpayment' reduces the value of the remaining shares, but the manager is willing to bear this cost to signal the firm's value. One might think that overpayment is necessary in a separating equilibrium because a signal must be costly to be effective, but this intuition is misleading. In order to be effective, a signal must be costly *to an imitator*, but it need not be costly to the sender of the signal. Dilutive equilibria in this model depend critically on the upward-sloping supply curve produced by heterogeneous shareholders.

Suppose shareholders are homogeneous and the supply curve is perfectly elastic — all shareholders are willing to sell their shares at the price v^{M}. Consider a tender offer to buy α shares at price $p = H$ per share. For α large enough, (α, p) is dominated for a low-value firm — regardless of the market's inference

[21] One might think that these differences are because large firms are more heavily represented in the later period, but the data in Lakonishok and Vermaelen (1990) show a similar pattern across size quintiles. In the 1980–1986 period, four of the five quintiles have a substantially lower premium (even though the fraction of shares purchased in not substantially smaller), or a substantially larger number of shares repurchased (even though the premium is not substantially higher). If one calculates the ratio of average premium to average fraction purchased, using the data from Table X of Lakonishok and Vermaelen (1990), Part 2 of Theorem 2 implies that this measure should be lower in the later period. The results by Quintile are as follows, with the first item in each ordered pair representing 1962–1979, and the second representing 1980–1986: Quintile 1 (small) = (2.68, 1.34), Quintile 2 = (1.28, 1.36), Quintile 3 = (1.15, 0.63), Quintile 4 = (1.41, 0.97), and Quintile 5 (large) = (1.53, 0.83).

function, a type-L manager would be better off making no repurchase. But such offers are not dominated for a high-value firm. Therefore, the dominance criterion requires that investors infer $v^{M}(\alpha, p) = H$. Because a type-H firm is repurchasing shares at true value, the repurchase does not dilute the value of the remaining shares, and the manager's payoff is $u(H)$. So with perfectly elastic supply, type-H managers cannot possibly get a payoff below $u(H)$ in any plausible equilibrium; the dominance criterion destroys all dilutive separating equilibria.

Perfectly elastic supply precludes (plausible) dilutive separating equilibria, but one might think that a *pooling* equilibrium could be dilutive 'on average', i.e., the tender price could be greater than the expected time-1 price. High-value firms would be underpaying, but low-value firms would be overpaying, and the second effect might dominate the first. However, with perfectly elastic supply, any dilutive pooling equilibrium depends on unreasonable beliefs — it does not survive the dominance criterion. We therefore have the following:

Theorem 3. *If the supply of shares is perfectly elastic, then no dilutive equilibrium (separating or pooling) survives the dominance criterion.*

Since a type-H manager must get a payoff of at least $u(H)$ in any plausible equilibrium, the number of shares purchased in a pooling equilibrium must be relatively large so the manager can benefit from buying shares at a bargain price. However, the number of shares purchased cannot be so large that it drives the type-L manager's payoff below $u(L)$ (Lemma 1, Appendix B). The proof of Theorem 3 shows that combining these two requirements dramatically restricts the set of plausible pooling equilibria. Any pooling equilibrium that survives the dominance criterion must have $\alpha = 1 - \pi$ and $p = E[v] = \phi H + (1 - \phi)L$. Since this purchase price is an unbiased estimate of share value, such an equilibrium is not dilutive [22].

So this model points to heterogeneous reservation values as important in understanding why repurchase tender offers are dilutive. Under the classical assumption of perfectly elastic share supply, there are no plausible equilibria in which the tender price is higher than the expected post-repurchase price.

4. Repurchase signaling versus dividend signaling

Thus far, the only strategy available to the manager of a firm has been the choice of tender offer. There are many other actions a firm might take to signal its

[22] Generically, no pooling equilibria survive the dominance criterion when supply is perfectly elastic. In order for the equilibrium described above to exist, the manager's utility function must be linear over the range $(L-k,\ H+k)$, where $k = (H-L)(1-\phi)(1-\pi)/\pi$. If the utility function is strictly concave anywhere in this interval, the dominance criterion destroys all pooling equilibria.

valuation. For example, rather than distributing cash to shareholders by repurchasing shares, a firm might pay a special dividend (or increase its regular dividend). When dividends are taxed more heavily than capital gains, paying a dividend can be costly enough to be a credible signal that the firm is undervalued (Bhattacharya, 1979). In this section, I demonstrate that share repurchases are more effective, i.e. less costly to the signaler, than many other possible signals. I focus on dividends as the alternative signal, but also discuss how the model can be adapted to accommodate other possible actions like 'burning money', corporate philanthropy, and spending on advertising or R&D. In the setting considered in this paper, such signals are dominated by repurchasing shares.

4.1. Extending the model to include dividends

As in previous sections, I assume that the manager's welfare is tied to the wealth of the firm's date-1 shareholders through the utility function u. I also maintain the assumption that any cash payout is financed by borrowing, but this is not crucial.

A strategy for a particular firm type is now a triple (α, p, D), where $D \geq 0$ represents the amount of cash spent on the dividend (or other signal). If paying dividends involves administrative expenses, D represents the total expense incurred by the firm, not just the amount of cash shareholders actually receive. The dividend is announced concurrently with the tender offer, and is payable to all shareholders of record at the time of the announcement [23]. The market's inference function v^{M} now has three arguments, with $v^{\mathrm{M}}(\alpha, p, D)$ representing the market's estimate of firm value when observing the action (α, p, D). The firm must borrow $D + \alpha^{\mathrm{M}} p$ to execute its strategy, so a strategy (α, p, D) is feasible under v^{M} if

$$v^{\mathrm{M}}(\alpha, p, D) \geq D + \alpha^{\mathrm{M}}\left[\alpha, p, D | v^{\mathrm{M}}(\alpha, p, D)\right] p.$$

Analogous to Eq. (2), the face value of the debt issued is

$$F(\alpha, p, D | v^{\mathrm{M}}) = \begin{cases} D + \alpha^{\mathrm{M}} p & \text{if } D + \alpha^{\mathrm{M}} p \leq L \\ D + \alpha^{\mathrm{M}} p + \left(\dfrac{H - v^{\mathrm{M}}}{v^{\mathrm{M}} - L}\right)\left(D + \alpha^{\mathrm{M}} p - L\right) & \text{if } D + \alpha^{\mathrm{M}} p > L, \end{cases} \qquad (7)$$

[23] The assumption that all existing shareholders, including those who subsequently sell out in a repurchase, receive the dividend is made for convenience — it has no important consequences.

where α^{M} means $\alpha^{\mathrm{M}}(\alpha, p, D|v^{\mathrm{M}})$. As in Eq. (3), the post-expiration stock price is

$$p^1(\alpha, p, D|v^{\mathrm{M}}) = \begin{cases} \dfrac{v^{\mathrm{M}} - D - \alpha^{\mathrm{M}} p}{1-\alpha^{\mathrm{M}}} & \text{if firm type is not revealed} \\ \dfrac{\max\left[v - F(\alpha, p, D|v^{\mathrm{M}}), 0\right]}{1-\alpha^{\mathrm{M}}} & \text{if firm type is revealed.} \end{cases} \tag{8}$$

Shareholders who hold on to their shares own shares with time-1 value given in Eq. (8), but they also receive a dividend (if dividends are paid). The benefit shareholders receive (per share) from the action D is denoted $b(D)$, i.e., shareholders would be willing to give up their dividend if doing so would increase share value by $b(D)$ [24]. I assume that $b(0) = 0$ and that $b(D) < D$ when D is positive, so shareholders would rather the firm increase share value by one dollar than spend an additional dollar per share on dividends — dividends produce a deadweight cost $D - b(D)$. This could be due to administrative costs (there is leakage so shareholders receive less than D) or to heavier taxation of dividends than of capital gains. I also assume, for convenience only, that this is always true at the margin: $b'(D) < 1$.

The manager's utility $u(p^1 + b(D))$ depends on the wealth of the shareholders who remain at time 1. The expected utility of the manager of a type-v firm when choosing (α, p, D) is therefore

$$\begin{aligned} &U_{v^{\mathrm{M}}}(\alpha, p, D|v) \\ &\quad = (1-\pi) u\left(\frac{v^{\mathrm{M}}(\alpha, p, D) - D - \alpha^{\mathrm{M}} p}{1-\alpha^{\mathrm{M}}} + b(D) \right) \\ &\qquad + \pi u\left(\frac{\max\left[v - F(\alpha, p, D|v^{\mathrm{M}}(\alpha, p, D)), 0\right]}{1-\alpha^{\mathrm{M}}} + b(D) \right), \end{aligned} \tag{9}$$

where α^{M} means $\alpha^{\mathrm{M}}(\alpha, p, D|v^{\mathrm{M}}(\alpha, p, D))$. The definitions of equilibrium and of dominated strategies given in Section 2 extend naturally. If we consider this model with D constrained to be 0, it is identical to the model of Section 2. One can see this by comparing Eqs. (7)–(9) with the corresponding Eqs. (2)–(4) in Section 2. All the previous results apply in this setting if the strategy space is restricted to actions $(\alpha, p, 0)$.

[24] For a simple case, suppose dividends involve no administrative expenses, are taxed at rate τ, and capital gains are not taxed. Then $b(D)$ is just the after-tax dividend $(1-\tau)D$. For more general tax systems, $b(D)$ would reflect the dividend/capital gain tax differential.

Unlike the case where repurchases were the only available signal, we cannot conclude that the firm will never default simply because $u(0) = -\infty$. Suppose the firm pays a dividend larger than L and it is subsequently revealed that the firm is worth only L, thus making $p^1 = 0$. Even though the stock is now worthless, shareholders received the dividend, and the payoff is $u(0 + b(D)) > u(0)$. In an attempt to convince the market that his or her firm is worth H, a type-L manager *may* be willing to pay a large enough dividend to cause default (later).

Paying a dividend reduces the market value of the shareholders' claim on the terminal cash flow by D, since the investors who are financing the dividend must be sold a claim worth D. If no shares are repurchased, the market value of equity is $v^M - D$ rather than v^M. I therefore assume that shareholder reservation prices, and hence the supply curve, shift downward by D: $p^S(\alpha | v^M, D) = p^S(\alpha | v^M) - D$. That is, I am assuming that paying a dividend doesn't change the *shape* of the supply curve [25].

Without dividends in the model, $u((H - \alpha^* p^*)/(1 - \alpha^*))$ is the highest possible payoff in a separating equilibrium (Lemma 2, Appendix B) — among all repurchases in Ω, (α^*, p^*) is the best. It is not obvious that this remains true with dividends in the model. We know from the previous analysis that $(\alpha^*, p^*, 0)$ is the best strategy that has $D = 0$, but there might be a signal with $D > 0$ that is better. The proof of the next theorem shows otherwise. The *best* a type-H manager can do is set $D = 0$ and signal by repurchasing α^* shares for p^*. The optimal dividend is no dividend, and share repurchases are what they would be in the absence of dividends. The manager is better off signaling by repurchasing shares than by paying a dividend or by choosing some combination of dividend and repurchase, because repurchases deter potential imitators more efficiently than dividends. The theorem generalizes Theorem 1 to the case of two available signals.

Theorem 4. *In any separating equilibrium that survives the dominance criterion, no dividends are paid. A low-value firm repurchases no shares, while a high-value firm repurchases α^* shares for p^* per share.*

To gain some intuition about why repurchases deter imitators more efficiently

[25] The result below that repurchases dominate dividends as signals would go through under weaker assumptions about the supply curve, but could be overturned if increasing the dividend caused the supply curve to flatten so dramatically that the firm had to buy *more* shares to prevent mimicry. Under the assumption made in the text, a larger dividend implies that fewer shares must be repurchased to deter imitators. If this were not the case — if there were some dividend D that flattened the supply curve so much that the firm had to buy more than α^* shares to deter imitators — the conclusion that the firm signals with repurchases alone would not hold. The optimal signal would then include a dividend as well as a repurchase.

than dividends, consider how an incremental change in dividends and in shares purchased affects the true value of each type of firm. For a low-value firm,

$$\frac{\partial}{\partial D}\left(\frac{L-D-\alpha p}{1-\alpha}+b(D)\right)=-\frac{1}{1-\alpha}+b'(D)<0,$$

and

$$\frac{\partial}{\partial \alpha}\left(\frac{L-D-\alpha p}{1-\alpha}+b(D)\right)=-\frac{p-(L-D)}{(1-\alpha)^2}<0.$$

For a high-value firm, the derivative with respect to D is identical, but the derivative with respect to α is not:

$$\frac{\partial}{\partial \alpha}\left(\frac{H-D-\alpha p}{1-\alpha}+b(D)\right)=-\frac{p-(H-D)}{(1-\alpha)^2}>-\frac{p-(L-D)}{(1-\alpha)^2}.$$

An increase in the size of the repurchase is less costly to a high-value firm because the premium $p-(H-D)$ is less than the *true* premium $p-(L-D)$ paid by an imitator. Dividends do not have this characteristic; they are equally costly for the two types of firms. Thus, if D is positive, a small decrease in the dividend and increase in the repurchase that leaves a type-L manager indifferent will make a type-H manager better off. Because of this, the optimal signaling strategy involves no dividends, but only share repurchases.

One might think that the attractiveness of repurchase signaling vis-à-vis dividend signaling would depend on the shape of the supply curve. For example, it is tempting to think that signaling with repurchases would be preferred when the supply curve is very elastic (because shares can be purchased at a relatively small premium), but signaling with repurchases would be worse when the supply curve is very steep. But repurchase signaling is always better, regardless of the form of the supply curve, because repurchases impose *relatively* greater costs on an impostor.

The model presented in this section has focused on dividends as the alternative signal. However, it can also be applied with little or no modification to other potential signals. The model applies as is to 'burning money' or to corporate philanthropy from which the firm gains no benefit. One can simply interpret D as the amount of money burned or given away and set the function $b(D)\equiv 0$, since shareholders get no personal benefit from the disbursement. Signals that affect the terminal cash flow v (wasting money on excessive advertising, excessive research and development, or any other negative-NPV project) could be handled without too much difficulty. If D is the amount spent on the 'project', let $g(D)$ be the resulting increment to the terminal cash flow. Then the true share value would be $(v+g(D)-D-\alpha^{M}p)/(1-\alpha^{M})$ rather than $(v-D-\alpha^{M}p)/(1-\alpha^{M})+b(D)$. If we define $\hat{D}=D-g(D)$ and $\hat{b}(\hat{D})\equiv 0$, the previous analysis applies directly as long as the project affects both firm types in the same way (i.e., the increment $g(D)$ to firm value is the same for low-value and high-value firms). It complicates matters if the NPV of the wasteful spending differs across types. The preference for repurchases is reinforced if the alternative spending is more wasteful for the high-value firm than for the low-value firm. On the other hand, if the spending is more wasteful for the low-value firm, it is possible that signaling by taking on negative-NPV projects would be preferred to signaling by repurchasing shares [26].

4.2. *Fixed costs of repurchase tender offers*

The last subsection showed that share repurchases dominate dividends as a signaling device in this model. A slight generalization of the structure of the model yields the result that dividends are preferred in some circumstances and repurchases in others. The resulting price changes predicted by the model are consistent with the empirical evidence that share repurchase announcements elicit much larger price responses than unexpected dividend increases. I discuss this briefly in this subsection — the details can be found in Persons (1991).

The administrative expenses associated with paying a dividend are very close to zero. Repurchase tender offers, on the other hand, involve substantial expenses — the costs of preparing SEC filings, advertising the offer, preparing and mailing letters of transmittal to shareholders, hiring a dealer manager, information agent, and depositary, etc. So suppose there are significant fixed costs of making a tender offer, while the deadweight cost $D - b(D)$ of paying a dividend is very small for small dividends, i.e. $\lim_{D \to 0} D - b(D) \approx 0$ [27]. Then, depending on the parameter

[26] In a similar vein, one generalization of the model would be to add some additional costs of external financing, which one might think of as costs arising from liquidity constraints. Suppose we add such liquidity costs — say λ — as a negative cash flow at date 1, and assume that these costs increase in the amount of external financing, $D + \alpha^{M} p$. If these costs are identical for the two firm types, nothing really changes — the 'signal' is $D + \alpha^{M} p + \lambda$ rather than $D + \alpha^{M} p$. However, it is more reasonable that these liquidity costs would be more severe for the type-L firm than for the type-H firm. In this case, it is no longer true that dividends affect firm value identically for the two firm types, so it is *possible* that dividend signaling would be preferred to repurchase signaling. However, this is very unlikely. If the cash spent on the repurchase, $\alpha^{*} p^{*}$, is greater than the dividend signal, D^{*}, then the preference for repurchases is reinforced rather than overturned. On the other hand, if $D^{*} > \alpha^{*} p^{*}$, dividends have the potential to be useful signals. (Whether D^{*} is larger than $\alpha^{*} p^{*}$ depends on the valuation difference $H - L$, the tax code and the slope of the supply curve.) But even in this case, for dividends to be preferred, these differential liquidity costs would have to be large enough to outweigh the combined effects of: (1) the differential liquidity costs arising from a repurchase; (2) the price premium $H - L$ that an impostor must pay to imitate a repurchase signal; and (3) the amplification that results when a repurchase reduces the number of outstanding shares, which magnifies the first two effects. A straightforward extension of the model that analyzes this explicitly is available from the author.

[27] If the deadweight costs of paying dividends arise (solely) from differences in the tax treatment of dividends and capital gains, we will have $\lim_{D \to 0} D - b(D) = 0$.

values, either a dividend or a repurchase will be the preferred signal (and the only signal chosen in a dominance-surviving separating equilibrium). Specifically, when the high-value firm is only slightly underpriced, dividend signaling will be preferred, and when it is severely underpriced, repurchase signaling will be preferred. Repurchases are still better discriminators *at the margin* — once the fixed costs have been incurred, it always pays to decrease the dividend and increase the repurchase — but the mispricing must be large to justify incurring the large fixed costs of executing a tender offer. If the firm is only slightly underpriced, there isn't much information to be signaled, and the manager is better off paying a dividend and avoiding the cost of a tender offer. Since dividend signaling occurs when the firm is slightly underpriced, the price response to the signal is relatively small. Repurchases are observed as signals when the underpricing is more severe, so the price response to the signal is larger. As discussed in the introduction, the empirical evidence indicates that repurchase tender offers elicit much larger average price reactions than do unexpected dividend increases.

The payoff to a manager who signals with a dividend increase is obviously independent of the elasticity of the supply curve — since no shares are repurchased — and it is easy to show that the payoff to a manager who signals with a repurchase is greater when the supply curve is flatter. This means that a firm with more elastic share supply will choose a repurchase more often, i.e., for a larger set of parameters. In the cross section, this suggests that firms with more institutional ownership are more likely to repurchase shares, ceteris paribus.

If the secular increase in institutional ownership has increased share elasticity over time (as argued in Section 3.2), the model predicts three results of this change. First, it predicts a movement toward less dividend signaling and more repurchase signaling, as more firms find themselves on the repurchase side of the crossover point. Bagwell and Shoven (1989) have documented a dramatic trend toward repurchases during the 1980's, and the model points to changes in share elasticity as a contributing factor. The second result of more elastic share supply is that, for a given degree of underpricing $(H-L)$, a firm will repurchase more shares at a smaller premium. The third prediction is that the average market response to repurchase tender offers will be smaller when supply curves are more elastic, because some cases of relatively small underpricing — that would have been signaled with a dividend when supply curves were steeper — will now be signaled with a repurchase. The second and third predictions are supported by the evidence in Lakonishok and Vermaelen (1990), who find smaller market reactions in the 1980's than in the pre-1980 period (an average return to all shareholders of 11.52% versus 16.19%), even though the average repurchase is larger in the 1980's [28].

[28] One could also test these last two implications in the cross section: firms with more elastic share supply should execute larger repurchases that generate smaller price reactions, on average.

One might be uncomfortable with the conclusion that firms choose specialized strategies — a firm chooses a tender offer or a dividend, but not both. After all, many firms that make tender offer repurchases also pay dividends. I don't think this is a telling criticism, but it points out a limitation of the model. I would like to interpret the model as follows. A firm may commit to a particular dividend policy for various reasons — to control agency problems between managers and shareholders, to distribute cash flow in excess of investment needs, to attract a particular clientele, etc. Take this policy as exogenous to the model and then consider a manager who learns that his or her firm is undervalued. Should the manager attempt to communicate this information to the market by increasing the dividend (or paying a special dividend) or by repurchasing shares? If you grant me license to interpret the model this way, then the result is that a firm signals undervaluation to the market by repurchasing shares or by unexpectedly increasing its dividend, but not by both. For moderately good news, the firm increases the dividend; for very good news, the firm repurchases shares. A firm signaling via repurchase may also pay its 'normal' dividend.

5. Conclusion

I have developed a model of tender offer repurchases that explicitly incorporates heterogeneous shareholder reservation values. The model reproduces some documented empirical relationships which are not possible (in the context of this model) when shareholders have identical reservation values. The model yields a strong characterization of plausible separating equilibria, pinning down the tender price and the number of shares repurchased. Analyzing the comparative statics of this equilibrium yields testable propositions about repurchase tender offers.

Signals other than repurchases, such as dividends, are also considered. It is shown that repurchases are more effective signals at the margin, so, absent fixed costs of tender offers, other signals would not be used. Given the significant fixed costs of making a repurchase tender offer, repurchases are used to signal large information asymmetries, while dividends are used to signal small information asymmetries. As a result, repurchase tender offers cause larger stock price increases than do dividends, consistent with existing evidence.

Acknowledgements

I would like to thank the members of my dissertation committee — G. Constantinides, D. Diamond, R. Gertner, M. Harris, S. Kaplan and R. Vishny — for their help. I am also grateful for comments from D. Brown, C. Leach, K. Lehn (the editor), C. Smith, V. Warther, an anonymous referee and seminar participants

at Chicago, Harvard, MIT, Northwestern, Ohio State, Rochester, Stanford, Texas, Wisconsin and Yale.

Appendix A

A.1. The supply curve for shares

This appendix derives the characteristics of the supply curve facing the firm. I assume that any given shareholder has a reservation value r that is an increasing function of his or her expected (per-share) terminal cash flow. In equilibrium, p^1 is this expected cash flow, so a shareholder's reservation value is $r(p^1)$ [29]. $r(p^1) \geq p^1$, because a shareholder could get p^1 per share by selling in the open market. When faced with a tender offer, a shareholder is willing to tender if, and only if, $p \geq r(p^1) = r((v^M - \alpha^M p)/(1 - \alpha^M))$. When the tender price p is less than v^M, no shares are tendered $(\alpha^T(\alpha, p|v^M) = 0)$ because, in this case,

$$r\left(\frac{v^M - \alpha^M p}{1 - \alpha^M}\right) \geq r(v^M) \geq v^M > p,$$

so every shareholder is better off holding his or her shares. When $p = v^M$, the shareholder tenders if $p \geq r(v^M)$ since the post-repurchase price will be v^M. When the tender price is greater than v^M, the tender decision generally requires some conjecture about how other shareholders are going to respond to the tender offer. If others are not going to tender their shares, the decision turns on whether $p \geq r(v^M)$. However, if other shareholders tender, the post-tender price will be less than v^M, and the shareholders may wish to tender even though $p < r(v^M)$. So I assume that we have a Nash equilibrium in this auxiliary game and all agents realize how many shares will be tendered in response to any tender offer (α, p) when the market infers firm value to be v^M. I call this function $\alpha^T(\alpha, p|v^M)$, where the T is meant to suggest 'tendered'.

I make the following assumptions about the function α^T, the first three based on an appeal to plausibility and the last for convenience.

1. When $0 < \alpha^T(\alpha, p|v^M) < 1$, α^T is nondecreasing in both α and p, and is decreasing in v^M.
2. α^T is continuous.
3. For any v^M and any $\hat{\alpha} < 1$, there exists some (α, p) such that $\alpha^T(\alpha, p|v^M) \geq \hat{\alpha}$.
4. $\alpha^T(\alpha, p|v^M) > 0$ if and only if $p > v^M$.

[29] More precisely, the expected cash flow is the *expected* value of p^1 at the time the tender offer is made, which is $(v^M - \alpha^M p)/(1 - \alpha^M)$. In a separating equilibrium, this is the same as p^1. In a pooling equilibrium, this is the same as p^1 if true firm type is not revealed at time 1; if revelation occurs, p^1 will be different.

The monotonicity assumption seems reasonable enough. A higher fraction sought or a higher tender price attracts at least as many shares, and fewer shares are tendered to a given offer if shareholders think the shares are more valuable. The continuity assumption also seems reasonable — a small change in the tender offer causes a small change in shareholder response. The third assumption says that the firm can attract any given fraction of shares if the tender price and fraction sought are high enough. The last assumption says that some shares are tendered whenever a premium is offered, and no shares are tendered if no premium is offered.

Fix any tender price p and assume that the market believes the firm is worth v^{M}. Consider the 'maximum' number of shares which shareholders are willing to tender at the price p in response to an allowable ($\alpha < 1$) tender offer. This 'maximum', defined as $\overline{\alpha}(p|v^{\mathrm{M}})$, is

$$\overline{\alpha}(p|v^{\mathrm{M}}) = \sup_{\alpha \in [0,1)} \alpha^{\mathrm{T}}(\alpha, p|v^{\mathrm{M}}) = \lim_{\alpha \to 1} \alpha^{\mathrm{T}}(\alpha, p|v^{\mathrm{M}}),$$

where the second equality is because α^{T} is monotonic in α. $\overline{\alpha}$ inherits continuity and monotonicity from α^{T}. I assume there is some $\alpha < 1$ for which the limit above is achieved, so $\max_{\alpha \in [0,1)} \alpha^{\mathrm{T}}(\alpha, p|v^{\mathrm{M}})$ exists and is equal to this limit. I make the additional assumption (slightly stronger than assumption 1 above) that $\overline{\alpha}(\cdot|v^{\mathrm{M}})$ is increasing whenever it is strictly between 0 and 1. Since shareholders demand a premium above v^{M}, we obviously have $\overline{\alpha}(p|v^{\mathrm{M}}) = 0$ when $p \leq v^{\mathrm{M}}$. For $p > v^{\mathrm{M}}$, $\overline{\alpha}(\cdot|v^{\mathrm{M}})$ is continuous and is strictly increasing until it hits the upper bound 1. As long as $p > v^{\mathrm{M}}$ and we haven't hit the upper bound $\overline{\alpha} = 1$, any higher tender price is capable of attracting more shares. Note that when $\overline{\alpha}(p|v^{\mathrm{M}}) < 1$, it is actually possible for the firm to purchase $\overline{\alpha}$ shares for p per share. (From the assumption that $\max_{\alpha \in (0,1)} \alpha^{\mathrm{T}}(\alpha, p|v^{\mathrm{M}})$ exists, there is some $\hat{\alpha}$ such that $\alpha^{\mathrm{T}}(\hat{\alpha}, p|v^{\mathrm{M}}) = \overline{\alpha}(p|v^{\mathrm{M}})$. Now an offer to purchase $\max\{\hat{\alpha}, \overline{\alpha}(p|v^{\mathrm{M}})\}$ shares at the price p will result in the purchase of $\overline{\alpha}(p|v^{\mathrm{M}})$ shares.)

Now, given any $\alpha \in (0, 1)$, consider the complementary question of the minimum tender price at which the firm can attract (at least) α shares, $p^{\mathrm{S}}(\alpha|v^{\mathrm{M}})$. $p^{\mathrm{S}}(\alpha|v^{\mathrm{M}})$ is just the inverse of $\overline{\alpha}(p|v^{\mathrm{M}})$ — if α is the maximum number of shares the firm can attract at the tender price p, then p is the minimum price capable of attracting α shares (based on the strict monotonicity of $\overline{\alpha}$), i.e. $p^{\mathrm{S}}(\overline{\alpha}(p|v^{\mathrm{M}})|v^{\mathrm{M}}) = p$. Since $\overline{\alpha}$ is increasing when it is between 0 and 1, p^{S} is increasing. We thus have the supply curve $p^{\mathrm{S}}(\alpha|v^{\mathrm{M}})$ continuous and increasing in α and v^{M}. We also have $\lim_{\alpha \downarrow 0} p^{\mathrm{S}}(\alpha|v^{\mathrm{M}}) = v^{\mathrm{M}}$, because of assumption 4 above.

Appendix B

B.1. Proofs

This appendix is available from the author upon request.

References

Bagnoli, M., R. Gordon and B.L. Lipman, 1989, Stock Repurchase as a Takeover Defense, Review of Financial Studies 2, 423–443.

Bagwell, L.S., 1991a, Share Repurchase and Takeover Deterrence, Rand Journal of Economics 22, 72–88.

Bagwell, L.S., 1991b, Shareholder Heterogeneity: Evidence and Implications, American Economic Review 81, 218–221.

Bagwell, L.S., 1991c, Characteristics of Shareholder Heterogeneity in Dutch Auction Stock Repurchases, working paper, Northwestern University.

Bagwell, L.S., 1992, Dutch Auction Repurchases: An Analysis of Shareholder Heterogeneity, Journal of Finance 47, 71–105.

Bagwell, L.S. and J.B. Shoven, 1989, Cash Distributions to Shareholders, Journal of Economic Perspectives 3, 129–140.

Barclay, M.J. and C.W. Smith, Jr., 1988, Corporate Payout Policy: Cash Dividends versus Open Market Repurchases, Journal of Financial Economics 22, 61–82.

Bhattacharya, S., 1979, Imperfect Information, Dividend Policy, and 'The Bird in the Hand Fallacy', Bell Journal of Economics 10, 259–270.

Bradley, M., A. Desai and E.H. Kim, 1988, Synergistic Gains from Corporate Acquisitions and Their Division Between the Stockholders of Target and Acquiring Firms, Journal of Financial Economics 21, 3–40.

Brown, D.T., 1988, The Construction of Tender Offers: Capital Gains Taxes and the Free Rider Problem, Journal of Business 61, 183–196.

Brown, D.T. and M.D. Ryngaert, 1992, Heterogeneous Shareholders: Evidence from Buybacks and Control Contests, Journal of Business 65, 529–556.

Cho, I.-K. and D.M. Kreps, 1986, Signaling Games and Stable Equilibria, Quarterly Journal of Economics 102, 179–221.

Comment, R. and G.A. Jarrell, 1991, The Relative Signalling Power of Dutch-Auction and Fixed-Price Self-Tender Offers and Open-Market Share Repurchases, Journal of Finance 46, 1243–1271.

Constantinides, G.M., 1983, Capital Market Equilibrium with Personal Tax, Econometrica 51, 611–636.

Constantinides, G.M. and B.D. Grundy, 1989, Optimal Investment with Stock Repurchase and Financing as Signals, Review of Financial Studies 2, 445–564.

Constantinides, G.M. and M.S. Scholes, 1980, Optimal Liquidation of Assets in the Presence of Personal Taxes: Implications for Asset Pricing, Journal of Finance 35, 439–449.

Dann, L.Y., 1981, Common Stock Repurchases: An Analysis of Returns to Bondholders and Stockholders, Journal of Financial Economics 9, 113–138.

Dann, L.Y., R.W. Masulis and David Mayers, 1991, Repurchase Tender Offers and Earnings Information, Journal of Accounting and Economics 14, 217–251.

Gay, G.D., J.R. Kale and T.H. Noe, 1990, Dutch Auction Share Repurchases, working paper, Georgia State University.

Hausch, D.B. and J.K. Seward, 1993, Signaling with Dividends and Share Repurchases: A Choice Between Deterministic and Stochastic Cash Disbursements, Review of Financial Studies 6, 121–154.

Kadapakkam, P.-R. and S. Seth, 1994, Capital Gains Taxes and Stockholders' Response to Tender Offers: Evidence from Dutch Auction Share Repurchases, working paper, University of Houston.

Kamma, S., G.Kanatas and S. Raymar, 1992, Dutch Auction versus Fixed-Price Self-Tender Offers for Common Stock, Journal of Financial Intermediation 2, 277–307.

Lakonishok, J. and T. Vermaelen, 1990, Anomalous Price Behavior Around Repurchase Tender Offers, Journal of Finance 45, 455–475.

Masulis, R.W., 1980, Stock Repurchase by Tender Offer: An Analysis of the Causes of Common Stock Price Changes, Journal of Finance 35, 305–319.

Milgrom, P. and J. Roberts, 1986, Price and Advertising Signals of Product Quality, Journal of Political Economy 94, 796–821.

Miller, M.H. and K. Rock, 1985, Dividend Policy under Asymmetric Information, Journal of Finance 40, 1031–1051.

Ofer, A.R. and A.V. Thakor, 1987, A Theory of Stock Price Responses to Alternative Corporate Cash Disbursement Methods: Stock Repurchases and Dividends, Journal of Finance 42, 365–394.

Persons, J.C., 1991, Share Repurchases, Dividends, and Asymmetric Information, Ph.D. dissertation, University of Chicago.

Persons, J.C., 1994, Signaling and Takeover Deterrence with Stock Repurchases: Dutch Auctions versus Fixed Price Tender Offers, Journal of Finance 49, 1373–1402.

Stulz, R.M., 1988, Managerial Control of Voting Rights: Financing Policies and the Market for Corporate Control, of Financial Economics 20, 25–54.

Vermaelen, T., 1981, Common Stock Repurchases and Market Signalling: An Empirical Study, Journal of Financial Economics 9, 139–183.

Vermaelen, T., 1984, Repurchase Tender Offers, Signalling, and Managerial Incentives, Journal of Financial and Quantitative Analysis 19, 163–181.

Welch, I., 1989, Seasoned Offerings, Imitation Costs and the Underpricing of Initial Public Offerings, Journal of Finance 44, 421–449.