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ABSTRACT

This paper develops a model in which managers can signal their firms' true values by using either a dividend or a stock repurchase or both. The authors explain a number of stylized facts about these cash-disbursement mechanisms, particularly those concerning the relative magnitudes of stock price responses to dividends and repurchases. Most importantly, they explain why a stock repurchase elicits a significantly higher price response, on average, than a dividend announcement.

DIVIDENDS AND SHARE REPURCHASES are the principal mechanisms by which corporations disburse cash to their shareholders. The sheer volume of these corporate activities invites research attention; the majority of U.S. firms pay dividends, and, in 1984 alone, 600 firms spent $26 billion in repurchasing their own stock. Several studies have analyzed the responses of share prices and bond prices to the announcements of specific modes of cash distribution by firms, and the following stylized facts have been noted.

- Both dividends and stock repurchases have significant "announcement effects." When a firm announces a stock repurchase or a dividend increase, its stock price increases (Aharony and Swary [1], Asquith and Mullins [3], Dann [10], Handjinicolaou and Kalay [13], Stewart [28], and Vermaelen [29]). (Jensen and Smith [15] provide a summary. See also Loomis [18].[1]

* Ofer is from the Kellogg Graduate School of Management (KGSM), Northwestern University, and the Faculty of Management, Tel Aviv University, and Thakor is from the School of Business, Indiana University. We gratefully acknowledge the helpful comments of participants in the finance and microeconomics workshops at Indiana University, the North Carolina-Duke Finance Workshop, a finance seminar at State University of New York-Buffalo, a finance seminar at The University of Florida, the finance/accounting workshop at the Indian Institute of Management, The Western Finance Association meeting at Colorado Springs, and a finance seminar at New York University, as well as the helpful comments of an anonymous referee of this Journal, Kose John, David Nachman, George Kanatas, Lawrence Glosten, Avner Kalay, Marti Subrahmanyam, Joe Williams, and particularly Yuk-Shee Chan and Rob Heinkel. The usual disclaimer applies. This work was initiated while Thakor was visiting the KGSM at Northwestern University.

[1] The Loomis paper is a recent report on research by the *Fortune* staff. It states that the average gross annual returns to shareholders in firms repurchasing stock between 1974 and 1983—excluding "nonvoluntary" repurchases via "greenmail"—was 22.6% as compared with 14.1% for the S&P 500 over the same period. This suggests an apparent methodological weakness in the *Fortune* study. Comparing risk-unadjusted returns on the stocks of repurchasing firms with the returns on an index portfolio *may* not be meaningful if there are marked differences in systematic risk between the two portfolios. We cite this study, however, to indicate the interest in this issue even in the "nonacademic" literature and among managers.

More direct evidence—using a more discriminating empirical methodology—that changes in dividend policy convey information has recently been provided by Ofer and Siegel [23].)

- On average, a stock repurchase provokes a significantly higher stock price response than a dividend increase (Aharony and Swary [1], Dann [10], Jensen and Smith [15], Masulis [20], and Vermaelen [29]).[2]
- Firms that repurchase stock offer premia above the prerepurchase market prices for their own stock (Vermaelen [29, 30]).
- In many cases, despite an increase in the price per share subsequent to the announcement of the repurchase, the stock price drops in the "aftermarket," i.e., after the execution of the repurchase (Vermaelen [29]).
- Despite the postrepurchase price decline, the price increase subsequent to the repurchase announcement is relatively permanent in the sense that the price in the "aftermarket" remains higher than the price prior to the repurchase announcement (Vermaelen [29]).
- During August 1971 through June 1974—the period of "voluntary" dividend controls—the number of firms engaged in stock repurchases was significantly higher than the number repurchasing stock in comparable periods both prior to and following the period of dividend controls.

Our principal objective is to explain these stylized facts. The model we develop allows the informational roles of *both* stock repurchases and dividends to be analyzed in an *integrated* framework. An integrated approach is motivated by the fact that stock repurchases and dividends can substitute for each other. Furthermore, only an integrated approach seems capable of explaining the *relative* magnitudes of stock price responses to dividend increases and stock repurchases and the apparently substantive influence on repurchase activity stemming from the introduction of exogenous restrictions on dividend policies.

By permitting the (mispriced) firm to signal with dividends as well as stock repurchases, we aim to obtain conditions under which the firm will prefer one cash-disbursement mechanism over the other as a signal. From an analytical standpoint, therefore, our model differs significantly from the numerous "one-signal" models of financial signalling in the literature. These are discussed later.

We adopt a dissipative signalling framework in which managers transmit privately held information through both corporate cash-distribution methods. Firms have risk-neutral shareholders and risk-averse managers. Each manager holds a certain fraction of his or her firm and also has a current wage contingent on the per-share stock price of the firm.[3] There are three points in time. At the first point, the manager makes public an irrevocable stock repurchase/dividend

[2] There is no integrated empirical study available that compares the announcement effects of dividends and repurchases. Our observation is based on a comparison of the cumulative average abnormal returns measured in dividend studies with those in repurchase studies. It has been suggested to us that this comparison may not be entirely proper since companies usually spend a larger fraction of their outstanding equity on repurchasing stock than on paying a dividend. Note, however, that *how much* a firm spends on a repurchase and on a dividend is *endogenous* in our model. That is, we not only explain the relative price responses to dividends and repurchases, but we also explain *why* the firm spends what it does on each signal. See the discussion in Section IV.

[3] This specification seems especially suited for small firms that reportedly predominate stock repurchases.

decision. The execution of these payments takes place at the second point in time and is financed either by internally generated funds or by external funds that are costly *relative* to internal funds. The repurchase/dividend decision reveals the manager's privately held information about the mean of the random payoff accruing to the firm at the end of its planning horizon, which is the third point in time. This information is then impounded instantaneously into the firm's stock price, which in turn affects the manager's current wage. The manager cannot trade his or her holding of the firm's shares, a restriction of managerial latitude *during* a repurchase that is supported by the empirical evidence. At the second point in time, a random variable is realized that determines the firm's first cash flow. The firm fully utilizes this cash flow in repurchasing stock, paying a dividend, or both; the remainder is retained and carried over until the third point in time.

In our model, both dividends and stock repurchases entail deadweight losses for the firm's manager who sets the levels of these signals. Dividends are costly because they may necessitate external financing—costing more than internal funds—that the firm must carry until the end of its planning horizon. A repurchase is costly, in part, for the same reason. Additionally, however, the manager's (undiversified) holding of his or her own firm's stock increases due to the repurchase. This heightened risk exposure for the risk-averse manager represents another cost. Thus, we have differing signalling cost structures for the two cash-disbursement mechanisms, and this permits a characterization of different regions over which each signal is useful. When the disparity between the true intrinsic worth of an undervalued firm and its market price is relatively low, the firm employs dividend-based signalling because the incentive-compatible dividend is relatively small, implying that the associated signalling cost is lower than that attached to a stock repurchase. However, when the true value of the firm is very high compared with the cross-sectional average, a relatively large dividend is needed for informationally consistent signalling. The attendant cost is "excessive," and the manager now finds repurchase a less costly alternative. The intuition is that the total cash outlay required for repurchasing—an inherently more costly signal on a "dollar-for-dollar" basis[4]—is materially smaller, making this a more attractive choice now despite the higher risk entailment. Consequently, only a firm that perceives a relatively large undervaluation will attempt a stock repurchase. Smaller undervaluations will be rectified through dividend increases. Moreover, in Section III, we also discuss how our analysis sheds light on why stock-repurchasing firms tend to have relatively large insider holdings.

From a practical standpoint, even though stock repurchases are not very frequent, they appear to offer the firm greater timing flexibility than dividends since the latter are usually paid quarterly at fixed points in time. This distinction does not affect our analysis, however, since what is important is the timing of an

[4] This is a purely *marginal* statement. Every dollar spent on repurchase carries a higher signalling cost for the manager than an equivalent amount expended on a dividend. Of course, neither signal dominates the other for *all* feasible values of the privately known parameter when one considers the *aggregate* signalling cost for the manager. The reason is that the manager needs to spend less on repurchase than on a dividend to convey the same information.

announcement of a stock repurchase or dividend increase rather than the timing of the disbursement. Note also that we focus on *tender-offer* repurchases and exclude open-market repurchases (which are often announced after completion). According to our theory, open-market repurchases should have lesser information content,[5] which is in keeping with the empirical observation that the average change in share prices is fifteen percent when repurchases are done via tender offers and only four percent when they are done through the open market (Jensen and Smith [15]).

What follows is in four sections. Section I describes the model and presents the symmetric-information equilibrium. Section II takes up the asymmetric-information case. The equilibrium concept is defined, the main results are stated, and their relationship to the stylized facts mentioned earlier is discussed. Section III discusses the robustness of our results to model variations and reviews related literature. Section IV concludes. The Appendix has all proofs.

I. The Model and the First-Best Equilibrium

The economy has risk-neutral investors who own firms. Each firm is managed by a (representative) risk-averse manager with mean-variance preferences. Each manager's initial endowment is an ownership $\alpha \in (0, 1)$ of his or her firm. Insider stock holdings in repurchasing firms have been empirically documented to be nontrivial. The mean insider holding fraction in Vermaelen's [29] sample was 17.5 percent. Firms are initially all-equity financed with N_o shares outstanding, and each manager operates his or her firm to maximize his or her expected utility.[6]

Three points in time delineate the main events. At the initial point in time, $t = 0$, each firm starts out with no liquid assets, and its manager makes an irrevocable dividend/stock repurchase decision, which is executed at the second point in time. At $t = 0$, the firm also possesses a project that will generate two random payoffs in the future. At time $t = 1$, the next instant in time following $t = 0$, a positive cash flow C—the magnitude of C is known deterministically—is realized with probability $1 - \xi$, and a cash flow of zero is realized with probability ξ. The probability, $\xi \in (0, 1)$, varies across firms. At the third point in time, $t = 2$, another cash flow, $\tilde{\Pi}$, will be realized. The magnitude of $\tilde{\Pi}$ is random, and it has a probability distribution that varies across firms.

At $t = 1$, the firm pays the managerial wage, and pays the announced dividends, repurchases some of its stock, or both. If at $t = 1$ the firm obtains a cash flow $C > 0$, it will use it to finance as much of the above outflows as possible. If the outflows exceed C, the firm makes up the shortfall with external financing. To avoid signalling effects of capital structure, all external funds are assumed to be

[5] The reason is that the conditions needed to support the information role of a repurchase—principally, a precommitment by the manager not to tender his or her own shares—will generally not hold for open-market repurchases. Our formal analysis shows clearly the role of managerial willingness not to trade.

[6] This stipulation reflects the by now popular view that managers can be expected to be only imperfectly monitored by shareholders. Although Fama [11] has conjectured the triviality of such incentive problems in the face of competitive labor-market forces, Holmström [14] has shown that, even in a multiperiod setting, extremely stringent assumptions are needed to sustain Fama's conjecture.

borrowed. As in Bhattacharya [6], frictionless access to external financing is unavailable, so that such borrowing occurs at a (single-period) rate R that exceeds the single-period riskless rate r.[7] We assume that $t = 0$ and $t = 1$ are sufficiently close to each other *relative* to the difference between $t = 1$ and $t = 2$ so that no discounting of payoffs at $t = 1$ is necessary to compute their present value at $t = 0$; the single-period discount rate r computes the time-0 value of time-2 payoffs.

The expected value of $\tilde{\Pi}$ is denoted by Π and its variance by σ^2. We assume that all firms fall in one of two categories—type 1 or type 2. The expected value of $\tilde{\Pi}$ for type-1 firms is Π_1, and, for type-2 firms, it is Π_2, with $\Pi_1 > \Pi_2 > 0$. The variance σ^2 is the same for all firms. Moreover, in order to unambiguously rank the two firm types, we assume that ξ_1, the probability that a zero cash flow will occur at $t = 1$ for a type-1 firm, is less than ξ_2, the corresponding probability for a type-2 firm. Thus, a type-1 firm is "better" than a type-2 firm in terms of the probability distribution of its cash flow both at $t = 1$ and at $t = 2$. In all other respects, firms are identical; i.e., the managers of both types of firms have the same preferences and so on.

As in Ross [25], we take as exogenously given the managerial-incentive contract. The contract is intended to align managerial incentives with those of existing shareholders and stipulates that the manager be paid (at $t = 1$) a wage equal to the market value of b shares of stock at $t = 0$.[8] W_i is the wage of the manager of the type-i firm, $i = 1, 2$. The incentive-contract approach is taken because the two most extensive surveys on stock repurchase motives (Austin [4] and Marks [19]) mention executive stock compensation plans as the prime reason for repurchase activity. Although the manager has unencumbered disposal options for his or her wage, he or she is not allowed to trade his or her endowed ownership, α, of the firm. This assumption is driven by strong empirical evidence. Despite the absence of legal restrictions on insider tendering, insiders commit themselves not to tender their shares and they often announce this commitment in the offering circular[9] (Vermaelen [29]).

[7] There are many justifications for the assumption that the cost of removing a cash flow deficit exceeds the benefit of a cash flow surplus of the same size. One justification is that external financing, even for large firms, involves transactions costs. Capital market-based external financing instruments, such as commercial paper, entail flotation costs. Small firms, which constitute the overwhelming majority of the firms engaged in repurchasing stock, do not have access to the commercial paper market. For such firms, the disparity between the costs of external funds and internally generated cash reserves is likely to be even greater.

For example, one option for such firms would be bank borrowing, which will be costlier for the firm than retained earnings due to the reserve-requirements tax levied on banks and passed on to bank borrowers. Another justification—given by Bhattacharya [6]—is that, if the firm attempts to adjust by maintaining buffer stocks of liquid assets earning less than the discount rate or arranges "distress" financing at additional cost, then, once again, external financing will impose a cost beyond that encountered with internal funds.

[8] We assume that b is the same for all firms because we later wish to examine a situation in which *all* investors, including the firm's existing shareholders, are unaware of the firm's type. In that case, shareholders of firms with relatively high true intrinsic values cannot gain from owning higher valued firms by offering their managers wage packages that contain few shares of (more valuable) stock. Moreover, cross-sectional constancy of b also rules out any *ex ante* observability of firm types through the managerial wage contract.

[9] One could (correctly) argue that it is dangerous to justify the assumption that managers cannot trade during a repurchase with the empirical evidence that they do not trade. That is, a model in

The expected utility of the manager is given by

$$\mathrm{E}(U) = E_x - K\sigma_x^2,$$

where E_x is the expected value of the manager's payoff from wages and personal shareholdings, σ_x^2 is the variance of this payoff, and the positive constant K is a risk-aversion parameter. The manager has no security holdings other than his or her investment in the firm. Further, the manager's wage is based on the price per share that prevails immediately after the announcement of the dividend and/or stock repurchase but *prior* to the actual payment of the dividend and/or the actual repurchase of stock. This assumption helps to simplify the analysis when asymmetric information is introduced. The reason is that, in an informationally consistent signalling equilibrium, the price per share that exists immediately after the signal is issued (before the dividend payment or stock repurchase) is the *first-best* price since signalling costs have not been incurred yet. This considerably reduces the number of alternative managerial wages to be considered.

We assume that all taxes are zero. We have done our analysis with taxes and found that the principal results remain basically unchanged. Because taxes make dividends more costly relative to a repurchase, by introducing taxes one reduces the critical cutoff "value difference"—measured as the true firm value minus the presignalling market value—below which a firm signals only with dividends and above which some repurchase is optimal.[10] There are no other substantive changes.

At $t = 0$, the manager determines the dividend payment d and the fraction, $\beta \in [0, 1)$, of the stock to repurchase. Both decisions are executed at $t = 1$. Related to these decisions are the following three valuation equations. If there is no dividend or stock repurchase, then the value of the firm, as established by risk-neutral investors (throughout $i = 1, 2$), is

$$V_i^o = \{\Pi_i + [1 - \xi_i][1 + r][C - W_i] - \xi_i W_i[1 + r]\}\{1 + r\}^{-1}, \tag{1}$$

where $W_i = bV_i/N_o$. If a fraction $\beta \in (0, 1)$ of the firm's outstanding shares are repurchased, the firm's postrepurchase value is

$$\hat{V}_i^o = \{\Pi_i + [1 - \xi_i][1 + r][C - \beta V_i^o - W_i] - \xi_i[1 + R][\beta V_i^o + W_i]\}\{1 + r\}^{-1}. \tag{2}$$

If the firm pays a dividend of d, then its ex-dividend value is

$$V_i' = \{\Pi_i + [1 - \xi_i][1 + r][C - W_i - d] - \xi_i[1 + R][W_i + d]\}\{1 + r\}^{-1}. \tag{3}$$

A first-best equilibrium obtains when each firm's Π (and the associated ξ) is common knowledge. We now establish that, in this case, it is not optimal for the manager to pay any dividend or repurchase stock.

which one can trade, but in equilibrium does not, is possibly different from a model in which trading is proscribed by assumption. In the Appendix, we indicate how our analysis would change if the no-trading restriction were lifted. It turns out that the main results can be sustained, but at the cost of some additional parametric restrictions.

[10] In what follows, this means that only Proposition 3 is materially affected.

Proposition 1: *The first-best equilibrium entails no dividend payment and no stock repurchase.*

The intuition is clear. Dividends and stock repurchases force the firm to seek external financing that is costly in the state in which the $t = 1$ cash flow is zero. This reduces firm value and makes the manager worse off. In addition, a repurchase also results in the manager owning a larger fraction of the firm. This increases his or her (undiversified) risk exposure and further reduces expected utility.

It should be emphasized that, from a *corporate* standpoint, there is *no* difference in the risk connotations of repurchases and dividend payments, conditional on both disbursements being of equal magnitude. Moreover, this observation holds regardless of *how* the disbursement is financed, i.e., from cash, external funds (borrowing), or a foregone investment in the firm's capital budget. The key here is the effect of the corporate cash-disbursement mode on the manager's *personal* welfare. When cash is distributed to the shareholders through a dividend payment, it accrues to *all* shareholders, including the manager. Because the manager has received the dividend, it is part of his or her investment portfolio and can be reinvested to suit his or her risk preferences. However, cash distribution through a stock repurchase accrues only to the *tendering* shareholders. Since the manager precommits not to tender his or her stock, he or she does not receive the cash. The concomitant increase in his or her fractional holding of the firm then implies that his or her undiversified risk exposure in the firm subsequent to a stock repurchase exceeds that subsequent to a dividend. Thus, the central assumption that creates a signalling-cost structure difference between dividends and repurchases is the manager's exclusion from tendering, and this assumption has strong empirical support, as indicated earlier. Following the proof of Proposition 1 in the Appendix, we have formally shown the validity of this intuition. It is clear from these formal arguments that the intuition applies regardless of whether dividends and stock repurchases are financed from cash or a foregone investment in a risky project.

II. The Asymmetric Information Case

We shall assume now that, even though investors are aware that there are type-1 firms (those with $E(\tilde{\Pi}) = \Pi_1$ and a low $\xi = \xi_1$) and type-2 firms (those with $E(\tilde{\Pi}) = \Pi_2$ and a high $\xi = \xi_2$) in the market, they cannot distinguish between these firms *a priori*. The cross-sectional distribution of the two types of firms and all other parameters are common knowledge. Thus, if there is no *ex ante* discrimination among firms by type, then each firm will be valued in the market at the cross-sectional average. In what follows, we shall assume that shareholders would like their managers to release their private information by signalling and thus offer a wage contract that induces them to signal. An assumption of this nature is standard in all signalling models.

To simplify the algebra, we assume henceforth that $\xi_1 = 0$ and $\xi_2 = 1$. All our results go through, however, even with the more general specification.[11] Moreover,

[11] See Section III. The only difference is that, unlike the general case, with $\xi_1 = 0$ and $\xi_2 = 1$ one could identify the firm's type with certainty *ex post* if one could observe whether there was a positive

even though the firm's liquidation value (Π_i) is observable to all, we assume that interim cash surpluses and deficits (at $t = 1$) are observable only to the firms' managers. We shall proceed as follows. Initially, we assume that firms can signal *only* with dividends. In this case, we prove that type-1 firms distinguish themselves from type-2 firms by paying a dividend that type-2 firms do not pay. Next, we prove that, as long as the level of dividend needed for an informationally consistent equilibrium is less than the positive cash flow C less the managerial wage, the signalling equilibrium involves only dividends and not stock repurchase. However, if Π_1 is sufficiently larger than Π_2, so that the informationally consistent dividend level exceeds $C - W_1$, then a stock repurchase will be used in a signalling equilibrium, possibly in conjunction with dividends. This establishes that a sufficiently deeply undervalued firm *will* choose to repurchase stock despite the availability of a dividend as a signal. Finally, we show that, for a large enough difference between the type-1 firm's true value and the cross-sectional average firm value, each type-1 firm will *only* repurchase stock and spend in excess of $C - W_1$ dollars to do so. This is the case in which we are able to show that the postrepurchase price per share of the type-1 firm will drop below the price per share prevailing after the repurchase announcement but before the actual repurchase.

Equilibrium Concept: We use Riley's [24] reactive equilibrium concept.[12] This permits exclusive focus on fully separating and nonrandomized allocations. In our two-type case, a unique equilibrium exists and involves a pair of distinct contracts, one taken by each firm type, that represents the Pareto-dominating pair among those pairs that are fully separating and incentive compatible.

Before proceeding to the main results, we need some more notation. Let $V^*(d)$ be the market value of a firm that issues a dividend of d. We have written this value explicitly as a function of d to emphasize that the market is *a priori* uninformed about the firm's type and thus sets its value based *solely* on its observed dividend payment. In what follows, all firms values are *ex-dividend* values. Further, let $V_i^o(d)$ be the true value of a type-i firm when it pays a

cash flow at $t = 1$. This introduces the possibility of a costless, ex post contingent contract and a nondissipative signalling equilibrium à la Bhattacharya [7]. Such an equilibrium would Pareto dominate the one we characterize. It is to avoid this "difficulty" that we have assumed, realistically, that neither the cash flow nor the actual amount possibly borrowed at $t = 1$ is publicly observable. This will rule out a nondissipative equilibrium as an *a priori* superior alternative although, in a larger context, we cannot claim to have ruled out mechanisms possibly embedded in different (or perhaps more general) model structures that could be used to force a nondissipative outcome back into consideration. Note that, because of managerial risk aversion, when $\xi_i \in (0, 1)\ \forall\ i$, the unobservability assumption on cash surpluses or deficits at $t = 1$ may be dispensed with. The reason for this is that, because $\xi_i \in (0, 1)$, an ex post contingent contract that makes the firm's value—and hence a portion of managerial consumption—depend on the observed cash surplus or deficit at $t = 1$ may impose excessive risk *ex ante* even on the *truthful* type-1 manager. Compensating a highly risk-averse manager for this risk may be prohibitively costly, making the contingent contract less attractive than our signalling equilibrium.

[12] An *allocation* is a triplet that defines the dividend level, the repurchase fraction, and the accompanying firm value. Then, a reactive equilibrium here is a pair of allocations A such that, for any additional pair B offered by investors such that $A \cup B$ generates profits for these investors, there is a further pair C such that B generates losses for investors offering that allocation, and investors offering C earn positive profits when $A \cup B \cup C$ is offered.

dividend of d. Of course, in an informationally consistent equilibrium, we must have $V^*(d) = V_1(d)$ and $V^*(0) = V_2(0)$ if the equilibrium involves type-1 firms paying a dividend of d and type-2 firms paying no dividend.

PROPOSITION 2: *Suppose firms are not allowed to repurchase stock. Then, assuming that* $\alpha[1 + R] < [1 + r]$, *there exists in equilibrium a dividend level* $d > 0$ *such that the type-1 firms signal their type by paying a dividend* d *and type-2 firms pay no dividend, as long as* $d \leq C - W_1$.

The condition $\alpha[1 + R] < [1 + r]$ is a restriction on the size of the manager's holding of his or her own firm's stock and is needed only to ensure that the informationally consistent d is strictly positive.[13] Intuitively, if the manager holds a very large fraction of his or her own firm and cannot trade it, he or she will "care" more about the firm's future payoff than its present market value. The type-2 manager (henceforth a type-i manager is the manager of a type-i firm), for whom the payment of dividends is more costly than for the type-1 manager, will, therefore, find dividend payment a distasteful alternative *despite* being able to increase his or her $t = 1$ wage because investors incorrectly infer from the dividend that his or her firm is type 1 and bid up its price. The reason is that the improvement in his or her expected utility from an increase in his or her current wage is small compared with the decline in his or her expected utility from a dividend-induced reduction in the firm's terminal payoff. Consequently, for a sufficiently large α, the type-2 manager is unwilling to pay a dividend to masquerade as a type-1 manager even if d is very small. Thus, $d = 0$ would be chosen by *both* firms. But this is not a separating equilibrium. The condition $d \leq C - W_1$ is, at this stage, simply an assumption that is made in the proof. As we will show in our next proposition, however, it ensures that our assumption that firms cannot repurchase stock is not a binding restriction. When $d \leq C - W_1$, it is indeed optimal not to repurchase stock.

The intuition behind Proposition 2 lies in the inverse relationship between signalling cost and true value that Spence [27] identified as a necessary condition for signalling equilibria.[14] Because of the assumed absence of taxes, paying a dividend is costless for the type-1 firm as long as $d \leq C - W_1$ and external financing is not necessary at $t = 1$. However, for the type-2 firm, signalling with a dividend is costly because such a firm does not receive a cash flow at $t = 1$ and is thus forced to maintain its borrowing until $t = 2$ at a rate $R > r$.[15] Therefore, a sufficiently high dividend payment by the type-1 firm will deter the type-2 firm from mimicking. In other words, the critical condition that ensures the viability of dividend signalling is that the probability of being short the necessary cash flow in the interim period is inversely correlated with the long-term profitability

[13] A "back-of-the-envelope" calculation shows that this restriction does not constrain things much. Vermaelen's [29] study reports that the α in his sample ranged from 0.1% to 87%. Even if one takes $\alpha = 87\%$ and $r = 10\%$, this condition simply constrains R to be less than 26.44%. For less extreme values of α, the upper bound on R will be much higher.

[14] Note also that the differential signalling cost that drives Proposition 2 does *not* depend on our assumption that $\xi_1 = 0$ and $\xi_2 = 1$. The proposition will hold as long as $\xi_1 < \xi_2$.

[15] The assumption $R > r$ is essential to produce a signalling cost structure for dividends but is inessential for repurchasing to be a signal.

of the firm.[16] Note that the size of the dividend payment by the type-1 firm is just large enough to persuade the type-2 firm not to mimic. That is, any dividend payment that is smaller will result in mimicry.[17]

We shall now establish the suboptimality of a stock repurchase when $d \leq C - W_1$. In proving this result, we are going to use a perturbation argument. To develop that argument, we need some preliminaries. As before, let d be the incentive-compatible dividend level when only dividends can be used as a signal. Let $d_\varepsilon = d - \varepsilon$ for some small positive scalar ε, and let β be the fraction of stock the firm must repurchase to restore incentive compatibility when the dividend is reduced by ε from the incentive-compatible level d. Also, define $V^*_\beta(d - \varepsilon)$ as the market value of a firm that has paid a dividend of d and repurchased β of its stock. The true value of such a firm is $V_1(d - \varepsilon, \beta)$. Further, define $V^*(d - \varepsilon)$ as the market value of a firm that has paid a dividend of d_ε and *announced*—but not executed—a repurchase of a fraction β of stock. $V_1(d - \varepsilon)$ is the true value of such a firm. Clearly, in equilibrium we must have $V_1(d - \varepsilon, \beta) = V^*_\beta(d - \varepsilon)$ and $V_1(d - \varepsilon) = V^*(d - \varepsilon)$. Finally, let $U_\varepsilon(\Pi_i \mid \Pi_j)$ be the expected utility of the type j manager signalling his or her firm as type i. We next present a useful result.

LEMMA 1: $V^*_\beta(d - \varepsilon) = [1 - \beta]\mathrm{V}^*(\mathrm{d} - \varepsilon)$.

We can now establish our next proposition.

PROPOSITION 3: *As long as the incentive-compatible dividend level is less than $C - W_1$, no stock will be repurchased by any manager in the reactive equilibrium.*

The intuition is as follows. As long as the type-1 manager can distinguish his or her firm from lower valued firms by paying a dividend less than $C - W_1$, the emission of only a dividend-based signal is costless for that manager. A reduction in the dividend payment, therefore, does not alter his or her expected utility. However, the accompanying stock repurchase that is needed to restore incentive compatibility increases the manager's (undiversified) ownership of his or her firm's stock and reduces expected utility.

Proposition 3 relies on d being no greater than $C - W_1$. We will shortly show that d is an increasing function of the *difference* in the true values of the two types of firms. Thus, the assumption that $d \leq C - W_1$ is tantamount to assuming that the true values of type-1 and type-2 firms are not spaced too far apart. We will now demonstrate that, when the disparity between these true values is sufficiently great, repurchasing stock becomes an optimal strategy.

Before we do that, however, we need to examine the price impact of repurchase when the true values of the type-1 and type-2 firms are sufficiently far apart. From (A25) in the Appendix, we see that d is an increasing function of $W_1 - W_2$. $W_1 - W_2$ increases as $V_1^o - V_2^o$ increases, which in turn means that $W_1 - W_2$

[16] In a more general model with more than two events, the notion of correlation is possibly more complicated than is indicated here. (See Milgrom [21].)

[17] On the basis of the fact that the type-2 firm pays no dividend in equilibrium, one *cannot* argue that *any* positive dividend by the type-1 firm will do. The reason is that the type-2 firm pays no dividend *only* in equilibrium, *conditional* on the type-1 firm paying a dividend high enough to make it unprofitable for the type-2 firm to mimic.

increases as $\Pi_1 - \Pi_2$ increases. Thus, for a sufficiently large difference between Π_1 and Π_2, the incentive-compatible dividend level—if a dividend is the only signal—will exceed $C - W_1$. We can thus write the value of the type-1 firm paying a dividend of d in this case as

$$\tilde{V}_1(d) = \{1 + r\}^{-1}\{\Pi_1 - [1 + R][d - C + W_1]\}. \tag{4}$$

Let $\tilde{V}_1(d - \varepsilon)$ be the value of the type-1 firm when there is a (reduced) dividend payment of $d - \varepsilon$ but no repurchase. Thus,

$$\begin{aligned}\tilde{V}_1(d - \varepsilon) &= \{1 + r\}^{-1}\{\Pi_1 - [1 + R][d - \varepsilon - C + W_1\} \\ &= \tilde{V}_1(d) + \varepsilon[1 + R][1 + r]^{-1}.\end{aligned} \tag{5}$$

Further, let $\tilde{V}_1(d - \varepsilon, \beta)$ be the type-1 firm's value when it pays a dividend of $d - \varepsilon$ and repurchases a fraction β of the firm. Suppose the price per share paid in the repurchase is $\tilde{V}_1(d - \varepsilon)N_o^{-1}$. Then

$$\begin{aligned}\tilde{V}_1(d - \varepsilon, \beta) &= \{1 + r\}^{-1} \\ &\quad \times \{\Pi_1 - [1 + R][d - \varepsilon - C + W_1 + \beta\tilde{V}_1(d - \varepsilon)]\} \\ &= \tilde{V}_1(d - \varepsilon) - [1 + R][1 + r]^{-1}\beta\tilde{V}_1(d - \varepsilon) \\ &< \tilde{V}_1(d - \varepsilon) - \beta\tilde{V}_1(d - \varepsilon) \\ &= [1 - \beta]\tilde{V}_1(d - \varepsilon).\end{aligned}$$

Thus, the prerepurchase price per share, $\tilde{V}_1(d - \varepsilon)N_o^{-1}$, is higher than the postrepurchase price per share, $\tilde{V}_1(d - \varepsilon, \beta)[N_o\{1 - \beta\}]^{-1}$. This implies that the firm will be able to complete its repurchase only at the prerepurchase price per share, i.e., the price that prevails *after* the firm has announced its stock repurchase and dividend plans and paid its dividend but *before* the repurchase has actually taken place.[18] (In the discussion following Proposition 5, we explain why the firm will be able to repurchase only at the prerepurchase price per share.) We can now establish one of our two principal results.

PROPOSITION 4: *For a sufficiently large $\Pi_1 - \Pi_2$, the type-1 manager will use repurchase as a signal, possibly in conjunction with dividends.*

This proposition asserts that, whenever issuing a dividend is costly for the type-1 firm's manager because that dividend payment exceeds the net available cash inflow expected at $t = 1$, it is always optimal to repurchase some stock and cut back on the dividend payment. The intuition stems from the differences between the two cash-distribution mechanisms with respect to variations in signalling costs *vis-à-vis* benefits across type-1 and type-2 managers. The reactive equilibrium involves maximizing the type-1 manager's expected utility subject to the constraint that the type-2 manager receives his or her first-best expected utility and that there is no misrepresentation. Thus, the signal—or combination of signals—chosen in equilibrium is the one that is *relatively* the most disadvantageous for the type-2 manager, i.e., the one most efficacious in coaxing the type-

[18] It does not matter much to our analysis whether the stock repurchase is made before the dividend is paid or after.

2 manager not to mimic. This is achieved with a pure dividend signal when $d \geq C - W_1$ because, in this range, a dividend is costly for the type-2 manager and costless for the type-1 manager. As long as that dividend level is incentive compatible, it produces the greatest relative disadvantage for the type-2 manager since it yields the type-1 manager his or her first-best expected utility. This is no longer true when $d > C - W_1$. Dividends are equally costly at the *margin* now for both managers although *total* dividend-signalling costs are still higher for the type-2 manager.[19] Moreover, the marginal signalling benefits with dividends are also the same for both managers. Thus, the discriminating ability of dividends is weakened when $d > C - W_1$. A stock repurchase, however, does not suffer from this effect. Although an increase in his or her undiversified holding of his or her own firm's stock has the same negative *risk-related* impact on *each* manager's expected utility, this additional risk is less onerous for the type-1 manager, *even at the margin,* because the repurchase only forces him or her to assume a larger stake in an asset he or she knows is valuable. By the same token, a repurchase, in addition to imposing more risk, forces the type-2 manager to hold more of an asset he or she knows is not worth as much as the asset of the type-1 firm; i.e., the type-2 manager's repurchase gives him or her a larger claim to a lower mean terminal cash flow.

The upshot of this is that the type-1 manager spends less on a repurchase than on a dividend to discourage the type-2 manager from mimicry. The type-1 manager, therefore, accepts a large dividend reduction—which lowers external financing costs, enhances terminal firm value, and improves his or her expected utility—in exchange for a small increase in his or her ownership share. The latter is small and thus has a relatively unimportant (adverse) impact on his or her expected utility. The *net* effect is higher expected utility for the type-1 manager.

Since in our model a repurchase takes place only when Π_1 is sufficiently greater than Π_2, the market price response to a stock repurchase should, on average, be greater than the market price response to a pure dividend signal. This prediction of our model is consistent with the empirically documented stock price responses to dividends and stock repurchases that were discussed in the introductory section. Our analysis thus far also explains the significant announcement effects associated with dividends and stock repurchases.

The other empirical regularities can be understood by examining the conditions under which a pure repurchase signal will be used in equilibrium. Suppose the only permissible signal is a stock repurchase. Let $\Pi_1 - \Pi_2$ be so large that the amount spent by the firm on repurchasing a fraction β of its stock exceeds $C - W_1$. We will now show that, at the margin, the type-1 manager will not want to reduce β and pay a dividend to compensate for the reduction. This implies the optimality of a stock repurchase signal uncontaminated by a dividend signal for a firm sufficiently more valuable than the cross-sectional average.

Let $V^*(\beta)$ be the market value of the firm's equity when a fraction β of the firm is repurchased, and let $U_\beta^*(\Pi_i \mid \Pi_j)$ be the expected utility of the type-j manager "reporting" his or her firm's type as i. Let $V^*(\beta - \varepsilon, d)$ be the market value of the firm's equity when the repurchase fraction is reduced to $\beta - \varepsilon$ (for

[19] This difference in total signalling costs means that it is possible to get a (fully revealing) reactive equilibrium even if a dividend is the only available signal and $d > C - W_1$.

$\varepsilon > 0$) and a dividend $d > 0$ is paid to restore incentive compatibility. The expected utility of a type-j manager reporting as type i in this case is $\hat{U}^*_\beta(\Pi_i \mid \Pi_j)$. Now,

$$V^*(\beta) = \{\Pi_1 - [1 + R][\beta V_1(0) + W_1 - C]\}\{1 + r\}^{-1}, \tag{6}$$

$$V_1(0) = \{\Pi_1 + [1 + r][C - W_1]\}\{1 + r\}^{-1}, \tag{7}$$

and $\beta V_1(0) > C$ by assumption. Next, we write the relevant expected utilities as

$$\begin{aligned} U^*_\beta(\Pi_1 \mid \Pi_1) = W_1 + \alpha[1 - \beta]^{-1} \\ \times [\Pi_1 - \{1 - R\}\{\beta V_1(0) + W_1 - C\}] \\ \times [1 + r]^{-1} - \alpha^2[1 - \beta]^{-2}K\sigma^2, \end{aligned} \tag{8}$$

$$\begin{aligned} U^*(\Pi_2 \mid \Pi_1) = W_2 + \alpha[1 + r]^{-1} \\ \times [\Pi_1 + \{1 + r\}\{C - W_2\}] - \alpha^2K\sigma^2, \end{aligned} \tag{9}$$

$$\begin{aligned} U^*(\Pi_2 \mid \Pi_2) = W_2 + \alpha[1 + r]^{-1} \\ \times [\Pi_2 - \{1 + R\}W_1] - \alpha^2K\sigma^2, \end{aligned} \tag{10}$$

$$\begin{aligned} U^*_\beta(\Pi_1 \mid \Pi_2) = W_1 + \alpha[1 - \beta]^{-1} \\ \times [\Pi_1 - \{1 + R\}\{\beta V_1(0) + W_1\}] \\ \times [1 + r]^{-1} - \alpha^2[1 - \beta]^{-2}K\sigma^2. \end{aligned} \tag{11}$$

We can now state our second principal result.

PROPOSITION 5: *There exists a sufficiently large $\Pi_1 - \Pi_2$ such that, in the reactive equilibrium, the type-1 firm repurchases its stock at an aggregate cost greater than C and pays no dividend. The type-2 firm neither repurchases stock nor pays a dividend. Moreover, the postrepurchase price per share for the type-1 firm is lower than the price per share at which it repurchased its stock.*

The intuition here parallels that underlying Proposition 4. When the amount spent on repurchasing exceeds $C - W_1$, that signal is costly both due to its adverse risk implication for the manager and due to the costly external funding it necessitates. At the margin, therefore, a repurchase is more disadvantageous than a dividend for the type-2 manager, making it suboptimal for the type-1 manager to employ a dividend in concert with a repurchase in this case.

The reason why the postrepurchase price per share falls is that it reflects the dissipation of firm value caused by having to borrow at $R > r$ to finance the repurchase. Note that this corporate cost of repurchase will *not* be borne by the tendering shareholders. Once the firm *announces* its repurchase plan, its stock price should respond to the signal and move up to its first-best value (which does not take the cost of repurchase into account). Now, if the tendering shareholders are "asked" to share in the corporate repurchase cost, they can simply decline to tender their shares. The price per share, which has already risen to its (true) first-best value in response to the information conveyed by the announcement, will not drop since a drop occurs only if a repurchase takes place. Thus, it will not be possible to execute the repurchase. This implies that the firm will be able to repurchase its stock only at a price that does not impound the dissipative repurchasing cost. However, once the repurchase is completed, the share price will drop in proportion to the *corporate* repurchase cost.

The only exception is when *all* existing shareholders tender and are bought out on a pro rata basis. However, this cannot happen since the manager, who holds stock, does not participate in the repurchase. That is, even if all outside shareholders tender on a pro rata basis, they still have an incentive to transfer all of the corporate repurchasing cost to the nontendering insiders.

Another way of viewing this result is that the *firm* bears the corporate signalling cost of repurchasing in equilibrium. That is, investors anticipate the corporate signalling cost and insist on selling out at the first-best price so that the transactions-costs portion of the repurchase-signalling cost is indeed absorbed by the firm. This result is familiar from other signalling models where the firm *sells* securities at a discount equal to the signalling cost.

As long as a (nonmanaging) shareholder acts optimally, our model implies that he or she will tender. The result is oversubscription. Dann [10] empirically supports this with the finding that the mean (median) of the number of shares tendered as a percentage of the number of shares sought to be repurchased by the firms was 142.3% (115.6%). SEC Rule 13e-4 makes it mandatory for the firm to repurchase stock on a pro rata basis from all *tendering* shareholders in this case.[20]

It is transparent by now why firms that repurchase stock offer premia above their prerepurchase market price. Moreover, even though the price in the "aftermarket" is lower than the repurchase price, it will generally exceed the price before the repurchase announcement. This is because, as we have shown, a repurchase is undertaken only by firms with true values that are sufficiently higher than the cross-sectional average. Thus, the price appreciation following the repurchase annoucement should greatly exceed the corporate repurchase cost. In other words, the repurchase announcement will evoke a relatively "permanent" price increase.

The global equilibrium behavior of the two signals is characterized next.

PROPOSITION 6: *For a sufficiently large $C - W_1$, there exist real-valued scalars $\delta_B^* > \delta_A^* > 0$ such that a reactive equilibrium exists in which*

(i) $d_1^* > 0, \beta_1^* = 0, d_2^* = 0, \beta_2^* = 0 \ \forall \ \Pi_1 - \Pi_2 \leq \delta_A^*$
(ii) $d_1^* > 0, \beta_1^* > 0, d_2^* = 0, \beta_2^* = 0 \ \forall \ \Pi_1 - \Pi_2 \in (\delta_A^*, \delta_B^*)$
(iii) $d_1^* = 0, \beta_1^* > 0, d_2^* = 0, \beta_2^* = 0 \ \forall \ \Pi_1 - \Pi_2 \geq \delta_B^*$,

where (d_i^*, β_i^*) is the pair of signals adopted in equilibrium by the type-i firm.

Claims (i) and (iii) are restatements of Propositions 3 and 5, respectively. Claim (ii) is, however, stronger than Proposition 4, which does not tell us whether

[20] The nontendering shareholders will, of course, be excluded. The empirical evidence does show, however, that not all stock repurchase tender offers are oversubscribed. Masulis [20] found that about a third of the tender offers are oversubscribed. While this is somewhat puzzling within the context of our model, it occurs possibly because the reservation price for some shareholders—induced by their personal transactions costs and their capital-gains tax—exceeds the tender-offer price.

dividends will be used when it first becomes optimal to repurchase stock. Proposition 6 asserts that in this "middle" range, there will be a "mixture" of signals employed by the type-1 firm. Figure 1 is a graph if this result.

Finally, our two-signal approach sheds light on the substitutability between dividends and stock repurchases as signals and explains why repurchasing activity increased during the period of dividend controls, August 1971 through June 1974.

III. Existence of Equilibrium, Robustness of Results, and Comparison with Related Work

We take up three issues in this section. First, we demonstrate graphically that the reactive equilibrium described in Proposition 6 is indeed *sustainable*. Second, we discuss the robustness of our results to variations in model structure, with some observations on equilibrium characterization for more than two types. Third, we briefly review some related theoretical literature and point out the salient differences between that work and ours.

A. *Existence of the Reactive Equilibrium*

In Proposition 6, we have derived an allocation such that, if a reactive equilibrium exists, then it must be the one described in that proposition. What

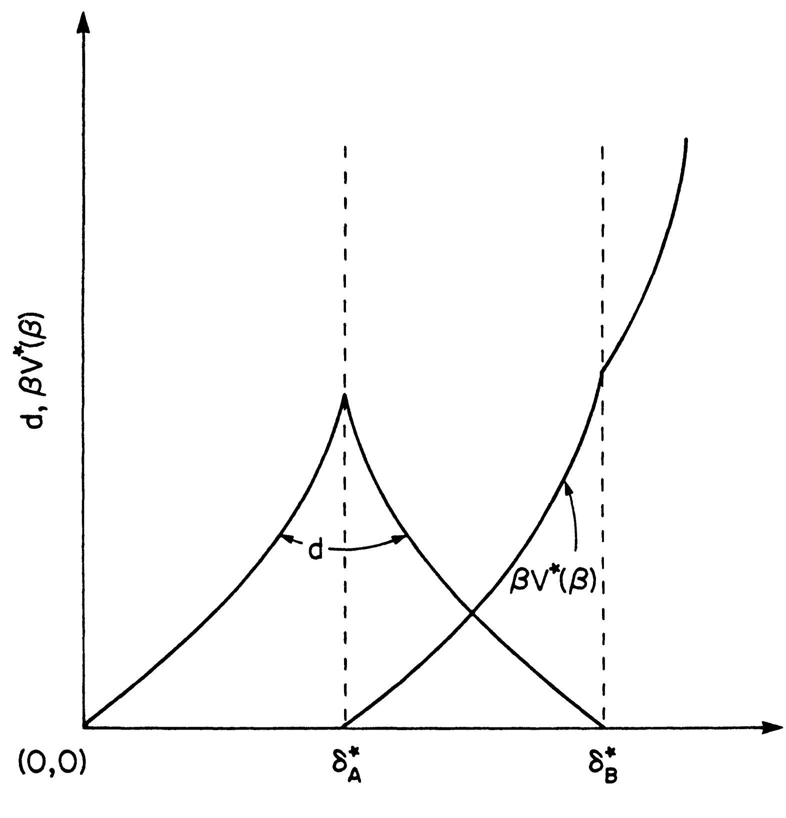

Figure 1. Equilibrium Behavior of Dividends and Stock Repurchases

remains is for the reader to be convinced that the allocation is indeed an equilibrium; i.e., it cannot be upset by a pooling allocation. To see this, examine Figures 2 and 3. We have sketched, in dividend-stock price space, indifference curves for the two types of managers as well as the (competitive) stock market valuation lines (MVL's) for their firms. Our object is to show that, even with dividend signalling, no pooling allocation could upset the equilibrium. Thus, with both dividends and repurchases, the equilibrium can never be upset (since more alternatives are available to defeat a pooling allocation).

The type-1 manager's indifference curve is flat up to $d = C - W_1$ and then rises linearly. The type-2 manager's indifference curve has a strictly positive slope throughout. The slopes of the two indifference curves are identical for all $d > C - W_1$. The MVL, which specifies the firm's true market value for any d, is linear and downward sloping throughout for the type-2 firm. It is flat for the type-1 firm up to $d \leq C - W_1$, and then it slopes down at the same rate as for the type-2 firm. The pooling MVL is a "cross-sectionally weighted" MVL for the two types of firms. Up to $d \leq C - W_1$, it therefore slopes down at a rate intermediate between that for the type-1 firm (zero slope) and that for the type-2 firm (positive slope). For $d > C - W_1$, since both types of firms have MVL's with identical slopes, the pooling MVL also slopes down at the same rate as for either the type-1 or the type-2 firm. To see how these functions are obtained,

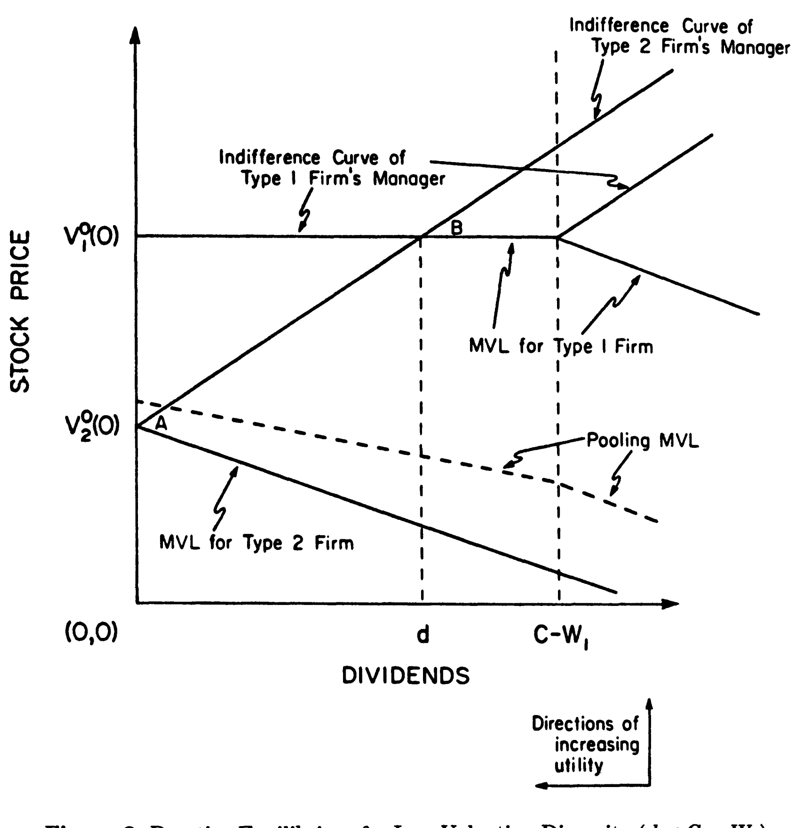

Figure 2. Reactive Equilibrium for Low Valuation Disparity ($d \leq C - W_1$)

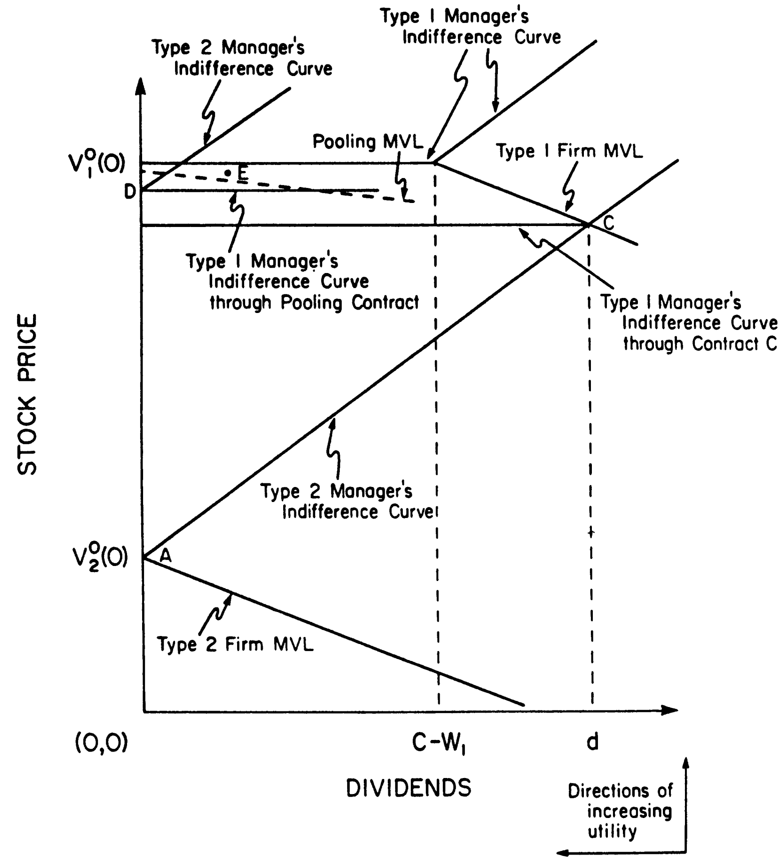

Figure 3. Reactive Equilibrium for High Valuation Disparity ($d > C - W_1$)

note that the MVL for any firm type is simply the *true* firm value, $V_i' + d$, as a function of the dividend payment, where V_i' itself depends on d and is given by (3) with $\xi_1 = 0$ and $\xi_2 = 1$; i.e., the MVL is the *true* ex-dividend firm value plus the dividend paid. To obtain managerial indifference curves in dividend-price space, we compute the slope of a type-i manager's indifference curve as $-\{\partial\bar{\mathrm{E}}(U_i)/\partial d\}\{\partial\bar{\mathrm{E}}(U_i)/\partial V_i'\}^{-1}$, where $\bar{\mathrm{E}}(U_i)$ is the type i manager's expected utility (given in expression (A10) in the Appendix). With this, it is straightforward to sketch the relevant functions in Figures 2 and 3.

In Figure 2, we can see that the disparity in the first-best values of the two firms is not too great, and, thus, the incentive-compatible $d < C - W_1$. The equilibrium allocations for the type-1 and type-2 firms are B and A, respectively. In this case, the pooling MVL lies completely below the line that represents simultaneously the type-1 manager's indifference curve and the type-1 firm's MVL and passes through B. Thus, no pooling contract can ever upset the equilibrium.

In Figure 3, we have a situation in which the true values of the two firm types are spaced sufficiently far apart so that the incentive-compatible $d > C - W_1$. The equilibrium allocations for the type-1 and type-2 firms, respectively, are C

and A. If the pooling MVL is as shown in the figure, then some investors can offer a pooling allocation D that will attract the managers of both types away from their equilibrium allocations. These investors can also make positive net gains since they pay a price that lies *below* the pooling MVL. However, if they do this, another group of investors can react and profitably offer an allocation E that will lure away all the type-1 firms to it but not the type-2 firms. This will impose losses on the original deviant investors who now hold only type-2 firms. Moreover, the reacting investors can do no worse than break even in the event that other investors offer more attractive allocations to lure away the type-1 firms. Thus, $\{A, C\}$ must be a reactive equilibrium.

These existence arguments also clarify that the tender-offer price is uniquely determined in equilibrium in our model. Because the manager does not tender his or her own stock, setting the offer price above the firm's (true) first-best value lessens the manager's expected utility. Thus, competition among uninformed shareholders will, in the usual Bertrand fashion, ensure that the offer price is no higher than the first-best value. Of course, our reactive-equilibrium existence arguments have shown clearly that the offer price can be no lower than first best. Thus, we have established that the tender-offer price is uniquely and endogenously determined in our model. This further distinguishes our work from other repurchase-signalling models (discussed later in this section) where the offer price is not unique.

B. Robustness of Results

We have mostly assumed a special probability structure, namely that $\xi_i \in \{0, 1\}$, $i = 1, 2$. This has helped to simplify the algebra and bring out the intuition more sharply. However, in some cases our special structure appears to facilitate the results to an extent that raises questions about the sustainability of these results in a more general setting.[21] For example, when the good firm pays only a dividend to signal, it can costlessly distinguish itself from the bad firm since it knows with certainty that it will have a cash surplus. We would like to know whether dividends still dominate for low values of profitability differences when the ξ_i's take interior values. Moreover, would a repurchase still dominate for high values of profitability differences?

To address these concerns, let us assume that $0 < \xi_i < 1$. Using steps similar to those employed in proving the propositions stated earlier, we show in the Appendix that a pure dividend signal will still dominate for low values of profitability differences. All that is required in proving this assertion is satisfaction of the familiar condition that the manager's fractional ownership endowment in the firm is not too large. The intuition for this condition is as follows. If managers own very large fractions of their own firms and do not trade their stock, then they will be concerned mainly with their *terminal* payoffs rather than the current rise in firm value attainable through signalling. This means that the bad firm's manager will not find misrepresentation very attractive, particularly if it calls for increasing his or her undiversified risk exposure. Consequently, a relatively small repurchase fraction will guarantee incentive compatibility. The

[21] We thank Rob Heinkel for prodding us to think about some of these issues.

manager of the good firm will, therefore, find a small stock repurchase an attractive alternative, given the accompanying reduction in expected external financing costs relative to paying only dividends.[22]

This result suggests that firms that have dominant insider holdings will tend to rely more on stock repurchases. Empirically, firms with large insider holdings have been found to predominate among stock-repurchasing firms.

Next, we establish that, for sufficiently high values of profitability differences, a pure repurchase signal will still dominate. As we have seen, the key to this result is that the marginal cost of dividend signalling is different for the two types when $d \leq C - W_1$ but equal when $d > C - W_1$. If that is true, then dividends discriminate well when $d \leq C - W_1$ but not when $d > C - W_1$. We will now prove that this property holds even with $\xi_i \in (0, 1)$, $i = 1, 2$, and the good firm incurs a dividend-signalling cost when $d \leq C - W$.

Note that the type-1 firm seeks external financing of d with probability (w.p.) ξ_1 and zero w.p. $1 - \xi_1$ when $d \leq C - W_1$. When $d > C - W_1$, it seeks external financing of d w.p. ξ_1 and $d - C + W_1$ w.p. $1 - \xi_1$. The type-2 firm, if it wishes to mimic the type-1 firm, seeks external financing of d w.p. ξ_2 and zero w.p. $1 - \xi_2$ when $d \leq C - W_2$. When $d > C - W_2$, it seeks external financing of d w.p. ξ_2 and $d - C + W_2$ w.p. $1 - \xi_2$. Thus, ignoring the effect of managerial ownership and setting, for simplicity, $W_1 = W_2 = W$, the *difference* between the signalling costs of the two firms is $d[\xi_2 - \xi_1]$ when $\mathrm{d} \leq \mathrm{C} - \mathrm{W}$, and $d[\xi_2 - \xi_1] - [d - C + W][\xi_2 - \xi_1]$ when $d > C - W$. Differentiating each difference with respect to d tells us that the *marginal difference* between the dividend-signalling costs of the two types of firms is

$$\begin{array}{lll} [\xi_2 - \xi_1] & \text{when} & d \leq C - W, \\ 0 & \text{when} & \mathrm{d} > \mathrm{C} - \mathrm{W}. \end{array}$$

Thus, even with $\xi_i \in (0, 1)\ \forall\ i$, we have exactly the same effect; i.e., the discriminating ability of dividends is greater when $d \leq C - W$ than when $d > C - W$.

One may wonder if our model is sensitive to the two-type specification. It is not. Extending the number of types to even a continuum leaves unaffected our main results.[23] To visualize an equilibrium with many types, suppose there are four types of firms appropriately rank ordered with the least profitable firm denoted type 4 and the most profitable firm denoted type 1. Then, with suitably chosen parameter values, the type-4 firm will not signal, the type-3 firm will signal only with dividends, the type-2 firm will employ both a stock repurchase and a dividend as signals, and the type-1 firm will use only a repurchase as a

[22] Such a restriction on managerial ownership is not needed when $\xi_i \in \{0, 1\}$ because, in that case, a small dividend payment does not involve any external financing costs for the good firm.

[23] This claim is based on the assumption that the cross-sectional variation in $\xi_i[1 - \xi_i]$ is not too large. That is, suppose I is the set of possible values that i can take. Then the Lebesgue measure of the set $\{\xi_i[1 - \xi_i] \mid \xi_i \in (0, 1), i \in I\}$ must not be too large. The reason is that a systematically large cross-sectional variation would imply significantly different risk impositions on the managers of different types of firms for any *given* β. This would make a stock repurchase differentially costly for different types based on *risk alone*—possibly in a counterveiling manner to the effect of differences in the signalling cost structures based on differences on Π_i—and thus alter the results.

signal. With more types, one could have two or more types signalling only with (different) dividends and two or more types signalling only with different repurchase fractions and offer prices. Also, a unique reactive equilibrium exists in these more general cases. Thus, assuming more than two types seems a needless embellishment.

C. Comparison with Related Work

Because of its treatment of vector-valued signalling, our research differs from that of Bhattacharya [6, 7], Hakansson [12], John and Williams [16], Miller and Rock [22] (where the firm signals *only* with a dividend), and Vermaelen [30] (where it signals *only* with a stock repurchase). In this regard—namely the utilization of multiple signals to reveal a single unknown attribute—our analysis resembles Ambarish, John, and Williams [2], Besanko and Thakor [5], and Vishwanathan [31] although it has not been our goal to contribute to the theoretical exploration of vector-valued signalling. Indeed, analytical complexity has generally been suppressed, occasionally sacrificing generality that would not compromise predictive ability.

In its signalling cost structure for dividends *alone*, our model is closest to Bhattacharya's [6], where the value dissipation caused by a dividend is attributable to transactions costs. But Bhattacharya assumes a tax disadvantage for dividends that we do not. Our signalling cost structure for repurchase *alone* differs significantly from Vermaelen's [30].[24] In Vermaelen's model, the tender-offer price is *exogenous*—it can take any value as long as it exceeds the firm's true worth—even though it is recognized that it potentially communicates valuable information. By contrast, in our model, all variables with information content—including the offer price—are endogenously and uniquely determined.

Two very recent working papers address issues similar to ours. Constantinides and Grundy [9] use a *nondissipative* framework to look at the signalling potential of stock repurchases and different external financing modes when the firm has to fund an investment opportunity. The most important difference between their work and ours is that they do not examine dividend signalling, thus precluding an explanation for the relative price responses to repurchases *and* dividends that constitute the central focus of our work. Rather, they examine the information content of various alternative financial claims such as straight and convertible debt.

Choi [8] models firms that can choose stock repurchases and dividend payments as information communicators. The three most significant differences between

[24] Our signalling cost structure for repurchase is similar, in part, to the signalling cost structure for outside financing in Leland and Pyle (L-P) [17]. In L-P, the cost of equity retention for the manager is the distortion in his or her optimal holding of the firm, which, in turn, causes the manager to bear a suboptimally high amount of unsystematic risk. There are, however, several differences between L-P's work and ours. First, L-P's is a one-signal model, whereas we study vector-valued signalling. This is a noteworthy distinction because efficiency rankings for two signals distinguishing among firms with one unknown attribute each are analytically nontrivial in the dissipative case. Second, a part of the repurchase-signalling cost in our model is the value dissipation caused by costly external financing. This cost element is absent in L-P. Third, the manager's first-best holding of the firm is positive in L-P but zero in our model. Finally, our work permits an explanation for *relative* price responses to two partially substitutable signals; L-P's work does not.

Choi's work and ours are as follows. First, the signalling cost structures—both for dividends and for repurchase—are very differnt in the two models.[25] Second, because the repurchase price in Choi can take any value as long as it exceeds the true firm value, there is an infinity of possible equilibria consistent with price values within the permissible range; the exact choice of repurchase price from the range is exogenous to the model. Third, in Choi's model, all firms that derive a positive net benefit from signalling choose to signal only with a repurchase. The dividend-paying firms are pooled and cannot be separated one from the other.[26]

An analytical similarity between our model and those of Choi [8], Constantinides and Grundy [9], and Vermaelen [30] is the assumed willingness of the "insider" not to tender his or her own shares. This indicates that, *regardless* of the cost structure used to make repurchase a credible information signal, an equilibrium will fail to exist if the manager liquidates his or her ownership in the firm "prematurely." That is, he or she must agree to "play out the whole game."[27]

IV. Concluding Remarks

It has long been known that firms attach importance to *how* they distribute cash to their shareholders. Recent empirical work has reinforced the notion that this is probably because such activities convey information and that the market reaction to a repurchase differs from that to a dividend. However, a proper understanding of *why* the market reads more favorable information in a repurchase than in a dividend increase has been hampered until now by the absence of a theory that explores the informational capacities of both signals *simultaneously*. Our research has attempted to redress this by taking a modest first step toward an integrated theory of informationally motivated cash-distribution activities.[28]

Five of our principal findings deserve reiteration. First, we have shown that both dividends and repurchases will generally be used as signals and that neither dominates the other under all circumstances. Second, we have rationalized the empirically documented larger information content of a repurchase relative to that of a dividend. Third, we have shown that, whenever a firm pays only a dividend, it never uses (costly) external funds to finance the payment. On the other hand, when only repurchase is resorted to, there is always external financing in addition to internally available funds. Thus, we have an *endogenous* justifica-

[25] The signalling cost structure for repurchase in Choi resembles Vermaelen [30], and, for dividends, it resembles Miller and Rock [22].

[26] In Choi, this implies that these firms have *no* reason to pay dividends and could carry over their surplus cash to the end of the planning horizon *without altering* the price response evoked by a dividend.

[27] Not surprisingly, variants of this condition appear in *all* financial signalling models, e.g., Bhattacharya's [6] dividend-signalling model, Miller and Rock's [22] dividend-signalling model, and Ross's [25] capital structure-signalling model. In all these models, it is assumed that those who benefit from signalling do not "take their money and run" at the time of emission of the signal.

[28] Dividends and stock repurchases are not perfect substitutes as cash-distribution mechanisms. The IRS is prone to view a stock repurchase as a dividend for tax purposes if repurchasing is done too frequently.

tion for why a firm would spend more on a repurchase than on a dividend. Fourth, we have shown that the tender-offer price can be uniquely and endogenously determined even when a repurchase signals information. Fifth, we have explained why there may be a postrepurchase price decline even though the firm's stock is not mispriced at any time after the intent to repurchase is made public.

Because of the role assigned to managerial utility maximization in signalling, our model seems particularly suited to relatively small firms in which insiders can be expected to have sizeable stock holdings. Vermaelen [29] found that 70% of the repurchasing firms he examined had equity market values less than $80 million and that, in his sample, the mean insiders' holding fraction was 17.5%.

Although a managerial incentive contract that provides the manager a reason to signal is essential for the analysis, the model permits considerable flexibility in the design of the specific contract. For example, it can contain a fixed component and option-like features. All that is needed is that a nontrivial component of the manager's compensation be driven positively by the postsignal value of the firm.[29] Moreover, managers need not be as undiversified as in our model; limited diversification is admissible as long as managers are risk averse with respect to their firms' payoffs; i.e., they should have substantial holdings of their own firms' stocks (as the empirical evidence suggests they do).

Finally, a word on possible extensions. An obvious extension would be to incorporate capital structure as an additional signal, especially since dividend and stock repurchases both result in an immediate change in the firm's capital structure.[30] Of course, the signal-substitutability argument as a motivation for such a study is not quite as compelling since capital structure is not a cash-disbursement mechanism. A more challenging extension would be to build an integrated model that includes other financial signals such as corporate earnings forecasts, some of which may be nondissipative, and to explain the persistence of costly signals when less costly alternatives are apparently available.

Appendix

(The reader who finds these proofs terse may obtain further details from the second author.)

Proof of Proposition 1: Suppose there is no dividend payment or stock repurchase. Then, rearranging (1) produces

$$V_i^o = [\Pi_i + \{1 - \xi_i\}\{1 + r\}C]N_o \times [N_o\{1 + r\} + \{[1 - \xi_i][1 + R] + \xi_i[1 + R]\}b]^{-1} \quad \text{(A1)}$$

[29] It is a common feature of *all* financial signalling models that the welfare of the agent emitting the signal depends somehow on the response (usually the post-signal price) of the uninformed (usually the market) to the signal. In our model, as in Ross [25], this is achieved through a managerial wage contract. In other models, such as Bhattacharya [6], Choi [8], Miller and Rock [22], and John and Williams [16], it is achieved somewhat differently, but the effect is the same.

[30] Vermaelen [29] finds, however, that the capital-structure effect of a repurchase does not seem very relevant in explaining the stock price response. Of course, the signalling effects of more *direct* capital structure changes have been theoretically explained in a number of papers, such as Ross [25] and, more recently, Shah and Thakor [26].

The manager's expected utility is

$$\mathrm{E}(U) = bV_i^o/N_o + \alpha V_i^o - \alpha^2 K\sigma_{Ti}^2, \tag{A2}$$

where $\mathrm{E}(U_i)$ is the expected utility of the type-i firm's manager and σ_{Ti}^2 is the variance of the total type-i firm wealth at $t = 2$. Note that

$$\sigma_{Ti}^2 = \sigma^2 + \xi_i[1 - \xi_i][C\{1 + r\} + \{R - r\}W_i]^2. \tag{A3}$$

Now suppose a fraction β of the firm's outstanding shares are repurchased. The firm's postrepurchase value is given by (2). The manager's expected utility is

$$\hat{\mathrm{E}}(U_i) = W_i + \alpha[1 - \beta]^{-1}[1 + r]^{-1} \times \begin{Bmatrix} \Pi_i + [1 - \xi_i][1 + r][C - \beta V_i^o - W] \\ - \xi_i[1 + R][\beta V_i^o + W_i] \end{Bmatrix} - \alpha^2[1 - \beta]^{-2}K\hat{\hat{\sigma}}_{Ti}^2, \tag{A4}$$

where

$$\hat{\hat{\sigma}}_{Ti} \equiv \sigma^2 + \xi_i[1 - \xi_i]\{C[1 + r] + [R - r][\beta V_i^o + W_i]\}^2. \tag{A5}$$

We can write $\hat{\mathrm{E}}(U_i)$ as

$$\hat{\mathrm{E}}(U_i) = W_i + \alpha[1 - \beta]^{-1}\hat{V}_i^o - \alpha^2[1 - \beta]^{-2}K\hat{\hat{\sigma}}_{Ti}^2. \tag{A6}$$

Rearranging (2), we get

$$\begin{aligned} \hat{V}_i^o &= V_i^o - [1 - \xi_i]\beta V_i^o - \xi_i[1 + R][1 + r]^{-1}\beta V_i^o \\ &< V_i^o - [1 - \xi_i]\beta V_i^o - \xi_i\beta V_i^o \\ &= [1 - \beta]V_i^o. \end{aligned} \tag{A7}$$

Further, comparing (A3) and (2), we have

$$\hat{\hat{\sigma}}_{Ti}^2 > \sigma_{Ti}^2. \tag{A8}$$

(A6), (A7), and (A8) indicate that the manager will not repurchase stock since

$$\begin{aligned} \hat{\mathrm{E}}(U) &< W_i + \alpha V_i^o - \alpha^2[1 - \beta]^{-2}K\sigma_{Ti}^2 \\ &< \mathrm{E}(U_i). \end{aligned} \tag{A9}$$

We now turn to dividends. With a dividend payment of d, the firm's value is given by (3), and the manager's expected utility is

$$\overline{\mathrm{E}}(U_i) = W_i + \alpha[d + V_i'] - \alpha^2 K\hat{\sigma}_{Ti}^2, \tag{A10}$$

where

$$\hat{\sigma}_{Ti}^2 \equiv \sigma^2 + \xi_i[1 + \xi_i]\{C[1 + r] + [R - r][d + W_i]\}^2. \tag{A11}$$

Differentiating (A11) with respect to d gives

$$\begin{aligned} \partial\overline{\mathrm{E}}(U_i)/\partial d &= \alpha - \alpha[1 - \xi_i] - \xi_i[1 + R][1 + r]^{-1} \\ &\quad - 2\alpha^2 K\hat{\sigma}_{Ti} - \xi_i[1 - \xi_i][R - r] \\ &< 0. \end{aligned}$$

Thus, the manager will choose not to pay any dividends. Q.E.D.

Formalization of the Intuition that Repurchases Increase the Manager's Risk Relative to Dividends: Since we want this to be a "ceteris paribus" argument, let us assume that equal amounts are spent on repurchase and dividend. Thus, $\beta V_i^o = d$. From (2) and (3), it follows, then, that $\hat{V}_i^o = V_i'$, and, from (A5) and (A11), it follows that $\hat{\hat{\sigma}}_{Ti}^2 = \hat{\sigma}_{Ti}^2 \equiv [\sigma^*]^2$. Initially, suppose both the dividend and the repurchase are financed out of cash. Rewriting (A7), we have

$$\hat{V}_i^o = [1 - \beta]V_i^o - \tau, \tag{A11}$$

where τ is a real-valued, positive scalar. Now, using (A6) in conjunction with (A11) yields the manager's expected utility with a repurchase as

$$\hat{\mathrm{E}}(U_i) = W_i + \alpha V_i^o - \alpha[1 - \beta]^{-1}\tau - \alpha^2[1 - \beta]^{-2}K[\sigma^*]^2. \tag{A12}$$

Since $\hat{V}_i^o = [1 - \beta]V_i^o - \tau$, $\beta V_i^o = d$, and $\hat{V}_i^o = V_i'$, we have $V_i' = V_i^o - d - \tau$. Thus, the manager's expected utility with a dividend is

$$\overline{\mathrm{E}}(U_i) = W_i + \alpha V_i^o - \alpha\tau - \alpha^2 K[\sigma^*]^2. \tag{A13}$$

Comparing (A12) and (A13), we see that $\hat{\mathrm{E}}(U_i) < \overline{\mathrm{E}}(U_i)$, and there are two sources that create a greater cost for the manager in repurchasing stock than in paying a dividend. One is the greater risk imposition on the manager—the difference between $\alpha^2[1 - \beta]^{-2}[\sigma^*]^2$ and $\alpha^2[\alpha^*]^2$—in a repurchase. The other is the difference between $\alpha[1 - \beta]^{-1}[\tau]$ and $\alpha\tau$, which is the additional cost for the manager in expected value terms. This cost arises from the fact that, for both dividends and repurchases, there is a state of nature in which the firm must resort to costly external financing, but, for dividends, this cost is shared by all the shareholders, whereas, for a repurchase, it is imposed solely on the nontendering shareholders, the manager being one of them. (This particular cost disappears when we assume extreme probability values, but the risk-related cost remains.)

Next, this intuition is established even when *both* dividends and repurchases are financed out of the firm's capital budget, thus resulting in foregone investment opportunities. To stay within this model, suppose that this investment is made at $t = 1$ and financed by C. We assume stochastic constant returns to scale, and, for simplicity, the project payoff, available at $t = 2$, is uncorrelated with the firm's terminal payoff $\tilde{\Pi}$. Let $m \in [r, R]$ repesent the expected return from this new investment ($\tilde{m}$ is the actual return) and let $\omega^2 > 0$ be its variance. The manager's expected utility with a repurchase is now expressed as

$$\hat{\mathrm{E}}(U_i) = W_i + \alpha V_i^o(m) - \alpha[1 - \beta]\tau(m) - \alpha^2 K[\sigma^*(\tilde{m})]^2[1 - \beta]^{-2},$$

and his or her expected utility with a dividend as

$$\overline{\mathrm{E}}(U_i) = W_i + \alpha V_i^o(m) - \alpha\tau(m) - \alpha^2 K[\sigma^*(\tilde{m})]^2,$$

where

$$V_i^o(m) = \{\Pi_i + [1 - \xi_i][1 + m][C - W_i] - \xi_i W_i[1 + R]\}\{1 + r\}^{-1},$$

$$\tau(m) \;\; = [1 - \beta]V_i^o(m) - \hat{V}_i^o(m),$$

$$\hat{V}_i^o(m) = V_i^o(m) - [1 - \xi_i][1 + m][1 + r]^{-1}\beta V_i^o(m)$$
$$- \xi_i \beta V_i^o(m)[1 + R][1 + r]^{-1},$$
$$\sigma^*(\tilde{m}) \equiv \sigma^2 + \omega^2 + \xi_i[1 - \xi_i]\{C[1 + m] + [R - m][\beta V_i^o(m) + W_i]\}^2.$$

The cost structure differences here are similar to those obtained previously.

Proof of Proposition 2: Setting $\xi_2 = 1$ and using (1), we have

$$V_2(0) = \{\Pi_2 - [1 + R]W_2\}\{1 + r\}^{-1}. \tag{A14}$$

Similarly,

$$V_1(d) = \{\Pi_1 + [1 + r][C - W_1 - d]\}\{1 + r\}^{-1}. \tag{A15}$$

$$V_1(0) = \{\Pi_1 + [1 + r][C - W_1]\}\{1 + r\}^{-1}. \tag{A16}$$

From (A15) and (A17), we see immediately that

$$V_1(d) = V_1(0) - d. \tag{A17}$$

Now let $U(\Pi_i \mid \Pi_j)$ be the manager's expected utility when his or her firm's true type is Π_j and he or she signals Π_i. Suppose investors conjecture—correctly in equilibrium—that a firm that announces (and pays) a dividend of d is a type-1 firm and that a firm that pays no dividend is a type-2 firm. Then

$$U(\Pi_2 \mid \Pi_2) = W_2 + \alpha\{1 + r\}^{-1}$$
$$\times \{\Pi_2 - W_2[1 + R]\} - \alpha^2 K\sigma^2, \tag{A18}$$

$$U(\Pi_1 \mid \Pi_2) = W_1 + \alpha\{1 + r\}^{-1}$$
$$\times \{\Pi_2 - [d + W_1][1 + R]\} + \alpha d - \alpha^2 K\sigma^2 \tag{A19}$$

$$U(\Pi_1 \mid \Pi_1) = W_1 + \alpha\{1 + r\}^{-1}$$
$$\times \{\Pi_1 + [C - d - W_1][1 + r]\} + \alpha d - \alpha^2 K\sigma^2, \tag{A20}$$

$$U(\Pi_2 \mid \Pi_1) = W_2 + \alpha\{1 + r\}^{-1}$$
$$\times \{\Pi_1 + [C - W_2][1 + r]\} - \alpha^2 K\sigma^2. \tag{A21}$$

In a reactive equilibrium, the following incentive-compatibility (I.C.) conditions hold:

$$U(\Pi_i \mid \Pi_i) \geq U(\Pi_j \mid \Pi_i) \; \forall \; i, j = 1, 2. \tag{A22}$$

However, the Pareto-dominating pair of I.C. contracts has the following property:

$$U(\Pi_1 \mid \Pi_1) > U(\Pi_2 \mid \Pi_1) \tag{A23}$$

$$U(\Pi_2 \mid \Pi_2) = U(\Pi_1 \mid \Pi_2). \tag{A24}$$

Using (A24) in conjunction with (A18) and (A19) yields the equilibrium dividend

$$\alpha d[R - r] = [W_1 - W_2]\{[1 + r] - \alpha[1 + R]\}. \tag{A25}$$

Since $W_1 > W_2$, we have $d > 0$ as long as $\{1 + r\} > \alpha\{1 + R\}$, as assumed.

Finally, we need to check that (A23) can be satisfied with the d that satisfies (A25). Comparing (A20) and (A21), we see that this is true. Q.E.D.

Proof of Lemma 1: We know that the following equations hold:

$$V_\beta^*(d-\varepsilon) = \{1+r\}^{-1}\{\Pi_1 + [1+r][C - \{d-\varepsilon+W_1+\beta V^*(d-\varepsilon)\}]\}. \quad \text{(A25)}$$

$$= \{1+r\}^{-1}\{\Pi_1 + [C - \{d-\varepsilon+W_1\}][1+r]\} - \beta V^*(d-\varepsilon). \quad \text{(A26)}$$

$$V^*(d-\varepsilon) = \{1+r\}^{-1}\{\Pi_1 + [C - d + \varepsilon - W_1][1+r]\}. \quad \text{(A27)}$$

Substituting (A27) in (A26), we have the desired result. Q.E.D.

Proof of Proposition 3: We can write

$$\begin{aligned} U_\varepsilon(\Pi_1 \mid \Pi_2) = {} & W_1 + \alpha[d-\varepsilon] - \alpha^2[1-\beta]^{-2}K\sigma^2 + \alpha[1-\beta]^{-1} \\ & \times [1+r]^{-1}[\Pi_2 - \{d-\varepsilon+W_1+\beta V^*(d-\varepsilon)\}\{1+R\}]. \end{aligned} \quad (28)$$

Note that β is determined by

$$U_\varepsilon(\Pi_1 \mid \Pi_2) = U(\Pi_2 \mid \Pi_2), \quad \text{(A29)}$$

where $U_\varepsilon(\Pi_1 \mid \Pi_2)$ is given by (A28) and $U(\Pi_2 \mid \Pi_2)$ by (A18). The I.C. condition is

$$U_\varepsilon(\Pi_1 \mid \Pi_1) > U(\Pi_2 \mid \Pi_1), \quad \text{(A30)}$$

where $U(\Pi_2 \mid \Pi_1)$ is given by (A21) and

$$\begin{aligned} U_\varepsilon(\Pi_1 \mid \Pi_1) = {} & W_1 + \alpha[d-\varepsilon] - \alpha^2[1-\beta]^{-2}K\sigma^2 + \alpha[1-\beta]^{-1} \\ & \times [1+r]^{-1}\{\Pi_1 + [1+r][C - d + \varepsilon - \beta V^*(d-\varepsilon) - W_1]\}. \end{aligned} \quad \text{(A31)}$$

We will prove directly, however, that

$$U_\varepsilon(\Pi_1 \mid \Pi_1) < U(\Pi_1 \mid \Pi_1). \quad \text{(A32)}$$

Using Lemma 1, we can combine (A31) and (A20) to produce (A32). Thus, the type-1 manager is worse off reducing the dividend to repurchase stock. Q.E.D.

Proof of Proposition 4: When $\Pi_1 \gg \Pi_2$, we could have the d that satisfies (A25) being greater than C. Let $\tilde{U}_\varepsilon(\Pi_1 \mid \Pi_j)$ be the expected utility of the type-j manager when he or she signals to be type 1 using a dividend of $d - \varepsilon$ and repurchasing fraction β of his or her stock. Thus,

$$\begin{aligned} \tilde{U}_\varepsilon(\Pi_1 \mid \Pi_2) = {} & W_1 + \alpha[1-\beta]^{-1}[1+r]^{-1}\{\Pi_2 - [1+R] \\ & \times [d-\varepsilon+W_1+\beta\tilde{V}_1(d-\varepsilon)]\} + \alpha[d-\varepsilon] - \alpha^2 K\sigma^2[1-\beta]^{-2}. \end{aligned} \quad \text{(A33)}$$

Let $\tilde{U}(\Pi_1 \mid \Pi_j)$ be the expected utility of a type-j manager when he or she signals his or her firm to be type 1 using a dividend of $d > C$. Thus,

$$\tilde{U}(\Pi_1 \mid \Pi_2) = W_1 + \alpha d + \alpha[1+r]^{-1}\{\Pi_2 - [1+R][d+W_1]\} - \alpha^2 K^2\sigma. \quad \text{(A34)}$$

Using the I.C. conditions used in the proof of Proposition 3,

$$\tilde{U}_\varepsilon(\Pi_1 \mid \Pi_2) = U(\Pi_2 \mid \Pi_2), \quad \text{(A35)}$$

in a reactive equilibrium, where $U(\Pi_2 \mid \Pi_2)$ is given by (A18). However, since

$d > C$ was also an equilibrium (assuming dividend is the only allowable signal), we have

$$\tilde{U}(\Pi_1 \mid \Pi_2) = U(\Pi_2 \mid \Pi_2). \tag{A36}$$

Combining (A35) and (A36) produces

$$\tilde{U}_\varepsilon(\Pi_1 \mid \Pi_2) = \tilde{U}(\Pi_1 \mid \Pi_2). \tag{A38}$$

Using (A37) in conjunction with (A33) and (A34) and then rearranging yields

$$\begin{aligned}
&\alpha[1-\beta]^{-1}[1+r]^{-1}\{-[1+R][d-\varepsilon+W_1+\beta\tilde{V}_1(d-\varepsilon)]\} \\
&\qquad + \alpha[d-\varepsilon] - \alpha^2[1-\beta]^{-2}K\sigma^2 \\
&= \alpha d - \alpha^2 K\sigma^2 - \alpha[1+R][1+r]^{-1}[d+W_1] - \alpha\Pi_2[1-\beta]^{-1}[1+r]^{-1}\beta.
\end{aligned} \tag{A39}$$

For any ε reduction in d, (A38) determines the β needed to restore I.C. Now, substituting (A38) in $U_\varepsilon(\Pi_1 \mid \Pi_1)$ and simplifying, we get

$$\begin{aligned}
\tilde{U}_\varepsilon(\Pi_1 \mid \Pi_1) &= W_1 + \alpha[1-\beta]^{-1}[1+r]^{-1}[\Pi_1 + \{1+R\}C] - \alpha\beta_2\Pi \\
&\quad \times [1-\beta]^{-1}[1+r]^{-1} + \alpha d - \alpha^2 K\sigma^2 - \alpha[1+R][1+r]^{-1}[d+W_1].
\end{aligned} \tag{A40}$$

Next,

$$\begin{aligned}
\tilde{U}(\Pi_1 \mid \Pi_1) = W_1 &+ \alpha[1+r]^{-1}\{\Pi_1 - [1+R][d-C+W_1]\} \\
&+ \alpha d - \alpha^2 K\sigma^2.
\end{aligned} \tag{A41}$$

Comparing (A40) and (A41) shows that $\tilde{U}_\varepsilon(\Pi_1 \mid \Pi_1) > \tilde{U}(\Pi_1 \mid \Pi_1)$, which implies that the type-1 manager has a preference for reducing d by ε and repurchasing a fraction β of his or her firm's stock. The type-2 manager will issue no dividend and repurchases no stock. Q.E.D.

Proof of Proposition 5: For the sake of brevity, we will simply outline here the major steps involved in proving this proposition. The first step is to verify that the β that solves $U^*(\Pi_2 \mid \Pi_2) = U^*_\beta(\Pi_1 \mid \Pi_2)$ gives $U^*_\beta(\Pi_1 \mid \Pi_1) > U^*(\Pi_2 \mid \Pi_1)$. It is easy to check that this is true since $\Pi_1 + \{1+R\}C > \Pi_2$. Thus, the β is I.C. Next, assume that β is reduced to $\beta - \varepsilon$ for $\varepsilon > 0$ and that a dividend $d > 0$ is paid. The relevant expected utilities in this case are denoted by hats. Noting that, in a reactive equilibrium, $\hat{U}^*_\beta(\Pi_1 \mid \Pi_2) > U^*(\Pi_2 \mid \Pi_2)$, we can obtain an expression that gives us the d needed to restore I.C. when β is reduced by ε. Substituting this expression in $\hat{U}^*_\beta(\Pi_1 \mid \Pi_1)$ and comparing with $U^*_\beta(\Pi_1 \mid \Pi_1)$, we can verify that $U^*_\beta(\Pi_1 \mid \Pi_1) > \hat{U}^*_\beta(\Pi_1 \mid \Pi_1)$ as long as $\Pi_1 + C\{1+R\} > \Pi_2$, which is certainly true. It is straightforward to verify that the I.C. condition $\hat{U}^*_\beta(\Pi_1 \mid \Pi_1) > \hat{U}^*_\beta(\Pi_2 \mid \Pi_1)$ holds. Thus, the manager will not wish to reduce the repurchase fraction and issue a dividend. Finally, from (6) and (7), we have $V_1(0)N_o^{-1} > V^*(\beta)[N_o\{1-\beta\}]^{-1}$, which means that the postrepurchase price per share will be lower than the price per share at which the repurchase took place. Q.E.D.

Proof of Proposition 6: Claims (i) and (iii) are obvious in light of the previous results. To establish (ii), note that the range (δ^*_A, δ^*_B) corresponds to $\Pi_1 - \Pi_2$ values such that a solitary dividend signal by the type-1 firm exceeds $C - W_1$. In this case, we know from Proposition 4 that a repurchase will be used, at least to some extent. Also, (δ_A^*, δ_B^*) must be the interval over which a solitary repurchase signal entails a total cost less than $C - W_1$. This follows from the fact that, when the amount spent on repurchasing exceeds $C - W_1$, we have $\Pi_1 - \Pi_2 \geq \delta_B^*$. (The assertion that $\delta_B^* > \delta_A^*$ comes from the observation that the amount spent on repurchasing is zero for $\Pi_1 - \Pi_2 \leq \delta_A^*$ and greater than $C - W_1 > 0$ for $\Pi_1 - \Pi_2 \geq \delta_B^*$. Because $\Pi_1 - \Pi_2$ takes values in a continuum and the manager's expected utility is continuous in the relevant variations, we cannot have a jump in the optimal repurchase cost from zero to an arbitrarily large positive number $C - W_1$.) Now assume counterfactually that there is only repurchase for $\Pi_1 - \Pi_2 \in (\delta_A^*, \delta_B^*)$. Since the repurchase cost falls short of $C - W_1$, there exists a small enough reduction in the repurchase fraction such that the accompanying dividend payment needed to restore incentive compatibililty is small enough to ensure that the total expenditure on repurchase and dividends is less than $C - W_1$. However, we have proven that, whenever a dividend payment can be made without using external funding, it is optimal to pay a dividend even if repurchasing is available as an option. Thus, when $\Pi_1 - \Pi_2 \in (\delta_A^*, \delta_B^*)$, a dividend payment and a stock repurchase will be optimal as a combination. The fact that this optimal allocation is indeed a reactive equilibrium is evident from the arguments in Section IIIA. Q.E.D.

Demonstration That Signalling with Only a Dividend Dominates for Low Values of Profitability Difference Even When $\xi_i \in (0, 1)\ \forall\ i$: Since this requires essentially replicating the steps in the proofs of Propositions 2 and 3, we shall be brief. With $0 < \xi_1 < \xi_2 < 1$, using steps similar to those in the proof of Proposition 2, we obtain

$$U(\Pi_2 \mid \Pi_2) = W_2 + \alpha V_2(0) - \alpha^2 K \sigma_{T2}^2, \tag{A42}$$

$$\sigma_{T2}^2 \equiv \sigma^2 + \xi_2[1 - \xi_2][C\{1 + r\} + \{R - r\}W_2]^2, \tag{A43}$$

$$U(\Pi_1 \mid \Pi_2) = W_1 + \alpha[1 + r]^{-1} \times \begin{Bmatrix} \Pi_2 + [1 - \xi_2][1 + r][C - W_1 - d] \\ - \xi_2[W_1 + d][1 + r] \end{Bmatrix} + \alpha d - \alpha^2 K \hat{\sigma}_{T2}^2, \tag{A44}$$

$$\hat{\sigma}_{T2}^2 \equiv \sigma^2 + \xi_2[1 - \xi_2]\{C[1 + r] + [R - r][d + W_1]\}. \tag{A45}$$

The equilibrium d equates (A42) and (A44), and $d > 0$ as long as

$$[1 + r] > \alpha[\xi_2\{1 + R\} + \{1 + r\}\{1 - \xi_2\}]. \tag{A46}$$

That is, the manager's fractional ownership in the firm should not be too large. It is also easy to check that, with this positive d, $U(\Pi_1 \mid \Pi_1) > U(\Pi_2 \mid \Pi_1)$.

Thus, we have shown that pure dividend signalling is attainable in the general case. To prove that repurchasing stock is not optimal when $d \leq C - W_1$, we can use steps similar to those in the proof of Proposition 3 to see that, as long as

$$W_1 - W_2 > \alpha \begin{Bmatrix} [1 - \beta]^{-1} V_1(d - \varepsilon, \beta) - V_1(d) + V_2(0) \\ - [1 - \beta]^{-1} V_2(d - \varepsilon, \beta V^*(d - \varepsilon), W_1) - d \\ + \alpha K[\{1 - \beta\}^{-2} \tilde{\sigma}_{T2}^2 - \{1 - \beta\}^{-2} \tilde{\sigma}_{T1}^2 + \sigma_{T1}^2 - \sigma_{T2}^2] \end{Bmatrix}, \tag{A47}$$

the manager will not repurchase stock. The sign of the quantity in the braces that multiplies α on the RHS of (A47) is ambiguous. However, regardless of its sign, (A47) will hold as long as α is sufficiently small. Thus, we again have a familiar condition: the manager's ownership should not be too large.

Implications of Relaxing the "No-Managerial-Trading" Restriction: We now assume that the manager is allowed to completely liquidate his or her endowed stock holding at the beginning of the planning horizon. Clearly, a signalling equilibrium cannot exist with either dividends or stock repurchase if the type-1 manager does this. The expected utility of type-1 manager who sells out is

$$\bar{\mathrm{E}}(U) = [bN_o^{-1} + \alpha]\bar{V},$$

where $\bar{V}$ is the cross-sectional average market value of any firm when there is no signalling. (If the type-1 firms do not signal, then type-2 firms have no incentive to signal.) Let $\mathrm{E}_1(U \mid \eta_1)$ be the expected utility of the type-1 manager when he or she chooses a feasible signal vector η_1 (generally including a dividend and a repurchase) to signal that his or her firm is type-1. Then, if

$$\mathrm{E}_1(U \mid \eta_1) > \bar{\mathrm{E}}(U), \tag{A48}$$

the manager of the type-1 firm will *voluntarily* impose on himself or herself the no-trading restriction and *publicize* this restriction. In this case, we can remove the assumption that the manager *cannot* trade because, in equilibrium, he or she will choose not to. Note, however, that, if managers are allowed to liquidate their holdings, our formal analysis will be altered. There will be two changes. First, since the type-2 manager does not signal in equilibrium, he or she will liquidate his or her holding and enjoy an expected utility of

$$\mathrm{E}_2(U) = [bN_o^{-1} + \alpha]\hat{V}_2(0),$$

where $\hat{V}_2(0)$ is the true value of a type-2 firm that does not signal and that has a manager who sells out. The type-2 manager will not misrepresent if

$$\mathrm{E}_2(U) \geq \mathrm{E}_2(U \mid \eta_1), \tag{A49}$$

where $\mathrm{E}_2(U \mid \eta_1)$ is the expected utility of a type-2 manager choosing the signal vector of the type-1 manager. Second, the I.C. condition for the type-1 manager will be (A48). These changes will involve additional parametric restrictions to sustain our results but will affect little else.

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