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Dividends, Dilution, and Taxes: A Signalling Equilibrium

KOSE JOHN and JOSEPH WILLIAMS*

ABSTRACT

A signalling equilibrium with taxable dividends is identified. In this equilibrium, corporate insiders with more valuable private information optimally distribute larger dividends and receive higher prices for their stock whenever the demand for cash by both their firm and its current stockholders exceeds its internal supply of cash. In equilibrium, many firms distribute dividends and simultaneously issue new stock, while other firms pay no dividends. Because dividends reveal all private information not conveyed by corporate audits, current stockholders capture in equilibrium all economic rents net of dissipative signalling costs. Both the announcement effect and the relationship between dividends and cum-dividend market values are derived explicitly.

DIVIDENDS HAVE LONG PERPLEXED financial economists. Despite recent successes in constructing signalling equilibria with dividends, many important questions remain unanswered.¹ For example, why do corporations declare dividends and simultaneously sell new stock or, alternatively, distribute dividends and not repurchase stock? How do dividends with their dissipative costs—primarily adverse personal taxes—coexist with other presumably less costly technologies for releasing inside information, like audited annual reports? Do plausible signalling equilibria with dividends require transaction costs incurred by either corporations when issuing or retiring stock or investors when trading outstanding shares? Finally, how do the tax rates and demands for liquidity of such investors as widows, senior citizens, and financial institutions influence signalling equilibria?

A satisfactory theory of signalling with dividends must also have empirical content. In particular, such a theory should provide empirically testable propositions detailing the effects of announced dividends on stock prices,² cross-sectional connections between dividends and market values, and any resulting relationships between payout ratios and rates of return on stocks.³ In addition,

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¹ See Bhattacharya [3, 4], Hakansson [11], and Miller and Rock [20].

² See, e.g., Pettit [24], Charest [6], Aharony and Swary [1], Asquith and Mullins [2], and Patell and Wolfson [23].

³ See Elton and Gruber [8], Black and Scholes [5], Litzenberger and Ramaswamy [17, 18], Hess [12], Kalay [16], and Miller and Scholes [22].

the theory should help to explain other empirical phenomena, such as connections between dividends and clienteles of investors and the well-documented smoothing of dividends relative to cash inflows.⁴ Finally, a comprehensive theory might also have implications for relationships reported in the traditional literature, e.g., the purported negative correlations between dividends and both investment opportunities and risks.⁵

Hopefully, this paper helps in small part to resolve some of these issues. By design, the model provides an extremely adverse environment for signalling with dividends. Here, taxes are paid only on dividends; no transaction costs are incurred when issuing, retiring, or trading shares; and all sources and uses of firms' funds are fully observed by outsiders through costless public audits. Nevertheless, there exists a signalling equilibrium with dissipative dividends. In this equilibrium, corporate insiders distribute taxable dividends if and only if the demand for cash by both their firm and its current stockholders exceeds the supply of internal funds. Thus, some firms pay dividends, while others do not. Of those firms which pay dividends, many simultaneously sell new shares to outside investors. Still other firms pay dividends, sell no new shares, and, instead, support their stock prices and thereby benefit current claimants who sell outstanding shares to new investors.

The intuition behind this signalling equilibrium is surprisingly simple. When raising funds for investment, a firm must either issue new shares or retire fewer outstanding shares. Similarly, to raise cash on personal account, current stockholders must sell existing shares. In either case, current stockholders suffer some dilution in their fractional ownership of the firm. Reducing this dilution on either corporate or personal account is clearly more valuable to current stockholders when inside information is more favorable. Consequently, insiders, acting in the interests of their current stockholders, may distribute a taxable dividend if outsiders recognize this relationship, bid up the stock price, and thereby reduce current stockholders' dilution. In the resulting signalling equilibrium, insiders control dividends optimally, while outsiders pay the correct price for the firm's stock.

This signalling equilibrium exists because the marginal benefit to insiders of distributing dividends differs across firms. For firms with more valuable inside information, the premium paid in the market for stocks with marginally larger dividends, and thereby the reduction in dilution for current shareholders, just compensates stockholders for the incremental personal taxes on dividends. By contrast, for firms with less favorable inside information, the dissipative costs of the same dividend exceed at the margin the gains from reducing dilution. Consequently, there exists in the market a pricing function for stock which separates firms with more favorable inside information from those with less. In the resulting signalling equilibrium, firms with more favorable inside information optimally pay higher dividends, other things equal, and receive appropriately higher prices for their stock.

⁴ See Fama and Babiak [9], and the references cited therein.

⁵ See, e.g., Joy [15], p. 385.

The model is presented in Section I. To maximize their current stockholders' wealth, corporate insiders choose, conditional on their firm's investment, both its dividend and net new issue of stock. The representative firm, financed exclusively with equity, pays no taxes and incurs no transaction costs when either distributing dividends, or issuing or retiring shares. Investors, by contrast, pay taxes on dividends at a single, constant marginal rate, but no transaction costs when trading securities. In addition, outsiders observe through costless public audits all components of the firm's sources and uses of funds, but not its complete production technology. Instead, this latter information can be communicated convincingly from insiders to outsiders only through dividends or net new issues of shares.

Section II contains all major results. These properties include sufficient conditions for a signalling equilibrium, a firm's optimal dividend, the relationship in equilibrium between the firm's optimal dividend and its market value, the impact on its cum-dividend market value of an announced increment in its dividend, and the effect on the firm's investment of dissipative signalling costs. In the signalling equilibrium, corporate insiders declare a dividend if and only if the demand for cash by both their firm for investment and their stockholders for liquidity exceeds the internal supply of corporate cash. Among all firms which signal, those with more favorable inside information optimally pay larger dividends and realize higher prices for their stock, other things equal. In equilibrium, current shareholders capture all economic rents net of taxes on dividends. In this model, taxes are critical; without taxes or other costs of paying dividends, there is no signalling equilibrium.

Empirical implications are discussed in Section III. As predicted by the model and partially confirmed in previous empirical studies, the cross-sectional distribution of payout ratios has at least one mode at zero. Of those firms which pay dividends, many simultaneously issue new shares. Other firms which pay dividends have stockholders who demand current cash, e.g., widows, senior citizens, and financial institutions. Cross-sectionally, larger (smaller) dividends are associated with higher (lower) stock prices. Also, higher payout ratios are associated cross-sectionally with higher average returns and lower risks of return on corporate assets. Finally, because the cross-sectional impact of dividends is a simple function only of observables, it is testable empirically.

In Section IV, all major results are summarized and some possible extensions are sketched. All technical details appear in the Appendix.

I. The Model

Consider a representative firm. To abstract from problems related to its capital structure, the firm is financed exclusively with equity.⁶ At the beginning of the model's single time period, corporate insiders—the board of directors—commit their firm to an aggregate investment, *I*. Conditional upon this investment,

⁶ For the relationship between debt and dividends, see, e.g., John and Kalay [13, 14], and the references cited therein.

insiders then select a dividend, D . Funds for both investment, I , and dividends, D , can come from either corporate cash, C , or net new shares of stock, N , sold (purchased) at the ex-dividend price per share, p_e . When distributing dividends and issuing or retiring shares, the firm incurs no transaction costs. Consequently, its sources and uses of funds must satisfy the constraint:

$$D + I = C + p_e N. \quad (1)$$

Henceforth, upper and lower case letters represent respectively aggregate values for the firm and values per share.

Outsiders in the capital market observe without error the firm's sources and uses of funds. Initially, a costless public audit accurately measures the corporate cash, C . By design, this costless audit discriminates against costly dividends by forcing full, prior use of a costless technology for revealing private information. Simultaneously, corporate insiders announce their firm's dividend, D , and net external financing, $p_e N$. Because the market sets the ex-dividend price per share, p_e , insiders can determine only the dollar amount of net external financing, $p_e N$, and not the number of net new shares N . Finally, outsiders compute from the firm's sources and uses of funds (1) its investment, I . In this way, the firm's cash, C , dividend, D , and investment, I , initially become public information.

After one period, each firm realizes its final cash inflow. Insiders then liquidate their firm and distribute all proceeds pro-rata to its stockholders. Assuming that stockholders pay no personal taxes on liquidating dividends, the firm then has a terminal value equal to its final cash inflow. Here, this simple specification has two advantages. First, it is realistic. Under the Internal Revenue Code, Section 331, liquidating dividends commonly generate only capital gains or losses for the recipient. Second, by distributing no dividends, incurring no transaction costs when issuing or retiring shares, and finally liquidating the firm as above, insiders impose on their stockholders no dissipative costs. Again, this imposes a severe test for signalling with dividends.

Information about the firm's future cash inflow is asymmetric. To specify this asymmetry as simply as possible, fix the firm's investment at some feasible value, I , and represent by X the present value of the resulting, future cash inflow, as calculated by corporate insiders conditional on their private information. Although unessential for the subsequent analysis, this present value, X , can be interpreted as insiders' conditional expectation of the future cash inflow computed with respect to a state-price density function. This density function uniquely prices stocks in a complete market without taxes on capital gains.⁷ In general, the present value, X , can reflect private information about the firm's future return on either assets in place, opportunities to invest, or both. In any case, the value, X , is inside information; it is known to insiders but not observed directly by outsiders. By contrast, the distribution of the private attribute, X , across firms is common knowledge. For analytical simplicity, its distribution function is strictly increasing on the interval, $1 \leq X < \infty$, with the lower bound conveniently normalized at 1.

⁷ See Ross [27].

Dividends are costly to stockholders. When the representative investor receives a dividend, he must immediately pay a tax on the dividend at the constant, marginal personal rate, t . By assumption, the representative firm's stock is currently held solely by investors in a homogeneous clientele. Thus, this firm, owned exclusively by a clientele taxed at the rate, t , generates from its dividends the dissipative costs, tD . Alternatively, tD can be interpreted as the clientele's cost of avoiding personal taxes on dividends through a trading scheme as in Miller and Scholes [21].⁸ In fact, the dissipative costs, tD , need not be related to taxes; other costs associated with dividends can be substituted.⁹ Moreover, these costs need not be linear in dividends; any cost function strictly increasing in dividends is sufficient for existence of the subsequent equilibrium. Finally, to highlight the costs of signalling with dividends, stockholders are presumed to pay no taxes on capital gains. Similarly, firms pay no taxes on corporate income, capital gains, or undistributed profits.¹⁰

Because the firm's stock can be traded both cum-dividend and ex-dividend, its market prices per share, cum- and ex-dividend, must be related. To specify this relationship as simply as possible, suppose that a dividend's announcement data, ex-date, and payment date follow in immediate sequence.¹¹ Also, denote by Q the number of shares outstanding immediately prior to the net issue of N shares. In this simple model, with a single tax rate on dividends t , each stockholder at the ex-date then receives, after personal taxes, the dividend per share, $(1 - t)D/Q$. Consequently, to preclude riskless arbitrage around the ex-date, the cum-dividend price per share, p , must equal the ex-dividend price per share, p_e , plus the after-tax dividend per share, $(1 - t)D/Q$.¹²

$$p = p_e + (1 - t)D/Q. \quad (2)$$

In this model, signalling is motivated solely by insiders' desire to receive in the market a higher price for their currently liquidated component of the firm. In general, this liquidation occurs when either the firm finances its current dividend and investment by issuing new shares on corporate account or current stockholders sell outstanding shares on personal account. Accordingly, denote by L the liquidity, measured before personal taxes on dividends, demanded from the firm

⁸ Without some costs, either explicit or implicit, the trading scheme of Miller and Scholes [21] is inconsistent with plausible tax equilibria. The argument is simple. Apply their trading scheme to interest on corporate bonds, rather than dividends on stock. If the scheme is completely costless, then corporate bonds must be priced in equilibrium with all implicit tax rates equal to zero—contrary to the empirical evidence of Trczinka [29] and others. In this case, all firms would then issue only taxable bonds. Thus, without explicit costs, the above trading scheme must entail an implicit cost: the difference in the yield to maturity between taxable and tax-exempt bonds.

⁹ Bhattacharya [3] focuses on transaction costs. Miller and Rock [20] study the costs of foregone corporate investment.

¹⁰ In practice, the Accumulated Earnings Tax, IRC 531-37, is rarely applied to large corporations (see, e.g., Miller and Scholes [21, pp. 333-335]).

¹¹ In practice, the announcement date precedes by about one week the ex-dividend date, which precedes by about one month the payment date.

¹² In this model, the single tax rate t on dividends precludes the problems discussed in Kalay [16], and evident empirically in Eades, Hess, and Kim [7].

by its current stockholders. To meet this demand, current stockholders can sell shares either cum or ex-dividend. However, with the model's single tax rate on dividends, t , and the resulting no-arbitrage condition (2), stockholders are indifferent between selling shares cum and ex-dividend. Hence, for analytical simplicity, suppose that current stockholders receive the total dividend, D , and then sell M outstanding shares to new investors at the ex-dividend price per share, p_e :

$$L = D + p_e M. \quad (3)$$

Thus, the right-hand side of (3) measures the firm's supply of liquidity to its current shareholders, before personal taxes on dividends. Also, to simplify the subsequent analysis, suppose that current stockholders retain some shares: $M < Q$.

In (3), the demand for liquidity L from the firm by its current shareholders is specified exogenously as a constant.¹³ Here, this simple specification is possible only because no particular demand is critical. For example, in the plausible special cases with either no demand, $L = 0$, or borrowing by current stockholders to finance net purchases of the firm's shares, $L < 0$, all subsequent results still hold. In fact, the constant, exogenous demand, L , is introduced solely for expositional clarity. As shown in Section IV, more complicated models of liquidation produce nearly identical results under surprisingly plausible conditions. Thus, the main results from the basic model are first developed in Section II and then extended to more realistic, complicated specifications in Section IV.

With initially asymmetric information, outside investors may value the firm incorrectly out of equilibrium. In particular, outsiders observe only the firm's sources and uses of funds (1), including its aggregate dividend, D , and then collectively price the firm, cum-dividend, at $P(D)$, with $P \equiv pQ$. Here, P and p represent, respectively, the firm's total market price and price per share, both measured cum-dividend. As indicated, the firm's market price, $P(D)$, depends only on its dividend, D . As previously assumed, and for reasons fully explained in Section IV, corporate investment, I , is a constant in this simple model, so that the net external financing $p_e N$ is uniquely determined in (1) by the dividend, D . Suppressing the constants, C and I , as well as the dependent variable, $p_e N$, then produces the indicated pricing function, P . In the perfectly competitive capital market, both insiders and outsiders take the pricing function, P , as given—assuming that such a function exists. Existence of a pricing function, P , which induces corporate insiders to signal truthfully with dividends becomes a major burden of the subsequent analysis.

By assumption, insiders always act to maximize their stockholders' wealth. This they accomplish by maximizing their current stockholders' cash inflow, $(1 - t)D + p_e M$, computed net of personal taxes on dividends, plus the true present value of their remaining equity in the firm after dilution on both personal

¹³ More generally, the demand for liquidity L could be stochastic. If L is stochastic, then it is replaced in the maximand (4) by its conditional expectation, calculated under the unique state-price density function implicitly pricing securities in a complete capital market. Following Ross [27], this extension is straightforward. Different exogenous specifications of the demand for liquidity appear in Bhattacharya [3] and Miller and Rock [20].

and corporate account. Because current stockholders retain in the firm the fractional equity $(Q - M)/(Q + N)$ after sales (purchases) to new investors of M outstanding shares and N new shares, their remaining equity has the true present value, $X(Q - M)/(Q + N)$. Consequently, conditional on the corporate cash, C and investment, I , stockholders' liquidity, L , and private information, X , insiders then select the optimal dividend, $D(X)$, and net new funds, $p_e N(X)$, which solve the problem:

$$\max_{D, p_e N} \left\{ (1 - t)D + p_e M + \frac{Q - M}{Q + N} X \right\}, \quad (4)$$

subject to (1) through (3), $D \geq 0$, and $p_e N > -p_e Q$.¹⁴ In short, insiders maximize their firm's true value to its current stockholders.

With this objective, corporate insiders act in the interests of their current stockholders. Specifically, the dividend, $D(X)$, and the net new financing, $p_e N(X)$, maximize the firm's true value to its current stockholders, given the pricing function, P . This has two implications. First, insiders have no intrinsic preference in (4) for revealing private information. Instead, truthful signals may or may not follow incidentally from a solution to (1) through (4), depending on the pricing function, P . Second, insiders can maximize both their stockholders' wealth and their personal wealth if both groups trade their shares identically in (3). Indeed, if insiders ignore their stockholders' preferences, trade their shares in (3) independently of their private information, and control their corporation in (4) to maximize their personal wealth, then in equilibrium, their firm should attract a clientele of stockholders with identical preferences. However, if insiders not only trade anonymously their personal shares but also control their corporation for personal gain, then no signalling equilibrium can exist—exactly as in other signalling models.¹⁵

For expositional clarity, the insiders' problem (1) through (4) is rewritten as follows. Insert the financial constraints, (1) through (3), into the maximand (4), and delete the variable, $p_e N$. This produces the equivalent maximand:

$$U(D, P, X) \equiv L - tD + \frac{P + tD - L}{P + tD + I - C} X. \quad (5)$$

Given (5), the previous problem simplifies to selecting the dividend $D(X)$ which solves

$$\max_{D \geq 0} U(D, P, X). \quad (6)$$

In turn, the firm's optimal net new financing follows from its sources and uses of funds (1). Henceforth, (6) is called the incentive-compatibility condition.

¹⁴ A similar maximand, derived differently, appears in Miller and Rock [20]. Both specifications differ sharply from familiar signalling models in which insiders maximize only market values. See, for example, Bhattacharya [3, pp. 261–262].

¹⁵ If insiders can trade anonymously on personal account, they can signal falsely and then sell their shares before outsiders learn the truth. This precludes a signalling equilibrium, as discussed in Ross [26, pp. 28, 30].

The insiders' maximand (5) measures the firm's true value to its current shareholders, given an arbitrary market price, P . As such, this true value, U , holds under either symmetric or asymmetric information. Under symmetric information, i.e., when both insiders and outsiders observe the private attribute, X —the true value (5) simplifies as follows. Denote by $V(D, X)$ the firm's true value to its current clientele, given symmetric information. Were outsiders to observe the firm's private attribute, X , and thereby its true value, V , then competition in the capital market would produce a market price, P , equal to V . Inserting the value, V , into the maximand (5) then yields the functional equation,

$$V(D, X) = U[D, V(D, X); X].$$

From (5), this functional equation is quadratic in V with two real roots: $V(D; X) = L - tD$ and

$$V(D, X) = C + X - I - tD. \quad (7)$$

If, as previously assumed, current stockholders retain some shares, $M < Q$, then the firm's true value, V , to its clientele must exceed their proceeds, net of personal taxes, from current sales of shares, $L - tD$. In this case, (7) is the unique true value under symmetric information. As indicated, this true value, V , equals the firm's net present value, $C + X - I$, minus the dissipative cost of dividends, tD .

In this context, a signalling equilibrium is defined as follows. Given a perfectly competitive capital market, both insiders and outsiders regard the pricing function as fixed by market forces. Conditional on the pricing function, P , as well as the stockholders' liquidity, L , corporate cash, C , investment, I , and information, X , insiders then select their firm's optimal dividend, $D(X)$, to solve (6). In turn, outsiders both buy new shares and trade outstanding shares, believing correctly that the stock's total market price, $P[D(X)]$, measured cum-dividend, equals its concurrent true value, $V[D(X); X]$, to the firm's stockholders:

$$P[D(X)] = V[D(X), X]. \quad (8)$$

Henceforth, (8) is called the competitive-rationality condition. By definition, a signalling equilibrium $\{D(X), P[D(X)]\}$ must satisfy both the incentive-compatibility condition (6) and the competitive-rationality condition (8). As an application of Riley [25], this information equilibrium is a natural extension of the Walrasian model of price-taking.

II. Signalling Equilibrium

This section contains the main results of the paper. First, conditions sufficient for existence of a signalling equilibrium with dividends are identified. Next, properties of the signalling equilibrium are derived. In part, these properties include the optimal signalling function, the relationship between optimal dividends and market values, and the impact of announced increments in dividends on stock prices.

Existence of a signalling equilibrium with dividends can be shown using the results of Riley [25]. Here, a signalling equilibrium exists if Riley's assumptions

1 through 6 hold for the insiders' maximand, U , and the firm's true value, V . Assumptions 1, 2, and 4, mainly technical requirements in this model, are verified in the Appendix. Assumptions 3, 5, and 6—the critical restrictions with economic content—are verified below.

In his third assumption, Riley requires that the insiders' maximand increase in the price P paid for the signal D . Differentiating (5) with respect to the aggregate, cum-dividend price, P , verifies that $U_P > 0$ whenever

$$C < L + I. \quad (9)$$

In (9), the demand for cash by current stockholders on personal account, L , and corporate account, I , exceeds the firm's internal supply of cash, C . In this case, current stockholders and the corporation collectively sell shares to new investors and thereby dilute the fractional claim of current owners. As a result, a larger price, P , for the firm reduces this dilution, benefiting existing owners.

Riley's assumption 5 generalizes the familiar requirement of Spence [28] that the marginal cost of signalling decreases in the unobservable attribute. Specifically, assumption 5 stipulates that the marginal rate of substitution between the signal, D , and the market price, P , decreases in the attribute, X :

$$\frac{\partial}{\partial X} \left(-\frac{U_D}{D_P} \right) < 0. \quad (10)$$

Differentiating the maximand (5) shows that (10) holds if and only if $U_{PX} > 0$. In turn, $U_{PX} > 0$ requires that (9) hold and existing stockholders retain in (3) some shares: $M < Q$. Thus, when stockholders sell on personal and corporate account to new investors a fraction of the firm, $(M + N)/(Q + N)$, between 0 and 1, then their reduction in dilution, $U_P > 0$, from a larger market price, P , provides greater personal benefit with more favorable inside information, X : $U_{PX} > 0$.

Riley's assumption 6 requires that the corresponding problem with symmetric information, in which outsiders also observe the present value of the future cash inflow, X , has a unique maximum.¹⁶ Here, this property follows immediately from (7). Because the true value, V , decreases monotonically in the dividend, D , insiders optimally forego dividends under symmetric information—a familiar result.¹⁷

If inequality (9) holds and current shareholders retain some fraction of the firm, then there exists from Riley [25] a signalling equilibrium conditional on the corporate cash, C , and investment, I , as well as the personal liquidity, L . Specifically, if (9) holds, then stock must be sold to new investors, either by the corporation for investment or initial stockholders for personal liquidity. In either case, initial shareholders suffer some dilution. By signalling with dividends, insiders can then increase their firm's market price and thereby reduce this dilution. For stockholders retaining some fraction of their firm, the marginal benefit of reducing dilution is greater with truly more valuable firms: $U_{PX} > 0$.

¹⁶ The remaining part of Riley's assumption 6 does not apply here because the signal D has the feasible range $[0, \infty)$.

¹⁷ See Miller and Modigliani [19].

Thus, there exists a pricing function for the firm's stock, P , which compensates sufficiently only stockholders of truly more valuable firms to induce their insiders to signal with larger dividends. For truly less valuable firms, the equilibrium pricing function, P , compensates stockholders for the taxes assessed on dividends only at smaller dividends. Consequently, only insiders in firms with larger present values, X , signal with larger dividends, other things equal. In short, truthful revelation of the inside information, X , through the dividend, $D(X) > 0$, is optimal for all firms satisfying the above two conditions.

By contrast, insiders optimally pay no dividends whenever $C > I + L$. For a firm not satisfying inequality (9), the demand for cash on corporate and personal account is sufficiently small so that no shares must be sold to new investors. Instead, if $L < C - I < 0$, then all new shares issued by the firm can be sold through rights to existing stockholders. Alternatively, if $0 < L < C - I$, then all shares sold pro-rata by the firm's homogeneous clientele of stockholders can be repurchased by the firm. In either case, stockholders receive cash exceeding their demand for liquidity, L , and then must invest their excess cash elsewhere. However, neither transaction alters any existing stockholder's fractional ownership in the firm. Therefore, whenever (9) is violated, the firm's shareholders are indifferent to their stock's current market price. To minimize their stockholders' taxes, corporate insiders then optimally distribute no dividend: $D(X) = 0$. Also, with no loss in generality, insiders can be presumed to set their firm's stock price to satisfy the competitive rationality condition (5): $P(0) = V(0, X)$.

In the signalling equilibrium, corporate insiders distribute dividends because outsiders conjecture correctly that more valuable firms satisfying the above conditions pay greater dividends. Conditional on this conjecture, outsiders then collectively price the firm, cum-dividend, at $P(D)$.¹⁸ In turn, insiders take the pricing function as given, solve (6), and increase dividends until the marginal cost of additional dividends equals the net marginal benefit to current shareholders:

$$t = (t + P') \frac{L + I - C}{(P + tD + I - C)^2} X, \quad (11)$$

whenever inequality (9) holds. In the first-order condition (11), the benefit to current stockholders from reducing dilution is measured net of the dilution from financing additional dividends by either issuing more shares or retiring less shares on corporate account. As subsequently shown, insiders optimally distribute larger dividends $D(X)$ with more favorable private information X . Because outsiders can then distinguish between firms, competition in the capital market forces investors to pay in (8) the correct price for the firm, $V[D(X), X]$, measured cum-dividend. Consequently, outsiders' original conjecture is correct in equilibrium.

¹⁸ If outsiders conjecture that dividends convey no information and thus pay no premium for stocks with dividends, then insiders distribute no dividends. However, any investor can then make alternative, profitable offers to buy stocks which unravel this pooling contract. See Riley [25], Theorem 5. Also, from Riley's Theorem 4, the signalling equilibrium can unravel if the distribution function for the private attribute X is sufficiently convex.

Properties of the signalling equilibrium can now be derived. Following Riley [25], the optimal signalling function, D , is uniquely determined by its initial condition. Here, as in Riley, the initial condition is selected to minimize the dissipative cost of signalling for firms with the least favorable inside information, $X = 1$:

$$D(1) = 0. \quad (12)$$

Because any pricing function, P , satisfying (8) and (11) uniquely determines the dividend signalling function, D , up to a constant of integration, the initial condition (12) minimizes the dissipative cost of signalling for all firms subject to the constraint, $D \geq 0$. For this unique, efficient signalling equilibrium, conditional on the corporate cash, C , and investment, I , as well as the personal liquidity, L , the following proposition is proved in the Appendix.

PROPOSITION. *In the unique, conditionally efficient signalling equilibrium, the optimal dividend is*

$$D(X) = \frac{1}{t} \max(I - C + L, 0) \ln X, \quad (13)$$

for $X \geq 1$. Also, the market price of the firm's stock is

$$P[D(X)] = C + X - I - tD(X), \quad (14)$$

for $X \geq 1$. Finally, the impact of announced increments in dividends is

$$P'[D(X)] = t \frac{P[D(X)] + tD(X) - L}{I - C + L}, \quad (15)$$

for $X \geq 1$ and $C < I + L$.

The proposition completely characterizes the conditionally efficient signalling equilibrium. In (13), the optimal dividend increases in the private attribute, X —a property familiar from other signalling models. In addition, this dividend, $D(X)$, decreases in the personal tax rate, t , increases in the demand for personal liquidity, L , and decreases in the supply of corporate cash, C . Finally, the dividend, $D(X)$, is proportional to the logarithm of the stock's present value, X , measured net of current dividends and investment. In this sense, insiders optimally smooth dividends relative to the stock's true value.

In equilibrium, the stock's market price satisfies (14). Specifically, the firm's market price, $P[D(X)]$, equals its net present value, $C + X - I$, minus the optimal signalling costs, $tD(X)$. Here, this result holds because the firm's market price satisfies the competitive rationality condition (8) and thereby equals in equilibrium its true value under symmetric information (7). Consequently, current stockholders capture in equilibrium all economic rents net of signalling costs.

The impact of increments in dividends appears in (15). Not surprisingly, increments in dividends around the optimal dividend, $D(X)$, increase the market price of the firm's stock, $P[D(X)]$, measured cum-dividend. More surprisingly, this impact is proportional to the personal tax rate, t , on dividends, as shown by

substituting (14) into (15). In other words, in equilibrium stockholders must be compensated at the margin by a proportional increment in their stock price for incurring the proportional personal taxes from dividends.

In the signalling equilibrium, market prices are related to dividends. In particular, for each firm paying a dividend, $D(X) > 0$, (13) and (14) guarantee that

$$P[D(X)] = C - I - tD(X) + \exp \frac{tD(X)}{I - C + L}, \quad (16)$$

whenever (8) holds. In turn, (15) and (16) imply that, across firms, market prices are increasing and convex in optimal dividends. Here, (16) makes no claim about cause and effect; rather, it reveals a relationship across firms between stock prices, cum-dividend, and optimal dividends which depends only on observables.

This signalling equilibrium is dissipative. Hence, if all investors hold completely diversified portfolios, then a pooling equilibrium, in which no firms signal and all stock prices equal the average value, would produce greater wealth for all investors. However, a pooling equilibrium is unstable. From Riley [25], Theorem 5, any uninformed investor can offer to buy stock conditional on dividends or any feasible signal, induce only insiders in truly more valuable firms to accept, both make profits and impose losses on other investors, and thereby unravel the pooling equilibrium. This is not surprising. Because Riley's signalling game is noncooperative, the cooperative, pooling solution is Pareto-superior, but infeasible.

III. Empirical Implications

This signalling equilibrium has interesting empirical implications. Moreover, many of these implications are new. Among the novel results, some help to explain existing empirical evidence, while others offer opportunities for further empirical work.

As in Bhattacharya [3] and Miller and Rock [20], larger (smaller) dividends are associated, *ceteris paribus*, with higher (lower) stock prices, cum-dividend.¹⁹ Here, however, dividends reveal information beyond that conveyed by public audits of corporate cash inflows. Moreover, the cross-sectional effect (15) is explicit and thereby testable empirically. Although announcement effects of dividends have been documented in several empirical studies, no theoretical models have been tested to date.

More surprisingly, insiders in all but the least valuable firm optimally declare a dividend if and only if their stockholders' demand for cash on corporate and personal account, $I + L$, exceeds the firm's internal supply of cash, C . This condition for signalling has three implications. First, many firms distribute dividends, while others do not. Second, of those firms distributing dividends, many simultaneously sell new shares—despite the dissipative costs of dividends. Finally, firms paying dividends have, other things equal, clienteles of stockholders

¹⁹ Several empirical studies document dividend announcement effects. A partial list includes Fama, Fisher, Jensen, and Roll [10], Pettit [24], Charest [6], Aharony and Swary [1], Asquith and Mullins [2], and Patell and Wolfson [23].

who demand current cash—e.g., widows, senior citizens, and financial institutions. Such phenomena, puzzling under symmetric information with taxes, have been observed empirically.²⁰

After controlling for corporate investment, insiders smooth dividends relative to stock values measured after current dividends, dilution, and taxes. The smoothing function, the natural logarithm, is a property in (13) of the signalling equilibrium. As such, it arises endogenously from the optimal behavior of insiders. Because this property pertains to stock prices, it differs from the well-documented smoothing of dividends relative to net cash inflows.²¹

In addition, cross-sectional distributions of dividends and payout ratios are predicted to have the following properties. Given sufficiently large demands for external funds, $I - C + L$, firms with higher expected returns and thereby higher values of X have higher payout ratios, $D(X)/P[D(X)]$, other things equal. This follows from (13) and (16). Also, firms with more risky returns on assets in place pay lower dividends, other things equal. This latter property follows from (13) whenever the true present value, X , decreases in the relevant measure of risk—a condition easily verified for assets in place. Indeed, both relationships have long appeared in the traditional literature.²²

Finally, this paper has implications for recent empirical studies which report a positive relationship between dividend yields and returns on common stocks.²³ Is this relationship due empirically, various authors ask, to the effects of information or taxes? As indicated here, both effects are relevant. With symmetric information and taxes, insiders anticipate (7) and optimally pay no dividends; whereas, with asymmetric information and no taxes, the optimal signalling function (13) does not exist, and dividends convey in (15) no information. By contrast, dividends disappear with the addition of taxes to Miller and Rock [20]. Instead, their corporate insiders can communicate both credibly and less expensively all private information solely through repurchases of securities.

IV. Summary and Extensions

In this paper, a signalling equilibrium with taxable dividends is identified, and its properties are developed. In equilibrium, insiders in firms with truly more valuable future cash inflows distribute larger dividends and receive higher prices for their stock whenever the demand for cash by both their firm and its current stockholders exceeds its internal supply of cash. Thus, many firms distribute dissipative dividends, rather than repurchasing shares, while others distribute dividends and simultaneously sell new shares. Also, other things equal, firms which pay dividends have clienteles of stockholders who demand current cash—such as widows, senior citizens, and financial institutions. For this signalling equilibrium, both the announcement effect and the relationship between dividends and cum-dividend market values are derived explicitly.

²⁰ See Joy [15, p. 385].

²¹ Again, See Fama and Babiak [9], and the references cited therein.

²² See, e.g., Joy [15, p. 385].

²³ See the references cited in footnote 3.

Because this model is simple, many extensions are possible. Most notably, in a more complete model of equilibrium, the demand for liquidity, L , must be determined endogenously. To see how this might affect the previous results, replace the constant demand, L , in (3) by the value, $L(D, P)$, which reflects both the firm's aggregative dividend, D , and its total market price, cum-dividend, $P(D)$. Assume that the demand function, L , is differentiable in both arguments and recompute Riley's condition (10). In place of (9), this yields the inequality:

$$0 > (L + I - C)(L_D - t) + t(P + tD - L)L_P. \quad (17)$$

Given (17), Riley's assumptions again hold whenever current stockholders retain some shares, so that (17) replaces (9). Again, this signalling equilibrium is characterized by the previous proposition, with one exception. Now, the conditionally optimal dividend, $D(X)$, no longer satisfies (13), but only the initial condition (12) and the differential equation (3a) in the Appendix.

To interpret (17) consider two special cases. First, if $L_D < t$, then stockholders pay at least some personal taxes on the firm's dividends, D , from funds raised elsewhere—e.g., personal cash or sales of personal securities other than the firm's stock. In this case, if $L_P = 0$, as in Section I, then a signalling equilibrium again exists whenever inequality (8) holds. By contrast, if $L_D = t$, then the dividend, D , does not directly affect the cash received by stockholders after personal taxes on dividends, as in the familiar literature with symmetric information.²⁴ In this second case, (17) holds and a signalling equilibrium exists whenever $L_P < 0$. Indeed, this latter inequality is quite plausible. With personal taxes on capital gains (losses) assessed (credited) only when realized, stockholders optimally defer gains and realize losses. Depending on the distribution of stockholders' tax bases, sales of the firm's stock then decrease with increments in its cum-dividend price. Unfortunately, the complications produced by this more elaborate model of equilibrium are well beyond the current signalling literature.²⁵ Moreover, these complications are tangential to the main message of this paper—the existence of a signalling equilibrium with dividends, dilution, and taxes.

Although fixed in the previous signalling equilibrium, the firm's investment is easily endogenized as follows. Represent by $X = F(I; x)$ the firm's present value of its future cash inflow, conditional on its investment I and private information x . Given I , the previous argument then produces the unique, conditionally optimal dividend (13). Denote this optimal dividend by $D(I, x)$, the resulting value of insiders' maximand (5) by $U\{D(I, x), P[D(I, x), I], x\}$, and the optimal investment for this maximand by $I(x)$. Because the conditionally optimal dividend, $D(I, x)$, is unique, there is a signalling equilibrium. That is, a pricing function, P , exists such that the corporate dividend, $D(x) = D[I(x), x]$, and investment, $I(x)$, jointly maximize (5) and satisfy the competitive-rationality condition, $P[D(x), I(x)] = V[D(x), I(x), x]$. However, this signalling equilibrium is no longer unique. Instead, many combinations of dividends, D , and investment, I , can convey all inside information to the market.

²⁴ This preserves the spirit of Miller and Modigliani [19].

²⁵ For example, when different investors face different tax rates on ordinary income, the ex-dividend pricing relationship (2) becomes considerably more complicated (see Kalay [16]).

Still other extensions are possible. Specifically, dissipative signalling models with dividends can include securities other than common stock and costs other than differential taxes. For example, to support sales of corporate bonds and preferred stocks, insiders may optimally distribute dividends, raise prices, and thereby reduce current stockholders' dilution. By contrast, Bhattacharya [3] focused on transaction costs incurred by firms when raising new capital. Problems with transaction costs become both more realistic and more complicated if stockholders also incur brokerage costs when trading shares in response to adjustments in dividends, corporate net cash inflows follow a random walk, and investment opportunities arrive independently over time. In this case, firms might optimally finance dividends from internal cash and investment, if necessary, from new issues of shares. The total transaction costs incurred by both the firm and its stockholders might then drive the signalling equilibrium.

Here, all stockholders belong to one clientele characterized by a single tax rate and a homogeneous demand for liquidity. In a more realistic model, investors would have different tax rates and different demands of liquidity determined by the optimal solutions to their portfolio-consumption problems. A signalling equilibrium in such a model would include not only optimal dividends determined by insiders and credible communication of private information to the market, but also clienteles for dividends among investors. In equilibrium, clienteles of investors, categorized by tax rates and demands for liquidity, would presumably purchase stocks of identifiable firms, categorized by their current net cash inflows, returns on existing assets, investment opportunities, and risks.

Still another extension might include multiple technologies for monitoring and signalling. In this case, outsiders would presumably monitor firms using all equally credible technologies in order of increasing cost. Here, less costly technologies could include ratings of corporate bonds, audits by public accountants, and studies by security analysts. Any residual asymmetry of information would then induce signalling with taxable dividends and other devices. In the resulting equilibrium, dividends and other signals might reveal information inaccessible using less costly monitors—e.g., insiders' forecasts of their firm's future prospects. In such a model with competing costly technologies, the survival of dividends is, of course, an open question.

Finally, in a repeated game with reputations, dividends might reveal corporate characteristics to outsiders, completely or partially, with or without dissipative costs. Specifically, corporate insiders might recognize the relationship between repeated dividends and their firm's reputation and optimally smooth dividends over time relative to corporate cash inflows. Thus, even if neither the firm nor its stockholders currently demand cash, insiders might optimally pay a current dividend. Were this dividend to protect and enhance the firm's reputation, it might then justify its dissipative cost.

Appendix

This Appendix is organized as follows. First, the signalling problem from Section I is restated. Next, the assumptions of Riley [25, pp. 334–335], are checked. Finally, the proposition in Section II is proved.

Signalling Equilibrium. Given (7), problem (6) and (8) simplifies to finding a pricing function, $P \geq 0$, which satisfies

$$D(X) \equiv \arg \max_{D \geq 0} U[D, P(D), X]; \quad (\text{a})$$

$$P[D(X)] = C + X - I - tD(X). \quad (\text{b})$$

Assumptions. Using the notation in this paper, Riley's assumptions 1 through 6 can be restated as follows.

- (A1) The private attribute X is distributed on $[1, \infty)$ according to a strictly increasing distribution function.
- (A2) The maximand U from (5) and the value $V + tD$ from (7) are differentiable in all arguments.
- (A3) The maximand U is increasing in the price $P + tD$.
- (A4) The value $V + tD$ is positive, increasing in the attribute X , and nondecreasing in the dividend D .
- (A5) The maximand U everywhere satisfies the single-crossing property (10).
- (A6) The value V from (7) decreases in the dividend D .

These assumptions are easily checked using the correspondence between notation itemized in Table A1. As indicated, the notation is slightly asymmetric, reflecting a minor difference between the two models. Here, current stockholders pay the signalling costs; in Riley's model the firm pays all signalling costs. Thus, the true value of Riley's firm must exceed the true value, V , in this model by the signalling costs, tD . The relationship between prices in Table A1 then follows from the incentive-compatibility condition (8). The remainder of Riley's assumption 6 does not appear in (A6) because it does not apply in this problem. In Riley's model, the unknown attribute can have a compact support; here, the attribute X is distributed on $[1, \infty)$.

Assumption (A1) appears in Section I. Riley's assumptions (A2) and (A4) are satisfied by the maximand (5) and the true value (7). Finally, (A3), (A5), and (A6), hold, as verified in Section II, under the conditions specified there.

Proof of the Proposition. Property (14) follows from (b). For the announcement effect (15), insert (14) into the first-order condition (11) and rearrange terms. Finally, for the dividend signalling function (13), insert both (14) and the derivative of (14) with respect to X into (15) to yield, whenever (9) holds, the

Table A1
Correspondence between Notation

	Notation in Riley [25]	Corresponding Variable Here
Private attribute	θ	X
Signal	y	D
Insiders' maximand	U	U
True value	V	$V + tD$
Market price	P	$P + tD$

differential equation:

$$D' = \frac{I - C + L}{tX}, \quad (c)$$

on $X \geq 1$. Finally, integrate (c) subject to the initial condition (11) to give (13).

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