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Dividend Policy under Asymmetric Information

MERTON H. MILLER and KEVIN ROCK*

ABSTRACT

We extend the standard finance model of the firm's dividend/investment/financing decisions by allowing the firm's managers to know more than outside investors about the true state of the firm's current earnings. The extension endogenizes the dividend (and financing) announcement effects amply documented in recent research. But once trading of shares is admitted to the model along with asymmetric information, the familiar Fisherian criterion for optimal investment becomes time inconsistent: the market's belief that the firm is following the Fisher rule creates incentives to violate the rule.

We show that an informationally consistent signalling equilibrium exists under asymmetric information and the trading of shares that restores the time consistency of investment policy, but leads in general to lower levels of investment than the optimum achievable under full information and/or no trading. Contractual provisions that change the information asymmetry or the possibility of profiting from it could eliminate both the time inconsistency and the inefficiency in investment policies, but these contractual provisions too are likely to involve dead-weight costs. Establishing which route or combination of routes serves in practice to maintain consistency remains for future research.

THE STANDARD FINANCE MODEL of optimal investment/financing/dividend decisions for the firm (as summarized, say, in Fama and Miller [16], Chapters 2 and 3 which in turn builds on the earlier work of Miller and Modigliani [33]) assumes, among other things, that outside investors and inside managers have the same information about the firm's current earnings and future opportunities. We propose in Section I of this paper to replace that assumption with the more plausible one that managers know more than outside investors about the true state of the firm's current earnings.

For the theory of finance, that replacement brings both good news and bad news. The good news is that dividend (and financing) announcement effects, amply documented in recent empirical research, now become implications of the basic decision model rather than qualifications appended to it as in the original Miller-Modigliani (hereafter referred to as MM) treatment [33, p. 430]. In a world of rational expectations, the firm's dividend (or financing) announcements provide just enough pieces of the firm's sources and uses statement for the market to deduce the unobserved piece, to wit, the firm's current earnings. The market's estimate of current earnings contributes in turn to the estimate of the expected

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future earnings on which the firm's market value largely hinges. The model's dividend information effects are thus entirely consistent both with the MM proposition that the value of the firm is governed by its earnings and earning power; as well as with the findings of Watts [44] and Gonedes [17] that in time-series forecasts of future earnings, current and past dividends appear to have little predictive power over and above current and past earnings.

The bad news is that the price of allowing for information asymmetry and dividend announcement effects may be the loss of the familiar Fisherian criterion for optimal investment by the firm—viz., invest in real assets until the marginal internal rate of return equals the appropriately risk-adjusted rate of return on securities. In a world where the market takes announced dividends (or financing) as a clue to unobserved earnings, temptations arise to run up the price by paying out more dividends (or engaging in less outside financing) than the market was expecting, even if that means cutting back on investment. The market will eventually learn the truth and the price will presumably then fall back as Miller and Modigliani [33, p. 430] and others have noted. But that eventual restoration will be of little concern to those shareholders who have managed to sell out at the inflated postannouncement price (or to those managers whose compensation is tied directly or indirectly to the firm's short-run price performance). The nonselling shareholders would be hurt by this deception, of course; but if the market takes the firm to be following the Fisherian optimum investment policy, we show that the potential gain to the sellers from departing from the optimum will exceed the loss to stayers. The familiar Fisherian optimum is thus no longer a time-consistent equilibrium investment policy once inside information and the possibility of profiting from it are admitted to the model.

Policies that are time inconsistent have little survival value and hence hold little interest for economists. In Section II of the paper we go on to explore in some detail one possible route to restoring consistency to dividend and investment policies in the face of the informational asymmetries and associated incentives introduced in Section I. That route is a signalling equilibrium à la Spence [41]. Outside investors realize they know less than the insiders and take into account the temptations managers face to exploit their superior information on behalf of the selling shareholders. The postannouncement price that outsiders will offer thus discounts the likely departure from the Fisherian optimum. Management, in turn, understands that the market is allowing for this departure and will accordingly provide it. To do otherwise would send a bad news signal to the market. Thus, both sets of expectations can be simultaneously fulfilled and the essential time consistency restored to the firm's payout and investment policies, but only by sacrificing efficiency. The new consistent optimum investment level will be below the familiar first-best optimum of the standard, full-information model. The deviation from the full-information optimum investment is shown to be larger, the greater is the weight that the firm's objective function places on the current price as set in the market by outsiders as opposed to the price the insiders know to be warranted, and the greater is the degree of persistence in the firm's underlying income stream.

The signalling model we develop in Section II represents one route, but only

one route, to the restoration of time consistency. An alternative is to remove the conditions that give rise to the inconsistency, viz., inside information and the possibility of exploiting it and thereby avoiding the inefficiencies encountered on the other route. Certainly, many institutional arrangements exist, such as disclosure laws and restrictions on insider trading, which move the decision problem closer to the classical conditions. More such arrangements will undoubtedly be flagged as the time-consistency problem of dividend policy becomes more widely appreciated. Which route, or more likely in our view, which combination of routes, the real world takes in practice to maintain consistency, despite informational asymmetry, remains to be shown.

I. Dividend and Investment Policy under Asymmetric Information: Announcement Effects and the Consisting Problem

Announcement effects and their consequences under conditions of asymmetric information are analyzed here for a two-period, one-decision, no-tax, uncertainty model of the firm's dividend/investment/financing decision.

A. Evolution of the Earnings Stream

The evolution of firm's (random) earnings stream, \tilde{X} , is described by the equations:

$$\tilde{X}_1 = F(I_0) + \tilde{\varepsilon}_1 \tag{1}$$

$$\begin{aligned} \tilde{X}_2 &= F(I_1) + \tilde{\varepsilon}_2 \\ &= F(\tilde{X}_1 + B_1 - D_1) + \tilde{\varepsilon}_2. \end{aligned} \tag{2}$$

At time zero (the past), the firm invested I_0 in a production process whose output at the end of the period is $F(I_0)$ plus a random increment $\tilde{\varepsilon}_1$. The sum of the two constitutes the firm's earnings, \tilde{X}_1 . At the start of period 1 (the present), those earnings plus any additional funds raised, B_1 , are divided between dividend payments, D_1 , and investment, I_1 . The investment of I_1 yields an end-of-period output of $F(I_1)$ plus another random increment, $\tilde{\varepsilon}_2$. The total earnings, \tilde{X}_2 , are distributed to the security holders at the start of period 2 (the future), and the firm is disbanded.

The production/investment function $F(I)$ is assumed to have the following properties: $F \in C^\infty$; $F(I) \geq 0$; $F(0) = 0$; $F' > 0$; and $F'' < 0$. For the additive random terms, we assume:

$$E_0(\tilde{\varepsilon}_1) = E_0(\tilde{\varepsilon}_2) = 0$$

$$E(\tilde{\varepsilon}_2 | \varepsilon_1) = \gamma \varepsilon_1.$$

The unconditional, period 0 expectation of each random shock is zero. But the conditional expectation of the second period random increment, given the first, is $\gamma \varepsilon_1$, where γ is an assumed coefficient of persistence. If $\gamma = 1$, the first period shock is permanent; if $\gamma = 0$, the first shock is entirely transitory. Values of $\gamma >$

1 (extrapolation) or even $\gamma < 0$ (reversal) can also be accommodated should the context require them.¹

B. The Firm's Decision Problem

At the start of period 1, after the earnings and the dividend/investment/financing decisions have been announced, the cum-dividend value of the shares held by the original owners will be

$$\begin{aligned} V_1 &= D_1 + \frac{1}{1+i} E(\tilde{X}_2) - B_1 \\ &= D_1 + \frac{1}{1+i} [F(I_1) + \gamma \varepsilon_1] - B_1 \end{aligned} \quad (3)$$

where i is the "appropriately risk-adjusted discount rate for the firm's expected earnings." (Pardon our casualness, but as will become clear later, uncertainties of the kind associated, say with the CAPM, are not central to the issues in this paper.)

Under the standard perfect market/full information assumptions, a firm operating in the best interest of its current shareholders will choose values of D_1 , I_1 , and B_1 that maximize V_1 subject to the firm's budget or sources/uses constraint:

$$X_1 + B_1 = I_1 + D_1 \quad (4)$$

or equivalently

$$X_1 - I_1 = D_1 - B_1 \quad (5)$$

where the left-hand side of (5) represents the firm's "net cash flow from operations" and the right-hand side the firm's "net dividend." Making use of (4) or (5) to rewrite (3), the value of the shares can be expressed in discounted net cash flow form as

$$V_1 = X_1 - I_1 + \frac{1}{1+i} [F(I_1) + \gamma \varepsilon_1]. \quad (6)$$

An immediate implication of (6) is, of course, the MM dividend invariance theorem, viz., given the firm's investment decision, I_1 , the value of the firm is independent of its dividend decision, D_1 . The seeming gain to the original shareholders from a higher dividend suggested from (3) is exactly offset, given X_1 and I_1 , by having to sell off more of the firm to outsiders.²

¹ The assumption that the random shocks enter additively rather than, say, multiplicatively, greatly simplifies the derivation of optimal investment policies, but is not critical for any of the important conclusions (assuming appropriate additional restrictions on the size of the multiplicative shocks).

² At this stage of the argument, with perfect markets and full information to all participants, it does not matter whether the outside financing B_1 is via stock issues (at the ex-dividend price) or bond issues. In either case, the money raised from outsiders must exactly equal the present value of the claims they receive to the firm's period 2 returns. Once the full-information assumption is relaxed, however, circumstances can arise in which the two forms may not be equivalent (see footnote 9).

Given the MM proposition on dividends and financing, the problem of maximizing the market value of the shares of the original owners thus reduces to one of selecting the optimal level of investment, I_1^* , leading in turn to the familiar optimality criterion

$$F'(I_1^*) = 1 + i \tag{7}$$

in rate of return form, or

$$F'(I_1^*)/(1 + i) - 1 = 0 \tag{7'}$$

in net present value form. Note that under our assumptions, I_1 is independent of X_1 (and hence also of the random realization ε_1). But the dividend is not. If $I_1^* < X_1$, then the net dividend $D_1 - B_1$ is positive; and if $I_1^* > X_1$, the net dividend is negative, i.e., the firm engages in net outside financing.

C. The Earnings Announcement Effect

Expressions such as (3) or (6) represent the market value of the firm at the start of period 1, immediately after the previous period's investment/financing/dividend decisions are announced to the public. To the extent that these announced values differ from those anticipated by the market at the end of period 0, the disclosure triggers price adjustments, the direction and size of which depend in turn on how the market forms its anticipations. Here and throughout we take these anticipations, whatever their precise form, to be "rational expectations" in the sense of Muth [35]. For the stochastic components of the earnings terms, this means the market is presumed to know the joint distribution of $\tilde{\varepsilon}_1$ and $\tilde{\varepsilon}_2$. The market is presumed also to know the form and the relevant parameters of the firm's objective function. The market can step into management's shoes, as it were, and understand the decision problem which management is trying to solve.

More precisely, we assume that the firm is, and that the market knows the firm is, seeking to maximize (3) or (6) subject to the sources/uses constraint, (4) or (5). With the market assumed to know the parameters of (3) or (6)—the production function $F(\cdot)$, the original input I_0 , the market discount rate i and the earnings persistence coefficient, γ —the market anticipates an investment level of I_1^* from (7) and that level will in fact be realized. The preannouncement value of the firm can thus be expressed as

$$\begin{aligned} E_0(V_1) &= E_0(\tilde{X}_1) - E_0(I_1) + \frac{1}{1 + i} [E_0(F(I_1))] \\ &= F(I_0) - I_1^* + \frac{1}{1 + i} [F(I_1^*)] \end{aligned} \tag{8}$$

where the notation E_0 serves as a reminder that the anticipation in (8) are formed before the announcements are made.³ The corresponding postannouncement

³ The dating to period 0, however, is not critical. Interim earnings reports or other news between 0 and 1 can readily be accommodated with appropriate reinterpretations of the residual uncertainty, $\tilde{\varepsilon}_1$. That is, ε_1 should be thought of as that information about earnings not already available when the announcements are made.

value is

$$\begin{aligned} V_1 &= X_1 - I_1^* + \frac{1}{1+i} [E_1(X_2)] \\ &= F(I_0) + \varepsilon_1 - I_1^* + \frac{1}{1+i} [F(I_1^*) + \gamma \varepsilon_1]. \end{aligned} \quad (9)$$

Subtracting (8) from (9) then gives the “earnings announcement effect.” The price change following the disclosure of the firm’s earnings is proportional to the surprise in earnings, the proportionality factor being greater, the greater the persistence parameter, γ , viz.,

$$V_1 - E_0(V_1) = \varepsilon_1 \left[1 + \frac{\gamma}{1+i} \right] = (X_1 - E_0(\tilde{X}_1)) \left[1 + \frac{\gamma}{1+i} \right]. \quad (10)$$

D. The Dividend Announcement Effect

Earnings announcement effects of a kind consistent with (10) have long been accepted into the canon of empirical results in finance and accounting although their existence was once the subject of considerable controversy. (For a recent survey, see Watts [44].) A similar, but longer-persisting controversy, arose over the existence of “dividend announcement effects,” in the sense of price movements in response to dividend declarations unaccompanied by simultaneous earnings announcements. Such price responses have always been part of the real-world folklore but only recently has their presence been demonstrated convincingly in carefully-controlled empirical studies (see especially Aharony and Swary [1], Asquith and Mullins [2], and Brickley [7]). Since stock prices, following MM, are taken to reflect the firm’s earnings and earnings opportunities, the presumption has been that dividend announcements convey information about the firm’s future earnings prospects. But no consensus yet exists as to what this information is, whether it adds anything beyond what is conveyed by the firm’s earnings statements, and, especially, why (even without allowing for tax penalties) firms choose to communicate information via their dividend declarations.

These and related questions can readily be answered, using the present model. Recall from (5) that the actual net dividend announced at period 1 must equal the actual net cash flow of period 1, $X_1 - I_1$. The period 1 earnings expected at the end of period 0 will be $E_0(\tilde{X}_1) = F(I_0)$. The expected (and the actual) investment, under our assumption of rational behavior and expectations, will be the optimum level, I_1^* . The difference between actual and expected net dividends will thus be

$$(D_1 - B_1) - E_0(D_1 - B_1) = X_1 - E_0(\tilde{X}_1) = \varepsilon_1 \quad (11)$$

and the price change triggered by the announcement of the net dividends (with or without simultaneous announcement of the earnings) will be

$$\begin{aligned} V_1 - E_0(V_1) &= ((D_1 - B_1) - E_0(D_1 - B_1)) \left[1 + \frac{\gamma}{1+i} \right] \\ &= \varepsilon_1 \left[1 + \frac{\gamma}{1+i} \right]. \end{aligned} \quad (12)$$

Announcement effects, including the observed dividend announcement effects, thus emerge naturally as implications of the basic model rather than as *ad hoc* appendages or qualifications as (alas) in Miller-Modigliani [33].

The model has additional empirical implications. The dividend announcement effect of (12) can be decomposed further into two components: one is the dollar-for-dollar effect of the dividend surprise itself; the other is the extrapolative effect of that surprise via the persistence parameter, γ . The higher the value of γ , the stronger the persistence in earnings and the greater the predicted responsiveness of price to unexpected dividends.

Note also that while the announced dividends do indeed convey information about the firm's likely future earnings, they do so only indirectly and need not represent deliberate policy by the firm's managers to communicate their views about future prospects. Their dividend announcement serves merely to provide the missing piece of the sources/uses constraint which the market needs to establish the firm's *current* earnings. That earnings figure, in turn, rather than the dividend itself, then serves as the basis for estimating future earnings. By this indirect route, therefore, dividends can acquire an important "informational content" even though, as Watts [44] and Gonedes [17] have shown, dividends appear to have little predictive power for future earnings over and above that contained in current and past earnings.^{4,5}

Because the dividend announcement in (12) reveals fully the value of current earnings, subsequent announcement of those earnings should be redundant. Yet, market prices do seem to respond to earnings announcements even when the earnings announcement follows closely after dividend announcements. Remember, however, that the "dividend" in (12) is the *net* dividend, $D_1 - B_1$; while our treating the two components as simultaneous often simplifies exposition, it is not, nor is it intended to be, literally descriptive. Firms typically announce their dividends quarterly, immediately following the Board of Directors meeting at which the decision was made. The market uses that dividend announcement, in the light of its understanding of the firm's dividend policies, to form a new estimate of expected current earnings. The new conditional expectation, $E_1(\tilde{X}_1 | D_0, D_1)$ —the term D_0 being added as a reminder that the market is using its knowledge of the firm's past policies as well as the current dividend—improves the previous unconditional estimate, $E_0(\tilde{X}_1)$, but normally not completely. The full story of the current condition does not emerge until the firm announces its earnings or until it completes the net dividend by specifying its plans for outside financing.⁶

⁴ Announcing the net dividend can supply *exactly* the missing piece of the current cash flow in our model because the other unobserved piece, I_1 is supplied by the market's assumed rational expectations of the firm's optimal investment policies. In practice, of course, some uncertainty may well surround investment decisions, and it remains for future empirical research to establish how much of observed announcement effects are traceable to resolution of those uncertainties rather than to resolving uncertainties about earnings.

⁵ Just how much marginal information, if any, is conveyed by dividends over and above that of earnings is still a matter of some dispute. Part of the problem is that announcements are made continually so that some dividend announcements are always being made before some earnings announcements and after others. For some recent evidence suggestive of interaction effects between dividend surprises and earnings surprises see Kane, Lee, and Marcus [26].

⁶ For most firms, dividend changes appear to respond to earnings changes after a lag (see Lintner

E. The Financing Announcement Effect

Price perturbations similar to those occasioned by dividends or earnings announcements have in fact been observed following announcements by firms of outside financings (see, e.g., Huart [22] and Dann and Mikkelson [10]). Such financing announcements are associated on balance with falls in stock prices—falls that academic opinion would prefer to be able to attribute to “information effects” rather than to management failures to act in the interests of the shareholders.⁷ But since information effects are differences between realizations and expectations, they should have a mean of zero if the complete sample space of “surprises” is correctly specified. What then are the complementary events that offset the predominantly negative returns on financing announcements?

That question has a simple answer in the present model. The financing announcement effect is merely the dividend announcement effect, but with sign reversed. Recall that our discussion so far has been couched in terms of the net dividend, $D_1 - B_1$. Positive values of net dividends can be interpreted as “dividends” in the ordinary sense and negative values as “financing.”⁸

The sign and size of the price change following an announcement of new financing will then depend on the relation of optimal investment I_1^* to the preannouncement expectation of earnings, either $E_0(\tilde{X}_1)$ or $E_1(\tilde{X}_1 | D_0, D_1)$. If the internal net cash flow had been expected to be positive, financing is bad news; the negative net dividend signifies that \tilde{e}_1 has been negative and earnings are less than expected. But if expected earnings had been low relative to I_1^* , so that some positive financing had been anticipated, the announcement effect might go either way, depending on whether the actual announced financing turned out to be greater or less than expected.

That most recent studies report predominantly negative announcement effects for an entire class of announcements, such as net new financings, thus need not be considered anomalous. It may signify only that on balance, the market expects earnings to exceed investment. A complementary class of “good news” events does exist, but might be overlooked if attention is restricted to financing announcements narrowly construed. The relevant sample space extends over dividend (and earnings) announcements as well as financing announcements.^{9,10}

[29] and Fama and Babiak [14]), but the factors governing the lag structure remain obscure. MM conjectured that the Directors change dividends only in response to what they regard as permanent rather than transitory changes in earnings—a policy that could be accommodated within the present model framework by extending the information asymmetry to include the persistence parameter γ . For some recent empirical work bearing on the permanent earnings hypothesis see Kormendi, Leftwich, and Lipe [27] and Marsh and Merton [30].

⁷ Huart [21] and Asquith and Mullins [2] find large and highly significant negative price movements on the announcement of common stock financings. Dann and Mikkelson [9] find similar fall-offs for announcements of debt financing—large and highly significant for convertible issues, smaller and less significant (about the 10% level) for straight debt issues.

⁸ Or, alternatively, positive values could be interpreted as negative outside financing, i.e., as purchases of securities including, of course, repurchase of shares or retirements of outstanding securities. Such share repurchases should have announcement effects similar to those of dividends and that does indeed seem to be the case (see Vermaelen [42] and Masulis [31]).

⁹ The financing announcement effect here considered is independent of the type of security issued because the information asymmetry extends only to the return on past investments, \tilde{e}_1 . Should

F. The Inconsistency of the Optimal Policies when Intermediate Trading Can Occur

The analysis of information effects to this point has assumed the market to expect, and correctly, that the firm will follow an optimal investment policy. But what if the firm were to cheat by cutting investment below the optimal level and paying out the proceeds in a higher dividend? Were the market now to add the higher dividend to the assumed optimal level of investment, the market would overestimate the firm's current earnings and hence place a higher-than-warranted value on the firm's shares.

That a firm might fool the market at least temporarily by such tactics was recognized by MM [33, p. 430], but they suggested the price rise would presumably be "reversed when the unfolding of events had made clear the true nature of the situation." True enough. But what of those shareholders who managed to sell their holdings at the temporarily inflated price? Their gain is permanent.

The possibility of reaping such gains means that, without imposing further restrictions on the model, the firm's investment decisions can no longer be presumed to conform to the classical optimality criterion, $F'(I_1^*) = 1 + i$. If the market really were to believe that the firm's decisions conformed to the classical criterion, those stockholders planning to sell shares after the dividend announcement (but before the true state of the earnings are known) could "bribe" the firm's decision makers to cut back investment and pay the funds out as a dividend. Those not planning to sell might, in principle, offer a "counter-bribe" to keep the decision maker impartial, as the old joke has it. But, in the present context, it is easy to show that the potential bribing power of the sellers to induce departure from the classical, full-information optimum exceeds the counter-pressure that the stayers could bring to bear.¹¹

If k is the fraction of shares sold, we know from (12) that the total gain to the sellers from a \$1 increase in the firm's net dividend would be $k\left(1 + \frac{\gamma}{1+i}\right)$,

which is clearly positive as long as $\gamma \geq 0$.¹² The stayers too, receive the dividend. But they lose the present value of the investment foregone so that the total net

management, however, also have information not available to the public about future returns, \tilde{e}_2 , then the choice of stock issue or bond issue can be expected to convey additional information over and beyond that in the decision to go outside for funds. For a formal model in which the market's response to the announcement of stock financing differs from that of bond financing, see Heinkel [19]. See also Myers and Majluf [35] for an account of the "lemon-like" properties of common stock financing under asymmetric information (see also John and Williams [23]).

¹⁰ Huberman [22] has extended the present model by introducing the firm's precautionary balances as an additional link in the chain from the earnings surprise to the financing announcement to the change in market value.

¹¹ We assume that there would be no costs to making such side payments or, at least, that the costs of dividing the spoils would be small enough to keep the consistency problem from becoming moot. There remains, of course, the issue of why, given their different interests, the two groups ever joined together in a common enterprise. Presumably, those buying into the firm did not know *ex ante* at time 0 which group they would be in at time 1; merely that there was some probability that they might want to sell off all or part of their holdings before the ultimate liquidation of the firm in time 2.

¹² The main point goes through even if $\gamma < 0$, but for a dividend cut rather than an increase.

change in their wealth will be $(1 - k) \left(\frac{F'(I_1^*)}{1 + i} - 1 \right)$. Since $F'(I_1^*) = 1 + i$ at the

full-information optimum, the net loss on the unsold shares is zero and hence smaller than the gain to the sellers from departing from the optimum.

Thus, the familiar injunction to push investment until $F'(I_1^*) = 1 + i$ no longer yields a consistent equilibrium once inside information and the possibility of profiting from it are admitted to the model. The market's belief that the firm is following the rule would create incentives to depart from it.

Inconsistent policies have little survival value and hence little interest to economists. Something has to give. In the present context of dividend policy, firms *could* restore the consistency of the optimal investment policy by entering into binding precommitments about their dividend policies. But in general, they don't.¹³ Nor do they eliminate the information asymmetries that lead to the observed dividend announcement effects and thereby to the incentives to abandon the optimal investment policy.

Other possibilities come to mind for restoring consistency to the classical investment policy by abandoning one or more of the troublesome assumptions. We shall return to them in due course, after first exploring in the other direction for investment policies that remain consistent despite dividend announcement effects and the temptations they raise.

II. Consistent Dividend and Investment Policies under Asymmetric Information

We show in this part the conditions under which consistency can be restored to dividend and investment policies under asymmetric information for a firm with the same earnings process and production possibilities as in Section I. The price for restoring that consistency appears to be underinvestment, relative to the optimum achievable, in principle, under full information and/or no trading.

A. Information Asymmetry and the Firm's Objective Function

Asymmetry of information means here that at the time of announcing the net dividend (which we shall simply call D_1 from now on), the realization of the first random increment ε_1 is known to the firm's managers and directors, but *not* to the outside investing public. More precisely, the state of the information with respect to earnings, investment, and net dividends of the two groups at the time of the announcement can be expressed as:

$$\{X_1, I_1, D_1\} \equiv \{I_0, \varepsilon_1, I_1, D_1\} = \phi^d \quad (13)$$

$$\{I_0, D_1\} = \phi^m \quad (14)$$

¹³ An exception, of course, would be the dividend restrictions imposed in loan covenants. But as Kalay [25] shows, these constraints are rarely binding. And even when they are, they are often renegotiated. Remember, also, that the information is conveyed by the net dividends. The inconsistency problem would thus still remain for financing decisions, despite restrictions on dividends in the narrow sense.

where ϕ^d and ϕ^m are the information sets respectively of the inside “directors” and the outside “market.”

These differences in information about earnings lead in turn to differences in the perceived value of the firm. Viewed by the managers and directors, who know the true value of ε_1 , the “warranted” cum-dividend value of the firm is

$$V_1^d = D_1 + \frac{1}{1+i} [F(I_1) + \gamma\varepsilon_1] \tag{15}$$

and is formally equivalent to the full-information value given earlier in (6). For the market outsiders, however, who do not observe ε_1 , the value of the firm is given by

$$V_1^m = D_1 + \frac{1}{1+i} [E_1^m(F(I_1) + \gamma\tilde{\varepsilon}_1) | \phi^m].^{14} \tag{16}$$

Information asymmetry thus renders ambiguous the standard injunction to the firm’s managers to maximize the wealth of the current shareholders. For those current shareholders planning to sell out after the dividend announcement, wealth is given by (16). For those planning to hold, wealth is given by (15). Policies that increase wealth for one group need not do so for the other.

Some additional properties must therefore be imposed on the firm’s objective function to resolve the potential conflicts of interest between those current shareholders planning to sell out and those planning to hold for the longer run. At the very least, the optimal dividend decision implied by the objective function must leave neither the sellers nor the stayers with any power or incentive to bribe the managers to depart from that policy.

One objective function for the firm compatible with that requirement is a simple “social welfare function” in which the firm’s managers attach weights to the interests of each group proportional to the values of their holdings. The firm’s problem can then be written as

$$\begin{aligned} \max_{D_1, I_1} W_1 &= kV_1^m + (1-k)V_1^d \\ &= k \left[D_1 + \frac{1}{1+i} [E_1^m(F(I_1) + \gamma\tilde{\varepsilon}_1) | \phi^m] \right] \\ &\quad + (1-k) \left[D_1 + \frac{1}{1+i} [F(I_1) + \gamma\varepsilon_1] \right] \end{aligned} \tag{17}$$

subject to

$$D_1 + I_1 = X_1,$$

where, k , as before, is the fraction of the shares owned by the selling stockholders. Since a first-order condition for a maximum of (17) with respect to D_1 for given

¹⁴ Note that for simplicity, we use the same discount rate in (15) and (16) even though the perceived risk may differ in the two cases. As will become clearer later, nothing essential would change under separate discount rates.

X_1 requires

$$k \frac{\partial V_1^m}{\partial D_1} + (1 - k) \frac{\partial V_1^d}{\partial D_1} = 0, \quad (18)$$

the no-bribery condition is clearly met.

Objective functions like (17) of the weighted average or social welfare function form have now become virtually canonical in modeling the firm's financing and investment decisions under conditions of asymmetric information (see among others, Ross [40] who seems to have led the way, Kalay [25], Beja [5], Heinkel [20], and Greenwald, Stiglitz, and Weiss [18]). Barro and Gordon [4] use an analogous function (with weights on inflation and unemployment) in their analysis of macroeconomic policy). In principle, the objective function (17) could be pushed one stage deeper and the k derived endogenously from the portfolio rebalancing decisions of the shareholders or their agents (see, e.g., Harris and Raviv [18] in the context of the calling of convertible securities or Downes and Heinkel [12] following Leland and Pyle [29] in that of initial public offerings). But we shall defer extensions into the underlying portfolio choices to other occasions so as to focus here more sharply on the interactions between the firm's decisions and the market's anticipations.

B. The Interaction of Expectations and Decisions

The market's valuation, given by Equation (16), is a function of public information only, the most important piece being the firm's dividend. To emphasize this, we write the valuation as $V_1^m(D)$. The directors' valuation, by contrast, depends not only upon the publicly announced dividend but also upon the unannounced earnings, X , so that we write it as $V_1^d(X, D)$. (For simplicity, we shall suppress the time-period subscripts in the expressions to follow.)

The relation between $V^d(X, D)$ and $V^m(D)$ is a circular one. Given the valuation schedule of the market, the directors maximize the objective, Equation (17):

$$\max_D W(X; D, V^m(D)) = kV^m(D) + (1 - k)V^d(X, D).^{15} \quad (19)$$

To each level of earnings, X , we can associate some level of dividends that maximizes (17). Conversely, to each level of dividends, D , we can find those earnings for which D is optimal. This correspondence, which goes from D to X , is written $X(D)$.

If $X(D)$ is single-valued and if the market is rational, the market's valuation should agree with the directors':

$$V^m(D) = V^d(X(D), D) = V^d(X, D). \quad (20)$$

We have thus come full circle. Beginning with the market's valuation, we return, via the directors' maximization, to the market's valuation.

Valuation schedules that satisfy (19) and (20) represent what Riley [39] has

¹⁵ Observe that we have eliminated I as a choice variable in the objective function. Once X is given and D is chosen, the level of investment is determined by the constraint $I = X - D$.

termed “informationally consistent price functions.” He shows that under certain assumptions, infinitely many such informationally consistent valuation schedules will exist (all, among other things, infinitely differentiable). That our model meets the Riley assumptions is verified in Appendix A.

From among the many possibilities, our concern is to identify the particular schedule that Pareto dominates the others. We do know at least one of its distinctive features: a firm whose earnings are at the lowest end of the admissible range will choose the same values for D and I as for the full-information case. Since its dividend announcement in an informationally consistent equilibrium must reveal it to be at the bottom, there is no danger of being considered worse than it really is, and no hope of passing for better. In our notation, the firm, whose earnings are at the lower bound \underline{X} , chooses the Fisherian optimal level of investment, I^* so that

$$D^* = \underline{X} - I^*$$

and

$$X(D^*) = \underline{X}. \tag{21}$$

To find the rest of the Pareto-dominant valuation schedule, we substitute (20) into (19) and calculate the first-order condition for the optimal D :

$$kV_x^d(X(D), D)X'(D) + kV_d^d(X(D), D) + (1 - k)V_d^d(X, D) = 0 \tag{22}$$

or, since $X(D) = X$,

$$kV_x^d(X(D), D)X'(D) + V_d^d(X(D), D) = 0. \tag{23}$$

Equation (23) is an ordinary differential equation which uniquely describes the schedule, $X(D)$, given the boundary condition (21).

The solution is pictured graphically in Figure 1. We attach at each location in the diagram a vector whose slope is $X'(D)$ as given by Equation (24). To the left of the line $X = I^* + D$ the vectors point down; to the right they point up.¹⁶ The smooth curve running tangent to the vectors and passing through the boundary point (D^*, \underline{X}) is the unique solution to Equation (23). Note that the curve is decreasing on the left side of the full information solution line and increasing on the right side. The right-hand branch of the $X(D)$ schedule is the Pareto-dominating solution.

That the relevant solution must lie on the right side of the line, that is, in the zone where higher dividends are associated with higher earnings, can be established either by direct appeal to the general proofs in Riley [39], or, more informally, by checking the second-order conditions for a maximum of (17). If Equation (22) is differentiated once more, the second order sufficiency condition

¹⁶ The graph as drawn has $\underline{X} > I^*$, but that is not a necessary feature. The upward sloping vectors approach asymptotically a line parallel to the full-information line, but with a lower level of investment. The level of investment is the I^{**} of earlier versions of this paper and can be derived from the solution to (24) below with $X'(D) = 1$ (i.e., with $I'(D) = 0$).

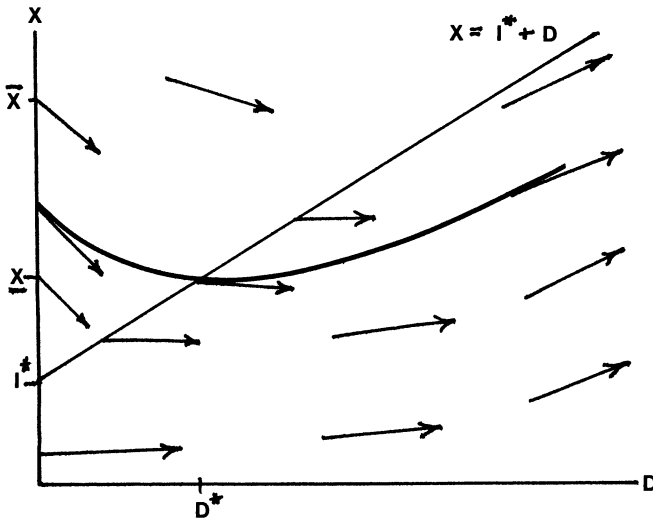


Figure 1. The Solution to the Signalling Equation

for a maximum is

$$\frac{\partial}{\partial D} [kV_x^d(X(D), D)X'(D) + kV_d^d(X(D), D)] + (1 - k)V_{dd}^d(X, D) < 0.$$

Doing the same to Equation (23) and substituting, we arrive at a simple condition guaranteeing a maximum:

$$-V_{dx}^d(X, D)X'(D) < 0.$$

Since $V_{dx}^d = -F''/(1 + i)$ is always positive, a maximum occurs if and only if $X'(D)$ is positive. In other words, the firm always chooses a dividend lying along the increasing portion of the $X(D)$ schedule. Should the firm choose a dividend solving the first-order condition but lying on the decreasing side of the $X(D)$ schedule, the firm would be minimizing the value of the objective. Thus, only dividends which exceed D^* are optimal. The larger a firm's earnings, the larger its dividend, beginning with lowest firm, which pays D^* .

That $X(D)$ is an increasing function over the domain of observed dividends has an important consequence. In Equation (15), we can replace I with $X - D$ and ϵ with $X - F(I_0)$ and rewrite the differential Equation (23) as

$$X'(D) = \frac{F'(X(D) - D) - (1 + i)}{kF'(X(D) - D) + k\gamma}. \tag{24}$$

Since for all observed dividends $X'(D)$ is positive, it must be the case that the numerator of (4) is also positive. But this says that $X(D) - D$ must be less than the Fisherian optimum level of investment. Time-consistency is thus restored to dividend and investment policy under information asymmetry, but only at a sacrifice in efficiency. (An illustrative example of the equilibrium solution is worked out in Appendix B.)

C. Dividends as Signals

The solution in Figure 1 is a separating equilibrium with obvious parallels to the well-known job-market signalling model of Spence [41]. The unobserved attribute in this case is $\tilde{\varepsilon}_1$ the random component of current earnings. The cost of signalling that attribute to the market by increasing (net) dividends is the foregone use of the funds in productive investment. And this cost of signalling any specified level of earnings will be higher, the lower the level of earnings actually achieved.¹⁷

The lower level of real investment under the signalling equilibrium shows up, of course, as a correspondingly higher dividend payout ratio than in the full-information case. The difference in investments and payouts reflects the parameters governing the effectiveness of dividends as signals, especially the earnings persistence parameter, γ (determining the impact of dividend surprises on current market prices), and the turnover parameter, k (measuring the weight in the objective function on current price as opposed to long-run returns). The higher the value of γ and k , other things equal, the higher the payout ratio and the lower the investment level in the signalling equilibrium.¹⁸

Note also that in the present case, as in the Spenceian signalling equilibrium, no one is fooled. Even where dividends are higher than in the full-information equilibrium, the selling shareholders do not earn above-normal returns at the expense of the staying shareholders (or of the purchasers of the shares). Both groups, sellers and stayers (and buyers), earn the market rate of return i . There is no sequence, except conjecturally, of temporary price rise and offsetting fall of the kind envisioned in Miller-Modigliani [33, p. 430]. The damage is caused by the *possibility* of deception, which the market allows for, not by the deception itself. And it shows up, not as wealth transfers, but as lost opportunities whose consequences are borne by all the shareholders, sellers and nonsellers alike.

Because a signalling equilibrium is fully revealing, the model here presented provides no support, of course, for a policy of sustaining dividends in the face of earnings disasters. Dividends make sense as signals for the good-news, not the bad-news firms. For the good-news firms, the cost of signalling may be worth bearing to avoid giving the market the (false) impression that earnings were not good enough to justify a dividend. (Teachers and students of finance will think

¹⁷ Although many informal references to dividends as signals can be found in both the nonacademic and the academic literature in finance, the first formal modelling is due to Bhattacharya [6]. A recent rigorous modelling that builds, as we do here, on the work of Riley [38] is that of John and Williams [23]. These dividend signalling models differ from ours by taking management's views of *future* returns on investment to be the information conveyed by the dividend signal; and by taking the cost of the signal to be the presumed differential tax penalty on dividends over capital gains. John and Williams, however, go on to generalize their analysis to allow for other costs as validators of dividend signals.

¹⁸ Although the full-information and signalling models imply different investment levels and dividend payout ratios, they remain observationally equivalent with respect to the dividend and financing announcement effects discussed earlier in Parts D and E of Section I of this paper. The information conveyed by the announcements is the same in both models, to wit, the realization of $\tilde{\varepsilon}_1$. Or, to put it the other way around, one cannot conclude that dividends are serving as signals in the technical sense merely because prices jump on dividend announcements.

at once of the General Public Utilities case featured for many years in the dividend policy section of the Harvard Business School casebooks. See, e.g., Butters, Fruhan, and Piper [8], pp. 229–239.) But in a world with rational expectations, dividends, for all their pleasant connotations, cannot turn a loser into a winner. In fact, the best place for empirical researchers to look for evidence of dividend signalling may well be among firms falling into adversity, not because they then start signalling, but because they stop.

D. Alternative Routes to Restoring Consistency

The signalling equilibrium is one route to restoring consistency of investment decisions in the face of informational asymmetry, but not an efficient one. Incentives thus exist for firms to search for other, cheaper ways of resolving the inconsistency. Binding commitments about dividend policy have apparently not been the answer. But there is at least one natural alternative route: changing one (or both) of the conditions that give rise to the problem, viz., inside information and the possibility of profiting from it.

The potential for abuse in the conjunction of those conditions has certainly not escaped notice. Eliminating the profit from trades by “insiders” was in fact precisely the purpose of Section 16(b) of the Securities Exchange Act. Section 16(b) requires officers, directors, and major stockholders of registered companies to turn back to the corporation any profits on purchases and sales within six months of each other. In-and-out trading, however, is only one way, and not necessarily the most important way, to benefit from dealing with less-informed outsiders. The statutory proscriptions of 16(b) (or analogous privately negotiated agreements between the firm and its officers) clearly do not reach the subtler potential gains that we have seen in the context of the dividend problem—potential gains, moreover, accruing to a broader class of stockholders than just the “insiders” of the statute. Nor are these subtler potential gains reached by Section 10(b) of the Act which has been interpreted as imposing liability on any persons selling (or buying) shares on the basis of false information or without disclosing any “inside information” they may have material to its value. (For a fuller account of Section 10(b), see Easterbrook [14] and Posner and Scott [38, especially Chapter 5].) The potential gains to sellers in the dividend context arise not because the sellers deliberately withhold material information they have—indeed, most or even all of the sellers may be no better informed than the buyers—but because the market’s prior experience may lead it to misinterpret the information that the announced dividend does supply.¹⁹

In principle, of course, even this possibility for misinterpreting the dividend announcement would disappear if the firm’s managers had incentives to disclose the “true” state of the firm’s affairs prior to announcing the dividend.²⁰ In our

¹⁹ Something closer to the kind of abuse aimed at by Section 10(b) would arise if the dividend itself were not disclosed immediately. Exchange regulations, however, require that the votes of the directors on the dividend be made public immediately. For an account of some of the incidents in the early 1900’s that led to this rule, see Dewing [10, p. 744].

²⁰ Or, in the other direction, if the managers released no information. But Diamond’s analysis suggests that such an approach is unlikely to be a welfare improvement.

simple, abstract model, this "truth" is represented by the realization of the random variable, $\tilde{\varepsilon}_1$. In practice, however, what management can convey is at best only an estimate of its current "earnings" constructed according to generally accepted accounting principles. These principles, given the normal range of business opportunities for postponing or accelerating transactions, leave management considerable discretion as to the precise figure to be reported, particularly over intervals as short as a quarter, the typical interval between dividend payments. In fact, earnings announcements involve much the same temptations as dividend announcements.

We need not develop further here, however, the implications of the temptations to manipulate earnings. For present purposes, the important point is merely that earnings announcements are, and are known to be, estimates subject to error. As noted earlier, to the extent that firms announce their earnings before their dividend announcements (and we know that by no means all of them do so), the estimates implied by those earnings announcements can readily be incorporated into the market's information set; and with the reinterpretation of $\tilde{\varepsilon}_1$ as that random component of earnings unobservable to the market even after an earnings report, the earlier analysis and conclusions remain the same.

Despite information asymmetries, and the temptations they create, the inefficient investment policies of our consistent equilibrium might still be avoidable, in principle, by compensation schemes penalizing the firm's managers *ex post* for departures from optimality. If the penalties were (and were known to be) severe enough, the firm's promise to follow the full-information solution would again become credible.

But lost opportunities are errors of omission, not commission, and they cannot be presumed to leave an easily followed audit trail. The lost opportunities may *seem* to leave an easy trail in our consistent solution, but only because we assumed for simplicity that the firm's production function and other decision parameters are known by outside investors (and hence presumably also by any outside auditors). Our analysis goes through essentially unchanged, however, under the weaker and more plausible assumption that the firm and the outsiders know the parameters of the production function only up to a white-noise disturbance term (uncorrelated with any of the random terms or decision variables). But under those more realistic conditions, *ex post* settling-up would entail the costs of acquiring the information about investment opportunities as well as the costs of defining, enforcing, and litigating contracts based on that information.

III. Conclusions

Finance specialists have long recognized the inability of the standard full-information model of the firm's dividend-investment decision to accommodate the now thoroughly documented evidence of dividend-announcement effects—effects that clearly imply asymmetries of information between the investing public and the firm's decision makers. In the absence of a superior alternative, however, they have continued to use many of the main implications of the full-

information model, especially its investment optimality criterion, in the hope that any “manipulations” of announcement effects will prove ephemeral and will be reversed once the truth becomes known.

We have seen, however, that such hope may not be warranted once the analysis recognizes the possibility of trading shares (rather than merely “owning” them as in the standard valuation models). When trading is admitted to the model along with asymmetric information, the consistency of the full-information optimum investment and dividend policies can no longer be taken for granted.

Inconsistent policies will presumably be eliminated, but elimination may come in any of a number of different ways. One possibility is to keep the assumptions of asymmetric information and the possibility of trading shares and then to seek consistent alternative decision rules for investment dividends. Such rules do exist. They preserve many of the properties of the standard model, and they provide a straightforward rationalization of the observed announcement effects. But, subject to only trivial exceptions, these rules imply levels of investment that are lower and levels of dividends that are higher than under the standard, full-information optimum.

Rather than accept this waste of profitable investment opportunities, the firm’s founders might try to eliminate the asymmetries and temptations that give rise to the problem. But this approach, too, involves dead-weight costs.

Which route, or more likely, which combination of routes to a consistent solution emerges in practice as least costly is a question for future empirical research.

Appendix A

The Riley Conditions

This appendix verifies that the six assumptions given by Riley [38, pp. 334–335] hold for the model considered here. First, recall the definitions,

$$W(X; D, V^m) = kV^m + (1 - k)V^d(X, D)$$

and

$$V^d(X, D) = D + \frac{1}{1+i} [F(X - D) + \gamma(X - F(I_0))].$$

The assumptions are:

- (A1) The unobservable attribute, X , is distributed on $[\underline{X}, \bar{X}]$ according to a strictly increasing distribution function.
- (A2) The functions $W(\cdot)$ and $V^d(\cdot)$ are infinitely differentiable in all variables.
- (A3) $W_3 > 0$.
- (A4) $V(X, D) > 0$, $V_X(X, D) > 0$.
- (A5) $\frac{\partial}{\partial X} \left(\frac{-W_2}{W_3} \right) < 0$.
- (A6) $W(X; D, V^d(X, D))$ has a unique maximum over D .

Assumptions (A1) to (A4) are immediate. Assumption (A5) is that

$$\begin{aligned} \frac{\partial}{\partial X} \left(\frac{-W_2}{W_3} \right) &= \frac{\partial}{\partial X} \left(-\frac{(1-k)}{k} \left[1 - \frac{F'(X-D)}{1+i} \right] \right) \\ &= \frac{(1-k)}{k(1+i)} F''(X-D) < 0 \end{aligned}$$

which is obviously true. Assumption (A6) requires that $V^d(X, D)$ has a unique maximum over D , which it does at the point $D = X - I^*$.

Appendix B

An Example

For this example, define the production function as:

$$F(I) = a \ln(I + b); \quad a, b > 0.$$

The Fisherian optimal level of investment, I^* , for this production function is $a/(1+i) - b$, which is assumed to be positive.

Suppose that the persistence parameter, γ , is zero. Then the differential equation, (24), describing the $X(D)$ schedule is

$$X'(D) = \alpha - \beta(X - D), \quad \text{given } X(D^*) = \underline{X} \tag{B1}$$

where α and β are defined as

$$\alpha = (a - (1+i)b)/ka \quad \text{and} \quad \beta = (1+i)/ka.$$

The second of these parameters is obviously positive. The positivity of the first follows from the assumed positivity of the optimal level of investment, I^* .

The solution to (B1) is

$$X(D) = (\alpha - 1)\beta^{-1} + D + \beta^{-1}\exp(-\beta(D - D^*)). \tag{B2}$$

Observe that the boundary condition is satisfied, since at $D = D^*$,

$$\begin{aligned} X(D^*) &= (\alpha - 1)\beta^{-1} + D^* + \beta^{-1} \\ &= \alpha\beta^{-1} + D^* = I^* + D^* = \underline{X}. \end{aligned}$$

This solution corresponds to the curve in Figure 1. It is clearly single-valued and infinitely differentiable. A check on the derivative shows that the schedule is increasing for $D > D^*$ and decreasing for $D < D^*$. We already know that for every $X > \underline{X}$, the maximizing dividend lies on the increasing portion of the schedule. As a result, the only dividends observed are those larger than D^* . Since $X(D)$ is invertible on this domain, the market's valuation is informationally consistent. We also have that the optimal level of investment, for all observed dividends, is

$$\begin{aligned} X(D) - D &= (\alpha - 1)\beta^{-1} + \beta^{-1}\exp(-\beta(D - D^*)) \\ &= I^* - \beta^{-1}(1 - \exp(-\beta(D - D^*))) \leq I^*. \end{aligned} \tag{B3}$$

Thus, managers always underinvest in production. Finally, as k increases, the parameter β increases, and this reduces the slope of the $X(D)$ schedule in the observable range, as Equation (B3) indicates.

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