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DIVIDEND ANNOUNCEMENTS AND DOUBLE INEFFICIENCY OF PRODUCTION: THE IMPLICATIONS OF UNCERTAINTY AND ASYMMETRIC INFORMATION*

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Abstract

A two-period model of the firm is constructed in a world which is characterised by uncertainty regarding earnings and production possibilities and by asymmetric information between insiders and outsiders. It is then shown that dividend announcements reveal more about the firm's value than earnings announcements do and that the two together reveal information about the investment policy of the firm that each one can not reveal. Moreover, Fisher-optimum investment policy is not sustainable through time. A solution to the problem of declaring dividends that fulfill the rational expectations criterion is proposed leading to double (allocative and X-) inefficiency of production. (JEL G14)

1. Introduction

Miller and Rock, 1985 (henceforth M-R) demonstrated that in an uncertain world with asymmetric information between company directors and the stock market, dividend and earnings announcements amount to the same thing. They both reveal the true earnings of the firm to the market. Moreover they showed that if the market believes the firm to operate under the Fisherian rule for

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optimum investment[1] there exists an incentive to violate this rule, by declaring dividends unwarranted by that rule. This leads to the adoption of a suboptimum investment policy that satisfies the time-consistency criterion, i.e. an investment policy for which there exists no incentive to violate it. Uncertainty in the M-R paper takes the form of a shock to the firm's earnings which, however, does not affect its production possibilities. These production possibilities are assumed to be known to both the directors and the public.

The purpose of this article is to generalise the M-R model. The generalisation proceeds in two different directions and in such a way that the M-R model can be derived as a special case. First, by allowing the shock to affect the firm's production possibilities - its transformation frontier. It is shown that in such a world the earnings and dividend announcements reveal different pieces of information but knowledge of one together with knowldge of the production function is enough to reveal the other. Second, it is shown that if the production function is not known to the market, the dividend announcement reveals more about the change in the firm's value than does the earnings announcement. As in M-R the full information optimum solution regarding the production decision is not time-consistent i.e. there exists an incentive to violate it. But, in addition to the inefficiency of the investment decision shown by M-R, it is also shown that, within the context of the generalised model, for a time-consistent solution it is in general true that the firm will not exploit its opportunities to the maximum producing along a transformation frontier inside the best available one.

In other words, when the shock affects the transformation frontier and the latter is not known by the market, a time-consistent solution regarding the firm's dividend policy leads to double inefficiency of production.

2. Set-up of the Model

It is assumed that the production function of the firm takes the form:

$$\widetilde{X} = F(I_{t-1}, \widetilde{\varepsilon}_t) \tag{1}$$

where $\widetilde{X}$ is the firm's random earnings stream. I is the amount invested and $\widetilde{\varepsilon}$ represents a ranodm increment. Subscript t denotes time. I and $\widetilde{e}$ are assumed to enter the production F in an interdependent way so that a change in the expectation of ε before the investment has been made will affect the investment decision ($I_t = I[E(\varepsilon_{t+1})]$). But, on the other hand, after the investment has been made, it is irreversible and then the production function of the firm becomes:

$$\{\widetilde{X}/I\} = F(I, \widetilde{\varepsilon}/I) = f(I) + \widetilde{\varepsilon} \tag{2}$$

Hence it is assumed that after the investment has been made the shock affects earnings in an additive way without affecting investment which is assumed to be irreversible.

Both F and f are assumed to be "well-behaved".

A two-period model is examined. It is assumed that at time 0 when the investment decision I for period 1 is made $E(\widetilde{\varepsilon}_1) = 0$.

Therefore the first period's production function is:

$$\widetilde{X}_1 = f(I_0) + \widetilde{\varepsilon}_1 \tag{3}$$

Shocks however do happen and are expected to have a degree of persistence γ, i.e. $E(\widetilde{\varepsilon}_2/\varepsilon_1) = \gamma\varepsilon_1$. Therefore the second period's production function is:

$$\widetilde{X}_2 = F(I_1, \widetilde{\varepsilon}_2) = F(I_1, \gamma\widetilde{\varepsilon}_1) \tag{4}$$

The sources and uses of funds constraint (end of period 1) is given as:

$$D_1 = X_1 - I_1 \tag{5}$$

where D is the net dividend (i.e. dividends paid net of borrowing).

3. The Value of the Firm at the End of the First Period

The cum-dividend value of the shares at the end of the first period is:

$$V_1 = D_1 + E(\widetilde{X}_2) / (1+i) = D_1 + E(F(I_1, \gamma\varepsilon_1)] / (1+i) \tag{6}$$

where i is the discount rate "appropriately" adjusted for risk.

Substituting equation (5) into equation (6) the value of the firm is:

$$V_1 = X_1 - I_1 + [F(I_1, \gamma\varepsilon_1)] / (1+i) \text{ or}$$

$$V_1 = f(I_0) + \varepsilon_1 - I_1 + [F(I_1, \gamma\varepsilon_1)] / (1+i) \tag{7}$$

Note that the Miller-Modigliani, 1961, theorem of dividend invariance still holds as the only determinant of the firm's value is the investment decision. Moreover the optimum investment level I_1 is determined by $dF/dI = 1+i$.

4. Reality vs. Expectations and the Earnings Announcement

The expected, as of time 0, value of the firm at time 1 is given by:

$$E_0(V_1) = E_0(\widetilde{X}_1) - E_0 (I_1) + E_0 [F (I_1, \widetilde{\varepsilon}_2)] / (1+i)$$

Given that at time 0 both $E_0(\widetilde{\varepsilon}_1)$ and $E_0(\widetilde{\varepsilon}_2)$ are equal to zero the expected value of the firm is given by:

$$E_0(V_1) = f (I_0) - I^e_1 + f(I^e_1) / (1+i) \tag{8}$$

where I^e_1 is the optimum level of investment at $t = 1$ if $\varepsilon_2 = 0$.

Therefore:

$$V_1 - E_o(V_1) = \varepsilon_1 - (I_1 - I^e_1) + [F (I_1, \gamma\varepsilon_1) - f (I^e_1)] / (1+i) \tag{9}$$

The first term in the RHS of equation (9) is the effect on the valuation of the firm caused by the shock per se. What of the second and third terms? Recalling the assumption that the shock affects the production possibilities of the firm and therefore its investment decision, the second and third terms are interpreted as the change in the Net Present Value resulting from the change in investment which is, in turn, caused by the expectation that in period 2, $E_1(\varepsilon_2) = \gamma\varepsilon_1 \neq 0 = E_0(\varepsilon_2)$.

Therefore, if the market knows the production function, the earnings announcement is by itself enough to deduce the change in the value of the firm caused by the shock to the firm. For if the production function and ε_1 are known, so are I_1, I^e_1, $F(I_1, \gamma\varepsilon_1)$ and $f(I^e_1)$.

5. The Dividend Announcement

The expected net dividend, as of time 0, to be paid out at the end of period 1 is given by taking expectations of the sources and uses equation (5):

$$E_0 (D_1) = E_0 (X_1) - E_0 (I_1) = E_0 (X_1) - I^e_1 \tag{10}$$

The actual dividend paid out is given by the sources and uses equation (5):

$$D_1 = X_1 - I_1 \tag{11}$$

By substracting equation (10) from equation (11) we derive the value of the difference between actual and expected dividend as:

$$D_1 - E_0 (D_1) = \varepsilon_1 - (I_1 - I^e_1) \qquad (12)$$

The first term in the RHS of equation (12) is the shock to the firm's earning's and the second term is the change in the level of investment resulting from that shock. Recall that if the production function (1) is known so is the relationship between investment and earnings:

$$I = I(\varepsilon) \qquad (13)$$

From equations (12) and (13):

$$D_1 - E_0 (D_1) = \varepsilon_1 - [I_1 - I^e_1]$$

$$D_1 - E_0 (D_1) = \varepsilon_1 - [I (\gamma\varepsilon_1) - I^e_1] \qquad (14)$$

and therefore it is straightforward to deduce the dividend to be paid from the earnings announcement and vice-versa.

Substituting from equation (12) into equation (9) we see that the change in the value of the firm resulting from a shock ε can be given, in terms of the dividend announcement, as:

$$V_1 - E_0 (V_1) = D_1 - E_o (D_1) + [F (I_1, \gamma\varepsilon_1) - f (I^e_1)] / (1+i) \qquad (15)$$

It might appear then that, at first sight, the dividend announcement is not, by itself, enough to reveal the true change in the value of the firm. But we have just shown that equations (12) and (13) reveal the earnings stream — see equation (14)— and therefore equations (14) and (15) provide enough information to derive the change in the firm's value.

6. The Miller-Rock Model as a Special Case

In the Miller-Rock model

$$F(\iota, \varepsilon) = f (I) + \varepsilon$$

Therefore $I^e_1 = I$ and

$$F (I, \varepsilon) - f (I) = \varepsilon$$

and equations (9), (14), (15) become:

$$V_1 - E_0 (V_1) = \varepsilon_1 + \gamma\varepsilon_1 / (1+i)$$

$$= \varepsilon_1 (1+\gamma / (1+i)) \quad (9)'$$

$$D_1 - E_0 (D_1) = \varepsilon_1 \quad (14)'$$

$$V_1 - E_0 (V_1) = D_1 - E_o (D_1) + \gamma\varepsilon_1 / (1+i) \quad (15)'$$

Q.E.D.

7. The Informational Superiority of the Dividend Announcement if the Production Function is Unknown

It has so far been assumed that the production function is known and it has been demonstrated that in such a case the dividend and earnings announcements have the same informational value in revealing the firm's value. It will now be assumed that the production function is not known and with this assumption as a basis it will be demonstrated that dividends reveal more about the change in the value of a firm affected by a shock than does the earnings announcement. Recall that the earnings and dividend announcement effects are given by equations (9) and (15):

$$V_1 - E_0 (V_1) = \varepsilon_1 - (I_1 - I^e_1) + [F (I_1, \gamma\varepsilon_1) - f (I^e_1)] / (1+i) \quad (9)$$

$$V_1 - E_0 (V_1) = D_1 - E_0 (D_1) + [F (I_1, \gamma\varepsilon_1) - f(I^e_1)] / (1+i) \quad (15)$$

As neither F, f are known nor can I_1, I^e_1 be deduced from ε_1 it is obvious that the dividend announcement (equation (15)) provides a better approximation to the valuation of the firm than does the earnings announcement (equation (9)).

Seen from a different perspective (equation 12) the dividend announcement incorporates the earnings announcement *plus* the change in the level of investment the change in earnings has caused:

$$D_1 - E_0 (D_1) = \varepsilon_1 - (I_1 - I^e_1). \quad (12)$$

This also brings into focus another point. If shocks are of the M-R type i.e. if they do not affect the production possibilities of the fiorm, knowledge of the production function is not at all essential for the earnings and/or the dividend announcements to reveal the change in the value of the firm. For in such a case:

$$V_1 - E_0(V_1) = \varepsilon_1 [1 + \gamma / (1+i)] \qquad (9)'$$

which is independent of the production function. Obviously some knowledge of the production function is required so as to provide an "anchor" for the firm's value (as distinct from changes in it). The same is also true in the case discussed above where the production function is not known and where the informational superiority of the dividend announcement effect relative to the earnings announcement effect obviously refers to *changes* in the value of the firm.

Finally note that the dividend announcement together with the earnings announcement now reveal the change in investment policy as (from equation 12):

$$(I_1 - I^e_1) = \varepsilon_1 - [D_1 - E_0(D_1)]$$

Therefore, and in the absence of knowledge of the production function, as the earnings announcement complements the dividend announcement and together, and only then, do they reveal information about the firm's change in investment, the informational content of the earnings announcement that follows the dividend announcement is significant and not redundant (see [4], p. 1037).

Moreover, the same can be said about dividend announcements that follow earnings announcements as the two are complementary and not equivalent in revealing the change in investment policy.

8. Intermediate Trading and the Inconsistency of the Optimal Policies

It is straightforward to show that, as in M-R, if 100k% of the shares are sold after a dividend announcement, the Fisherian optimum for investment is time-inconsistent. To prove it assume that managers raise the dividend by 1$ over and above the dividend warranted by the firm's earnings and its optimum investment policy.

The total gain to the sellers of the shares from this 1$ rise in the net dividend paid out by the firm, is the net dividend itself plus the increase in the firm's valuation caused by erroneous expectations of higher earnings[2].

Therefore the gain to the sellers is

$$k [1 + F_\varepsilon + F_I I_\varepsilon / (1+i)]$$

But $F_\varepsilon + F_I I_\varepsilon = dF/d\varepsilon > 0$ and the above expression is always positive.

Those who do not sell out on the other hand, the stayers, have a change in their net wealth equal to the dividend, which they receive anyway, minus the loss in the value of the firm caused by the suboptimum policy:

$$(1 - k)\,[1 - F_I/\,(1+i)\,]$$

Given that, at the optimum, $F_I = 1+i$ their loss is zero and therefore less that the gain to the sellers. The optimum investment policy is therefore time-inconsistent (3).

But this is not the end of the story if the firm's production function is unknown by the market. It is easier to consider this informational asymmetry with the help of a diagram. Consider figure 1.

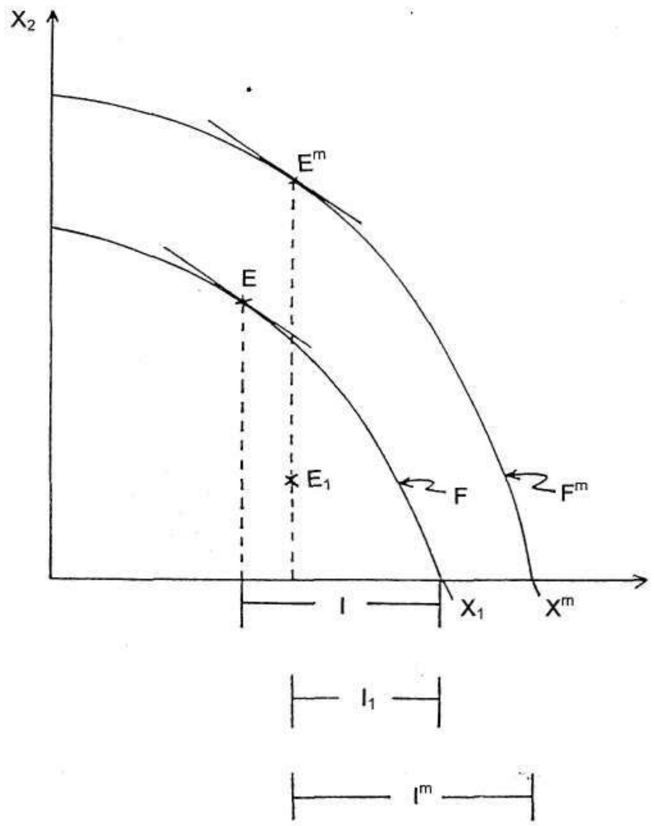

Fig. 1. Asymmetric Information and the Incentive to Cheat with Faulty Dividend Announcements.

Assume that the firm's true earnings (not known to the public) are Xi and the best available transformation frontier is F. The straight lines tangent to F, F^m at E, E^m are parallel to each other and correspond to an interest rate i. I is therefore the optimum investment level. But as the transformation frontier F is not known by the public, the firm's management can chose to produce within F such as Ei. The corresponding investiment level is Ii. The difference I - Ii is paid out as dividend letting the market believe that the true earnings are X^m, the transformation frontier is F^m and the corresponding investment level I^m. Let I -I ι = 1$.

Then the gain to the sellers is:

$$G = k \{ 1 + [F^m (I^m) - F (I)] / (1+i)\}$$

while the net change in the wealth of the stayers is:

$$C = (1-k) \{ 1 + [F_1 (I_1) - F(I)] / (1+i) \}$$

or, in continuous terms:

$$G = k [1 + (F_\varepsilon + F_I I_\varepsilon) / (1+i)]$$

$$C = (1-k) [1 - (F_\varepsilon + F_I I_\varepsilon) / (1+i)]$$

where subscripts ε, I denote partial derivatives w.r.t. ε,I.

The total net change in wealth for both sellers and stayers is:

$$G + C = 1 + [(2k - 1) (F_\varepsilon + F_I I_\varepsilon)] / (1+i) \qquad (16)$$

Clearly, except by happenstance, the RHS of equation (16) is always different from zero. If it is negative the directors will declare the warranted dividend. For declaring a lower one will lower the value of the shares of the sellers (the perceived transformation frontier will be inside F, say F_1) while it can not increase the value of the shares of the stayers (as the transformation frontier can not in reality be outside F, say F^m).

The likelihood however that it will be positive is quite high. For:

$$1 + [(2k - 1) (F_\varepsilon + F_I I_\varepsilon)] / (1+i) > 0$$

$$\text{implies } 1 > [(1 - 2k) (F_\varepsilon + F_I I_\varepsilon)] / (1+i)$$

F_ε, F_I, I_ε are all positive so that if $k>0.5$ (i.e. if the majority of shareholders are (potential) sellers, a reasonable assumption nowadays) the RHS is negative and the above inequality is always true.

Let us examine now what hapens if $k<0.5$. The above expression is equivalent to

$$(1+i) / (1-2k) > dF/d\varepsilon.$$

If $dF/d\varepsilon<1$ i.e. if the shock is of such a kind that its effect is reduced through time — in the sense that the gains from the shock next period (dF) are less than those this period ($d\varepsilon$) — then the above expression is certainly true. For $1+i > 1 > 1-2k$ and therefore

$$(1+i) / (1-2k) > 1 > dF/d\varepsilon)$$

If on the other hand $dF/d\varepsilon > 1$, i.e. if the shock is of such a (rare) type that the effects next period are larger than those this period, for the inequality to be true it is required that:

$$dF/d\varepsilon < (1+i) / (1-2k)$$

which is most likely to be satisfied the higher the proportion, k, of sellers is and the higher the interest rate is. Intuitively, a higher proportion, k, of sellers implies that the (certain) gains of the sellers increase in importance; while a higher interest rate, i, implies a relatively high discounting of the future and therefore the less weight the distortions caused by the payment of unwarranted dividends acquire compared to the benefit of receiving the benefit.

In general therefore it is true that except for the (certain) gains from declaring a higher than the warranted dividend at the expense of investment, there is also scope for cheating by declaring a higher than the warranted dividend at the expense of producing along a transformation frontier inside the best abailable one.

9. Double Inefficiency of Production Under Rational Expectations

The following discussion and prrof of the double inefficiency departs at points from Miller and Rock, 1985 and is based on an earlier version of their work, Miller and Rock, 1982.

Assuming that the information sets, φ^d and φ^m of the directors (full information) and the market (partial information) just after the announcement of the dividend are:

$$\varphi^d = \{ f, X_1, F, I_1, D_1\} = \{f, I_0, \varepsilon_1, F, I_1, D_1\}$$

$$\varphi^m = \{f, I_0, D_1\}$$

where f and F refer to last and next periods' production functions respectively.

The value attached to the firm by the same two groups after the dividend announcement is:

$$V^d{}_1 = D_1 + [F (I_1, \varepsilon_1)] / (1+i)$$

$$V^m{}_1 = D_1 + (E^m{}_1 [F (I_1, \varepsilon_1)] / \varphi^m\} / (1+i)$$

where $E^m{}_1$ denotes the expectation of the market at time t= 1.

Following M-R (pp. 1041-2) it is assumed that the directors decide upon production by maximising, subject to the budget constraint D= X-I, a weighted average, W, of the value attached to the firm by insiders, directors, and outsiders, the market. The weights correspond to the proportions of stayers and sellers respectively:

$$W = kV^m{}_1 + (1\text{-}k) V^d{}_1 \qquad \text{or}$$

$$W = k\{D_1 + [F (I_1, \varepsilon_1)] / (1+i)\} +$$

$$(1\text{-}k) \{D_1 + \{E^m{}_1 [F (I_1, \varepsilon_1)] / \varphi^m\} / (1+i)\} \qquad (17)$$

Investors are rational in the (Muthian) sense that their expectations correspond to reality. Recall that, under full information, the revelation of the shock, ε, that has affected the firm determines the best transformation frontier available. Consequently it also determines the optimum investment policy with dividends being determined residually. If, then, dividend announcements act as signals providing "clues" as to the true earnings of the firm, they also act as signals providing clues as to the true transformation frontier and investment policy of the firm.

Hence, rational expectations imply that the market expects directors to maximise (17) while their expectations are realised. Realisation of the expectations imply:

$$E^m{}_1 [F (I_1, \gamma\varepsilon_1) / D_1] = F^m [I^m (D_1), \gamma\varepsilon^m (D_1)] = F (I_1, \gamma\varepsilon_1) \quad (18)$$

where $I^m (D_1)$ is defined as $E^m{}_1 (I_1/D_1)$ and therefore:

$$E^m{}_1 (I_1/ D_1) = I^m (D_1) = I_1 \quad (19)$$

and $\varepsilon^m(D_1)$ is defined as $E^m{}_1(\varepsilon_1/D_1)$ and therefore:

$$E^m{}_1(\varepsilon_1/ D_1) = \varepsilon^m (D_1) = D_1 + I^m (D_1) - f (I_0) \quad (20)$$

The expected production function therefore is:

$$E^m{}_1 [F (I_1, \gamma\varepsilon_1)/ D_1] = F^m \{I^m(D_1), \gamma [D_1 + I^m(D_1) - f(I_0)] \} \quad (21)$$

Substituting the expected production function (21) and the sources and uses constraint (11) — to derive an expression of investment in terms of the dividend— into the objective function (17), the maximisation problem of the directors in terms of the observable variable D becomes:

$$\max_{D_1} W_1 = k \{D + F^m \{I^m (D_1), \gamma [D_1 + I^m (D_1) - f(I_0)] \}/ (1+i) \} +$$
$$(1-k) \{D_1 + \{F [(X_1 - D_1), \gamma\varepsilon_1] \}/ (1+i)\} \quad (22)$$

For an optimum decision and after substituting the budget constraint (11) and the equilibrium conditions (19), (20), (21):

$$dW_1/ dD_1 = 0 = 1 + \{k \{ F^m= [I^m (D_1), \gamma [D_1 + I^m (D_1) - f(I_o)] \} I^m{}_D (D) +$$
$$+ \gamma F^m{}_\varepsilon [1 + I^m{}_D(D_1)] \}/ (1+i) +$$
$$- (1-k) \{F^m{}_I [I^m (D_1), \gamma [D_1 + I^m (D_1) - f (I_0)]] \}/ (1+i) \} \quad (23)$$

which can be written as the differential equation:

$$G [F^m ( ), F^m{}_I ( ), F^m{}_\varepsilon ( ), I^m ( ), I^m{}_D ( )] = 0 \quad (24)$$

By assuming $F^m{}_e = 1$, i.e. the investment decision is independent of the shock that has affected the firm, the above problem reduces to that addressed in M-R. But M-R showed that, in the framework of an investment decision unaffected by the shock, the investment decision is suboptimal. Therefore, by assuming here that $F^{ra}{}_e = 1$, we can get the M-R solution to the problem. However this leads to *double inefficiency.* For as M-R showed, when the investment decision is independent of the shock that has affected the firm, the directors will chose an investment level lower than the optimum under full information i.e. one with a rate of return in excess of the interest rate. On the other hand $F^{m}_{e} = 1$ implies that the transformation frontier chosen is not the best available one since, in general, $F^{ra}_{e} \neq 1$.

10. Conclusion

Based on earlier work by Miller and Rock, 1985 a two period model of the firm is constructed in a world which is characterised on the one hand, by uncertainty regarding the firm's first period earnings and its transformation frontier in the second period, and, on the other hand, by assymetric information between insiders —company directors— and outsiders —the stock market. The model is used to examine the significance of the earnings and dividend announcements.

For both earnings and dividend announcements, their significance lies in providing information to the market about the shock that has affected the firm during the first period and the effects this will have on the second period's transformation frontier. But it is also shown that if the firm's production function is unknown, dividend announcements reveal more about the firm's value than earnings announcements do and that the earnings announcement together with the dividend announcement reveal information about the investment policy of the firm that each one can not reveal.

Moreover, the optimum investment policy, as defined by the Fisherian criterion, is not sustainable through time: the reason for the latter result is that there exist incentives to violate the Fisherian rule for optimum investment by declaring, at the expense of investment and the production possibilities of the firm, dividends higher than those warranted by this rule. A solution to the problem of declaring dividends that fulfill the rational expectations criterion is proposed. However, it is shown that this solution leads to double inefficiency of production, i.e. production takes place within transformation frontier of the curve at a suboptimum level of investment.

Ramasastry Ambarish, Kose John and Joseph Williams, 1987 (henceforth AJW) also sought to generalise the M-R model, but in a different direction. In the few paragraphs that follow a comparison is attempted between the AJW model and the present one.

Considering key aspects of the modeling first, the present and the AJW model are similar in assuming asymmetry of information regarding the Production Possibility frontier. However, the AJW model differs in introducing a second variable in the Production Function, "assets in place", that is not dependent on investment.

In addition the two models differ in that AJW:

- use a one period model of the firm;
- allow and consider new issues of shares;
- differentiate between more and less productive firms, imposing the (reasonable) condition that the more productive firms are careful in choosing a signaling bahevior that does not allow the less productive firms to mimic it.

Using this model, AJW extend M-R in a different direction than the one in the present paper. In particular they show that when asymmetric information

> "has a greater relative impact on the present value of assets in place than the present value of opportunities to invest... insiders optimally reduce their corporate investment relative to the symmetric [information] optimum and thereby forego projects with positive NPV. By contrast, when the reverse ... holds... insiders optimally invest more than their symmetric optimum and select projects with negative NPV". [p. 331]

It appears, therefore, that by allowing for two types of firms, more and less productive, AJW invalidate the incentive to produce within the PPF (as is the case in the present article) for that would simply imply intentionally downgrading one's firm to the less productive standard. In addition, by allowing the production function to depend on assets in place as well as investment opportunities they create incentives for both under and over investment, as cheating depends on two variables.

Footnotes

1. Where the marginal revenue from investment equals one plus the interest rate.

2. Recall that Di-Eo (Di) = $\varepsilon\iota$ - (Ii - $\Gamma\iota$). Although it is, in theory, possible to associate a higher Di with a fall in $\varepsilon\iota$ and an even greater fall in Ii, akin to a case where there is no future at all for the firm and it liquidates itself, this will not be considered here.

3. Note that by letting $F_e = 1$, $I_\varepsilon = 0$ one derives the M-R case.

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