

Stock price changes as signals to management*)

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I

The purpose of this paper is to explore the role of stock market prices in decision making within the firm. Suppose, for example, that over some period of time a firm's shares have experienced what is considered a significant price appreciation. It seems natural to assume that such an occurrence conveys potentially useful information about the firm's environment and hence might indicate a change in the firm's operating policy.

In considering the social significance of a stock market, there seems to be general, although somewhat vague, agreement that its ultimate purpose should be to guide new investment capital into those activities where it can most profitably be employed. In this connection, a dis-

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inction is usually made between primary and secondary security markets. Primary markets are the markets for new equity issues, where the issuing firms receives investment funds in return for their securities, while secondary markets are the »second-hand« markets where transactions are among investors only and where the firm whose securities are traded play no independent role. The volume of trading in primary markets typically constitute only a small fraction of trading in secondary markets. Yet, and although no direct allocation of investment capital takes place in secondary markets at all, their significance is seen as affecting, and effectively determining, the terms on which firms are able to obtain investment capital in the primary markets. These terms are generally considered relevant (in an opportunity cost sense) also for the allocation of investment financed through debt issues or through retained earnings.

With respect to the mechanism by which events in the stock market are transmitted as signals to the firm and acted upon there so as to affect the allocation of investment, conventional wisdom goes something like the following. An increase (say) in the price of a firm's shares will have the effect (or so it is postulated) of lowering the cost of capital to the firm. This lowering of the cost of capital will in return result in an expansion of the firm's capital investment and its level of activity generally. Thus, firms whose current or planned activities are considered by the market to be especially promising in terms of profitability will experience such a rise in its share price, and the result will be that new investment is allocated primarily to those firms.

In the explanation above, the only aspect whose validity as a description of the real world has sometimes been questioned is the assumption that at any given point in time a share's price »properly« reflects its real, long-term return potential. Clearly, if share prices moved in a completely capricious manner, there would be no basis for arguing that a price change should affect the allocation of investment capital. The requirement of an orderly and rational price determination can be formulated in different ways. One is to say that the stock price should equal the stock's »intrinsic value« in the sense of the fundamentalist's approach to security valuation. Another is to say that the market should conform to some version of the »efficient market hypothesis« in the sense that

»...new information is widely, quickly and cheaply available to investors, that this information includes what is knowable and relevant for judging securities, and that it is very rapidly reflected in security prices«¹⁾).

We may refer to this assumption as the «efficiency assumption», and we shall outline the main arguments bearing upon it in Section II. However, I will maintain that this is by far the whole story: even if we assume the security pricing process to be efficient and rational, the argument outlined earlier need not be valid. First, there is no clearcut relationship between the price of a firm's stock and its cost of capital, and it is therefore perfectly possible for management to misinterpret signals from the market even for simple accept/rejects decisions. Second, even if a price change has correctly been identified as a signal to increase capital investment, management may not have sufficient information to identify the precise amount by which investment should be increased. These problems are taken up in subsequent sections.

II

It is, I think, possible to distinguish two opposing views of the efficiency and rationality of real-world security pricing processes. In one view, stock prices are seen as set systematically and rationally by a process which leads them to be approximated by the economic value of the real resources which they represent. At the other extreme is the view, popularly associated with the name of Keynes (from his discussion in Chapter XII of «The General Theory»²⁾ but also in varying degrees shared by proponents of so-called «technical» security analysis. In this view, market trading is based largely on «psychological» factors; on anticipations of short-term price movements which may have little or nothing to do with the prospective yield over a longer period of time. As Keynes put it: »...the professional investor is forced to concern himself with the anticipation of impending changes, in the

¹⁾ Lorie, J. and Brealey, R. (eds.), *Modern Developments in Investment Management* (N.Y.: Praeger, 1972), p. 101.

²⁾ Keynes, J.M., *The General Theory of Employment, Interest and Money*, (N.Y.: Harcourt, Brace 1936).

news or in the atmosphere, of the kind by which experience shows that the mass psychology of the market is most influenced«³⁾). As a consequence, he describes the process in the well-known metaphor:

»...professional investment may be likened to those newspaper competitions in which the competitors have to pick out the six prettiest faces from a hundred photographs, the prize being awarded to the competitor whose choice most nearly corresponds to the average preferences of the competitors as a whole; so that each competitor has to pick, not those faces which he himself finds prettiest, but those which he thinks likeliest to catch the fancy of the other competitors, all of whom are looking at the problem from the same point of view. It is not a case of choosing those which, to the best of one's judgment, are really the prettiest, nor even those which average opinion genuinely thinks the prettiest. We have reached the third degree where we devote our intelligences to anticipating what average opinion expects the average opinion to be. And there are some, I believe, who practise the fourth, fifth and higher degrees«⁴⁾.

On the basis of such considerations, Keynes was naturally sceptical of the stock market as an efficient allocative mechanism:

»When the capital development of a country becomes a by-product of the activities of a casino, the job is likely to be illdone. The measure of success attained by Wall Street, regarded as an institution of which the proper social purpose is to direct new investment into the most profitable channels in terms of future yield, cannot be claimed as one of the outstanding triumphs of *laissez-faire* capitalism - which is not surprising, if I am right in thinking that the best brains of Wall Street have been in fact directed towards a different object«⁵⁾.

³⁾ *ibid.*, p. 155.

⁴⁾ *ibid.*, p. 156.

⁵⁾ *ibid.*, p. 159.

Keynes saw the extreme degree of liquidity of shareholdings as the principal source of irrationality in the pricing process: »these tendencies are a scarcely avoidable outcome of our having organised »liquid« investment markets«⁶⁾, and even went as far as suggesting that

»The spectacle of modern investment markets has sometimes moved me towards the conclusion that to make the purchase of an investment permanent and indissoluble, like marriage, except by reason of death or other cause, might be a useful remedy for our contemporary evils. For this would force the investor to direct his mind to the long-term prospects and to those only«⁷⁾.

Here we have to keep in mind the particular time at which this was written, and to remember that since that time both technological and - perhaps more importantly - legal restrictions have developed, which on the whole must have served to increase efficiency and reduce the scope for dysfunctional behavior.

Neither of the two views that we have just described was based on more than casual empirical evidence. The past fifteen years or so, however, have seen a veritable mushrooming of empirical studies which with remarkable consistency seems to support what is variously known as the »efficient market hypothesis« or the »random walk hypothesis«. In evaluating the relevance of these findings for the issue at hand, it is important to have a clear understanding of the relationship between these two concepts.

We have already given an informal characterization of the efficient market hypothesis. At least superficially, it would seem that evidence supporting this hypothesis would also support a view of security pricing as an orderly and rational process. What about the random walk hypothesis? What the random walk hypothesis says is that successive changes in a stock's price are independently distributed random variables⁸⁾; in other words, the price at one point in time equals the price at the preceding point plus some number randomly chosen. This

⁶⁾ *ibid.*, 159.

⁷⁾ *ibid.*, p. 160.

⁸⁾ In order for prices to perform a random walk, successive price changes should, strictly speaking, have zero mean. This requirement is normally not included in the definition of the random walk hypothesis, however.

might seem to imply that price movements are governed largely by accident without much regard for true value, and thus be taken as support of the Keynesian view. Such an interpretation is in no way warranted, and results from a misunderstanding of the random walk hypothesis. In fact, the random walk hypothesis should be seen as a *corollary* of the efficient market hypothesis, i.e., as being a consequence of an efficiently operating market.

The reason for this is simply that in an efficient market, all new information is quickly reflected in prices, and new information is, by definition, information that cannot be deduced from previously released information. But this means that new information necessarily appears in a random fashion. Events that could have been predicted yesterday can have no effect on prices today (they are already discounted), and the only unpredictable events are those which are random. Thus the very process of trading based on rational and systematic adaptation to new information serves to eliminate anything but random movements in stock prices. As a consequence, a stock price will not go up unless it is justified in terms of the market's evaluation of future earnings potential.

On this basis, the evidence in no way seems to conflict with the view that stock prices reflect relevant information on the financial condition and future prospects of firms.

III

As indicated earlier, all is not gravy even if we accept the security pricing process as rational and orderly. In this section we consider the following problem: Suppose we start from an equilibrium position, in which the firm is contemplating whether or not some specific investment project should be undertaken. The firm has not yet committed itself; we furthermore assume that information about the existence and return characteristics of the project is not yet publicly available (but would be once a decision to accept the project were made). Then some shift in some exogenous variable takes place and a new equilibrium is reached where the price of the firm's shares are higher than before. We then wish to see whether and in what way the desirability of the given investment project has been affected.

We take as our vehicle of analysis the two-period mean-variance general equilibrium capital asset pricing model (CAPM). Formulated in absolute money units (rather than rates of return) this model specifies the equilibrium value of firm j as

$$(1) \quad V_j = \frac{1}{r}(E_j - \gamma R_j)$$

where

V_j – value of the firm

r – one plus the riskfree interest rate

E_j – expected second-period value of the firm, i.e., $E \equiv E(X_j)$

R_j – the firm's risk measure, defined by $R_j = \sum_k \text{Cov}(X_j, X_k)$

γ – the market price of risk

The market price of risk reflects the average level of risk aversion in the market, and will here be considered an exogenously given datum.

In evaluating an investment project, it is assumed that it will be considered acceptable only if the effect of undertaking it is to raise the price per share. Under the assumptions of the CAPM, company value is independent of capital structure, and it is in that case easy to see that a project is acceptable, regardless of the method of financing, if the increase in company value caused by the project, ΔV_j , exceeds the cost of the investment.

Suppose now that it costs an amount I to undertake the project under consideration, and that its second-period return (or value) is represented by the random variable Z with $E(Z) \doteq E_z$, $\text{Var}(Z) = \sigma_z^2$, and $\text{Cov}(Z, X_k) = \alpha_{zk}$. If the project is accepted, the second-period value of the firm would be changed from X_j to $X_j + Z$, and it is fairly straight-forward⁹⁾ to show that the resulting increase in the equilibrium value of the firm is given by

$$\Delta V_j = \frac{1}{r}(E_z - \gamma R_z^j)$$

where R_z^j is the risk measure associated with the project when undertaken by firm j and defined by

⁹⁾ See, e.g., Mossin, J.: »Security Pricing and Investment Criteria in Competitive Markets«, *Amer. Econ. Rev.*, Dec. 1969, pp. 749-756.

$$R_z^j \equiv \sum_k \sigma_{zk} + \sigma_{zj} + \sigma_z^2.$$

Consequently, firm j 's acceptance criterion becomes

$$(2) \quad I \leq \frac{1}{r} (E_z - \gamma R_z^j).$$

We shall say the criterion is stricter (weaker) the smaller (larger) the value of the right hand side.

Examining the market valuation formula (1), we see that there are four variables that might directly cause the assumed increase in V_j :

- a decrease in the riskfree interest (r)
- a decrease in the market price of risk (γ)
- an increase in the firm's expected second-period value (E_j)
- a decrease in the firm's risk measure (R_j)

Of these, the first two are common to all firms. A change in the risk-free interest rate would clearly affect all firms in the same proportion and would therefore mean that a firm's share price relative to a market index would be unaltered, while a change in γ would affect firms with a high risk measure proportionately stronger. Changes in E_j and R_j are, of course, specific to the firm.

On the theoretical level it is now straightforward to see the effect that changes in the above variables will have on the investment criterion (2), at least as long as we take the return characteristics of the project (E_z and R_z^j) to be the same, i.e., unaffected by the factor that caused the change in V_j . In this case, the only significant factors are the non-specific variables r and γ ; if either of these caused the increase in V_j , the effect is clearly that the acceptance criterion has become weaker. Changes in E_j or R_j should, however, *per se* have no effect on the investment criterion.

Although these results do not contradict the conventional view, they cannot be said to agree very well, either. We see that a rise in company value does not *unambiguously* increase the propensity to expand capital investment; this follows only if the rise is due to a change in r or γ . What is more, the effect of a change in r or γ seems in some way rather

trivial; the premise of the conventional view is no doubt that the change in the stock price should be caused by factors specific to the firm in question.

Another important consideration is the fact that in a situation such as described, it is virtually impossible for the firm's management to distinguish (except perhaps for r) which particular variable has caused the change in company value, and may therefore react inappropriately. For example, a rise caused by a decrease in R_j may mistakenly be interpreted as being caused by a reduction in γ and lead to increased investment.

A shortcoming of our analysis is that the variable-by-variable approach on which it is based may not be very meaningful, since more than one of the variables $r, \gamma, E_j, R_j, E_Z, R_Z$ might be affected by the same set of events. A simple example would be a situation where a decrease in r is accompanied by a decrease in E_j with the result being no significant change in V_j , yet an increase in investment would be justified.

As another example, suppose we represent the random variables X_j and Z as fixed functions $X_j(\theta), Z(\theta)$ of points θ in a sample space («states of the world») with which is associated a probability distribution $F(\theta)$ [thus $E_j = \int X_j(\theta) dF(\theta)$, etc.]. The underlying reason for a change in V_j may then be a shift in the distribution $F(\theta)$. This will generally have the effect of changing both E_j, R_j, E_Z and R_Z simultaneously¹⁰⁾, and no general conclusions about the relationship between the firm's value and its investment criterion can be drawn. In fact, it is not difficult to construct numerical examples where the effect is the opposite of that postulated by the conventional view¹¹⁾.

A final example, which is of a certain interest in its own right, is the case where the project is of the non-diversifying, or «Modigliani-Miller» type¹²⁾. By this is meant a project whose return is proportional to (in every state of the world), and thus perfectly correlated with, the pre-investment return X_j , i.e., $Z = \alpha X_j$ where α is some fixed constant. According to the so-called proportionality assumption, the resulting

¹⁰⁾ In principle, γ might also be affected.

¹¹⁾ As might be expected intuitively, this is likely to happen for a project whose return is negatively correlated with X .

¹²⁾ Modigliani, F. & M.H. Miller, «The Cost of Capital, Corporation Finance, and the Theory of Investment», *Amer. Econ. Rev.*, June 1958, pp. 261-297.

change in company value should for such a project be given by $V_j = \Delta V_j = \alpha V_j$, although this relation can hold, at best, only as an approximation¹³). If it is accepted, however, the investment criterion becomes $I \leq \alpha V_j$. In this case an increase in V_j makes the criterion weaker regardless of the actual cause of the increase. The explanation is clearly that here the variables are, by assumption, linked together by the relations $E_Z = \alpha E_j$, $R_Z^j = \alpha R_j$.

IV

Although the analysis in the preceding section gives some insights, it may not adequately capture what many would feel are essential ingredients in the problem of stock price changes as signals to management. Recall that we made (among others) the following two assumptions:

- (i) Information about the project under consideration was not yet in the public domain; this means the observed change in company value was unrelated to the project itself.
- (ii) The firm's managers had available to them, and used explicitly in their calculations, the capital asset pricing model's market valuation formula (1); this means that, given estimates for E_Z and R_Z^j they could predict accurately the effect on V_j of accepting the project.

Regarding the former one might argue that what we should primarily be concerned with is precisely a situation where news of a potential investment outlet (e.g., the announcement of a technological advance) has *caused* company value to change. And with respect to the second, one might not be inclined to ascribe to managers the ability to use such sophisticated analytical techniques, although what with which to replace them might be somewhat harder to formulate. The idea, however, is to conceive of the firm as being lead by, rather than anticipating, the market's reaction.

¹³) We have clearly $E_Z = \alpha E_j$, but $R_Z^j = \alpha R_j + \alpha(1 + \alpha)\text{Var}(X_j)$. Only if the second term can be neglected will the proportionality assumption be valid; it otherwise overestimates the effect on V_j of accepting the project.

We may again consider a simple accept/reject decision for some given project. Assuming all pertinent information to be efficiently absorbed by the market, the implication for management is simple: go ahead with the project if and only if the stock price has gone up, since doing otherwise would make the price fall back to its previous level. A decrease in the stock price seems in such a case conceivable only if the market has been led to believe that a decision to go ahead has been made and does not like it; in that case management should hasten to make it clear that no such thing is considered.

A more interesting – but also more difficult – problem arises when the opportunity for new investment is not a uniquely specified project which must be either accepted or rejected, but rather involves the selection of a *level* of investment, with, of course, the level of return (in money units) varying accordingly. Examples might be an automobile manufacturer deciding not only whether, but on what scale, he should invest in an assembly and distribution system in Brazil; or deciding whether and if so on what scale to enter the domestic market for household appliances. We shall continue to use the term project for such opportunities even though the scale of investment is taken as variable. The problem is clearly significant only when the decision is considered largely irreversible. We also assume that the firm, by virtue of technological, brand name, or other forms of protection, has monopolistic access to the project in question.

To explore some aspects of this problem, we shall consider an investment model suggested by Jensen and Long¹⁴). This model is also based on valuation according to the CAPM, and takes as a starting point an initial equilibrium situation with second-period return variables denoted by X_k^* and equilibrium values by V_k^* . A new investment opportunity then becomes available to firm j ; the X_k^* thus remains unchanged for $k \neq j$. The second-period return on investment in this project is assumed to be of the stochastically constant returns to scale type, i.e., a second-period return of Y (a random variable) per unit of investment. We denote the mean of Y by E_Y , its variance by σ_Y^2 and $\text{Cov}(Y, X_k^*) = \alpha_{Yk}$ for all k .

¹⁴) Jensen, M. and J. Long, »Corporate Investment under Uncertainty and Pareto Optimality in the Capital Markets«, *Bell Jour. Econ.*, Spring 1972, pp. 151-174.

If an amount I were to be invested in the new project, X_j^* would change to $X_j = X_j^* + YI$, and we would correspondingly have

$$E_j = E_j^* + E_y I$$

$$\text{Var}(X_j) = \text{Var}(X_j^*) + 2\sigma_{yj}I + \sigma_y^2 I^2$$

$$\text{Cov}(X_j, X_k^*) = \text{Cov}(X_j^*, X_k^*) + \sigma_{yk}I \quad (\text{for } k \neq j)$$

The new value of the firm's risk measure would therefore be

$$R_j = R_j^* + (\sum_k \sigma_{yk} + \sigma_{yj} + \sigma_y^2 I)I,$$

and, using the market valuation formula (1), we can calculate the new equilibrium value of the firm as

$$(3) \quad V_j = V_j^* + \frac{1}{r}[E_y - \gamma(\sum_k \sigma_{yk} + \sigma_{yj} + \sigma_y^2 I)]I.$$

The important questions are now how the market reacts to news of the potential project, and whether it is possible for the firm's management to infer from this reaction an appropriate decision.

It is clear that to any particular change in market price these must correspond an (imputed) level of investment which in some sense represents what the market expects the actual investment level will be. Such an assessment must in turn be based on some perception (again implicit in the market) of what objective the firm will pursue in making its investment decision. Of course, we cannot directly verify any particular description of these relationships; all we can do is to postulate that market value is determined *as if* a certain hypothesis were true.

One such hypothesis (which may or may not be considered plausible) is that the change in market value is equal to what it would have been if an investment level designed to maximize price per share had been chosen and the relationship between this level and V_j is given by (3). I.e., we postulate that the information available in the market about the project allows an assessment of the level of investment that would

maximize the share price, and that the market price moves as if this level had in fact been chosen. Let us see what would happen under these circumstances.

Assuming (3) to be valid, the investment level that maximizes price per share is such that $dV_j/dI = 1$, or

$$\frac{1}{r}[E_y - \gamma(\sum_k \sigma_{yk} + \sigma_{yj}) - 2\gamma\sigma_y^2 I] = 1.$$

This can be rewritten as

$$E_y - \gamma(\sum_k \sigma_{yk} + \sigma_{yj} + \sigma_y^2 I) = r + \gamma\sigma_y^2 I.$$

If I satisfies this condition, the resulting increase in company value, $\Delta V_j = V_j - V_j^*$, becomes

$$\Delta V_j = \frac{1}{r}(r + \gamma\sigma_y^2 I)I.$$

Let the number of shares initially outstanding be n_j ; the increase in the price per share is then given by $\Delta p_j = (\Delta V_j - I)/n_j$, i.e.,

$$\Delta p_j = \frac{\gamma\sigma_y^2 I^2}{rn_j}$$

Thus, given an observed price increase of Δp_j , the corresponding (share price maximizing) investment level is given by

$$(4) \quad I^2 = \frac{r}{\gamma\sigma_y^2} (n_j \Delta p_j).$$

Here $n_j \Delta p_j$ is the increase in the market value of the firm's equity.

Suppose now that the firm's managers observe a certain rise in equity value following the news of the investment opportunity. Does this enable them to correctly select a level of I ? The answer is clearly no, unless they also happen to know (or believe they know)

- (i) that market demand is premeditated on the assumption that they themselves will choose I so as to maximize the share price;
- (ii) that (3) is a valid representation of market value as a function of I ;
- (iii) the numerical values for r , γ , and σ_y^2 .

But this is obviously begging the question, since if they were armed with all this information, there would be no need to observe the increase in the share price in the first place; they could have calculated what they considered an optimal I quite independently of, and without waiting for, any signal from the market. Of course, as a practical matter, they might want to observe the actual price change as a check that their calculations were in fact correct. But the basic – and perhaps somewhat paradoxical – conclusion remains the same: in order to interpret the market's signal correctly, management need so much additional information that the signal itself becomes redundant.

V

I have sometimes been struck by the apparent lack of concern among managers for the price of their company's shares, at least in a decision-making context. One might be inclined to explain such an attitude in terms of separate objectives for owners and managers, but in view of the discussion presented here, a more natural explanation suggests itself: stock price movements *per se* represent insufficient information for decision-making purposes. This state of affairs may perhaps also explain the almost complete absence of coverage of the significance of stock price changes in most textbooks on corporate financial management.

A word of warning is in order. The rather indefinite results of our exploration are not to be construed as a denial of a stock market's ability to effect a socially efficient allocation of investment capital, but rather as a critique of the conventional view of the role of stock prices as such in this process. Clearly, there are other ways of making investment decisions than through passive reliance on feedback information from the market¹⁵).

¹⁵) For a more thorough analysis of Pareto optimality of stock market allocations, see Mossin, J., *The Economic Efficiency of Financial Markets* (Lexington, Mass.: D.C. Heath & Co., 1976).