WORKING PAPER
ALFRED P. SLOAN SCHOOL OF MANAGEMENT

DIVIDEND BEHAVIOR FOR THE
AGGREGATE STOCK MARKET

Terry A. Marsh
Robert C. Merton

WP #1670-85

September 1983
May 1985
Revised August, 1986

MASSACHUSETTS
INSTITUTE OF TECHNOLOGY
50 MEMORIAL DRIVE
CAMBRIDGE, MASSACHUSETTS 02139

DIVIDEND BEHAVIOR FOR THE
AGGREGATE STOCK MARKET

Terry A. Marsh
Robert C. Merton

WP #1670-85

September 1983
May 1985
Revised August, 1986

DIVIDEND BEHAVIOR FOR THE AGGREGATE STOCK MARKET*[†]

Terry A. Marsh
Graduate School of Business Administration
University of California, Berkeley
and
Hoover Institution, Stanford University

Robert C. Merton
Sloan School of Management
Massachusetts Institute of Technology

ABSTRACT

    We develop and estimate a model of the dynamic behavior of aggregate
corporate dividends as a function of the change in permanent earnings of
firms. Although structured along the lines of the Lintner-Brittain-Fama-
Babiak models of individual-firm dividend behavior, the model uses changes in
stock prices instead of accounting earnings to measure permanent earnings
changes. The performance of the model is compared with both the accounting
earnings-based models and the trend-autoregressive model associated with
Shiller (1981a).

I. Introduction

In this paper, we develop a model of the dividend process for the aggregate stock market. Previous research has focused almost exclusively on dividend behavior at the micro level of the individual firm. Hence, to motivate the focus here on aggregate dividend behavior, we begin with a brief review of these earlier micro studies, this to be followed by a discussion which locates the place of our aggregate analysis within this body of research. In Sections 2-5, we derive and fit our econometric model of the dividend process. In Section 6, we compare the performance of the model with other models in the literature.

Although long a staple of financial management textbooks, corporate dividend policy remains a topic on which the field has failed to arrive at even a local sense of closure.[1] Fischer Black (1976) has aptly described this lack of closure as the "dividend puzzle." The pivotal point in this puzzle is the classical work of Miller and Modigliani (1961) which demonstrated the irrelevance of dividend policy for determining the firm's cost of capital.

Miller and Modigliani show that when investors can create any payout pattern they want by selling and purchasing shares, the expected return required to induce them to hold these shares will be invariant to the way in which firms "package" gross dividend payments and new issues of stock (and/or other zero net present value transactions). Since neither the firm's expected future net cash flows nor its discount rate is affected by the choice of dividend policy per se, its current market value cannot be changed by a change in that policy. Thus, dividend policy "does not matter." Although, under the MM proposition, there are no a priori reasons for firms to follow any

systematic dividend policy, there are also no penalties if they choose to do so.

Exceptions to the MM view are, of course, to be found in the literature. Gordon (1959;1962) and Lintner (1962) claim that dividend policy does affect the firm's cost of capital, and provide some early evidence to support the view that a higher dividend payout reduces the cost of capital (i.e., investors prefer dividends). Others argue that personal and corporate taxes cause dividend policy to affect the firm's cost of capital, but in the direction that a higher payout raises the cost of capital (i.e., investors prefer capital gains). Litzenberger and Ramaswamy (1979) and Poterba and Summers (1984;1985) offer empirical support for this view. On the other hand, Black and Scholes (1974), Miller and Scholes (1978;1982), Hess (1983), and Eades, Hess and Kim (1984) present analysis and evidence suggesting that, as an empirical matter, tax effects per se do not appear to affect the cost of capital. Easterbrook (1984) proposes an agency theory explanation for dividends. Along different lines from these studies, Shefrin and Statman (1984) have used behavioral theories of individual choice to argue that investors will prefer cash dividends, even if they are tax disadvantaged. Although some of these analyses might provide reasons to believe that investors are not indifferent between cash dividends and capital gains, the empirical evidence to date is still inconclusive for rejecting the Miller and Modigliani proposition.

Even with their view of investor indifference for dividends, Miller and Modigliani (1961, p. 431) do point out that dividend policy can matter if dividend changes are used by firms to convey information not otherwise known to the market. Bhattacharya (1979), Miller and Rock (1982), and John and

Williams (1984) use a signalling model approach to formalize this notion. Hakansson (1982) derives the additional general equilibrium conditions required for dividend signals to improve investor welfare. Aharony and Swary (1980) provide some empirical evidence on the informational content of dividends in their study of dividend announcement events for 149 NYSE industrials, in which they find that, on average, unexpected dividend and unexpected price changes are positively correlated around announcement dates. Asquith and Mullins (1983) find similar results for firms that initiate dividend payments for the first time. The evidence is, however, that the correlations, while statistically significant, are rather small, a conclusion also reached in empirical work by Watts (1973) and Gonedes (1978).

In summary, there are a number of conflicting theories of dividend behavior, and the empirical studies to date provide little compelling evidence for one over the others. The management of a firm is free to choose a dividend policy with virtually any time pattern it wants, subject only to the overall constraint that the present value of expected future distributions net of new stock offerings cannot exceed the present value of the firm's expected net cash flows generated by its investments. Indeed, except for certain debt indenture restrictions and accumulated earnings tax penalties, there do not appear to be any significant legal, accounting convention, or corporate tax factors to exert pressures on managers of publicly-traded and widely-held corporations to follow any particular dividend policy.

With so much controversy surrounding the various normative theories of the dividend process, it is perhaps not surprising that empirical researchers have relied heavily on positive theories of dividend behavior to specify their models. The prototype for these models is the Lintner model (1956) which is

based on stylized facts first established by him in a classic set of interviews of managers about their dividend policies. A similar model, motivated by Friedman's Permanent Income Hypothesis, is proposed by Fisher (1957). From the Lintner interviews, it was readily apparent that dividend policies across firms were hardly uniform. Lintner did, however, identify some common characteristics: Namely, managers tend to change dividends primarily in response to an unanticipated and nontransitory change in their firms' earnings, and they are guided by target payout ratios in making those changes. Using an econometric model based on these perceived patterns, Lintner found that he could explain a significant portion of annual dividend changes for a sample of companies over the period 1918-1941. Using similar types of models, subsequent empirical work by Fama and Babiak (1968), Petit (1972), and Watts (1973) supports Lintner's original findings.

With few exceptions (notably, Brittain (1966) and Shiller (1981a;b)), research on both normative and positive models of dividends has focused on the micro behavior of individual firms. The relative lack of research on aggregate dividend behavior is perhaps not surprising since many of the more interesting issues surrounding dividend policy are likely to be firm specific. For example, clientele effects and indenture restrictions which could in principle affect an individual firm's dividend policy are likely to "wash out" in any aggregate dividend analysis. Similarly, issues involving the informational content of an individual firm's dividends are likely to be considerably less important for the stock market as a whole than for an individual firm. It is, indeed, difficult to see how one could identify meaningful announcement dates for aggregate dividends to perform event studies along the lines of Gonedes (1978) and Aharony and Swary (1980).

If firms only changed their dividends to signal information and if the only information worth signalling is specific to the firm, then changes in aggregate dividends would be random and their magnitudes small. If, however, firms change their dividends for reasons other than signalling, then the very fact that aggregate dividend changes are unlikely to contain much signalling information may make them an especially useful series for measuring the informational content of an individual firm's dividend announcements. To identify the signals or abnormal changes in a firm's dividends, it is, of course, necessary to have a model of its "normal" dividend behavior. Watts (1973), for example, uses the Lintner model for this purpose. The Lintner model does not, however, take account of the cross-sectional dependencies among firms' dividend policies. It is reasonable to expect that in addition to its own economic circumstances, the firm would use the dividend behavior of other firms to calibrate its dividend policy--as, for example, observing industry practice in the selection of its target payout ratio. Moreover, these dependencies may be of considerable empirical significance in light of the already-documented strong correlations among different firms' contemporaneous stock price changes. Removal of the aggregate market component of a stock's return to obtain a better estimate of its abnormal price change is commonplace. Just so, use of an aggregate dividend model to remove the "systematic" component of an individual firm's dividend policy would appear to provide a better estimate of its abnormal dividend changes.[2]

If individual firms follow reasonably stable dividend policies over time, then the afore-mentioned cross-sectional dependencies will induce systematic behavior in the time series of aggregate dividends. It is, however, possible for aggregate dividends to exhibit stable and consistent time series

properties even if no such stability were found for individual firms. For example, in a purely demand-driven model for dividends, the demand for dividends is not firm-specific because investors only care about the dividend-capital gain mix at the portfolio level. Hence, as in the Miller (1977) theory of corporate debt, there will be in general, many different allocations of dividend policies to individual firms that will support an equilibrium in the dividend market. Thus, equilibrium aggregate dividends may be determinate, but which firms service this demand and the quantity each chooses to supply may not.[3]

In the next section, we motivate the specification of our econometric model with a discussion of the descriptive facts established in the Lintner interviews.[4] This is followed in Sections 3, 4 and 5, by the estimation and testing of the model.

Although sharing Lintner's stylized facts in common with the previously-cited empirical studies of micro dividend behavior, our model, in addition to being applied at the aggregate level, differs significantly from these earlier studies because it assumes that _economic_ earnings, instead of _accounting_ earnings, are the primary determinant of dividends. The analysis in Section 6 compares the performance of our model with one which uses accounting earnings. Because the Brittain (1966) study of aggregate dividends relies upon the relations between dividends and accounting variables, our analysis sheds light on his findings as well. In this same section, we also compare the relative performance of our model with the univariate trend-autoregressive model which is associated with the Shiller (1981a;b) model of aggregate dividends.

2. Model of Aggregate Dividend Dynamics

Lintner found considerable heterogeneity among firm dividend policies in his interviews of corporate managers. However, he also found some characteristics to be common to many of these firms' dividend policies. These stylized facts are summarized as follows: (i) Managers believe that firms should have some long-term target payout ratio; (ii) In setting dividends, they focus on the change in existing payouts and not on the level; (iii) A major unanticipated and nontransitory change in earnings would be an important reason to change dividends; (iv) Most managers try to avoid making changes in dividends which stand a good chance of having to be reversed within the near future.

Most textbook discussions seem to agree with the interpretation of these stylized facts to the effect that it is changes in some measure of long-run sustainable or "permanent" earnings, rather than current earnings, which drive dividend decisions. That is, a change in current earnings flow which is viewed by management as essentially transitory would not be likely to give rise to a noticeable change in dividends. Unfortunately, except for the special case of a firm whose future earnings are certain and generated without further net new investment, the textbooks are not specific in defining permanent earnings. Our interpretation (which is consistent with this special case) defines the permanent earnings per share of a firm at time t as equal to the expectation as of time t of that level of uniform payments which could be made by the firm to a single share in perpetuity. For an all-equity financed firm, permanent earnings are determined as follows: Let $\Pi(s)$ denote the real after-tax cash flow from the physical and financial assets of the firm at time s and $I(s)$ denote the real net new investment by the firm

at time s. I(s) = [gross new physical investment + purchases of financial assets-sales of physical and financial assets]. If α denotes the firm's real cost of capital, then the discounted value of the expected cash flows available for distribution to each share outstanding at time t is given by:

$$V(t) \equiv \epsilon_t \{ \int_t^\infty [\Pi(s) - I(s)]e^{-\alpha(s-t)}ds \}/N(t) \tag{1}$$

where ϵ_t denotes the expectation operator, conditional on information available as of time t and N(t) denotes the number of shares outstanding. V(t) is sometimes called the "intrinsic value" (per share) of the firm, and permanent earnings per share are determined by creating a perpetual annuity from this intrinsic value.[5] That is, if E(t) denotes permanent earnings per share of the firm at time t, then:

$$E(t) = \alpha V(t) \tag{2}$$

Since corporate managers set dividends for their firms, it is their assessments of permanent earnings which are relevant for the evolution of aggregate dividends. For this purpose, we denote managers' determination of permanent earnings by $E^m(t) = \alpha V^m(t)$ where $V^m(t)$ is given by (1) with the expectation operator $\epsilon_t = \epsilon_t^m$ based on the probability distribution for future $\Pi(s)$ and I(s) generated by the managers' information sets as of time t.

Although Lintner's stylized facts suggest that dividend changes are related to permanent earnings changes, the interview data on which they are based contain little information about the detailed functional form of that relation.[6] In the absence of a specific structural model of that relation, we posit that logarithmic dividends can be expressed as the sum of a rational

distributed lag of logarithmic permanent earnings, a drift term which is conditional on information known at time t, a(t), and a disturbance term $\eta(t)$. That is, we represent the aggregate dividend process as:

$$(1-\phi_1 L) \log[D(t)] = a(t) + (\lambda-\theta_1 L) \log[E^m(t-1)] + \eta(t) . \quad (3)$$

where $D(t)$ is the integral $\int_{t-1}^{t} D(s)ds$ of aggregate dividends paid per share of the market portfolio over the interval from time t-1 to time t; $E^m(t)$ is permanent earnings as defined in (2), per share of the market portfolio at time t; and the roots of the first order polynominals in the lag operator L are outside the unit circle.

As specified, (3) is consistent with the "short run" dividend dynamics of the Lintner model. It does not, however, capture his stylized fact (i) that firms typically set a long-run target for the dividend payout ratio. In line with the discussion concerning the steady-state properties of long-run equilibrium dividend payout, we take account of this long-run objective in our model by requiring that dividend payouts converge to a constant target ratio, i.e., as $t \rightarrow \infty$ (and in the absence of any disturbances),

$$\lim_{t\to\infty} \log[\frac{D(t)}{E^m(t-1)}] = \beta \quad . \quad (4)$$

This special assumption that the long-run target be literally constant is more stringent than necessary.[7] Moreover, this assumption does not, of course, imply that dividends and permanent earnings follow (trend) stationary processes.[8]

As shown in Appendix A, if the long-run steady-state condition (4) is imposed on the short-run dynamics (3), then (3) can be rewritten as:

$$\log[D(t+1)] - \log[D(t)] = g(t) + \lambda\{\log[E^m(t)] - \log[E^m(t-1)] - m(t-1)\}$$
$$+ \gamma\{\beta - (\log[D(t)] - \log[E^m(t-1)])\} + \eta(t+1)$$

(5)

where $m(t-1)$ is the time $t-1$ expectation of the logarithmic change in permanent earnings, $\{\log[E^m(t)] - \log[E^m(t-1)]\}$; and $g(t)$ is the expected logarithmic change in dividends, $\{\log[D(t)] - \log[D(t-1)]\}$, _if_ the time $t-1$ logarithmic payout ratio $\log[D(t)/E^m(t-1)]$ is equal to its long-run target β and the unexpected change in logarithmic permanent earnings, $\{\log[E^m(t)] - \log[E^m(t-1)] - m(t-1)\}$, is zero.

The model described by (5) takes the form of the well-known "error correction" model which has been studied and applied by Sargan (1964), Davidson, Hendry, Srba, Yeo (1978), Nickell (1980), Salmon (1982), and Ericsson and Hendry (1984). It obviously satisfies the condition for a long-run steady-state distribution for D/E^m because if $\eta(t+1) = 0$, then $\Delta\log[E^m(t)] = m(t-1)$ implies $\{\log[D(t)] - \log[E^m(t-1)]\} = \beta$ as required. Given the specification (4) of the long-run equilibrium, the model's potential for describing the short-run dynamics of aggregate dividends depends upon the appropriateness of the rational distributed lag in (3). Since the error correction model is applicable for a wide range of stochastic processes governing $E^m(t)$, including the geometric random walk (cf. Nickell (1980)), the major assumptions imbedded in (3) are those of symmetry in the responsiveness of dividend changes to permanent earnings changes and, empirically, the constancy of coefficients.[9]

In economic terms, the "normal" or unconditional growth rate for dividends, $g(t)$, equals $\alpha r(t)$ which is the usual expression for the deterministic growth rate of dividends where $r(t) \equiv 1 - D(t)/E^m(t-1)$ is

the retention rate (in terms of permanent earnings) at time t and α is defined as the aggregate cost of capital. That is, specification of the deterministic component $g(t)$ reflects the standard textbook proposition that if the current payout is high relative to permanent earnings and therefore the retention rate $r(t)$ is low, then dividends per share will be expected to grow more slowly than if the current payout were lower and the retention rate were correspondingly higher. The rest of the terms on the right-hand side of (5) describe the deviation of the growth in dividends from this normal rate.

The second term in (5), which is multiplied by λ, captures Lintner's stylized fact (iii) that managers will change dividends away from the anticipated path in response to an unanticipated change in permanent earnings, $\{\log[E^m(t)/E^m(t-1)] - m(t-1)\}$. The third term, which is multiplied by γ, is the "error correction" component which drags short-run dividends toward their long-run steady-state payout ratio, thus capturing Lintner's stylized fact (i). The value of γ, which should be positive, measures the average speed of convergence of the payout ratio to its target.

The a priori reasons for choosing the lag specification in (3) and (5), in which an unanticipated change in permanent earnings from time $t-1$ to time t causes a dividend change in the interval $(t, t+1)$, are as follows: first, an unanticipated change in permanent earnings, by definition, cannot be known until it happens, so any reaction in dividends to such a change must occur at the same time or later. Unlike delays in the reaction of speculative prices to new information, there are no arbitrage opportunities created by managers if they delay changing dividends in response to new information. Second, although firms usually declare dividends once a quarter, many firms only make significant changes at the end of their fiscal year. Third, even if

individual firms' managers did react instantaneously, the reaction in aggregate dividends will appear to be lagged because of different announcement dates and different speeds of reaction across firms.

In responding to an unanticipated change in permanent earnings, managers will change dividends in the same direction which implies that λ in (5) should be positive. From stylized fact (iv), managers prefer to avoid reversals in dividends, and it can be established that a partial adjustment policy with $\lambda < 1$ is optimal if reversals or changes are costly.

3. The Dividend Model Expressed as a Regression Equation

In the empirical studies of both Lintner's model and subsequent dividend models based on his original formulation, the equations corresponding to our (5) are treated as regression equations. We too assume that equation (5) is both a structural equation and a causal equation because our view of the economic process is that an unanticipated change in permanent earnings causes a predictable change in next period's dividends, and not the reverse.

Of course, in a complete general equilibrium model, dividend changes and intrinsic value changes, along with other quantities and prices, are jointly endogenous. However, insofar as the bivariate series of dividend changes and intrinsic value changes is concerned, there are persuasive grounds for treating the latter as a proper predetermined endogenous variable, particularly when the discount rate α is assumed constant.

As already noted, there are no important legal or accounting constraints on dividend policy, and hence, managers have almost complete discretion and control over the choice of dividend policy. If, however, managers are not irrational, then they will, at least, choose a dividend policy which is feasible in both the short and long runs. Such "feasible" policies must satisfy the constraint that the discounted value of expected future dividends per share is equal to the discounted value of expected future net cash flows as given by (1). Because managers set dividend policy, this constraint is properly specified in terms of their probability assessments. Hence, from (2), it follows that a rational dividend policy must satisfy:[10]

$$\varepsilon_t^m \{ \int_t^\infty D(s) e^{-\alpha(s-t)} ds \} = E^m(t)/\alpha \qquad (6) \quad .$$

As discussed in Marsh and Merton (1986), this constraint on dividend choice is very much analogous to the intertemporal budget constraint on consumption choice in the basic lifetime consumption decision problem for an individual. Like consumers in selecting their planned intertemporal expenditures for a given amount of wealth, managers, facing a given level of permanent earnings, have a great deal of latitude in their choice of dividend policy.[11] The fact that individual firms pursue dividend policies which are vastly different from one another is empirical evidence consistent with this view.

It does not follow from (6) that a change in dividend policy by managers will cause a change in their current assessments of permanent earnings.[12] For a fixed discount rate, α, it does however follow from (6) that an unanticipated change in permanent earnings must necessarily cause a change in

expected future dividends. The direction of causation between unanticipated changes in permanent earnings and changes in subsequent dividends posited in our model is, thus, consistent with the direction of causation between changes in current wealth and changes in future consumption that is normally assumed for the life-cycle model in a fixed-discount-rate world.[13]

In making the case for causality in equation (5), we are not unaware of the possibility that there are other exogeneous variables which may cause managers to change dividends. If this is the case and if, further, these variables are correlated with unanticipated changes in current permanent earnings, then, of course, equation (5) is flawed as a causal equation. If, however, managers are rational predictors of permanent earnings, then an unanticipated change in permanent earnings this period will be uncorrelated with all variables which are observable prior to this period (including both past dividends and permanent earnings). It therefore must also be uncorrelated with all future unanticipated changes in permanent earnings. Thus, if there are other exogeneous variables which explain next period's change in dividends, it seems unlikely that they would be correlated with this period's unanticipated change in permanent earnings. Hence, the assumption that equation (5) is a proper regression equation is likely to be robust with respect to other "missing" explanatory variables.

This property of rationally-predicted permanent earnings together with the lagged structure of equation (5) may perhaps at first suggest that the causality issue can be resolved empirically by applying an appropriate version of the Granger-Sims test of causality. A careful review of this possibility will, however, lead to the well-known identification problem that statistical tests alone are not sufficient to establish causality, and that ultimately

this issue can only be resolved by a priori economic reasoning (cf. Zellner (1979)).

4. A Reduced Form for the Dynamic Model

Although we have proposed equation (5) for aggregate dividend dynamics as both a structural and a regression equation, it cannot be estimated in its current form because management assessments of changes in firms' permanent earnings are not observable. In this section, we add the necessary further specification to estimate the model.

If managers are rational forecasters and the market is reasonably efficient, then the market's estimate of a firm's intrinsic value should on average be equal to the intrinsic value estimate made by that firm's management. We therefore assume that the discounted value $V^M(t)$ of the expected future aggregate net cash flows of all firms per market share, as estimated from the market's information set, is equal to the aggregate sum of the intrinsic values where the intrinsic value of each firm is estimated from the information set of that firm's management.[14] This market efficiency condition can be written as:

$$V^M(t) = V^m(t) \qquad \text{for all } t \qquad (7)$$

where $V^M(t)$ is given by (1) with $\varepsilon_t = \varepsilon_t^M$.

We further assume that the stock market price is equal to its intrinsic value, i.e., there are no speculative bubbles. From this assumption and (7), we can write the cum-dividend price of a share of the market portfolio at time t :[15]

$$P_c(t) = \varepsilon_t^M \{ \int_t^\infty e^{-\alpha(s-t)} [\Pi(s) - I(s)] ds \} / N(t) \qquad (8) \quad .$$

Using the market efficiency condition (7) and the definition of permanent earnings in (2), we can rewrite (8) as:

$$P_c(t) = E^m(t)/\alpha \qquad . \qquad (9)$$

If, as we have assumed, the expected real rate of return on the market, α, is a positive constant, it follows from (9) that the percentage change in stock market price is equal to the percentage change in managers' assessment of permanent earnings. Substituting for $E^m(t)$ from (9) and splitting the cum-dividend stock price change $P_c(t)/P_c(t-1)$ into its two component parts--the ex dividend change $P(t)/P(t-1)$ and the dividend yield $D(t)/P(t-1)$, we rewrite (5) as:

$$\log[\frac{D(t+1)}{D(t)}] = [\alpha - \frac{D(t)}{P(t-1)}] + \lambda \{ \log[\frac{P(t) + D(t)}{P(t-1)}] - \alpha \}$$

$$(10)$$

$$+ \gamma[\rho - \log \frac{D(t)}{P(t-1)}] + u(t+1)$$

where $\rho \equiv \beta + \log \alpha$. By rearranging terms, we can rewrite (10) as:

$$\log[\frac{D(t+1)}{D(t)}] + \frac{D(t)}{P(t-1)} = a_0 + a_1 \log[\frac{P(t) + D(t)}{P(t-1)}] + a_2 \log \frac{D(t)}{P(t-1)} + u(t+1)$$

$$(11)$$

where $a_1 = \lambda$; $a_2 = -\gamma$; and $a_0 = (1 - \lambda)\alpha + \gamma\rho$.

Note that (9) is not an identity. It is a specification which is valid under the hypothesis that market prices are rational predictors of firms' future net cash flows. Thus, (11) is a reduced-form equation, and as such, can be consistent with more than one set of structural hypotheses. If market price provides a good estimate of managements' assessments of permanent earnings, then (11) should be a good predictor of the dividend process. Such

would be the case if managers are rational predictors of future cash flows and the market is efficient. But, it would also be the case if the market is inefficient because it is moved by waves of optimism and pessimism, and managers either rely on market prices for their estimates of permanent earnings, or they are influenced by the same irrational waves as investors in making their assessments of intrinsic values.

To investigate this identification matter further, consider the following model first suggested to us by Zvi Griliches: Managers are rational forecasters of permanent earnings and they fully adjust dividends in response to changes in these earnings (i.e., $\lambda = 1$ in (5) and $\log[D(t+1)/D(t)] = \log[E^m(t)/E^m(t-1)]$). The market is assumed to be inefficient both because of random "animal spirits" and because investors tend to overreact to new information about the fundamentals. That is, replace (9) with the alternative hypothesis, $\log[P_c(t)/P_c(t-1)] = \psi\log[E^m(t)/E^m(t-1)] + \epsilon(t)$, where $\psi > 1$. If equation (11) is fit under these assumptions, then the predicted value for a_1 is given by $a_1 = \psi/[\psi^2 + q]$ where q is the ratio of the variance of animal-spirits-induced price changes to the variance of rational permanent-earnings changes.

As in our model, the Griliches model predicts that $0 < a_1 < 1$. If market price is a very noisy estimator of permanent earnings principally because of animal spirits (i.e., $q/\psi \gg 1$), then (11) should be a poor predictor of the evolution of dividends. Alternatively, the market could be efficient and (11) could be a poor predictor because management dividend decisions in the aggregate are not well described by behavioral equation (5). If (11) exhibits strong explanatory power, it is still possible for the Griliches model to hold if overreaction is the primary source of market

inefficiency (i.e., $q/\psi \ll 1$). It would, thus, appear that the empirical properties of equation (11) are alone inadequate to distinguish between our model and the Griliches alternative.

The focus of our study is not to test the hypothesis of stock market inefficiency, but instead to develop a model of aggregate dividend behavior which is consistent with that hypothesis.[16] Nevertheless, we digress briefly from that focus to point out some ancillary conditions to equation (11), which do provide some discriminatory power between our model and the Griliches model.

As already noted, unanticipated changes in rationally-forecasted permanent earnings should have no serial dependencies. In the Griliches model, this implies that successive changes in dividends should be uncorrelated. As shown in Section 6, the empirical time series of dividend changes exhibits rather strong positive serial correlation. In contrast, such serial correlations have little impact on the robustness of our model.

If one assumes that even inefficient stock prices cannot wander arbitrarily far from their intrinsic values for an indefinite period of time, then with a constant discount rate, the regressivity of price toward intrinsic value will induce negative serial dependency in stock price changes. If this regression takes place in a series of small adjustments systematically over time, then one would expect to find significant negative serial correlation in the stock return series. As is well known, the empirical evidence does not support this prediction.[17] If the regression takes place in the form of large adjustments at random and relatively infrequent points in time, then the standard estimates of serial correlation may not detect this dependency. However, these "outliers" would tend to cause the empirical distribution of

stock price changes to exhibit higher kurtosis than the distribution of rational permanent-earnings changes. In the context of the Griliches model, stock price changes should have higher kurtosis than dividend changes. As shown in Section 6, quite the opposite seems to be the case as an empirical matter. As discussed there, this finding is consistent with our model. Although hardly a complete analysis, these ancillary findings appear to support our model over the Griliches alternative. With this, we end the digression and return to the development of our model of dividend behavior in an environment with a rational stock market.

For (11) to be a proper reduced-form equation, its right-hand side variables must be predetermined relative to its left-hand side variable. As discussed at length in Section 3, an unanticipated change in permanent earnings this period (over which managers have no control) is an exogeneous variable relative to the change in next period's dividends which managers control almost completely. From (7) and structural equation (9), it therefore follows that an unanticipated change in this period's price is exogeneous relative to next period's dividend change, and hence, (11) is a proper reduced-form equation. In this limited sense of a reduced form, an unanticipated change in this period's price "causes" a (predictable) change in next period's dividends.

In specifying (11), our intent is to construct a simple model of the dividend process which nevertheless captures the basic stylized facts of management behavior. We have therefore assumed a simple one-period lagged adjustment. It is possible that the dividend process may involve higher-order lags with different speeds of adjustment, and as already noted, there may be other "missing" variables which enter into the process. As we will show, the

empirical conclusions derived from this simple model are likely to be robust with respect to refinements which include such additional variables.

5. Model Estimation

To estimate the reduced-form equation (11), we use annual data constructed from monthly dividend and price series for the value-weighted NYSE index contained in the Center for Research in Security Prices data set over the period 1926 to 1981.[18] Over the period 1927 to 1980, the discrete-time version of (11) estimated by ordinary least squares (OLS) is given by

$$\log[\ \frac{D(t+1)}{D(t)}\ ] + \frac{D(t)}{P(t-1)} = \underset{(0.157)}{-0.101} + \underset{(0.064)}{0.437} \log[\ \frac{P(t)+D(t)}{P(t-1)}\ ]$$

$$(12)$$

$$\underset{(0.050)}{-0.042} \log \frac{D(t)}{P(t-1)} + u(t+1)$$

$$\bar{R}^2 = 0.47 \qquad\qquad DW = 1.53$$

In (12), $D(t)$ refers to aggregate NYSE dividends totalled over year t, and $P(t)$ refers to price at the end of year t. The numbers in parentheses under the coefficients are standard errors, and not t-statistics. For example, the coefficient of the lagged logarithmic change in price has a standard error of 0.064, and a t-statistic of 6.83. The coefficient point-estimates in (12) indicate that the deviations of real dividend changes from their normal growth rate covary positively and strongly with the previous year's unexpected cum-dividend price changes and negatively with the previous year's dividend

yield. The Durbin Watson statistic suggests that there is positive autocorrelation in the residuals of the OLS fit of (12). Disturbance correlation can arise in various ways. As already noted, our simple model assumes one-period adjustment in dividends by management, whereas longer lags are entirely possible. Further, as we noted earlier, it is possible that the target dividend yield is not literally constant. For example, yield might change if tax rates, the technology of communications and trading, or the mix of institutional and individual ownership, change. It is highly likely that any yield changes induced by such factors, which will show up in the residuals in (12), are serially correlated. Indeed, any omitted variables which are serially correlated could be a potential source of residual autocorrelation.[19]

In light of the autocorrelation in the residuals of (12) we reestimated (11) using generalized least squares (GLS), and the results are:

$$
\log\left[\frac{D(t+1)}{D(t)}\right] + \frac{D(t)}{P(t-1)} = \underset{(0.198)}{-0.234} + \underset{(0.061)}{0.444} \log\left[\frac{P(t)+D(t)}{P(t-1)}\right]
$$

$$
\underset{(0.082)}{-0.085} \log\frac{D(t)}{P(t-1)} + u'(t+1)
$$

(13)

$$
\bar{R}^2 = 0.53 \qquad DW = 1.83
$$

Although the GLS estimate which takes into account the positive autocorrelation appears to have slightly more explanatory power, the results from either the OLS or GLS fits are essentially the same in that they explain about 50 percent of aggregate NYSE real dividend changes. As will be shown in Section 6, the explanatory power of our single-equation aggregate time series model[20] is considerably higher than that of univariate trend-autoregressive

models such as the one fitted by Shiller (1981a).

The point estimate of 0.44 for the coefficient on the lagged percentage price change is positive, substantial in magnitude, and highly significant. This finding is consistent with the hypothesis that the market price is a good indicator of permanent earnings and that managers systematically change dividends in response to an unanticipated change in permanent earnings.[21]

Because the coefficient on percentage price changes is both significantly greater than zero and significantly less than one, this finding is also consistent with the Lintner stylized fact that managers smooth dividends by responding in a partial adjustment fashion to an unanticipated change in permanent earnings. The well-established empirical fact that the variation in the percentage change in dividends is significantly less than the variation in the percentage change in prices, might suggest to some that prices are "too volatile." However, the empirical verification in (12) and (13) of the partial adjustment mechanism posited in our model provides an explanation of this well-established fact that is entirely consistent with market price being a rational predictor of future dividends.
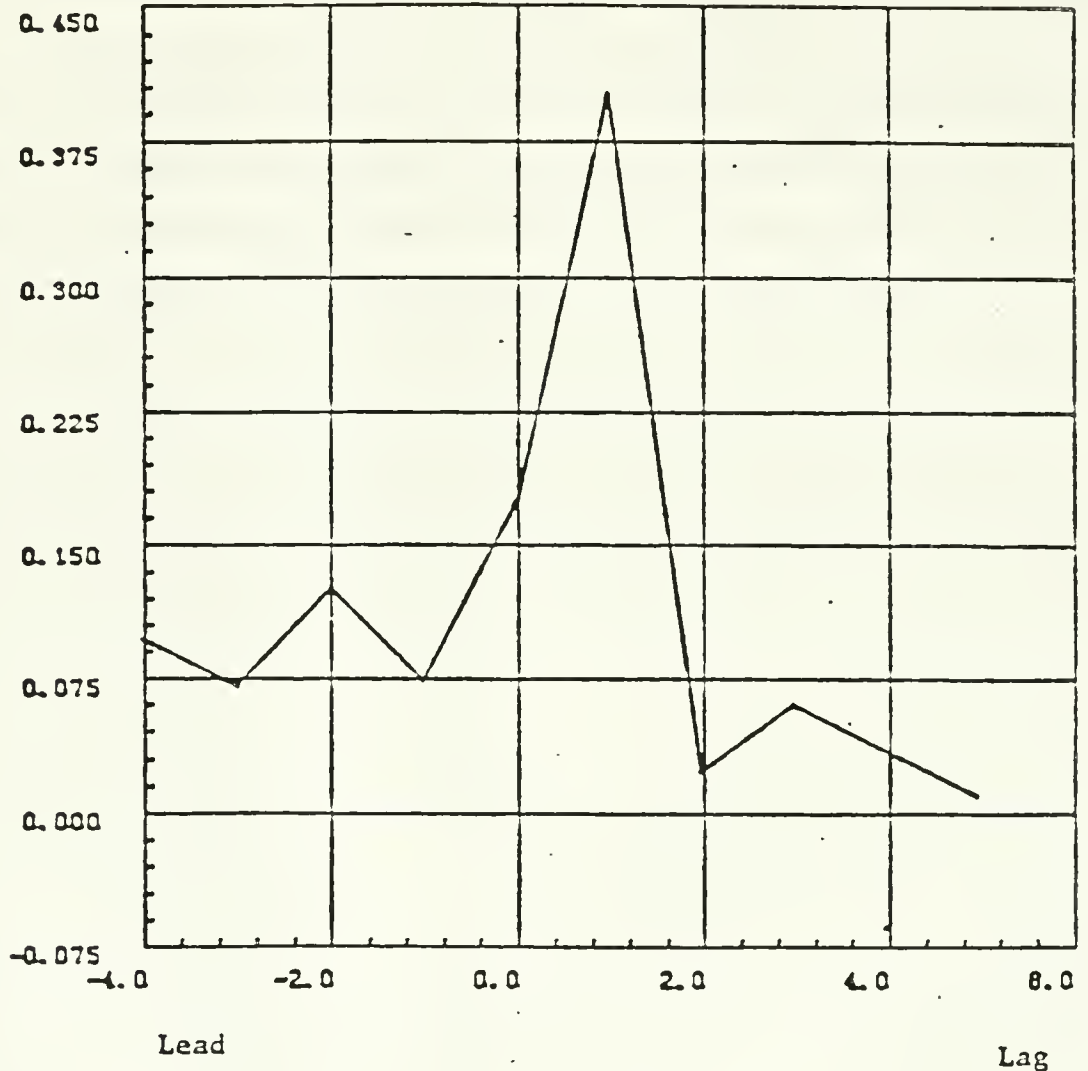
The estimated coefficient of the dividend-to-price ratio is negative in both (12) and (13), which is consistent with the hypothesis that this ratio converges to a long-run stationary distribution. The point estimates for the speed of adjustment are however, rather small which at best suggests that a substantial period of time is required for the dividend-to-price ratio to converge to its steady-state distribution. Thus, using the -0.085 estimate from (13), a conventional "half-life" calculation shows that it takes more than eight years for the expected value of this ratio to move halfway from its initial value to its expected steady-state value.[22]

To further investigate the extent of synchronization between dividend changes and price changes, we computed the leads and lags of the percentage changes in dividends regressed on percentage changes in prices estimated by the Hannan-efficient procedure, and these are plotted in Figure 1. By inspection, the cross correlation at the lag in price change of one year specified in our model dominates that at all other leads and lags. In even a reasonably efficient market, one would not expect lagged variables of any sort to have meaningful predictive power for future price changes. It is therefore not surprising that changes in dividends are not significantly correlated with subsequent changes in price. The modest positive correlation between contemporaneous dividend and price changes is, of course, consistent with an efficient market and is perhaps suggestive of a mild information or announcement effect for dividend and price changes at the aggregate level. Indeed, we do find about an 8 percent correlation between contemporaneous (i.e, year $t + 1$) unanticipated price changes and the residuals from our regression (13). As noted in the discussion of the informational content of dividends in the Introduction, it is difficult to identify an announcement date for aggregate dividends in a meaningful way. Moreover, what is perceived to be contemporaneous correlation between dividend and price changes over the coarse grid of annual data may simply turn out to be lagged price changes explaining subsequent dividend changes when examined under the finer grids of quarterly or monthly data. Thus, an 8 percent correlation is likely to be a significant overstatement of the announcement effect of aggregate dividends.

Unlike for speculative price changes, the Efficient Market Hypothesis does not rule out the change in dividends this period being predicted by variables which are observable prior to this period. Nevertheless, if the posited

Figure 1: Lead and lag structure of deviations in annual percentage real dividend changes, around their expected growth rate,[1] on percentage unexpected real cum dividend stock price changes,[1] for the NYSE value-weighted companies over the period 1927–1980, computed using the Hannan-efficient procedure.

Point Estimate
of $\hat{a}_1$ in (*)

Lead

Lag

Equation: $\log\left[\frac{D(t+j)}{D(t+j-1)} \right] + \frac{D(t+j-1)}{P(t+j-2)} = a_0 + a_1 \log\left[\frac{P(t)}{P(t-1)} + \frac{D(t-1)}{P(t-2)} \right]$ (*)

$$j = -4,\ldots,0,\ldots,+6$$

[1] Dividends, $D(t)$, are defined as year t cash dividend payments for all NYSE companies, and the index "price" $P(t)$ is the end of year t value weighted index. The dividend-price ratio, $D(t+j-1)/P(t+j-1)$ is, up to a constant, the expected rate of growth of dividends and prices in year $t+1$.

economic process underlying the specification of (11) is a reasonably accurate description of reality, then lagged price changes much beyond the one-year lag specified in (11) might be expected to exhibit relatively little explanatory power in forecasting this period's dividend change. If an unanticipated change in permanent earnings causes managers to change dividends, then strict rational forecasting would seem to dictate that their decision be based on their most recent assessment of permanent earnings, and hence earlier revisions in those assessments should have relatively little impact on the change in dividends. In attempting to smooth the time path of dividends, it is possible that managers would choose to change dividends in response to changes in a moving average or distributed lag of unanticipated permanent earnings changes over an extended past history. Such behavior would create a dependency between the current change in dividends and lagged price changes of all orders. Because these averaging techniques embody much "stale" information, it would appear that this approach to dividend smoothing leads to an inefficient use of the available information. If instead, managers change the dividend in a partial adjustment response to the most recent unanticipated change in permanent earnings, they can use the most up-to-date information. The partial dividend adjustment will be appropriate in a wide variety of contexts in which the policy problem facing managers does not admit a certainty-equivalence solution.

Even if managers forecast this rationally, there will still be some lag between a change in permanent earnings and the change it induces in subsequent dividends. As indicated in the discussion surrounding the specification of equation (5), at the level of aggregate dividends, it is unlikely that the lag between a change in permanent earnings and the change it induces in subsequent

dividends could be much shorter than a year.[23] The correlations between the change in dividends and lagged price changes displayed in Figure 1 are therefore consistent with this view of rational forecasting by managers. As a further, more quantitative test, (11) was reestimated with five years of lagged unexpected price changes as additional variables. None of these additional lagged variables had a coefficient point estimate more than one standard error from zero, and the F statistic for their inclusion is 0.361, which has a p value of 0.872.

If these empirical results had turned out differently, they would neither imply an arbitrage opportunity in the stock market nor an inefficiency in the allocation of capital. We need hardly mention again that managers have great latitude in their selection of dividend policies including the option to choose ones which are not based on the most up-to-date information. It is, however, reassuring for the overall creditability of our model that the data tend to support such "superrational" forecasting behavior by managers even in the relatively unimportant area of dividend policy.

With the exception of contemporaneous changes in other speculative prices, it is a well-established empirical fact that there are few, if any, observable variables which exhibit high contemporaneous correlation with changes in aggregate stock prices. It is, therefore, rather unlikely that the change in stock price is merely serving in (11) as a proxy for some other observable variables which, if included, would cause the significance of the coefficient on the price change to disappear.

We have investigated whether the dividend response to stock price changes is symmetric with respect to negative and positive price changes. The point estimate of this elasticity with respect to the twenty negative annual price

change observations in our sample is 0.597, while it is 0.271 with respect to the positive price changes. Although an asymmetry of dividend response to negative and positive price changes could be readily explained in a more complete dividend model, the small number of negative price change observations causes the standard error for the difference in point estimates to be so large that equality of the elasticity coefficients can not be rejected. In addition, two of the negative price change observations are the 1929 and 1974 market "crashes" in which the constant discount rate assumption is surely strained.

In his discussion of the stability of Lintner's original regression results, Tarshis (1959, p. 118) writes "Everything else in the economy changed in those years: it seems unreasonable that these many changes exerted no influence upon dividend policy." More recently, Brittain (1966) and Miller (1985) document apparent shifts in dividend payout policies in the late 1930s and the 1940s which they attribute to tax changes. As we have already discussed, the factors which historically could have caused dividend policy to be important may have themselves diminished in significance over the sample period, and thereby, induced secular changes in the dividend-response function. With these observations in mind, we examine the temporal stability of the coefficients in our regression model (11).

A plot of the elasticity coefficient a_1 in (11), estimated recursively forward and recursively backward, is presented in Figure 2. The plot suggests a downward shift in the coefficient in the 1940s. This suggestion is confirmed by formal squared CUSUM, Quandt (1958, 1960), and Chow tests (not reported here).[24] The absolute value of the coefficient of reversion of the dividend/price ratio, a_2, decreases steadily from approximately -0.49 at

Figure 2

Plot of the recursively estimated coefficient of elasticity[1] of the deviation in annual
percentage real dividend change around its expected growth rate, with respect to cum-dividend prior-
year stock price change, for the value-weighted NYSE companies over the period 1927-1979.

[1] The plot is of the point estimate of the coefficient a_1 where:

$$\log\left[\frac{D(t+1)}{D(t)} \right] + \frac{D(t)}{P(t-1)} = a_0 + a_1 \log\left[\frac{P(t) + D(t)}{P(t-1)} \right] + a_2 \log \frac{D(t)}{P(t-1)} + u(t + 1)$$

and: (A) a_1 is estimated recursively <u>forward</u>;

       (B) a_1 is estimated recursively <u>backward</u>.

Here, dividends $D(t)$, are defined as year t cash dividend payments for all NYSE companies,
and the index "price" $P(t)$ is the end of year t value-weighted NYSE index. The
dividend-price ratio, $D(t)/P(t-1)$, is, up to a constant, the expected rate of growth of
dividends in year $t + 1$.

the beginning of the period to -0.03 for the full period up to 1979. When (11) is estimated using robust regression and the tests of coefficient stability repeated [see Kuh, Samarov, and Shell (1986)], the change in the model coefficients appears to have begun as early as 1938. That instability might be attributed to the undistributed profits tax in the years 1936 and 1937.[25] A shift in dividend policy in the late 1930s and the 1940s is, of course, not necessarily attributable to taxes. For example, Officer (1971) shows that stock market volatility also shifts toward the end of the 1930s. We do find that if the elasticity coefficient a_1 in (11) is allowed to depend linearly on a naive measure of the market's volatility--the square of the cum dividend stock price change $\log P(t) + D(t)/P(t - 1)$ --the fit is marginally--but--significantly improved. However, the apparent shift in dividend policy remains.[26] We consider and reject the hypothesis that variations in the discount rate are the reason for the 1930s-1940s shift in dividend policy.[27]

As Miller and Modigliani (1961) make clear, the determination of gross dividends is the principal issue to be explained in resolving the "dividend puzzle." As an empirical matter, we find that both the explanatory power and coefficient estimates of our model remain virtually unchanged whether it is fit to gross dividends or aggregate net dividends (measured by gross dividends less net new stock issues). This finding may be surprising in the light of the recent five-year wave of mergers and acquisitions financed by cash and debt that has been large enough to cause net dividends to actually exceed gross dividends by significant amounts. It does not appear, however, that such large additional "distributions" to equityholders were typical during our earlier sample period, although the CRSP data from which we constructed our

net dividend series may not completely account for all such transactions.

For an all-equity financed firm, net operating cash flow minus investment equals the net dividend, as a cash-flow identity. Because net operating cash flow is largely not controllable by managers in the short run, it would appear from the cash-flow identity that a model of net dividend policy cannot be distinguished from a model of investment choice. Thus, the empirical invariance of our model to gross-versus-net dividends raises the question of whether it describes dividend policy or corporate investment behavior.

We believe that the aggregate net dividend series is not a reliable indicator of investment policy and therefore, that our model should not be interpreted as one of investment behavior. As noted in footnote 5, an important source of slippage in the empirical application of the identity is the cash inflow and outflow of the firm from financing sources not accounted for in the standard measure of net dividends. These sources would include changes in publicly-issued and privately-placed corporate debt, bank loans, trade credit and other short-term accruals, lease contracts, and other legal liabilities, such as pensions and customer warranties.

New stock issues which figure in the difference between gross and net dividend calculations are small by comparison, with these sources and uses of funds. For example, a five percent shift in the approximately $120 billion of outstanding nonfinancial corporate net trade credit would alone amount to more than half of the $8-$10 billion level of average annual common stock offerings. Public offerings of corporate debt typically exceed annual new equity issues, and hence, changes in debt offerings could easily offset changes in equity financing without affecting investment flows. Changes in the level of interest rates on floating-rate debt will also cause changes in

cash flow without a change in investment. Thus, it seems to us that dividends net of new equity issues cannot be reliably used to infer variations in investment policy.

In summary, our main empirical results are that (i) past (or possibly contemporaneous) changes in stock market prices explain a significant portion of the change in aggregate dividends, and (ii) the (partial) elasticity of the dividend response to a change in price is positive and significantly less than one. Further, there are reasonable grounds for believing that these results will be robust to more refined versions of this dividend model. If, for example, log-price and log-dividend levels follow integrated stochastic processes, as they seem to do empirically (cf., Kleidon (1983)), the target payout ratio can satisfy the steady-state properties assumed in the reduced form of our error correction model (11).

6. Further Discussion, and Comparison of Our Model With Others
    in the Literature

In this section, we compare the fit of the model of aggregate dividends which has been developed in previous sections with that of the "final form" trend-autoregressive model employed by Shiller (1981a) to describe aggregate dividends. We show that our model fits considerably better than does the trend-autoregressive model, and that lagged dividends explain little, if any, of the variation in aggregate dividends once prior-period-stock-price-changes are taken into account. We also claim that the characteristics of the observed distributions of dividend and stock price changes reported by Shiller

can be readily interpreted within the context of our model.

In Section 6.3, the explanatory power of our model of aggregate dividend behavior, in which stock price changes are used to measure changes in firms' permanent earnings, is also compared with models such as those fitted by Lintner (1956), Brittain (1966), and Fama and Babiak (1968) in which dividend movements are explained by accounting earnings changes. We find that our model using only prior-period stock price changes fits at least as well as accounting-earnings-based models, which use contemporaneous accounting earnings data. Moreover, our model significantly outperforms models which use lagged accounting earnings only, as would be required if these models were used to forecast future dividend changes.

6.1 A Trend-Autoregressive Model for Aggregate Dividends?

Shiller (1983) reports that "If $\log D(t)$ is regressed on $\log D(t-1))$, a constant and a linear time trend for 1872 to 1978, the coefficient of $\log D(t-1)$ is 0.807, with an estimated standard error of 0.058," implying that "log dividends would always be expected to return half way to the trend line in three years," (p. 237). We repeat essentially the same OLS regression on our data set, and the results are:

$$\Delta \log D(t) = \begin{array}{cccc} 2.492 & - & 0.249 \log D(t) & + & 0.004\, t + u(t) \\ (0.890) & (0.089) & & (0.002) \end{array} \tag{14}$$

$$\bar{R}^2 = 0.130 \qquad DW = 1.495$$

Because the left side of (14) is the change in $\log D(t)$, the comparable autoregressive coefficient is $(1 - 0.249) = 0.751$ which is rather close to Shiller's 0.807 estimate. By the standards of a conventional t-test, the

coefficients in both samples are significantly less than 1 with a -2.80 t-statistic in our sample versus a -3.33 t-statistic in his. The t-statistic for the trend coefficient in (14) is 2.00. This finding serves to confirm our belief that the important empirical results derived from our 1926-1981 data set are not likely to be significantly altered if fit to the longer 1871-1979 data set used by Shiller in his analysis of aggregate dividend and stock price behavior.

Because the Durbin-Watson statistic suggests positively autocorrelated residuals, the lagged endogeneous variable in (14) may cause the OLS coefficients to be biased. We therefore reestimated the reported Shiller equation (14) using a GLS iterative technique,[28] and the results are:

$$\Delta \log D(t) = \begin{array}{c} 5.225 \\ (1.211) \end{array} - \begin{array}{c} 0.524 \\ (0.121) \end{array} \log D(t) + \begin{array}{c} 0.009 \\ (0.003) \end{array} t + u(t)$$

$$(15)$$

$$\bar{R}^2 = 0.243 \qquad\qquad DW = 1.85$$

Hence, when the OLS specification of Shiller's autoregressive model for dividends is correctly adjusted for autocorrelation, its measured explanatory power almost doubles. That is, only about half of the total 24 percent explanation of the variation in dividend changes can be attributed to the lagged dividend and time trend variables. The other half is attributable to the time series model of the disturbances or "unknown variables" in the regression.[29]

Given the apparent statistical significance of the coefficients in (14) and (15), it is perhaps tempting to some to conclude that dividends follow an autoregressive process which approaches a steady-state distribution (possibly around a positive trend). Such a conclusion, if true, has far-reaching

implications for the whole of financial economics. For example, if (14) were to fully describe the "true" dividend process (i.e., $\bar{R}^2 = 1$), then this result, along with even a casual inspection of the stock return time series, would surely imply that stock prices are "too volatile." If, as implied by (15), dividends were to regress over 90 percent of the way to their deterministic trend line within one Presidential term, then uncertainty about the future path of dividends would be rather unimportant, and therefore, rational stock prices should exhibit trivial fluctuations. Because equities are the residual claims of the private sector, variations in their returns are "blown up" reflections of the uncertainties about the whole economy. If rational stock returns should have small variations, then the fluctuations in the economy should be even smaller. It would therefore seem that in such an environment we economists could safely neglect such uncertainties in the specification of our macroeconomic models. While perhaps an appealing hypothesis, the real world is not this way as further analysis of (14) and (15) will clearly indicate.

The fit of the autoregressive model (14) and (15) is rather poor, with half of the explanatory power of (15) represented by unspecified variables. With respect to a different regression on similar data, Shiller (1981a, p. 433) gives one possible explanation for low R^2: Namely, "...regression tests are not insensitive to data misalignment. Such low R^2 might be the result of dividend or commodity price index data errors." Although we agree that such data errors can be a source for lower R^2, our alternative explanation is simply that the autoregressive process posited in (14) and (15) is not an accurate specification of the dividend process.

Motivated by the analysis of our model of the dividend process, we add the

one-year lagged unanticipated change in the log of stock price to the specification of (15). By the same iterative GLS procedure used in (15), the results are:

$$\Delta \log D(t) = \underset{(0.918)}{2.107} + \underset{(0.064)}{0.347} \log\left[\frac{P(t)}{P(t-1)} + \frac{D(t)}{P(t-1)} \right]$$
$$- \underset{(0.092)}{0.213} \log D(t) + \underset{(0.002)}{0.004} \ t + u(t) \tag{16}$$

$$\bar{R}^2 = 0.473 \qquad\qquad DW = 1.755$$

By inspection, the addition of the previous year's unexpected price change in (16) doubles the explanatory power of (15). This measured increase in $\bar{R}^2$ greatly understates the impact of this added variable because, in addition to increasing $\bar{R}^2$ by 100 percent, it also virtually eliminates the explanatory power of the remaining unspecified variables whose effects are captured by the GLS procedure.[30] We would also note that by adding the log price change variable, the absolute magnitudes of both the log D(t) and time trend coefficients are cut in half.

To further explore the relative importance of the specified variables, equation (16) was reestimated: first, with the time trend deleted, and second, with both the time trend and log D(t) removed. The results are:

$$\Delta \log D(t) = \underset{(0.564)}{0.566} + \underset{(0.064)}{0.388} \log\left[\frac{P(t)}{P(t-1)} + \frac{D(t)}{P(t-1)} \right]$$
$$- \underset{(0.053)}{0.055} \log D(t) + u(t) \tag{17a}$$

$$\bar{R}^2 = 0.437 \qquad\qquad DW = 1.814$$

and

$$\Delta \log D(t) = -0.014 + 0.402 \ \log[\ \frac{P(t)}{P(t-1)} + \frac{D(t)}{P(t-1)}\ ] + u(t)$$
$$(0.016) \quad (0.063)$$

(17b)

$$\bar{R}^2 = 0.435 \qquad\qquad DW = 1.82$$

Comparing (16) with (17a), the elimination of the time trend variable causes only a modest reduction in $\bar{R}^2$, and it has little effect on the estimated coefficient of the log price change. However, by eliminating the time trend variable, the magnitude of the regressive coefficient on log D(t) falls by 75 percent, and with a p value equal to 0.309, it is not statistically significant. It would appear that there is a strong interaction between log D(t) and the time trend which together with the GLS iterative procedure is responsible for the significant coefficients in (15). If either variable is removed, then the magnitude and the statistical significance of the coefficient of the remaining variable are both nil. In this light, it is not surprising that the elimination of log D(t) as a variable in (17b) has no effect on either the $\bar{R}^2$ of that equation or the coefficient of log price change.

Unless the log price change can be "explained" by some distributed lag of past dividends (which, as an empirical matter, it cannot), then it surely belongs in the specification of the dividend process. Because it alone accounts for over 90 percent of the explanatory power of (16), its omission from (14) and (15) is rather important. In sharp contrast, the elimination of either the time trend or the log D(t) variables has no significant effect on the fit. Hence, unless there are strong a priori economic reasons to believe that these variables belong in the specification of the dividend process, there appears to be no valid empirical reason for their inclusion.

In our model of the dividend process, there is no role for a time trend. Its inclusion produces an insignificant coefficient, and actually causes the corrected OLS and GLS R^2's in (12) and (13) to fall. Our model would, however, predict that changes in log dividends are related to $\log D(t)$ through the dividend-to-price ratio, $\log[D(t)/P(t-1)]$. Although not explicit in our simple model, it is entirely consistent with the spirit of the model that lagged changes in log dividends explain part of the adjustment process used by managers to decide upon subsequent dividend changes. If this were the case, then $\log D(t)$ may be a proxy for these lagged changes. The inclusion of such lagged dividend changes would in no substantive way change the conclusions derived for the dividend and rational stock price processes in Section 5. To investigate this possibility, we reestimate equation (13) with the addition of $\log D(t)$ and the fitted results are given by:

$$\log[\frac{D(t+1)}{D(t)}] + \frac{D(t)}{P(t-1)} = \underset{(1.923)}{1.550} + \underset{(0.061)}{0.441} \log[\frac{P(t)}{P(t-1)} + \frac{D(t)}{P(t-1)}]$$

$$\tag{18}$$

$$- \underset{(0.267)}{0.247} \log[\frac{D(t)}{P(t-1)}] - \underset{(0.256)}{0.220} \log D(t) + u(t+1)$$

$$\bar{R}^2 = 0.532 \qquad\qquad DW = 1.88$$

The F statistic for $\log D(t)$ in (18) is 3.23 which is insignificant at the 5 percent level. If $\log D(t - 1)$ is added to (18), its estimated coefficient is -0.135 while that of $\log D(t)$ becomes 0.064. Although this result suggests that $\log D(t)$ in (22) may be a proxy for $\log[D(t)/D(t - 1)]$, the coefficient of $\log D(t - 1)$ is also statistically insignificant. As expected, the addition of these lagged dividend variables in (18) had no effect on the point estimate of the coefficient of lagged log

price change.[31]

In summary, adding the trend and lagged dividend variables of the Shiller autoregressive model to our specification does little to improve the explanatory power of our model in terms of $\bar{R}^2$. Moreover, the estimated coefficients of these "added" variables are statistically insignificant. The other side of this result is that the addition of the variables from our model to the autoregressive specification (14) substantially increases the explanatory power of that model. As these variables are added, however, the statistical significance of the autoregressive variables is reduced. This result is perhaps surprising because it is a common belief that the dividend time series is quite smooth by comparison with the price series. Thus, a distributed lag of past dividends together with a time trend might be expected to do a better job than stock price changes in explaining subsequent dividend changes, almost independently of the "true" economic specification.[32]

Although there appears to be no significant empirical evidence for regressivity in the time series of dividends, the lack of such evidence does not disprove the hypothesis that dividends have a stationary distribution around a deterministic trend. As discussed at length in Section 3, the resolution of such issues must ultimately come from economic reasoning. As Shiller (1983, p. 236) notes on the specification issue, "Of course, we do not literally believe with certainty all the assumptions in the model which are the basis of testing. I did not intend to assert in the paper that I knew dividends were indeed stationary around the historical trend." We surely echo this view with respect to the theoretical assumptions underlying our own empirical model. Nevertheless, unlike our model's assumptions, there appears to be little theoretical structure to support the assumption that dividends

follow a stationary process with a trend. In particular, there is neither an oral nor a written tradition in the financial economics literature that assumes dividends and rational stock prices have stationary distributions.[33]

One could, of course, revive Malthus, or the more contemporary "limits-to-growth" view of economics, to justify the assumption of a steady-state distribution for the levels of real dividends and prices. This theory, however, also rules out an exponential growth trend in these levels. Refitting equation (14) without the trend, we have that the OLS estimate is given by:

$$\Delta \log D(t) = \begin{array}{c} 0.802 \\ (0.576) \end{array} - \begin{array}{c} 0.076 \\ (0.055) \end{array} \log D(t-1) + u(t) \qquad (19)$$

$$\bar{R}^2 = 0.017 \qquad \qquad DW = 1.576 \qquad .$$

By inspection of (19), it would appear that at least in the dividend series, there is no evidence at all to support this "zero-growth" model.

Perhaps notable by its absence from this section is any discussion of tests of stationarity of stock price levels. We have not directly tested the time series of price changes for evidence of regressivity because the literature is almost uniform in failing to find any lagged variables which have much power in forecasting future stock price changes. Moreover, using autocorrelation and Dickey-Fuller (1979;1981) tests, Kleidon (1983) finds that neither the arithmetic nor the geometric Brownian motion models can be rejected against the trend model for the S&P 500 annual composite index over the period 1926-1979. We would expect that these same results would obtain for our data set.

Shiller (1981a, p. 432-433) does report that the dividend-to-price ratio appears to forecast next period's holding period returns. We replicated this

result on our data set, and found, as did he, that the R^2 is about 0.06.
As Shiller himself stresses, such regression tests are sensitive to data
problems, and such problems could explain the positive relation between stock
returns and lagged dividend yield.[34] In addition, Miller and Scholes (1982)
show that holding-period returns for individual firms can be forecasted just
as accurately using the reciprocal of stock price as they can using dividend
yield, which suggests that the numerator of the dividend-price ratio does not
play an important role in its predictive power for future stock price
changes. Of course, forecastability of discrete-period returns is compatible
with market efficiency if it reflects no more than forecastable variations in
expectations of those returns. However, as the size of Shiller's R^2
estimate would seem to indicate, forecastable changes in expected returns
probably account for only a small amount of the variation in one-year
holding-period returns.

6.2 The Distribution of Rational Stock Prices and Dividends

In Our Model

In our dividend model, the dividend-to-price ratio has a stationary
distribution with a finite variance. It follows that for T large,
$Var(\log[P(T)/P(0)])$ will be proportional to T. Hence, for large T, the
cumulative dynamics for P can be well-approximated as having come from a
geometric Brownian motion with an instantaneous expected rate of growth equal
to $(\alpha - \rho)$ where ρ is the expected "long-run" dividend-to-price
ratio computed from the steady-state distribution for D/P. In this same
sense, the asymptotic process for dividends will also be a geometric Brownian
motion with $Var(\log[D(T)/D(0)])$ proportional to T.

In a reply to a comment on his work by Basil Copeland, Shiller (1983, p. 237) notes that "Even if we assumed log dividends were a random walk with trend with independent increments, stock prices still would show too much volatility." As he correctly points out, if $D(t + 1)/D(t)$ is independent of $D(t' + 1)/D(t')$ for $t \neq t'$, then the current dividend will be proportional to the current price (i.e., in our notation, $D(t) = \rho P(t)$). Hence, in such a model, the variance of logarithmic dividend changes will equal the variance of logarithmic price changes. Shiller goes on to report that for his Standard and Poor data set from 1871-1979, the sample standard deviation for log dividend changes is 0.127, whereas the sample standard deviation for log prices changes is 0.176. Because the ratio of sample variances of 1.93 is significant at the 1 percent level, he concludes that prices are too volatile to be consistent with this model. In our much-shorter 1926-1981 sample period, the standard deviation of dividend changes is virtually the same as in his sample (0.124), but the standard deviation of price changes is higher (0.203) which leads to a larger sample variance ratio of 2.64. We therefore agree with Shiller's conclusion, although our description would be that "the sample variations in dividend changes are too small to be consistent with this model."

"$D(t) = \rho P(t)$" is the extreme polar case of our model where managers do not attempt to smooth dividends at all, and fully and immediately adjust dividends to reflect unanticipated changes in permanent earnings. If the "short-run" instantaneous variance rate for logarithmic price changes is σ^2, then in our model the corresponding short-run variance rate for dividends is $\lambda^2 \sigma^2$. If managers fully adjust dividends in response to unanticipated changes in permanent earnings, then $\lambda = 1$, and the variance

of dividend changes and price changes will be the same for all observation
intervals. If, as empirically appears to be the case, managers smooth the
dividend time path by making partial adjustment responses, then $\lambda < 1$,
and the variance of dividend changes will be strictly smaller than the
variance of price changes. If, indeed, our model completely explained the
process for dividend changes, then the coefficient estimate in (13) of 0.44
for λ would imply that the ratio of the variances of annual log price
changes to log dividend changes would exceed 5. Because the model explains
only about 50 percent of the variation in dividends, the actual ratio is
reduced to 2.64.

As is generally true of "smoothed" processes which are constrained to
converge to a more-variable process, the variance rate of the percentage
change in dividends increases as the interval over which it is computed is
increased. It is, however, also the case that for $\lambda < 1$:

$$\frac{\text{Var}(\log[D(T)/D(0)])}{T} \leq \frac{\text{Var}(\log[P(T)/P(0)])}{T}$$

for any interval T with equality holding only in the limit as $T \to \infty$.
Our model of rationally-determined prices and rationally-determined dividends,
therefore, predicts that the variance rate of logarithmic dividend changes
will always be smaller (and, at least for annual or shorter intervals,
considerably smaller) than the variance rate of logarithmic price changes. It
is, hence, reassuring to find this prediction confirmed by Shiller's
statistics which are based on a considerably longer sample period than our own.

In his 1981a paper (p. 428), Shiller also discusses the higher-order
moment properties of the stock price and dividend processes with a focus on
the relation between infrequent arrivals of important information and the

often-observed high-kurtosis (or "fat tail") sample characteristic of stock price changes. He demonstrates this relation by an illustrative example where dividends are taken to be independently and identically distributed. To capture the effect on stock price of infrequent arrivals of important information, he assumes that at each time t, with probability 1/n, the market is told the current dividend level and with probability (n − 1)/n, the market has no information about current or future dividends. In this example, the kurtosis of the stock price change is shown to be n times greater than the kurtosis of the normal distribution posited for dividends. Our model, however, predicts the exact opposite result: Namely, dividend changes should exhibit relatively <u>higher</u> kurtosis than stock price changes. That is, although the variance of dividend changes is smaller than for stock price changes, the time series of dividends should contain more relatively small changes and more relatively large changes than the corresponding time series of stock prices.

The "lumpy" arrival of information (which may, in fact, cause the sample distribution of log stock price changes to have fatter tails than a normal distribution) is not the source of this prediction about dividend changes. Instead, it comes as a result of managers smoothing the time path of dividends. To illustrate this point, we use an example which is very much like Shiller's information example.

Suppose that unanticipated logarithmic changes in stock price are serially independent and identically distributed. Suppose further, that managers smooth the time path of dividends according to the following rule: At each time t, with probability 1/n, they change the dividend to fully reflect the

unanticipated change in stock price (i.e., $\log[D(t)/D(t-1)] = \log[P(t)/P(t-1)]$) and with probability $(n-1)/n$, they change the dividend to equal its expected long-run normal growth rate (i.e., $\log[D(t)/D(t-1)] = g$). As expected for smoothed processes generally, in this example, the variance of dividend changes, σ^2/n, is smaller than the variance of stock price changes around trend, σ^2. If m_4 denotes the fourth central moment of the stock price change distribution, then the fourth moment of the dividend change distribution is m_4/n. Hence, the kurtosis of the dividend change process, $(m_4/n)/(\sigma^2/n)^2$, is simply n times the kurtosis of the stock price process, m_4/σ^4. Thus, unless managers do not attempt to smooth dividends at all (i.e., $n = 1$), the kurtosis of the controlled dividend process will always exceed the kurtosis of the (uncontrolled) stock price process. Indeed, the more strongly that managers attempt to smooth dividends (i.e., the larger is n), the greater is the relative kurtosis of the dividend process.

The basic reasoning underlying our claim that a large kurtosis of dividend changes relative to stock price changes is evidence in support of dividend changes being a (short-run) controlled process is hardly new. Over a half century ago, Means (1935) used it to contend that many product prices are "administered." By comparing the frequency of product price changes in "administered" and competitive markets, he found that administered market price changes were much less frequent and that when they did occur, the changes were much larger in magnitude than in competitive markets. That is, the distribution of administered price changes has fatter tails than the one for competitive prices. Quandt and Ramsey (1978) among others have developed techniques which take account of other information in addition to kurtosis to

estimate the parameters of the mixed distributions, which arise from such administered price processes.

In the light of these results, we estimate the kurtosis of each of the time series as a further empirical check on our model. As predicted, the estimated kurtosis for the annual logarithmic dividend changes, 7.377, is 2.79 times the estimate of 2.648 for the kurtosis of the logarithmic changes in stock prices.[35] As it happens, the sample kurtosis for stock prices is not much different than the kurtosis of 3 for a normal distribution whereas the sample kurtosis for dividend changes is more than two times larger.

6.4 Stock Price Versus Accounting Earnings as a Measure of Permanent Earnings

In deriving our reduced-form dividend model (11), we adopted the specification (9) that stock prices embody rational predictions of firms' future net cash flows and thus permanent earnings. In past empirical work based on the Lintner model, the practice is to use accounting earnings, modified accounting earnings, or cash flow data to measure firms' permanent earnings. Hence, we compare the performance of our model to these alternative measures of permanent earnings.

Since the readily available data on aggregate earnings are for the Standard & Poor's 500 companies, the results reported in this section pertain to this index. The fit of our model (11) for the S&P Index is virtually identical to that reported in (12) or (13) for the NYSE. The GLS fit for the period 1928-1980 is given by:

$$\log\left[\frac{D(t+1)}{D(t)}\right] + \frac{D(t)}{P(t-1)} = \underset{(0.178)}{-0.140} + \underset{(0.069)}{0.426} \log\left[\frac{P(t)+D(t)}{P(t-1)}\right]$$

$$\tag{20}$$

$$\underset{(0.061)}{-0.056} \log \frac{D(t)}{P(t-1)} + u'(t+1)$$

$$\bar{R}^2 = 0.41 \qquad DW = 1.94$$

If the change in accounting earnings from year t to t + 1 is used to explain (not predict) the dividend change from year t to t + 1 and (α − D/P) is used to account for the expected growth in accounting earnings, then the GLS fit of this contemporaneous-accounting-earnings model can be expressed as:

$$\log\left[\frac{D(t+1)}{D(t)}\right] + \frac{D(t)}{P(t-1)} = \underset{(0.158)}{0.146} + \underset{(0.081)}{0.518} \log\left[\frac{E(t+1)}{E(t)} + \frac{D(t)}{P(t-1)}\right]$$

$$\tag{21}$$

$$+ \underset{(0.051)}{0.039} \log \frac{D(t)}{P(t-1)} + u'(t+1)$$

$$\bar{R}^2 = 0.44 \qquad DW = 2.06$$

where   E(t)   refers to the aggregate accounting earnings for the S&P companies over year t.   These results suggest that data on year t+1 accounting earnings, which only become available at the end-of-year t + 1, explain no larger a percentage of aggregate dividend changes in year t + 1 than is explained by using price data available at the beginning of year t + 1.   Moreover, the coefficient on the dividend-to-price ratio (i.e., the dividend-to-permanent-earnings ratio), has the wrong sign for regressivity, although that coefficient is imprecisely measured with only fifty years of data.   Except for the regressivity coefficient, the contemporaneous accounting earnings model has roughly the same fitted characteristics as the lagged stock

price model.

We examined the temporal stability of the coefficients in regression model (22) and find a pattern of secular decline in their magnitudes quite similar to the one reported for our model in Section 5. When backward recursion is used over the period 1926-1980, the full-sample estimate of the coefficient of the earnings change variable declines by about 75 percent by the end of the sample period. The point estimate for the sign on the dividend-price variable decreases in magnitude but continues to have the "wrong" sign. As Brittain (1966) found, the standard diagnostic tests (Chow, Quandt likelihood, CUSUM squared) indicate that the instability occurs around the years 1939-1942.

Empirical analysis of the elasticity of response in accounting earnings to lagged stock price changes shows that it remains reasonably stable over the sample period. Thus, it appears that the secularly-reduced responsiveness of dividend changes to permanent earnings changes is essentially the same, whether permanent earnings are measured by stock price or accounting earnings. Therefore, it would seem unlikely that this seemingly-secular change in dividend behavior is the result of a temporal pattern of increasing disparity between managements' assessments of permanent earnings and those implied by stock prices.

If the accounting earnings change from period t-1 to t is substituted for the period t to t+1 change, the accounting model's explanatory power drops to about 20% (and only 10% if OLS is used). An examination of the distributed leads and lags of dividend changes and accounting earnings changes confirms that the substantial portion of their association is, in fact, contemporaneous. This result is consistent with Fama and Babiak's (1968) finding that their "best" accounting earnings-based model of dividend changes

includes contemporaneous and lagged earnings levels, since our accounting earnings change variable involves both contemporaneous and lagged accounting earnings levels.

Contemporaneous accounting earnings are roughly on a par with lagged stock price changes in explaining aggregate dividend changes, in part because lagged stock price changes themselves provide reasonably good forecasts of the subsequent earnings changes. If the component of contemporaneous accounting earnings changes which could have been predicted from the lagged stock price change is removed, then the unpredictable component of contemporaneous earnings, which we denote by UE(t), does add significantly (at the 95% level) to past price changes in explaining aggregate dividend movements. Using GLS over the 1929-1979 period:

$$\log[\frac{D(t+1)}{D(t)}] + \frac{D(t)}{P(t-1)} = \underset{(0.166)}{-0.069} + \underset{(0.069)}{0.426} \log[\frac{P(t) + D(t)}{P(t-1)}]$$

$$+ \underset{(0.085)}{0.246} \ UE(t) - \underset{(0.053)}{0.032} \log [\frac{D(t)}{P(t-1)}] + u'(t+1) \qquad (22)$$

$$\bar{R}^2 = 0.47 \qquad DW = 1.88$$

The F statistic for inclusion of the earnings forecast error UE(t) is about 7.96, which is significant at the 5% level. The OLS estimates and GLS estimates of (22) are virtually identical, which is consistent with the earnings forecast error eliminating part of the serial dependence in the disturbances. The measured correlation between the variable $\log[P(t+1)/P(t) + D(t+1)/P(t)]$ which, up to a constant, is the unexpected price change from the end of period t to the end of period $t + 1$, and the (GLS) residual $u(t + 1)$ in (19) is about 10%. By including contemporaneous unanticipated earnings, this contemporaneous correlation between unexpected price changes

and the (GLS) residual u(t + 1) in (22) is reduced to about 3.3%. Thus, the previously-noted small amount of "information content" in aggregate dividends is further reduced by taking account of earnings changes. We pursue this no further because, as we noted earlier, the information content of dividends and earnings is probably not well defined for an aggregate of corporations over a coarse annual grid.

7. Conclusion

In this paper, we have shown that aggregate dividends exhibit a systematic time series behavior which can be well described by an error-correction model in which aggregate real dividend changes are driven by the one-period lagged real changes in stock prices. Although the time series of aggregate dividends is considerably less volatile than the stock price series, this model significantly outperforms the trend-autoregressive model where a distributed lag of past dividends together with a time trend is used to explain subsequent dividend changes.

The stock price model performs on a par with dividend models which use contemporaneous and lagged accounting earnings variables, as in previous studies of the Lintner (1956) model by Brittain (1966), Fama and Babiak (1966), and Watts (1973). However, because the stock price model uses only lagged prices, it can be used to forecast future dividend changes, whereas the accounting earnings model which employs contemporaneous earnings cannot be used to forecast. The version of the accounting earnings model which uses only lagged accounting earnings to forecast dividends significantly

underperforms the stock price model.

As noted at the outset, a wide range of possible micro theories of dividend behavior could be consistent with the observed systematic behavior of aggregate dividends. However, our finding that aggregate dividends do exhibit systematic time-series behavior provides evidence that strictly firm-specific theories of dividends such as signalling, cannot by themselves explain the dividend puzzle.

FOOTNOTES

*   We dedicate this paper to the scientific contributions and the memory of John V. Lintner, Jr.

†   We are grateful to J. Hausman, M. Miller, S. Myers, R. Ruback, and especially F. Black for helpful comments, and to the Institute for Quantitive Research in Finance for partial funding. The first author is also grateful to the Batterymarch Fellowship Program under which portions of the work here were completed.

1   See Brealey and Myers (1984, Ch. 16) for a more complete summary of the dividend controversy. The degree to which this controversy is unresolved is exemplified by its inclusion in the Brealey and Myers (1984, p. 790) list of ten important unsolved problems in finance which "...seem ripe for productive research."

2   In fact, in their events study of the dividend behavior of split stocks, Fama, Fisher, Jensen, and Roll (1969) did adjust individual firm dividend changes for market-wide dividend changes before classifying the former as increases or decreases. FFJR did this to be internally consistent in associating security return residuals with dividend changes. Note that, as would be the case for our model at the micro-level, an added variable might well be required to account for dividend increases or decreases associated with a firm's "normal" secular progression through its "life cycle."

3   Note, however, that with only slight embellishment to include transactions costs for either issuers or investors, even this extreme demand-driven

model would predict systematic micro dividend behavior. With issuing

costs, for example, firms in mature or declining industries with large

cash flows relative to their new investment needs, would be marginally

lower-cost producers of dividends than firms in growth industries. Since

the position of a firm or an industry within its "life cycle" is hardly

random from year to year, both individual firm and industry payout

patterns are likely to exhibit serial dependencies. The empirical

evidence for micro-stability in dividends is explored in Marsh and Merton

(1985a).

4   The stylized facts distilled by Lintner from his interviews can be

interpreted as a description of "average" or "systematic" dividend

behavior. In this sense, these facts are macro rather than micro.

5   Although $V(t)$ is the present value per share of the future cash flows

available for distribution to the shares outstanding at time t, it does

not follow that the dividend per share paid at time s must equal

$[\Pi(s) - I(s)]/N(s)$. By the accounting identity, $\Pi(s) -$

$I(s) \equiv N(s)D(s) - [N(s + 1) - N(s)]P(s)$ where $[N(s + 1) - N(s)]P(s)$

is the cash flow received from the issue of new shares of stock at time

s, and therefore, $D(s) = [\Pi(s) - I(s) + (N(s + 1) - N(s))P(s)]/N(s)$.

If issues or purchases of shares are made at "fair" market prices, then

such future transactions have a zero net present value, and therefore,

have no effect on the current intrinsic value per share of the firm. If

the firm has debt in its capital structure, then interest payments must be

subtracted and net proceeds of new debt issues added to the cash flows of

the firm. As with stock issues, if the debt is issued or retired at fair

market prices, then such future debt transactions will also have no effect

on the current intrinsic value of the firm. Although the additional future cash flows from new share and debt issues do not affect current permanent earnings, for a given value of permanent earnings, such financial transactions provide management with considerable flexibility to control the time path of dividends per share.

6   At least at the time of his survey thirty years ago, Lintner's evidence indicated that dividend policy was not viewed by management as simply a balancing item in the flow of funds account: "Dividends [rather than retained earnings and savings] represent the primary and active decision variable in most situations" (p. 197) "...In general, management's standards with respect to its current liquidity position appeared to be very much more flexible than its standards with respect to dividend policy, and this flexibility provided by the buffer between reasonably definite dividend requirements in line with established policy and especially rich current investment opportunities" (p. 105). Other statements could be interpreted as hints regarding the loss function underlying dividend rules, but they are not very specific, e.g., by "stabilizing" dividends, managers can "minimize adverse shareholder reactions," and "management can live more comfortably with its unavoidable uncertainties regarding future developments" (p. 100).

7   It may be verified that only trivial modifications in the dynamical equation developed below are required to explicitly account for any steady-state variation in the ratio. For example, if it is hypothesized that the equilibrium ratio depends upon a vector of stationary stochastic variables $\underline{Z}(t)$, (4) is replaced by $\log[D(t)/E^m(t - 1)] = \beta_0 + \underline{\beta}'\underline{Z}(t)$, with the only effect being a change in the regressivity term in (5).

8   For example, if the dynamics of the firm's intrinsic value follows a geometric Brownian motion and if management pays out a constant proportion of permanent earnings as dividends, then the dividend dynamics will also be described by a geometric Brownian motion. No amount of time-detrending will make either of these processes stationary. Nevertheless, the ratio of dividends-to-permanent earnings is (trivially) a stationary process. For further discussion, see Rubinstein (1976, pp. 409-411) and Marsh and Merton (1985b, Appendix A).

9   The interpretation of the parameter γ in (5) suffers from the absence of a more precise underlying structural model which leads to (3). To see this, suppose for simplicity that $\Delta \log[E^m(t)] = m(t-1)$, $\eta(t) = 0$, in (5), but that the current dividend yield is out-of-equilibrium. Salmon (1982, p. 622) shows that a "proportional, integral, derivative" (PID) control rule:

$$\Delta \log[D(t)] = \beta - k_i\{\log[D(t)]-\log[E^m(t-1)]\} - k_p \, \Delta\{\log[D(t)]$$
$$- \log[E^m(t-1)]\} - k_d \, \Delta^2\{\log[D(t)]-\log[E^m(t-1)]\} \tag{i}$$

leads to the following error correction term:

$$\Delta \log[D(t)] = \{(k_p + k_i + k_d) - (k_p + 2k_d)L - k_d^2 L \}\{\log[D(t)] - \log[E^m(t-1)]\}$$
$$\equiv \{\beta - A(L)\{\log(D(t)] - \log[E^m(t-1)]\} \qquad . \tag{ii}$$

In the absence of a more explicit model, one can only speculate about the need to include a term like $\Delta^2\{\log[D(t)] - \log[E^m(t-1)]\}$ in (5). For example, in Salmon's general discussion, he argues that an error-correction rule might be appropriate when a decision-maker faces an

uncertain environment in which the control problem is itself changing over time. Terms like $\Delta^2\{\log[D(t)] - \log[E^m(t-1)]\}$ may pick up such changes, especially if the type of model changes that occur result in a non-time-additive "control problem" to be solved for the short-run dynamics of dividends. Insofar as changes in the long-run equilibrium dividend-price ratio are concerned, many can be accommodated in the formulations in the text. Given these formulations, if uncertainties about the "short-run" dividend control problem can not be completely described by a linear-quadratic problem, a non-linear model will generally be needed in place of (5)--the certainty equivalence principle will no longer hold and $\eta(t)$ will not be an additive error.

10 Strictly, feasibility only requires the weaker "less than or equal to." If, however, dividends include all distributions to stockholders and if managers do not throw cash away, then strict equality is required. In contrast to the actual dividend payments made, the term "dividend policy" refers to the contingent schedule or plan for future dividend payments. A dividend policy is, thus, much like the state-contingent functions for optimal control variables which are derived from the solution of a stochastic dynamic programming problem.

11 Indeed, even in the restrictive context of our simple behavioral model, any values for λ and γ in (5) such that $0 \leq \lambda \leq 1$ and $\gamma > 0$ are more than sufficient to ensure satisfaction of the rationality constraint.

12 Even the strongest supporters of the view that "dividend policy matters" would agree that the only effect of a change in dividend policy on investment policy is through its effect on the firm's cost of capital,

α. Although a change in dividend policy may "signal" a change in investment policy, one could hardly argue that such a dividend policy change "caused" the subsequent change in investment policy that it signalled.

13 See, for example, Hall (1978). We note further that if consumer behavior is to smooth the time path of <u>changes</u> in consumption, then the dynamics for a change in next period's consumption in response to an unanticipated change in this period's wealth may well be described by a partial adjustment process analogous to our equation (5).

14 Note that the degree of market efficiency posited here is much weaker than would be implied by assuming that the market information set contains all the relevant information contained in managers' aggregated information sets. Under our assumption, a manager may have information relevant to the estimation of his or her firm's intrinsic value that is not available to the market. If, as would seem reasonable, such nonpublic information is firm-specific, then differences between the market's and the manager's assessment of the individual firm's intrinsic value that arise from this source are likely to (statistically) disappear when these individual assessments are averaged over all firms. It is, of course, possible that the market's information set is richer than the individual manager's, even with respect to estimates of his or her own firm's intrinsic value. However, rationally-behaving managers would presumably take this possibility into account when making their dividend decisions.

15 As discussed in footnote 5, because of transactions by the firm in its own liabilities, it is <u>not</u> the case that $[\Pi(s) - I(s)]/N(s) \equiv D(s)$ in (8). Even without such transactions, managers can still implement

virtually any change in dividends per share by the purchase or sale of
financial assets held by the firm or by marginal changes in the amount of
investment in any other "zero net present value" asset (e.g.,
inventories). While these latter transactions will change the time
pattern of $\Pi(s) - I(s)$, they will not affect the present value of
these future cash flows, and therefore, will not affect the current level
of permanent earnings. The presence of such significant nonequity sources
of cash flow cause practical difficulties in testing theories which make
fine distinctions between the behavior of gross and net dividends.

16 The joint hypothesis implied by the assumptions used to derive equation
(11) includes the dividend behavioral equation (5) and a constant real
discount rate, in addition to stock market rationality. Thus, the
goodness-of-fit of (11) is hardly a meaningful test of stock market
rationality. This is, indeed, the central point in Marsh and Merton
(1986): made there, with respect to the joint hypothesis of Shiller's
(1981a) variance-bound tests and their interpretation as tests of stock
market rationality. If the model of dividend behavior posited here is
substituted for the Shiller assumption of a stationary process for
dividends, then these variance bounds will be systematically violated even
if stock prices are rationally determined. If, as the theoretical and
empirical evidence presented here suggests, this model of dividends is a
plausible alternative to the one posited by Shiller, then his variance
bounds are not a reliable test of stock market rationality. This is so
whether or not stock prices are, in fact, rationally determined. See
Merton (1987) for a related discussion of other variance-bound tests of
this hypothesis.

17 Although the majority of studies using serial correlation, filtering and
    spectral analysis tests supports this view, Summers (1986) shows that
    their power is low in detecting long-wave serial dependencies in stock
    returns. Moreover, Fama and French (1986) find evidence of a regressive,
    or temporary component in three-to-five year stock returns. Such findings
    are consistent with the view that stock prices deviate significantly from
    fundamental values with a slow speed of adjustment toward these values.
    They are, however, also consistent with rational stock prices and
    time-varying equilibrium expected returns.

18 Our data set is different from those used by Shiller (1981a). However,
    our data set, produces essentially the same empirical findings as reported
    by Shiller for his data sets. We, therefore, expect that the results
    reported here for our model will also obtain if it were fit to his data
    sets. (17) was also fitted using quarterly data. Although it might at
    first appear that the use of quarterly rather than annual data would
    quadruple the number of observations available, there are good reasons for
    doubting this. There is a distinct yearly (and half-yearly) seasonal in
    real quarterly dividends. If, as this suggests, managers wait until the
    fourth (fiscal) quarter to "take a look at the year's performance" before
    deciding to raise or lower that year's dividend relative to the previous
    year's, then the last quarter's dividend contains effectively the same
    information as the annual dividend. Further, any "seasonal adjustment" of
    quarterly dividends not only runs the risk of smoothing away the very
    innovations in dividends in which we are interested, but also is doubly
    hazardous when autocorrelated disturbances or lagged dependent variables
    might be present as in (11). Therefore only the results for annual data
    are reported.

19 Any of the above-mentioned ways in which the adjustment lags could arise
    are also potential explanations for disturbance autocorrelation, because
    in dynamic regression models, lag structure and disturbance
    autocorrelation can act as proxies for each other.

20 Our R^2 is below the 85% figure given in the original Lintner (1956)
    study. However, Lintner (1956), who stressed that his results were
    preliminary, pooled his time series observations from 1918-1941 for his 28
    companies to estimate his model. Fama and Babiak (1968), who reestimated
    Lintner's model separately for each firm over the years 1946-1964, report
    (e.g., in their Table 2) average R^2 figures of (roughly) 40%-45% which
    are comparable with ours.

21 By inspection of (12) and (13), the OLS and GLS estimates of the
    coefficient on percentge price changes are negligibly different. If the
    GLS transformation is interpreted as a quasi-differencing operator and a
    logic similar to that of Plosser, Schwert, and White (1982) is applied,
    then the invariance of the coefficient estimate to GLS suggests, in terms
    of Hausman's (1978) specification test, that there is no simultaneity bias
    in regressions (12) and (13).

22 The point estimate of the dividend-yield coefficient is sensitive to how
    the autocorrelation is taken into account. The half-life calculation in
    the text uses the GLS rather than the OLS estimate because the positive
    autocorrelation in the OLS residuals reduces the absolute magnitude of the
    (negative) dividend yield coefficient. Dynamic regression models with
    autocorrelated disturbances cannot be easily distinguished from ones with
    lagged-dependent variables, and the dividend yield will be correlated with
    the lagged-dependent variable if, as both our model and the Shiller model

posit, the dividend-to-price ratio is autoregressive. There is evidence that the residual autocorrelation estimate is somewhat sensitive to an outlier in 1951, but this outlier apparently has no effect on the estimates of the coefficients in our model. We therefore omit a more detailed analysis of the disturbance autocorrelation.

23 In their classic events-study of stock splits and the cash dividend changes which often accompany them, Fama, Fisher, Jensen, and Roll (1969) report a result similar to our's: stock splits, and the increased dividends which typically accompany them, were on average preceded by abnormal price increases. In their study, some of the average "run-up" in prices took place earlier than twelve months before the stock-split event, but FFJR deliberately select the individual companies which, ex post, split their stocks. The early small run-up in prices could easily wash out in our aggregate data, and in any case, the FFJR study does not provide information on changes in cash dividends other than those associated with the stock split.

24 Both these tests and the recursive estimation were performed using the TROLL program RECUR. Details of all results cited but not reported are available upon request.

25 The usual problems of identifying the point of shift in the regression regime are exacerbated when the shift occurs at the beginning (or end) of the sample period where the tax-change explanation would place it (e.g., Quandt 1958,pp. 877-878). Moreover, an advocate of Tarshis' position might argue that it is at best only "half-naive" to search for a single discrete shift in regimes over our long sample period.

26   The significance of stock price volatility changes in explaining dividend movements has implications for the stock price rationality debate. If managers "smooth out" what they consider to be irrational fluctuations in stock prices as measures of permanent earnings, then it seems rather implausible that the magnitude of the response coefficient to stock price changes would decrease, rather than increase, when stock price volatility decreases.

27   Tests for the effects of a nonconstant discount rate were performed using the program ADAPT, written by Craig F. Ansley.

28   In previous estimations, we used a "one-step" GLS procedure. Because Maddala (1971) has shown that "iteration pays" in GLS estimation when a lagged dependent variable is present, we use the iterative approach for the equations in this section.

29   Comparing the OLS and GLS R^2s provides only a heuristic measure of the incremental explanatory power afforded by the GLS regression, because the OLS R^2 is not a proper benchmark in light of autocorrelation in the residuals. The R^2 for the GLS regression, which, in this case and all others in the paper, we compute as (geometrically) the square of the cosine of the angle between the (centered) dependent variable and the (centered) fitted dependent variable, is also well known not to be uniquely defined for GLS and nonlinear regression models. However, we believe our statements in this paper concerning model fit are not sensitive to our R^2 measure, especially since the OLS and GLS fits of our model are essentially the same. Further, it is hard to think of a more "natural" way of generally measuring the tightness between the fitted and actual dependent variables.

30 As was the case for the OLS and GLS fits (12) and (13) of our model, the
    GLS fit of (16) does not significantly improve upon its OLS fit. The F
    statistic for the autoregressive correction in (16) is 2.85, which is not
    significant at the conventional 5 percent level. Thus, the addition of
    log price change to (15) substantially increases its explanatory power and
    improves the autoregressive model's specification (14) by eliminating the
    requirement that it be supplemented by more structure on the stochastic
    process for the "unknown" variables before it is a proper regression
    equation.

31 This regression is almost the equivalent of the Granger-Sims causality
    test referred to in the causality discussion in Section 3.

32 It is all the more surprising because the model does not use
    contemporaneous price changes. Because all the variables in our model are
    lagged, equation (18) is a "true" forecast equation in the sense that at
    time t, it provides an unconditional forecast for $D(t + 1)$. The
    relatively high $\bar{R}^2$ suggests that aggregate dividends may be forecasted
    rather successfully.

33 There is, of course, ample precedent in the economics literature for
    assuming that <u>relative</u> values such as the dividend-to-price and
    earnings-to-price ratios have steady-state or stationary distributions.
    As exemplified by our model, the existence of steady-state distributions
    for such relative values surely does not justify the assumption of
    stationarity distributions for the levels (or absolute values) of
    dividends, earnings, or prices. Further, unless investors are risk-
    neutral <u>and</u> the riskless rate of interest is constant, the assumption of a
    constant expected return on the market, made in Shiller (1981a,b) and in

much of the finance literature, is <u>inconsistent</u> with the trend-autoregressive process for dividends and stock prices. For proofs and further discussion, see Myers and Turnbull (1977) and Fama (1977).

34 Study of our sample using blunt interocular analysis suggests that there are a few influential "outliers" in the annual data which cause the correlation, and the correlation disappears all together with monthly data.

35 Although not presented here, the sample distributions of dividend and stock price changes were plotted using Tukey's (1970) robust statistics. These plots are consistent with the relatively "fat tails" of the dividend process implied by our reported kurtosis statistics.

APPENDIX A

The long-run steady state (4) in the text can be imposed on the short-run dynamics (3) by the further coefficient restrictions:

$$\lambda - \theta_1 = 1 - \phi_1 \equiv \gamma \quad (i.e., \quad \lambda - \theta_1 = 1 - \phi_1) \quad , \tag{A.1}$$

and by setting the constant in the deterministic function $a(t)$ in (3) equal to $\gamma\beta$. Denoting the function $a(t)$ <u>sans</u> the constant by $a'(t)$ and incorporating (A.1), we can rewrite (3) as follows:

$$\log[D(t+1)] - \log[D(t)] = \gamma\beta + a'(t) + \lambda\{\log[E^m(t)] - \log[E^m(t-1)]\}$$

$$-\gamma\{\log[D(t)] - \log[E^m(t-1)]\} + \eta(t+1) \tag{A}$$

or, by rearrangement:

$$\log[D(t+1)] - \log[D(t)] = a'(t) + \lambda\{\log[E^m(t) - \log[E^m(t-1)]\}$$

$$+ \gamma\{\beta - (\log[D(t)] - \log[E^m(t-1)])\} + \eta(t+1) . \tag{A.3}$$

To derive (5) in the text, define the expected logarithmic change in permanent earnings, $\{\log[E^m(t)] - \log[E^m(t-1)]\}$, as $m(t-1)$. Then (A.3) can be rewritten as:

$$\log[D(t+1)] - \log[D(t)] = a'(t) + \lambda m(t-1) + \lambda\{\log[E^m(t) - \log[E^m(t-1)] - m(t-1)\}$$

$$\tag{A.4}$$

$$+ \gamma\{\beta - (\log[D(t)] - \log[E^m(t-1)])\} + \eta(t+1) \quad .$$

Substituting $g(t) \equiv a'(t) + \lambda m(t)$ gives (5) in the text.

REFERENCES

Aharony, J., and Swary, I., 1980. Quarterly dividend and earnings announcements and stockholders' returns: An empirical analysis. The Journal of Finance 35(1):1-11.

Asquith, P., and Mullins, D.W., Jr., 1983. "The impact of initiating dividend payments on shareholder's wealth. Journal of Business, 56(1):77-95.

Bhattacharya, S., 1979. Imperfect information, dividend policy, and 'The Bird in the Hand' Fallacy. Bell Journal of Economics, (Spring):259-270.

Black, F., 1976. The Dividend Puzzle. In S.C. Myers (ed.), Modern Developments in Financial Management. Hinsdale, IL: Dryden Press.

Black, F., and Scholes, M.S., 1974. The effects of dividend yield and dividend policy on common stock prices and returns. Journal of Financial Economics 1(May):1-22.

Brealey, R.A., and Myers, S.C., 1984. Principles of Corporate Finance. (2nd ed.), New York: McGraw-Hill.

Brittain, J.A., 1966. Corporate Dividend Policy. Washington, DC: The Brookings Institution.

Darling, P.G., 1955. A surrogative measure of business confidence and its relation to stock prices. Journal of Finance 10(December):442-458.

Davidson, J.E.H., Hendry, D.F., Srba, D., and Yeo, S., 1978. Econometric modelling of the aggregate time-series relationship between consumers' expenditure and income in the United Kingdom. The Economic Journal 88(December):661-692.

Dickey, D.A., and Fuller, W.A., 1979. Distribution of the estimators for autoregressive time series with a unit root. Journal of the American Statistical Association 74(366)(June):427-431.

Dickey, D.A., and Fuller, W.A., 1981. Likelihood ratio statistics for autoregressive time series with a unit root. Econometrica 49(4)(July):1057-1072.

Eades, K.M., Hess, P.J., and Kim, E.H., 1984. On interpreting security returns during the ex-dividend period. Journal of Financial Economics 13(1):3-34.

Easterbrook, F.H., 1984. Two agency cost explanations of dividends. The American Economic Review 74(4):650-659.

Ericsson, N.R., and Hendry, D.F., 1984. Assertion without empirical basis:
an econometric appraisal of Monetary trends in ... the United Kingdom by
Milton Friedman and Anna J. Schwartz. Paper presented to the NBER
Research Program on Economic Fluctuations, Macro Conference, July 12-13,
Cambridge, MA.

Fama, E.F., 1977. Risk-adjusted discount rates and capital budgeting under
uncertainty. Journal of Financial Economics 5:3-24.

Fama, E.F., and Babiak, H., 1968. Dividend policy: An empirical analysis.
Journal of the American Statistical Association 63(December):1132-1161.

Fama, E.F., Fisher L., Jensen, F., and Roll, R., 1969. The adjustment of
stock prices to new information. International Economic Review
10(February):1-21.

Fama, E.F. and French, K.R., 1986. Permanent and temporary components of
stock prices. Mimeo (May).

Fisher, M.R., 1957. L'epargne et les profits des entreprises dans l'hypothese
du 'revenu permanent'. Economie Applique 10(Octobre-Decembre):539-562.

Gonedes, N.J., 1978. Corporate signalling, external accounting, and capital
market equilibrium: Evidence on dividends, income, and extraordinary
items. Journal of Accounting Research 16(1)(Spring):26-79.

Gordon, M.J., 1959. Dividends, earnings and stock prices. Review of Economics and Statistics 41(May):99-105.

Gordon, M.J., 1962. The savings, investment and valuation of a corporation. Review of Economics and Statistics (February):37-51.

Hakansson, N.H., 1982. To pay or not to pay dividends. Journal of Finance 37(May).

Hall, R.E., 1978. Stochastic implications of the life cycle--Permanent income hypothesis: Theory and evidence. Journal of Political Economy 86(6):971-987.

Hausman, J.A., 1978. Specification tests in econometrics. Econometrica 46(6):1251-1271.

Hess, P.J., 1983. Tests for tax-effects in the pricing of financial assets. Journal of Business (forthcoming).

John, K., and Williams J., 1984. Dividends, dilution, and taxes: A signalling equilibrium. Unpublished Paper, Graduate School of Business, New York University, 100 Trinity Place, New York, NY 10006.

Kleidon, A.W., 1983. Variance bounds tests and stock price valuation models. Unpublished Working Paper, Graduate School of Business, Stanford University:(January).

Kuh, E., Samarov, A., and Shell, M., 1986. TROLL PROGRAM: RECUR. Technical Report TR-62, Center for Computational Research in Economics and Management Science, Massachusetts Institute of Technology, Building E40-148, Cambridge, MA, 02139.

Lintner, J., 1956. Distribution of incomes of corporations among dividends, retained earnings, and taxes. The American Economic Review 61(2)(May):97-113.

Lintner, J., 1962. Dividends, earnings, leverage, stock prices and the supply of capital to corporations. Review of Economics and Statistics 64(3)(August):243-269.

Litzenberger, R.H., and Ramaswamy, K., 1979. The effect of personal taxes and dividends on capital asset prices. Journal of Financial Economics 7:163-195.

Maddala, G.S., 1971. Generalized least squares with an estimated variance covariance matrix. Econometrica 39(1)(January):23-33.

Malinvaud, E., 1966. Statistical Methods of Econometrics Amsterdam: North-Holland Publishing Company.

Marsh, T.A., and Merton, R.C., 1985a. Corporate dividend dynamics at the firm level. Mimeo, Sloan School of Management, MIT, 50 Memorial Drive, Cambridge, MA, 02139.

Marsh, T.A., and Merton, R.C., 1985b. Dividend behavior for the aggregate stock market. Working Paper No. 1670-85, Sloan School of Management, MIT, 50 Memorial Drive, Cambridge, MA, 02139.

Marsh, T.A., and Merton, R.C., 1986. Dividend variability and variance bounds tests for the rationality of stock market prices. American Economic Review (June)76:483-498.

Means, G.C., 1935. Industrial prices and their relative inflexibility. Senate Document 13, 74th Congress, 1st Session, Washington, D.C., U.S. Government Printing Office.

Merton, R.C., 1987. On the current state of the stock market rationality hypothesis. In R. Dornbusch and S. Fischer, (eds.), Macroeconomics and Finance: Essays in Honor of Franco Modigliani, Cambridge: MIT Press.

Miller, M.H., 1977. Debt and taxes. The Journal of Finance 32(2)(May): 261-175.

Miller, M.H., 1985. Behavioral rationality in finance: The case of dividends. Paper presented to the Conference on Behavioral Foundations of Theory, October 14-15, 1985.

Miller, M.H., and Modigliani, F., 1961. Dividend policy, growth and the valuation of shares. Journal of Business (October):411-433.

Miller, M.H., and Rock, K., 1982. Dividend policy under asymmetric information. Unpublished Paper, Graduate School of Business, University of Chicago, 1101 East 58th Street, Chicago, IL 60637, (November). Journal of Finance (forthcoming).

Miller, M.H., and Scholes, M.S., 1978. Dividends and taxes. Journal of Financial Economics 6:333-364.

Miller, M.H., and Scholes, M.S,. 1982. Dividends and taxes: Some empirical evidence. Journal of Political Economy 90:1118-1142.

Myers, S.C., and Turnbull, S.M., 1977. Capital budgeting and the capital asset pricing model: Good news and bad news. Journal of Finance 32(2):321-333.

Nickell, S., 1980. Error correction, partial adjustment and all that: An expository note. C.L.E. Working Paper No. 255, (May), London School of Economics.

Officer, R.R., 1971. A time series examination of the market factor of the New York stock exchange. Ph.D. Dissertation, University of Chicago.

Petit, R.R., 1972. Dividend announcements, security performance, and capital market efficiency. Journal of Finance (December):993-1007.

Poterba, J.M., and Summers, L.H., 1984. New evidence that taxes affect the valuation of dividends. Journal of Finance (December):1397-1415.

_____, 1985. The economic effects of dividend taxation. In E. Altman and M. Subrahmanyam (eds.), Recent Advances in Corporate Finance, Homewood, IL: Richard D. Irwin.

Plosser, C.I., Schwert, G.H., and White, H., 1982. Differencing as a test of specification. International Economic Review 23(3)(October):535-552.

Quandt, R.E., 1958. Tests of the hypothesis that a linear regression system obeys two separate regimes. Journal of the American Statistical Association 55(290)(June):324-330.

Quandt, R.E., 1960. The estimation of the parameters of a linear regression system obeying two separate regimes. Journal of the American Statistical Association 53(284)(December):873-880.

Quandt, R.E., and Ramsey, J.B., 1978. Estimating mixtures of normal distributions and switching regressions. Journal of the American Statistical Association 73(364)(December):730-752.

Rubinstein, M., 1976. The valuation of uncertain income streams and
the pricing of options. Bell Journal of Economics 7(2)(Autumn):407-425.

Salmon, M., 1982. Error correction mechanisms. The Economic Journal
92(September):615-629.

Sargan, J.D., 1964. Wages and prices in the United Kingdom: A study in
econometric methodology. In P.E. Hart, G. Mills and J.K. Whitaker,
(eds.), Econometric Analysis for National Economic Planning, London:
Butterworths:25-63.

Shefrin, H.M., and Statman, M., 1984. Explaining investor preference for cash
dividends. Journal of Financial Economics 13(2):253-282.

Shiller, R.J., 1981a. Do stock prices move too much to be justified by
subsequent changes in dividends? The American Economic Review
71(3)(June):421-436.

Shiller, R.J., 1981b. The use of volatility measures in assessing market
efficiency. The Journal of Finance 34(2)(May):291-311.

Shiller, R.J., 1983. Do stock prices move too much to be justified by
subsequent changes in dividends?: Reply. The American Economic Review
73(1):236-237.

Summers, L.H., 1986. Does the stock market reflect fundamental values? Journal of Finance 41(July):591-600.

Tarshis, L., 1959. Discussion of J. Lintner, Distribution of incomes of corporations among dividends, retained earnings, and taxes. American Economic Review 66(2)(May):118.

Theil, H., 1965. Linear Aggregations of Economic Relations. Amsterdam: North-Holland.

Telser, L.G., 1967. Discrete samples and moving sums in stationary stochastic processes. Journal of the American Statistical Association 62(318)(June):484-499.

Tukey, J.W., 1970. Explanatory Data Analysis. Reading, MA: Addison-Wesley.

Watts, R., 1973. The information content of dividends. The Journal of Business (April):191-211.

White, N., 1980. A heteroscedasticity-consistent covariance matrix estimator and a direct test for heteroscedasticity. Econometrica 48(4)(May):817-838.

Zellner, A., 1979. Causality and econometrics. In K. Brunner and A.H. Meltzer, (eds.), Three Aspects of Policy and Policy Making. Carnegie-Rochester Conference Series, Volume 10, Amsterdam: North-Holland Publishing Co.

Date **BASEMENT**