Permanent, Temporary, and Non-Fundamental Components of Stock Prices

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Abstract

This paper identifies various components of stock prices and examines the response of stock prices to different types of shocks: permanent and temporary changes in earnings and dividends, changes in discount factors, and non-fundamental factors. The analysis is conducted in a log-linear structural VAR framework. I find that about half of the yearly variation in prices is not related to either earnings or dividend changes. Time-varying interest rates do not help explain the remaining price movements. However, time-varying excess stock returns (i.e., risk premiums) account for much of the remaining variation in stock prices, in particular, in the postwar period. As a result, the deviation of stock prices from these fundamentals reduces to about 10% of stock price movements and tends to persist for a while before it declines eventually. This finding seems more compatible with a fad rather than a bubble interpretation.

I. Introduction

One of the important issues in financial economics is whether stock price movements reflect market fundamentals. This issue has been widely discussed in the context of the variance bounds tests of the simple present value relation. LeRoy and Porter (1981) and Shiller (1981) have shown that stock prices are too volatile to be compatible with subsequent dividends. Kleidon (1986), among others, has criticized these tests on the grounds that prices and dividends are non-stationary, so that the gross violations of the variance bounds are a consequence of an incorrect application of estimation techniques that assume stationarity to non-stationary series.[1]

West (1988a), however, has devised a variance bounds test that is valid even when dividends are non-stationary. Campbell and Shiller (1987) have derived testable implications of the present value model, taking into account the non-stationarity of prices and dividends. Both West and Campbell-Shiller have found

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[1]See also Flavin (1983) for another criticism of the variance bounds tests based on small sample bias.

strong evidence against the simple present value relation. Overall, with a few exceptions, various tests have found statistically significant excess volatility of stock prices and have rejected the simple present value relation.[2] This excess volatility of stock prices suggests either that a substantial fraction of stock price variation may arise from non-market fundamentals or that a time-varying discount factor may help explain the failure of the simple present value relationship (see Cochrane (1991), (1992), Campbell and Shiller (1988), (1989), Campbell (1991), and Campbell and Ammer (1993)). In the former case, it remains to be seen how much fraction in stock price variation is due to non-fundamentals. In the latter case, it remains to be seen which measures of discount rates are helpful in explaining stock price movements.

Recently, the need to explain the observed negative autocorrelation in long-horizon returns has emerged as an issue of importance.[3] Fama and French (1988) and Poterba and Summers (1988) explain the autocorrelation by introducing a temporary component into the stock price model in addition to a permanent component (see also Cochrane (1994)). However, neither paper identifies the sources of each component and analyzes the relation between each component of stock prices and dividends (see Lee (1995)). Again, there are two competing hypotheses for the mean reversion. If stock prices deviate from market fundamentals substantially and the deviation is mean reverting, then a possible non-fundamental component could play an important role in the mean reversion (see Summers (1986)). Or time-varying expected returns may help explain the mean reversion.

Therefore, it is important to identify and measure the deviation of stock prices from fundamentals and the relative importance of various components of prices due to permanent and temporary changes in earnings and dividends, changes in discount factors, and non-fundamental factors. I address these issues in this paper. In addition, I examine the dynamic responses of stock prices to non-fundamental shocks and various types of fundamental shocks. In doing so, I consider three types of log-linear models: a basic (trivariate) model and its two extensions. The basic model (Model I) assumes that expected real (one-period) stock returns are constant. The model consists of earnings, dividends, and stock prices, where I treat earnings and dividends as fundamentals. The second model (Model II) assumes that expected excess returns on stock, over the return on short debt, are constant. This model allows for a time-varying interest rate and consists of dividends, interest rate, and stock prices, where I treat dividends and interest rate as fundamentals. The third model (Model III) assumes that expected excess stock returns are time-varying. The model consists

[2]For examples of the exceptions, see Cochrane (1992) and Mankiw, Romer, and Shapiro (1991).

[3]It has been pointed out that using overlapping observations in multiperiod returns forecasts results in a small sample bias (toward smaller values) in asymptotic standard errors. See Kim, Nelson, and Startz (1991), Richardson and Smith (1991), Hodrick (1992), and Richardson (1993). Most tests of mean reversion in the U.S. market over long horizons have found the results to be marginal (see, e.g., Goetzmann (1993)).

The use of long-period data inevitably involves survival biases to some extent. In this paper, survivalships may have implications for i) the long-term autocorrelations (i.e., mean reversion), ii) the post-earnings-announcement drift in stock prices, iii) the unit root tests, and iv) predictability of long-horizon stock returns by dividend yields. For i and ii, see Brown, Goetzmann, and Ross (1995). For iii and iv, see Goetzmann and Jorion (1995).

of three fundamental variables—earnings, dividends, and time-varying discount factors—and stock prices. As a measure of the time-varying discount factor, I consider both interest rates and excess stock returns.

In Model I, I examine the effects of fundamental innovations on stock prices by relating earnings to dividends based on the hypothesis that changes in dividends are primarily determined by changes in some measure of permanent earnings (Marsh and Merton (1987) and Lee (1996a)). I then relate stock prices to dividends using a version of the present value model. As a result, I relate earnings (and dividends) to stock prices and examine the effects of fundamental innovations—permanent and temporary—on stock prices. The use of earnings as a fundamental variable is motivated, in part, by a recent finding of Campbell and Shiller (1988), who confirm that earnings serve as a natural proxy for the fundamental value of stocks.[4]

I allow stock prices to deviate from the simple present value model. The deviation is reflected in a non-fundamental component that is driven by innovations that do not influence fundamentals such as earnings or dividends. Therefore, I allow for three types of innovations in Model I: permanent and temporary innovations in fundamentals and a non-fundamental innovation.

I conduct a similar analysis for Model II allowing for a time-varying interest rate. Model II allows examination of the role of interest rate as another fundamental variable in explaining stock price movements. Model III is more general in that not only interest rates but also expected excess stock returns are time-varying. Model III allows examination of the non-fundamental component of stock prices by using a broad measure of fundamentals.

I identify the components of (or innovations in) fundamentals and a non-fundamental component by imposing identifying restrictions on each model. As a result, I can examine the dynamic effects of various types of innovations on earnings, dividends, discount factors, and stock prices as well as the empirical validity of the above-mentioned issues.

The decomposition of stock prices has important implications for other issues. First, when the variance bounds tests are rejected, some studies provide a "fad" interpretation while others provide a "bubble" interpretation. The present value relation is derived based on an Euler equation combined with a transversality condition. When prices do not satisfy the transversality condition, they are thought to contain bubbles. For example, prices can vary simply because of changes in expectations of future prices although there is no news about dividends. Most studies, however, do not interpret the variance bounds rejection as evidence for bubbles partly because the tests are based on finite samples (see Shiller (1984), (1989), West (1988b), Flood and Hodrick (1990), and Froot

[4]The t-ratios from predictive regressions of stock returns on the lagged values of financial fundamentals (e.g., dividend yields or price-earnings ratios) or macroeconomic indicators are subject to a small sample bias that may indicate that returns are more predictable than they in fact are. See Mankiw and Shapiro (1986), Stambaugh (1986), Hodrick (1992), Goetzmann and Jorion (1993), and Nelson and Kim (1993). In particular, Goetzmann and Jorion (1993) point out that time-series studies of returns conditional upon any ratio involving price levels (e.g., dividend yields) are subject to a substantial bias. Several studies have explored the small sample problems of the VAR method that include lagged endogenous variables (see Hodrick (1992), Goetzmann and Jorion (1993), and Nelson and Kim (1993).

and Obstfeld (1991)). Both in a fad and a bubble, the price deviates from the present value of future dividends or fundamentals due to noise, feedback trading (trade based on past price changes), irrational expectations (irrational waves of optimism and pessimism), or some other inefficiency. However, fad price deviations are slowly reversed, whereas bubble price deviations are expected to last forever (see Cochrane (1991), p. 471). Therefore, time-series behavior of price deviations is bound to shed some light on this debate.

Second, an important issue in empirical dividend policy modeling is whether dividend decisions are primarily determined by changes in either some measure of permanent earnings or current earnings (see Marsh and Merton (1987) and Lee (1996a)). The decomposition of earnings and dividends into permanent and temporary components and the examination of the relationship between the two components may provide some evidence on this issue.

Third, numerous studies document that drifts in cumulative abnormal returns continue beyond earnings announcements. As an explanation of this drift, Bernard and Thomas (1989), (1990) characterize investor perceptions of the earnings process as a random walk, suggesting that temporary changes in earnings are largely ignored by the market. In these studies, stock return behavior is modeled as a response to unexpected changes in earnings (e.g., Foster, Olsen, and Shevlin (1984) and Bernard and Thomas (1989), (1990)). If a substantial fraction of stock price movement arises from a component that is not captured by changes in earnings, then such a model would be very limited in its ability to describe an important part of stock return behavior (see also Brown, Goetzmann, and Ross (1995) for a potential effect of survivorship on this issue).

The remainder of the paper is organized as follows. Section II presents time-series representation of my basic model (Model I). The model is then used to identify three types of innovations. Section III provides further discussion by introducing time-varying interest rates and expected excess stock returns (Models II and III). Section IV describes the data and reports the empirical results. Section V concludes the paper.

II. Model I: A Log-Linear Model with a Constant Expected Stock Return

A. Time-Series Models of Earnings, Dividends, and Stock Prices

1. A Model of Earnings

Let the log of real earnings during period t be y_t. Recognizing that the earnings series is a non-stationary process and being concerned with the differential effect of permanent and temporary innovations in earnings on dividends and stock prices, I model the log of earnings (y_t) as the sum of permanent (y_t^p) and temporary (y_t^s) components,

$$(1) \qquad y_t = y_t^p + y_t^s, \quad \text{with}$$

$$(2) \qquad \Delta y_t^p = \Sigma_k q_1^k e_{1t-k} \quad \text{and} \quad y_t^s = \Sigma_k q_2^k e_{2t-k}, \quad \text{or}$$

$$(3) \qquad \Delta y_t \equiv y_t - y_{t-1} = \Delta y_t^p + \Delta y_t^s$$
$$= \Sigma_k q_1^k e_{1t-k} + \Sigma_k q_2^k \Delta e_{2t-k},$$

where $\Sigma_k = \sum_{k=0}^{\infty}$, y_t^p and y_t^s are permanent and temporary components of logged earnings, respectively, and e_{1t} and e_{2t} are permanent and temporary innovations in logged earnings, respectively. The specification in (2) shows that e_1 will have a permanent effect on earnings, whereas e_2 will have a temporary effect on earnings. Notice that, by construction, non-fundamental innovations, e_{nt}, do not enter the earnings y_t (or Δy_t) process at all.

2. A Model of Spread between Price and Dividend

Let the log of the real stock price of a stock measured at the beginning of time period t be p_t, and the log of the real dividend paid during period t be d_t. Under the assumption that expected real (one-period) stock returns are constant over time and by using log-linear approximations to the usual present value model of stock price, Campbell and Shiller (1988), (1989) have derived the so-called dividend ratio model in the log-linear form or the dynamic Gordon model. The model relates the log of dividend-price ratio (δ_t^*) to the present value of the first difference in log dividend (Δd_t),

$$(4) \qquad \delta_t^* \quad = \quad -E_t \Sigma_j \rho^j \Delta d_{t+j} + c^*,$$

where δ_t^* = the dividend-price ratio (dividend yield) $= d_{t-1} - p_t$; ρ = the average ratio of the stock price to the sum of the stock price and the dividend, which is close to but a little smaller than 1; $\Delta d_t = d_t - d_{t-1}$ = the growth rate of dividends; and c^* is a constant. Equation (4) states that the log price-dividend ratio is an expected discounted value of all future dividend growth rates.

By using $\delta_t^* = d_{t-1} - p_t$, and adding an error term that is a linear combination of non-fundamental shocks $e_n s$, (4) can be rewritten (ignoring a constant term) as

$$(5) \qquad s_{2t} \quad \equiv \quad p_t - d_{t-1} \quad = \quad E_t \Sigma_j \rho^j \Delta d_{t+j} + \eta_t,$$

where $\eta_t = \Sigma_k \delta_3^k e_{nt-k}$.

Given the extensive evidence that the simple present value model based only on dividends may not be sufficient to describe stock price behavior, I allow for an error term η_t in the stock price model to capture the extent of stock price deviation from the simple present value model. This is the source of the non-fundamental component in Model I, which is further developed below in more general models.

3. A Model of Spread between Dividend and Earnings

In the absence of an agreed-upon dynamic model of dividends, I relate the (non-logged) dividend process, D_t, to the (non-logged) earnings process, Y_t, using the hypothesis that dividend change is primarily determined by changes in some measure of permanent earnings.[5] Marsh and Merton (1987) and Lee (1996a) report empirical evidence supporting this hypothesis.[6]

[5]For the theoretical modeling of the idea of permanent earnings, see references in Lee (1996a).

[6]A popular model of dividend policies by individual firms is the partial adjustment model.

As a measure of permanent earnings, I use a present discounted value of future expected earnings,

$$(6) \qquad D_t \;=\; \alpha E_t \Sigma_j \beta^j Y_{t+j}, \quad 0 < \beta < 1,$$

where α is a constant proportionality factor, β is a discount factor, and E_t is the conditional expectations operator based on information available at time t.

As the present value model of stock price is transformed to (4) by using linear approximations, I transform the present value model of dividends in (6) into the following relation,

$$(7) \qquad \delta_t \;\equiv\; y_t - d_t \;=\; -E_t \Sigma_j \gamma^j \Delta y_{t+j} + c,$$

where $\delta_t = y_t - d_t = \log(Y_t) - \log(D_t)$, γ is a constant that is close to but a little smaller than 1, and c is a constant. (7) can be rewritten (ignoring a constant term c) as

$$(8) \qquad s_{1t} \;\equiv\; d_t - y_t \;=\; E_t \Sigma_j \gamma^j \Delta y_{t+j}.$$

Equation (8) states that the log dividend payout ratio is an expected present value of all future earnings growth rates. Since Δys are stationary, so is s_{1t}.

Modeling stock price as the present value of future dividends that are proportional to a measure of permanent earnings, I can represent stock price as a function of the permanent and temporary innovations in earnings, and further decompose it into permanent and temporary components. As a result, unlike previous studies such as Fama and French (1988) and Poterba and Summers (1988), I can examine the dynamic effects of these innovations on stock price.

B. A Log-Linear, Trivariate Model

Previous studies have found that the logs of earnings (y_t), dividend (d_t), and stock price (p_t) series are integrated of order one (i.e., non-stationary) processes and both the dividend payout ratios and the dividend yields are stationary (e.g., Kleidon (1986), Campbell and Shiller (1987), Cochrane (1992), Mankiw, Romer, and Shapiro (1991), and Lee (1996a)).[7] That is, both the logged earnings and dividend series and the logged dividend and price series are cointegrated of order one and one with a cointegrating vector $[1, -1]'$. To incorporate these findings, I consider a trivariate vector z_t consisting of the change in logged earnings (Δy_t), the spread between logged dividend and earnings ($s_{1t} = d_t - y_t$), and the spread between logged price and dividend ($s_{2t} = p_t - d_{t-1}$): $z_t = [\Delta y_t, s_{1t}, s_{2t}]'$. Then, by the Wold representation theorem, there is a trivariate moving average representation (TMAR) of $z_t = [\Delta y_t, s_{1t}, s_{2t}]'$,

$$(9) \qquad z_t = \begin{bmatrix} \Delta y_t \\ s_{1t} \\ s_{2t} \end{bmatrix} = \begin{bmatrix} \Sigma_k c_{11}^k e_{1t-k} + \Sigma_k c_{12}^k e_{2t-k} + \Sigma_k c_{13}^k e_{nt-k} \\ \Sigma_k c_{21}^k e_{1t-k} + \Sigma_k c_{22}^k e_{2t-k} + \Sigma_k c_{23}^k e_{nt-k} \\ \Sigma_k c_{31}^k e_{1t-k} + \Sigma_k c_{32}^k e_{2t-k} + \Sigma_k c_{33}^k e_{nt-k} \end{bmatrix}.$$

[7] See Section IV for empirical evidence on these. However, MacDonald and Power (1995) claim that dividend and price series are not cointegrated. For the comovements of earnings, dividends, and stock prices, see Lee (1996b).

The three innovations e_{1t}, e_{2t}, and e_{nt} are serially uncorrelated by construction, and are assumed to be contemporaneously uncorrelated by an orthogonalization, which will be discussed further in Section II.C. It is also assumed that the variance of the vector $e_t(=[e_{1t}, e_{2t}, e_{nt}]')$ is the identity matrix of rank 3 by a normalization.

Then, models of the log of earnings, dividends, and prices developed in Section II.A are characterized by the following restrictions.

Proposition 1. Models of earnings in (3), dividends in (8) and prices in (5) are characterized by the following restrictions on z_t in (9),

$$(10) \qquad \Sigma_k c_{12}^k = 0, \quad c_{13}^k = 0 \text{ and } c_{23}^k = 0 \text{ for all } k.$$

Proof. (See Appendix A).

The restriction $\Sigma_k c_{12}^k = 0$ distinguishes the temporary innovation, e_{2t}, from the permanent innovation, e_{1t}. Since c_{12}^k measures the effect of e_2 on the first variable in z_t (i.e., Δy_t) in k periods, the restriction $\Sigma_k c_{12}^k = 0$ requires e_2 to have a zero cumulative effect on Δy_t. This implies that e_2 may have a temporary effect on y_t, but cannot have a permanent effect on y_t. Therefore, e_{2t} is called the temporary innovation in fundamentals. In contrast, without such a restriction on e_{1t}, e_{1t} is allowed to have a permanent effect both on earnings and on stock prices (see Blanchard and Quah (1989)).

The restrictions that $c_{13}^k = 0$ and $c_{23}^k = 0$, for all k, identify e_{nt} as a non-fundamental innovation in that it does not affect either earnings or dividends at any time. Hence, e_{nt} does not enter either the earnings or dividend process and is not included in the unexpected change in earnings. Under this restriction, any innovation that affects either earnings or dividends, directly or indirectly, is fundamental. Notice that I need at least a trivariate model to incorporate three types of innovations. In short, the three types of innovations are identified based on their long-term effects on the variables and their relation to the fundamental variables (i.e., earnings and dividends).

C. A Restricted VAR Model

The trivariate moving average representation (TMAR) in (9) on which identifying restrictions are imposed is, in practice, obtained by inverting a trivariate vector autoregression (TVAR) model of z_t with non-orthonormalized innovations, and the restrictions are imposed on this TVAR model. Hence, I discuss the relation between the TMAR and a TVAR.

Suppose that I estimate the following TVAR model of z_t,

$$(11) \qquad z_t = \begin{bmatrix} \Delta y_t \\ s_{1t} \\ s_{2t} \end{bmatrix} = \begin{bmatrix} \Sigma_k a_{11}^k \Delta y_{t-k-1} + \Sigma_k a_{12}^k s_{1t-k-1} + \Sigma_k a_{13}^k s_{2t-k-1} + u_{1t} \\ \Sigma_k a_{21}^k \Delta y_{t-k-1} + \Sigma_k a_{22}^k s_{1t-k-1} + \Sigma_k a_{23}^k s_{2t-k-1} + u_{2t} \\ \Sigma_k a_{31}^k \Delta y_{t-k-1} + \Sigma_k a_{32}^k s_{1t-k-1} + \Sigma_k a_{33}^k s_{2t-k-1} + u_{3t} \end{bmatrix},$$

where $u_t(=z_t - E[z_t|z_{t-s}, s \geq 1])$ is a 3×1 vector, $[u_{1t}, u_{2t}, u_{3t}]'$, and $\text{var}(u_t) = \Omega = [\sigma_{ij}]$ for $i,j = 1,2$, and 3. That is, u_t is a non-orthonormalized innovation in z_t.

The relationship between the TMAR in (9) and the TVAR in (11) is described in the following proposition.

Proposition 2. The trivariate model of z_t with the restrictions in (10) provides restrictions that identify e_1, e_2, and e_n as permanent fundamental, temporary fundamental, and non-fundamental innovations, respectively.

Proof. (See Appendix B).

The coefficients, c_{ij}^k, in the TMAR (9) represent responses to innovations (shocks) in particular variables. Since e_t is serially and contemporaneously uncorrelated, I can allocate the variance of each element in z to sources in the elements of e. This forecast error variance decomposition can be used to measure the relative importance of fundamental vs. non-fundamental components of stock price. For example, $\sum_{k=0}^{t-1}(c_{ij}^k)^2 / \sum_{j=1}^{3}\sum_{k=0}^{t-1}(c_{ij}^k)^2$ provides the components of error variance in the t-step ahead forecast of z_i, which is accounted for by the jth innovation. By imposing restrictions on the TVAR, I can conduct a restricted VAR analysis, whose empirical results are reported in Section IV. Once a restricted TVAR model of $[\Delta y_t, s_{1t}, s_{2t}]'$ is estimated, a restricted TVAR model of $[y_t, d_t, p_t]'$ can also be obtained if there is interest in investigating the effects of each innovation on the *level* of earnings, dividends, and stock prices.[8]

III. More General Log-Linear Models

A. Model II: A Log-Linear Model with Time-Varying Interest Rates

I have assumed that the relevant discount rate is constant over time so that interest rate does not enter in Model I. In theory, the discount rate may play a potentially important role in the present value relationship. Changes in the discount rate could arise from changes in agents' marginal rates of substitution or changes in the conditional variance of innovations to the dividend process (due to changes in the conditional variance of the underlying earnings process). Some argue that the time-varying discount rate may help explain the failure of the simple present value relationship (e.g., Cochrane (1991), (1992)).

In this section, I consider the real interest rate r_t as another fundamental variable in place of earnings, and examine the non-fundamental component of stock price movements in a trivariate model consisting of dividends, the real interest rate, and stock prices. This amounts to assuming that expected returns on stock in excess of the return on short debt are constant. Campbell and Shiller

[8]By estimating a restricted trivariate model of z_t with identifying restrictions, I obtain estimates of $C_{ij}(L)$. Then, it follows that

i) from $\Delta y_t \equiv y_t - y_{t-1} = C_{11}(L)e_{1t} + C_{12}(L)e_{2t}$, y_t can be constructed recursively by $y_t = y_{t-1} + \Delta y_t = y_{t-1} + C_{11}(L)e_{1t} + C_{12}(L)e_{2t} = y_{t-1} + \Delta y_t^p + \Delta y_t^s$, with an initial value y_0;

ii) from $s_{1t} \equiv d_t - y_t = C_{21}(L)e_{1t} + C_{22}(L)e_{2t}$, d_t is obtained by $d_t = y_t + s_{1t} = y_t + C_{21}(L)e_{1t} + C_{22}(L)e_{2t} = y_t + s_{1t}^p + s_{1t}^s$, using y_t from i; and

iii) from $s_{2t} \equiv p_t - d_{t-1} = C_{31}(L)e_{1t} + C_{32}(L)e_{2t} + C_{33}(L)e_{nt}$, p_t is constructed by $p_t = d_{t-1} + s_{2t}$, using d_t from ii.

(1988), (1989), Campbell (1991), and Campbell and Ammer (1993) derive the following relation by using log-linear approximations (see also Cochrane (1992)),

$$(12) \qquad s_{2t} \equiv p_t - d_{t-1} = E_t \Sigma_j \rho^j \left[\Delta d_{t+j} - r_{t+j}\right] + \eta_t,$$

where $\eta_t = \Sigma_k \delta_3^k e_{nt-k}$.

To examine the potential contribution of time-varying interest rate in explaining stock price movements in the presence of dividends, I consider the trivariate model of $z_t = [\Delta d_t, \Delta dr_t, s_{2t}]'$ where $\Delta dr_t = \Delta d_t - r_t$,

$$(13) \qquad z_t = \begin{bmatrix} \Delta d_t \\ \Delta dr_t \\ s_{2t} \end{bmatrix} = \begin{bmatrix} \Sigma_k c_{11}^k e_{dt-k} + \Sigma_k c_{12}^k e_{rt-k} + \Sigma_k c_{13}^k e_{nt-k} \\ \Sigma_k c_{21}^k e_{dt-k} + \Sigma_k c_{22}^k e_{rt-k} + \Sigma_k c_{23}^k e_{nt-k} \\ \Sigma_k c_{31}^k e_{dt-k} + \Sigma_k c_{32}^k e_{rt-k} + \Sigma_k c_{33}^k e_{nt-k} \end{bmatrix}.$$

To identify e_{dt}, e_{rt}, and e_{nt} as a dividend innovation, an interest rate innovation, and a non-fundamental innovation, I impose the following restrictions,

$$(14) \qquad c_{12}^k = 0, \quad c_{13}^k = 0, \quad \text{and} \quad c_{23}^k = 0 \text{ for all } k.$$

The restrictions that $c_{13}^k = 0$ and $c_{23}^k = 0$ for all k require that the innovation e_{nt} affects only stock prices without affecting dividends and the interest rate. The restriction $c_{12}^k = 0$ requires that the innovation e_{rt} does not influence dividend movements so that it captures the marginal contribution of r_t in explaining stock price movements (see Appendix A). These restrictions are, in practice, imposed on the trivariate VAR model of $z_t (=[\Delta d_t, \Delta dr_t, s_{2t}]')$ following the procedure described in Section II.C (see Appendix B).

B. Model III: A Log-Linear Model with Time-Varying Expected Excess Stock Returns

Using log-linear approximations, Campbell (1991) and Campbell and Ammer (1993) derive a general log-linear model that allows for not only time-varying interest rates but also time-varying expected excess stock returns,

$$(15) \qquad s_{2t} \equiv p_t - d_{t-1} = E_t \Sigma_j \rho^j \left[\Delta d_{t+j} - r_{t+j} - \epsilon_{t+j}\right],$$

where ϵ_t is the log excess stock return on a stock held during period t relative to the return on short debt r_t. The third term on the right-hand side of (15) is approximately equal to the conditional expectation of the long-horizon excess return.

As a general time-series representation, I consider two versions of a four-variable model,

Model III.A: $z_t(=[\Delta y_t, s_{1t}, \Delta dr_t, s_{2t}]')$

$$(16)\quad z_t = \begin{bmatrix} \Delta y_t \\ s_{1t} \\ \Delta dr_t \\ s_{2t} \end{bmatrix} = \begin{bmatrix} \Sigma_k c_{11}^k e_{1t-k} + \Sigma_k c_{12}^k e_{2t-k} + \Sigma_k c_{13}^k e_{rt-k} + \Sigma_k c_{14}^k e_{nt-k} \\ \Sigma_k c_{21}^k e_{1t-k} + \Sigma_k c_{22}^k e_{2t-k} + \Sigma_k c_{23}^k e_{rt-k} + \Sigma_k c_{24}^k e_{nt-k} \\ \Sigma_k c_{31}^k e_{1t-k} + \Sigma_k c_{32}^k e_{2t-k} + \Sigma_k c_{33}^k e_{rt-k} + \Sigma_k c_{34}^k e_{nt-k} \\ \Sigma_k c_{41}^k e_{1t-k} + \Sigma_k c_{42}^k e_{2t-k} + \Sigma_k c_{43}^k e_{rt-k} + \Sigma_k c_{44}^k e_{nt-k} \end{bmatrix},$$

Model III.B: $z_t(=[\Delta y_t, s_{1t}, \epsilon_t, s_{2t}]')$

$$(17)\quad z_t = \begin{bmatrix} \Delta y_t \\ s_{1t} \\ \epsilon_t \\ s_{2t} \end{bmatrix} = \begin{bmatrix} \Sigma_k c_{11}^k e_{1t-k} + \Sigma_k c_{12}^k e_{2t-k} + \Sigma_k c_{13}^k e_{\epsilon t-k} + \Sigma_k c_{14}^k e_{nt-k} \\ \Sigma_k c_{21}^k e_{1t-k} + \Sigma_k c_{22}^k e_{2t-k} + \Sigma_k c_{23}^k e_{\epsilon t-k} + \Sigma_k c_{24}^k e_{nt-k} \\ \Sigma_k c_{31}^k e_{1t-k} + \Sigma_k c_{32}^k e_{2t-k} + \Sigma_k c_{33}^k e_{\epsilon t-k} + \Sigma_k c_{34}^k e_{nt-k} \\ \Sigma_k c_{41}^k e_{1t-k} + \Sigma_k c_{42}^k e_{2t-k} + \Sigma_k c_{43}^k e_{\epsilon t-k} + \Sigma_k c_{44}^k e_{nt-k} \end{bmatrix}.$$

To identify e_{1t}, e_{2t}, e_{rt} (or $e_{\epsilon t}$), and e_{nt} as a permanent innovation, a temporary innovation, an interest rate (or excess return) innovation, and a non-fundamental innovation, I impose the following restrictions,

$$(18)\quad \Sigma_k c_{12}^k = 0,\quad c_{13}^k = 0,\quad c_{14}^k = 0,\quad c_{23}^k = 0,\quad c_{24}^k = 0, \quad \text{and} \quad c_{34}^k = 0 \text{ for all } k.$$

Several observations can be made about models in (15)–(18). First, the log of real stock price p_t, which is derived from $s_{2t} + d_{t-1}$, is decomposed into two parts: fundamental (p_t^f) and non-fundamental (p_t^{nf}) components. The former is driven by permanent fundamental shocks (e_1) and temporary fundamental shocks (e_2) that influence both earnings and dividends, and a third type of fundamental shock (e_r or e_ϵ) that influences the real interest rate (or excess returns) without influencing either earnings or dividends.[9] In addition, p_t^f is non-stationary whenever d_t is non-stationary.

Second, comparison of the price-dividend ratios, s_{2t}, in (15) and (16)–(17) suggests that the non-fundamental component of price (p_t^{nf}) is driven by a fourth type of shock (e_{nt}) that does not influence fundamental factors such as earnings, dividends, or the real interest rate (or excess stock returns). It is due to the component $\Sigma_k c_{44}^k e_{nt-k}$.

[9]In this sense, innovations e_r (or e_ϵ) capture a marginal explanatory power in the presence of e_1 and e_2.

IV. Data and Empirical Results

A. Data and Preliminary Empirical Results

For empirical estimation, I used annual observations on stock prices, earnings, and dividends from the Standard and Poor's (S&P) Composite Stock Price Index for the period of 1871–1995.[10] The data set is extended back to 1871 by using the data in Cowles (1939). The nominal stock price series is the January S&P Composite Index, spliced to the series in Cowles (1939). The nominal earnings series for 1871 to 1925 is the earnings-price ratio series $R-1$ (Cowles (1939)) times the annual average S&P Composite Index for the year. For 1926 to 1995, the series is the S&P earnings per share adjusted to the index total for the year. The nominal dividend before 1926 was also taken from Cowles (1939). The nominal dividend series for 1926 to 1995 is dividends per share adjusted to the index, four quarter total, for the S&P Composite Index. I deflate the nominal series using a January Producer Price Index (before 1900, an annual average producer price index was used), with 1967 = 100. I use the commercial paper rate and the January Producer Price Index to compute the real rate of interest, r_t, and the excess stock return, ϵ_t, series. The interest rate is annual return on four- to six-month commercial paper (six-month starting in 1979), rolled over in January and July. The interest rate data starting in 1938 are from the Board of Governors of the Federal Reserve System, with pre-1938 data from Macaulay (1938).

To examine the non-stationarity of the data employed in my models, Table 1 reports autocorrelations and Table 2 presents the results of unit root tests. The sample autocorrelations of the y_t, d_t, and p_t series die off very slowly, with very large values of first-order autocorrelations, which indicates that they are very likely to be non-stationary processes. Table 1 also reports sample autocorrelations of the spreads between log dividends and log earnings (s_{1t}), between log stock prices and log dividends (s_{2t}), and between log prices and log earnings (s_{3t}). Autocorrelations of these spreads die off quickly with the values of first-order autocorrelations less than those of the y_t, d_t, and p_t series, indicating these spreads are likely to be stationary processes. Autocorrelations of r_t, $\Delta dr_t (= \Delta d_t - r_t)$, and ϵ_t appear to be those of a typical stationary process.

In Table 2, the augmented Dickey-Fuller (ADF) regression is used, allowing for more dynamics by including second-order autocorrelations. Table 2 also reports the Phillips-Perron (PP) tests for unit roots, which are robust to a wide range of serial correlations and time-dependent heteroskedasticity. I apply the same unit root tests to the spreads because their cointegrating coefficients are known. The null hypothesis is that a series is non-stationary: $\alpha = 0$ and $b = 1$. The test results indicate that y_t, d_t, and p_t series are non-stationary, whereas all

[10]Dividend payments tend to remain the same for close to a year. The quarterly dividend series reveals some degree of seasonality. In addition, quarterly data are not available for as long a time period as annual data. So I use annual data. The same dividend series is used in Campbell and Shiller (1987), (1988), and (1989), and the same earnings series is used in Campbell and Shiller (1988).

TABLE 1

Autocorrelations ($\rho(k)$) of Logged Series (1873–1995)

$k=$	1	2	3	4	5	6	7	8	9	10	11	12
y_t	0.91	0.82	0.77	0.72	0.69	0.69	0.68	0.64	0.63	0.64	0.63	0.60
d_t	0.94	0.88	0.82	0.78	0.73	0.67	0.62	0.59	0.57	0.55	0.53	0.51
p_t	0.94	0.86	0.80	0.74	0.68	0.62	0.56	0.50	0.46	0.42	0.38	0.35
Δy_t	−0.02	−0.22	−0.06	−0.07	−0.26	0.08	0.15	−0.15	−0.11	0.15	0.07	−0.09
Δd_t	0.09	−0.17	−0.09	−0.08	0.03	−0.01	−0.14	−0.10	0.09	0.06	−0.09	−0.17
Δp_t	0.06	−0.15	0.10	−0.04	−0.05	0.05	0.10	−0.12	−0.03	0.04	−0.12	−0.14
s_{1t}	0.67	0.40	0.30	0.20	0.15	0.27	0.33	0.28	0.31	0.36	0.26	0.18
s_{2t}	0.72	0.52	0.46	0.36	0.31	0.29	0.26	0.19	0.18	0.14	−0.01	−0.11
s_{3t}	0.68	0.45	0.32	0.19	0.14	0.19	0.17	0.03	−0.04	−0.11	−0.24	−0.33
Δs_{1t}	−0.10	−0.23	0.00	−0.06	−0.27	0.06	0.18	−0.13	−0.02	0.23	−0.05	−0.10
Δs_{2t}	−0.17	−0.24	0.07	−0.09	−0.03	0.01	0.09	−0.14	0.07	0.23	−0.12	−0.15
Δs_{3t}	−0.16	−0.15	−0.00	−0.12	−0.15	0.12	0.18	−0.11	0.01	0.09	−0.06	−0.12
r_t	0.39	0.08	0.07	−0.08	0.03	0.12	0.13	0.05	0.06	0.16	0.08	−0.04
Δr_t	−0.25	−0.24	0.11	−0.22	0.01	0.07	0.08	−0.07	−0.07	0.14	0.04	−0.04
Δdr_t	0.28	−0.08	−0.08	−0.19	−0.17	−0.00	0.03	−0.01	0.07	0.21	0.16	−0.02
$\Delta\Delta dr_t$	−0.25	−0.25	−0.08	−0.08	−0.11	−0.08	0.05	−0.08	−0.04	0.13	0.09	−0.20
ϵ_t	0.07	−0.21	0.09	−0.08	−0.17	0.05	0.13	−0.04	0.04	0.15	0.07	−0.12
$\Delta\epsilon_t$	−0.34	−0.32	0.26	−0.05	−0.16	0.07	0.13	−0.13	−0.01	0.10	0.07	−0.12

The term $\rho(k)$ denotes the kth-order autocorrelation, y_t is the log of real earnings series, d_t is the log of real dividend series, p_t is the log of real stock price series, r_t is the real rate of interest, ϵ_t is the excess stock return, Δdr_t is $\Delta d_t - r_t$, and Δ denotes the first difference operator. The term s_{it} for $i = 1, 2$, and 3 denotes spread between two variables (i.e., $s_{1t} = d_t - y_t$; $s_{2t} = p_t - d_{t-1}$; and $s_{3t} = p_t - y_{t-1}$). The data are for the S&P Composite Index and six-month commercial paper rates.

the spreads, the real interest rate, Δdr_t, and the excess stock return series are stationary by both the ADF test and the PP test.[11]

To estimate the VAR of z_t, I have to choose the number of lags in each equation. Considering both the Akaike (1974) information criterion (AIC) and the Schwarz (1978) criterion, I chose two lags for the TVAR of z_t.

B. Relative Importance of Each Innovation

Since I have derived restrictions that identify each type of innovation, I can examine the relative importance of each innovation (i.e., forecast error variance decomposition) under these restrictions.[12] The results for Model I are presented with standard errors in Table 3.[13] Because the *level* of y_t, d_t, and p_t series may be easier to interpret, I also present the decompositions for the levels in Panel B by expanding $\Delta y_t, s_{1t}$, and s_{2t} (see footnote 8).

Initially, about half the variation in prices is accounted for by non-fundamental innovations (e_n), but their importance declines slowly as the time horizon

[11] Goetzmann and Jorion (1995) show that tests of unit roots in dividend yields are affected by focusing on series with continuous histories. That is, survival conditioning may affect the unit root test statistics.

[12] Since innovations in my model are orthonormalized, I do not have to deal with covariances between innovations, whereas Campbell (1991) and Campbell and Ammer (1993) have to deal with them.

[13] The standard errors are computed by using a Monte Carlo integration due to Kloek and Van Dijk (1978). The Monte Carlo results are based on 1000 simulations and take into account the identifying restrictions.

TABLE 2

Unit Root Test: Sample Period, 1874–1995

i) Augmented Dickey-Fuller Regression:

$$\Delta x_t = a_0 + \alpha x_{t-1} + \sum_{i=1}^{2} \gamma_i \Delta x_{t-i} + \nu_t$$

ii) Phillips-Perron Regression:

$$x_t = b_0 + b x_{t-1} + v_t$$

Variables (x_t)	Dickey-Fuller Test τ_α	Phillips-Perron Test $Z(t_b)$
y_t	−1.535	−1.606
d_t	−1.056	−1.237
p_t	−1.040	−1.239
s_{1t}	−3.976*	−4.713*
s_{2t}	−2.879*	−4.107*
s_{3t}	−3.851*	−4.837*
r_t	−5.292*	−7.279*
ϵ_t	−6.125*	−10.225*
Δdr_t	−6.260*	−8.173*
Δy_t	−7.689*	−11.337*
Δd_t	−7.135*	−10.047*
Δp_t	−5.934*	−10.381*
$\Delta \epsilon_t$	−9.830*	−18.911*

The term y_t is the log of real earnings series, d_t is the log of real dividend series, p_t is the log of real stock price series, r_t is the real rate of interest, ϵ_t is the excess stock return, and Δdr_t is $\Delta d_t - r_t$. The term s_{it} for $i = 1, 2$, and 3 denotes spread between two variables (i.e., $s_{1t} = d_t - y_t$; $s_{2t} = p_t - d_{t-1}$; and $s_{3t} = p_t - y_{t-1}$). The data are for the S&P Composite Index and six-month commercial paper rates.

Critical values of t-statistics for both τ_α and $Z(t_b)$ with 100 observations are: 10%, −2.58; and 5%, −2.89 (Fuller (1976), Tables 8.5.1 and 8.5.2, pp. 371–373). The details of the adjusted t-statistics $Z(t_b)$ are referred to Phillips and Perron (1988). For the Phillips-Perron tests, two lags are used for the calculation of variance. The t-statistics with * denote significance at 10%.

increases. For example, 51.6% of the one-year forecast error variance in prices cannot be explained by either earnings or dividend changes. Among other implications, this suggests that the deviation of prices from the simple present value model is substantial. This finding casts doubt on the notion that changes in stock prices arise from changes in market fundamentals such as earnings and dividends. This finding is obtained under the assumption of a constant discount factor and prompts investigation of whether time-varying interest rates or time-varying expected excess stock returns are needed to explain the behavior of stock prices (see Cochrane (1992) and Campbell and Ammer (1993)). Unlike the permanent fundamental innovation (e_{1t}), the temporary fundamental innovation (e_{2t}) does not have any significant explanatory power.

Concerning the earnings series, about two-thirds of the fraction of the log earnings variation is due to the permanent changes. For example, 64.5% of the one-year forecast error variance in earnings is explained by e_1. However, most of the variation in the spread between dividends and earnings, s_{1t}, is accounted

TABLE 3

Relative Importance of Permanent (e_{1t}) and Temporary (e_{2t}) Innovations in Fundamentals and Non-Fundamental Innovations (e_{nt}) in Forecasting Three Variables of Model I, $z_t = [\Delta y_t, s_{1t}, s_{2t}]'$

Panel A.

	Variables Explained								
	Δy_t			s_{1t}			s_{2t}		
	Innovations in								
Forecast Horizons	e_{1t}	e_{2t}	e_{nt}	e_{1t}	e_{2t}	e_{nt}	e_{1t}	e_{2t}	e_{nt}
		%							
1 year	64.4	35.6	0.0	11.6	88.4	0.0	47.0	1.4	51.6
	(1.3)	(1.1)		(1.1)	(1.8)		(1.7)	(1.4)	(0.9)
2	63.3	36.7	0.0	11.8	88.2	0.0	31.0	3.9	65.1
	(1.3)	(1.1)		(1.1)	(1.8)		(3.4)	(3.4)	(1.6)
3	61.3	38.7	0.0	10.9	89.1	0.0	24.9	3.5	71.6
	(1.3)	(1.1)		(1.1)	(1.8)		(4.2)	(4.3)	(1.8)
4	61.1	38.9	0.0	10.4	89.6	0.0	22.2	3.1	74.7
	(1.3)	(1.2)		(1.2)	(1.9)		(4.4)	(4.5)	(1.9)
8	61.0	39.0	0.0	9.9	90.1	0.0	17.7	3.0	79.2
	(1.3)	(1.2)		(1.5)	(2.2)		(4.6)	(4.8)	(2.0)
12	60.9	39.1	0.0	9.9	90.1	0.0	16.6	3.0	80.4
	(1.3)	(1.2)		(1.6)	(2.4)		(4.7)	(4.9)	(2.0)
24	60.9	39.1	0.0	9.9	90.1	0.0	16.0	3.1	80.9
	(1.3)	(1.2)		(1.7)	(2.5)		(4.7)	(4.9)	(2.0)

(continued on next page)

for by the temporary changes in earnings. This implies that both earnings and dividends are primarily affected by the permanent changes in earnings so that the spread is mainly affected by the temporary changes in earnings. As such, most of the dividend variation is due to permanent shocks. As expected from the restrictions in (10), e_n does not explain earnings and dividends by construction.

In Model II, the restrictions in (14) identify three types of innovations in the TMAR as dividend innovations, real interest rate innovations, and non-fundamental innovations, respectively. The variance decomposition of the trivariate model is presented in Panels A and B of Table 4. Again, slightly less than half the variation in the log prices is accounted for by the innovations in fundamentals represented by dividends and interest rates. It is noted that the interest rate innovation e_{rt} plays a very limited role in explaining either the price-dividend ratios or stock prices. This finding suggests that allowing for a time-varying interest rate in the present value relation may not help explain the failure of the present value relationship. Comparison of the non-fundamental components in Models I (Table 3) and II (Table 4) indicates that earnings contain more information than the real interest rate for the stock price movements in the presence of dividends.

In Model III.A, the restrictions in (18) identify the four types of innovations in the four variable MAR in (16) as permanent fundamental, temporary funda-

TABLE 3 (continued)

Relative Importance of Permanent (e_{1t}) and Temporary (e_{2t}) Innovations in Fundamentals and Non-Fundamental Innovations (e_{nt}) in Forecasting Three Variables of Model I, $z_t = [\Delta y_t, s_{1t}, s_{2t}]'$

Panel B.

Forecast Horizons	y_t: e_{1t}	y_t: e_{2t}	y_t: e_{nt}	d_t: e_{1t}	d_t: e_{2t}	d_t: e_{nt}	p_t: e_{1t}	p_t: e_{2t}	p_t: e_{nt}
		%							
1 year	64.5	35.5	0.0	83.9	16.1	0.0	47.0	1.4	51.6
	(1.3)	(1.1)		(6.4)	(5.7)		(1.8)	(1.4)	(0.9)
2	69.7	30.3	0.0	89.6	10.4	0.0	51.8	0.9	47.3
	(1.4)	(1.2)		(5.5)	(4.7)		(1.8)	(1.3)	(0.8)
3	73.5	26.5	0.0	92.5	7.5	0.0	51.3	0.9	47.8
	(1.5)	(1.2)		(4.8)	(4.0)		(1.8)	(1.3)	(0.8)
4	76.5	23.5	0.0	94.0	6.0	0.0	52.1	0.8	47.1
	(1.6)	(1.2)		(4.4)	(3.7)		(1.8)	(1.3)	(0.8)
8	84.3	15.7	0.0	96.8	3.2	0.0	60.7	0.5	38.8
	(1.7)	(1.2)		(3.8)	(3.0)		(1.8)	(1.2)	(0.7)
12	88.3	11.7	0.0	97.9	2.1	0.0	68.6	0.4	31.0
	(1.8)	(1.2)		(3.4)	(2.7)		(1.8)	(1.2)	(0.7)
24	93.4	6.6	0.0	99.0	1.0	0.0	82.0	0.2	17.8
	(1.9)	(1.3)		(2.9)	(2.2)		(1.9)	(1.3)	(0.6)

This table reports the relative importance of each innovation (e_{1t}, e_{2t}, e_{nt}) in explaining the three variables in Model I ($\Delta y_t, s_{1t}, s_{2t}$) for various (1 through 24 years) forecasting horizons, shown in the first column. Innovations e_{1t}, e_{2t}, and e_{nt} denote permanent and temporary innovations in fundamentals and non-fundamental innovations, respectively. Variables Δy_t, s_{1t}, and s_{2t} denote growth rates in earnings, the spread between dividends and earnings, and the spread between prices and dividends, respectively. Panel A presents the results for the three variables in Model I and Panel B presents the results for the level of y_t (the log of real earnings), d_t (the log of real dividend), and p_t (the log of real stock price) series by expanding variables in Model I. The numbers in parentheses are standard errors computed by using a Monte Carlo integration due to Kloek and Van Dijk (1978). The Monte Carlo results are based on 1000 simulations and take into account the identifying restrictions. For example, at the one-year forecast horizon, 47.0% of the forecast error variance of p_t is explained by e_{1t}, 1.4% by e_{2t}, and 51.6% by e_{nt} (Panel B).

mental, the real interest rate, and non-fundamental innovations, respectively. The variance decomposition of the model is presented in Panels A and B of Table 5 with standard errors. Compared with the trivariate models, there is little increase in the fundamental component of stock prices. The marginal contribution of the real interest rate in the presence of earnings and dividends in explaining the stock price movements is very limited (0.2%–3.0%) but not insignificant. The weak explanatory power of the real interest rate may be partly due to the fact that about half the variation in the real interest rate is accounted for by earnings and dividends.[14]

[14]The contribution of the real interest rate in explaining stock price variation based on a bivariate model (i.e., in the absence of earnings and dividends) is between 3.6% and 12.7%.

TABLE 4

Relative Importance of Innovations in Dividends (e_{dt}), the Real Interest Rate (e_{rt}), and Non-Fundamental Factor (e_{nt}) in Forecasting Three Variables of Model II, $z_t = [\Delta d_t, \Delta d_t - r_t, s_{2t}]'$

Panel A.

	Variables Explained								
	Δd_t			$\Delta d_t - r_t$			s_{2t}		
	Innovations in								
Forecast Horizons	e_{dt}	e_{rt}	e_{nt}	e_{dt}	e_{rt}	e_{nt}	e_{dt}	e_{rt}	e_{nt}
	%								
1 year	100.0	0.0	0.0	66.3	33.7	0.0	44.9	0.3	54.8
				(2.8)	(0.5)		(1.5)	(0.1)	(1.0)
2	100.0	0.0	0.0	62.9	37.1	0.0	29.1	0.4	70.5
				(3.1)	(0.6)		(2.1)	(0.2)	(1.4)
3	100.0	0.0	0.0	63.4	36.6	0.0	23.9	0.9	75.2
				(3.5)	(0.6)		(2.3)	(0.3)	(1.4)
4	100.0	0.0	0.0	63.6	36.4	0.0	20.4	1.5	78.1
				(3.5)	(0.6)		(2.3)	(0.3)	(1.4)
8	100.0	0.0	0.0	63.5	36.5	0.0	14.6	2.8	82.7
				(3.5)	(0.6)		(2.1)	(0.3)	(1.3)
12	100.0	0.0	0.0	63.5	36.5	0.0	12.9	3.2	83.9
				(3.5)	(0.6)		(2.0)	(0.3)	(1.3)
24	100.0	0.0	0.0	63.5	36.5	0.0	11.9	3.4	84.7
				(3.5)	(0.6)		(1.8)	(0.2)	(1.2)

(continued on next page)

In Model III.B, the restrictions in (18) identify the four types of innovations in the four variable MAR in (17) as permanent fundamental, temporary fundamental, excess stock return, and non-fundamental innovations, respectively. Panels A and B of Table 6 show that the excess stock returns account for much of the stock price movement that is not explained by earnings or dividends. For example, 43.4% of one-year variation and 36.1% of two-year variation are explained by innovations in excess stock returns. As a result, only 10% of the price variation remains to be explained by the non-fundamental component, which persists for several years before it eventually declines. In sum, fundamental variables such as earnings and dividends can explain about half the variation in stock prices. Time-varying interest rates are not of much help in this regard. However, time-varying excess stock returns help explain much of the remaining variation in stock prices.

C. Dynamic Effects of Each Innovation

In addition to each innovation's predictive power, I can investigate, by plotting moving average coefficients, c_{ij}^k, how each type of innovation affects variables over various horizons. To save space, I present only the results for

TABLE 4 (continued)

Relative Importance of Innovations in Dividends (e_{dt}), the Real Interest Rate (e_{rt}), and Non-Fundamental Factor (e_{nt}) in Forecasting Three Variables of Model II, $z_t = [\Delta d_t, \Delta d_t - r_t, s_{2t}]'$

Panel B.

	Variables Explained								
	d_t			r_t			p_t		
	Innovations in								
Forecast Horizons	e_{dt}	e_{rt}	e_{nt}	e_{dt}	e_{rt}	e_{nt}	e_{dt}	e_{rt}	e_{nt}
	%								
1 year	100.0	0.0	0.0	13.0	87.0	0.0	44.9	0.3	54.8
	(2.6)			(10.3)	(2.1)		(1.5)	(0.1)	(0.9)
2	100.0	0.0	0.0	12.0	88.0	0.0	48.4	0.3	51.3
	(2.6)			(10.5)	(2.2)		(1.5)	(0.1)	(0.9)
3	100.0	0.0	0.0	11.9	88.1	0.0	47.3	0.6	52.1
	(2.4)			(10.3)	(2.2)		(1.6)	(0.2)	(0.9)
4	100.0	0.0	0.0	12.5	87.5	0.0	47.3	1.0	51.7
	(2.3)			(10.2)	(2.2)		(1.6)	(0.2)	(0.9)
8	100.0	0.0	0.0	12.5	87.5	0.0	53.9	1.5	44.6
	(2.1)			(10.2)	(2.2)		(1.7)	(0.2)	(0.9)
12	100.0	0.0	0.0	12.5	87.5	0.0	60.4	1.4	38.2
	(2.0)			(10.2)	(2.2)		(1.8)	(0.2)	(0.9)
24	100.0	0.0	0.0	12.5	87.5	0.0	73.9	1.0	25.1
	(2.0)			(10.2)	(2.2)		(1.8)	(0.2)	(0.9)

This table reports the relative importance of each innovation (e_{dt}, e_{rt}, e_{nt}) in explaining the three variables in Model II ($\Delta d_t, \Delta d_t - r_t, s_{2t}$) for various (1 through 24 years) forecasting horizons shown in the first column. Innovations e_{dt}, e_{rt}, and e_{nt} denote innovations in dividends, the real interest rate, and non-fundamental innovations, respectively. Variables $\Delta d_t, \Delta d_t - r_t$, and s_{2t} denote growth rates in dividends, the spread between growth rate in dividends and the real interest rate, and the spread between prices and dividends, respectively. Panel A presents the results for the three variables in Model II, and Panel B presents the results for the level of d_t (the log of real dividend), r_t (the real interest rate), and p_t (the log of real stock price) series by expanding variables in Model II. The numbers in parentheses are standard errors computed by using a Monte Carlo integration due to Kloek and Van Dijk (1978). The Monte Carlo results are based on 1000 simulations and take into account the identifying restrictions. For example, at the one-year forecast horizon, 44.9% of the forecast error variance of P_t is explained by e_{dt}, 0.3% by e_{rt}, and 54.8% by e_{nt} (Panel B).

Model III.B.[15] Figures 1 and 2 illustrate the dynamic responses, measured in standard deviations, of y, d, ϵ, and p to one standard deviation innovation in the permanent and temporary fundamentals (e_1 and e_2), in the excess stock returns (e_ϵ), and in the non-fundamental factors (e_n). These levels are derived by expanding the response of Δy, s_1, ϵ, and s_2 with appropriately modified standard errors.

Panels A and B of Figure 1 illustrate that the permanent innovation (e_1) has a strong, persistent effect on earnings, whereas the temporary innovation

[15]The dynamic responses based on Models I, II, and III.A are very similar to those of Model III.B, even in quantitative results. As such, they are not reported in the paper.

TABLE 5

Relative Importance of Permanent (e_{1t}), Temporary (e_{2t}), the Real Interest Rate (e_{rt}), and Non-Fundamental Innovations (e_{nt}) in Forecasting Four Variables of Model III.A, $z_t = [\Delta y_t, s_{1t}, \Delta d_t - r_t, s_{2t}]'$

Panel A.

	Variables Explained										
	Δy_t		s_{1t}		$\Delta d_t - r_t$			s_{2t}			
	Innovations in										
Forecast Horizons	e_{1t}	e_{2t}	e_{1t}	e_{2t}	e_{1t}	e_{2t}	e_{rt}	e_{1t}	e_{2t}	e_{rt}	e_{nt}
	%										
1 year	64.4	35.6	11.6	88.4	76.9	0.3	22.8	46.6	1.6	0.2	51.6
	(1.5)	(1.2)	(1.5)	(1.9)	(4.4)	(3.1)	(0.4)	(2.3)	(1.5)	(0.1)	(0.9)
2	63.3	36.7	11.8	88.2	67.7	14.6	17.7	30.5	3.6	2.3	63.6
	(4.2)	(3.7)	(2.3)	(2.7)	(4.7)	(3.7)	(1.0)	(4.4)	(3.6)	(0.7)	(1.8)
3	61.3	38.7	10.9	89.1	65.2	17.5	17.3	24.8	3.2	4.0	68.0
	(5.3)	(4.6)	(3.5)	(4.0)	(6.0)	(4.7)	(1.5)	(5.8)	(4.8)	(1.1)	(2.2)
4	61.1	38.9	10.4	89.6	65.4	17.4	17.2	22.5	2.8	4.7	70.0
	(5.7)	(5.3)	(4.3)	(4.8)	(6.6)	(5.5)	(1.8)	(6.6)	(5.6)	(1.4)	(2.6)
8	61.0	39.0	9.9	90.1	65.2	17.7	17.1	18.3	3.0	5.5	73.2
	(6.3)	(6.0)	(5.8)	(8.0)	(7.3)	(6.7)	(2.1)	(8.6)	(8.3)	(2.1)	(4.7)
12	60.9	39.1	9.9	90.1	65.2	17.7	17.1	17.3	3.3	5.7	73.7
	(6.4)	(6.1)	(7.0)	(10.8)	(7.6)	(7.1)	(2.2)	(10.1)	(10.9)	(2.7)	(7.6)
24	60.9	39.1	9.9	90.1	65.2	17.7	17.1	16.8	3.5	5.8	73.9
	(6.5)	(6.3)	(9.6)	(20.2)	(8.2)	(8.1)	(2.4)	(14.7)	(18.7)	(4.5)	(19.9)

(continued on next page)

(e_2) has a moderately strong initial effect and then its effect decays in a few years. This indicates that temporary changes in earnings constitute a nontrivial part of earnings initially. Panels C and D of Figure 1 show dividends' strong and persistent responses to the permanent innovation (e_1) and a weak, initial under-reaction to the temporary change in earnings (e_2), which seems consistent with the hypothesis that dividend change is primarily influenced by changes in some measure of permanent earnings.

Panels E, F, and G of Figure 1 illustrate that the initial response of the excess stock returns to the permanent shock is significantly positive, whereas its initial response to the temporary shock is not significant. Its response to its own shock is significantly positive only in the first period.

Figure 2 shows the responses of stock prices to the four types of innovations. Stock prices respond to the permanent change in fundamentals (e_1) in a strong and persistent manner, whereas their reaction to the temporary change in fundamentals (e_2) seems insignificant. A positive excess stock return innovation tends to exert a positive effect on the stock market prices for several periods. Its initial effect is almost as strong as that of the permanent shock e_1 but declines gradually over time. The stock market tends to moderately overreact to the non-fundamental shocks (e_n). Their initial effect on stock prices is not as strong as that of the permanent fundamental shocks, e_{1t}, and their effect diminishes slowly and steadily over time.

TABLE 5 (continued)

Relative Importance of Permanent (e_{1t}), Temporary (e_{2t}), the Real Interest Rate (e_{rt}), and Non-Fundamental Innovations (e_{nt}) in Forecasting Four Variables of Model III.A, $z_t = [\Delta y_t, s_{1t}, \Delta d_t - r_t, s_{2t}]'$

Panel B.

	Variables Explained										
	y_t		d_t		r_t			p_t			
	Innovations in										
Forecast Horizons	e_{1t}	e_{2t}	e_{1t}	e_{2t}	e_{1t}	e_{2t}	e_{rt}	e_{1t}	e_{2t}	e_{rt}	e_{nt}
		%									
1 year	64.5	35.5	83.9	16.1	4.3	37.6	58.1	46.6	1.6	0.2	51.6
	(1.4)	(1.1)	(6.7)	(5.6)	(29.5)	(27.2)	(1.9)	(2.3)	(1.5)	(0.1)	(0.8)
2	69.7	30.3	89.6	10.4	10.1	44.1	45.8	50.6	1.1	1.7	46.6
	(3.2)	(2.6)	(7.7)	(6.5)	(26.4)	(24.4)	(1.7)	(2.7)	(1.8)	(0.1)	(0.9)
3	73.5	26.5	92.5	7.5	9.7	45.6	44.7	49.8	1.1	2.7	46.3
	(5.2)	(4.4)	(8.5)	(7.1)	(25.5)	(23.5)	(1.6)	(3.4)	(2.4)	(0.2)	(1.1)
4	76.5	23.5	94.0	6.0	10.5	45.3	44.2	50.7	1.1	3.0	45.2
	(6.4)	(5.5)	(9.1)	(7.8)	(25.2)	(23.2)	(1.6)	(3.9)	(2.9)	(0.2)	(1.2)
8	84.3	15.7	96.8	3.2	10.6	45.3	44.0	61.0	0.7	2.7	35.6
	(8.0)	(6.8)	(10.1)	(8.7)	(25.1)	(23.2)	(1.6)	(5.2)	(4.0)	(0.3)	(1.4)
12	88.3	11.7	97.9	2.1	10.6	45.3	44.0	69.6	0.6	2.2	27.7
	(8.5)	(7.2)	(10.4)	(8.9)	(25.1)	(23.2)	(1.6)	(6.2)	(5.0)	(0.3)	(1.7)
24	93.4	6.6	99.0	1.0	10.6	45.3	44.0	83.0	0.4	1.2	15.4
	(9.0)	(7.6)	(10.4)	(8.8)	(25.1)	(23.2)	(1.6)	(7.8)	(6.4)	(0.4)	(2.0)

This table reports the relative importance of each innovation ($e_{1t}, e_{2t}, e_{rt}, e_{nt}$) in explaining the four variables in Model III.A ($\Delta y_t, s_{1t}, \Delta d_t - r_t, s_{2t}$) for various (1 through 24 years) forecasting horizons, which are shown in the first column. Innovations e_{1t}, e_{2t}, e_{rt}, and e_{nt} denote innovations in permanent and temporary fundamentals, the real interest rate innovations, and non-fundamental innovations, respectively. Variables $\Delta y_t, s_{1t}, \Delta d_t - r_t$, and s_{2t} denote growth rates in earnings, the spread between dividends and earnings, the spread between growth rate in dividends and the real interest rate, and the spread between prices and dividends, respectively. Panel A presents the results for the four variables in Model III.A, and Panel B presents the results for the level of y_t (the log of real earnings), d_t (the log of real dividend), r_t (the real interest rate), and p_t (the log of real stock price) series by expanding variables in Model III.A. The numbers in parentheses are standard errors, which are computed by using a Monte Carlo integration due to Kloek and Van Dijk (1978). The Monte Carlo results are based on 1000 simulations and take into account the identifying restrictions. For example, at the one-year forecast horizon, 46.6% of the forecast error variance of p_t is explained by e_{1t}, 1.6% by e_{2t}, 0.2% by e_{rt}, and 51.6% by e_{nt} (Panel B).

In sum, my findings indicate that the deviation of the stock market prices from such market fundamentals as earnings, dividends, and excess stock returns is not very substantial and declines gradually over time, which implies a mild over-reaction of the market to non-fundamental factors. The findings imply that i) the rejection of the simple present value model based on variance bounds tests is likely to be largely due to the lack of time-varying discount factors and partly due to the non-fundamental component in prices, and is more likely to be consistent with a "fad" interpretation; ii) the mean reversion in stock returns may be largely due to time-varying discount factors but, to some extent, is due

TABLE 6

Relative Importance of Permanent (e_{1t}), Temporary (e_{2t}), and the Excess Stock Returns (e_ϵ) Innovations and Non-Fundamental Innovations (e_{nt}) in Forecasting Four Variables of Model III.B, $z_t = [\Delta y_t, s_{1t}, \epsilon_t, s_{2t}]'$

Panel A. Whole Period (1874–1995)

	Variables Explained										
	Δy_t		s_{1t}		ϵ_t			s_{2t}			
	Innovations in										
Forecast Horizons	e_{1t}	e_{2t}	e_{1t}	e_{2t}	e_{1t}	e_{2t}	$e_{\epsilon t}$	e_{1t}	e_{2t}	$e_{\epsilon t}$	e_{nt}
		%									
1 year	64.5	35.5	11.6	88.4	30.5	1.1	68.4	44.4	2.0	43.4	10.2
	(1.5)	(1.1)	(1.2)	(1.6)	(2.1)	(1.7)	(1.6)	(2.0)	(1.6)	(1.2)	(0.2)
2	63.3	36.7	11.8	88.2	32.4	4.4	63.2	30.8	3.7	50.1	15.4
	(2.3)	(1.8)	(1.4)	(1.8)	(2.2)	(1.8)	(1.6)	(4.3)	(3.9)	(2.5)	(0.3)
3	61.3	38.7	10.9	89.1	32.9	4.2	62.9	25.7	3.8	52.6	17.9
	(2.7)	(2.2)	(1.9)	(2.2)	(2.3)	(1.9)	(1.7)	(5.5)	(5.0)	(3.1)	(0.4)
4	61.1	38.9	10.4	89.6	33.0	4.2	62.8	23.8	3.5	53.8	18.9
	(2.9)	(2.3)	(2.2)	(2.4)	(2.4)	(1.9)	(1.7)	(5.4)	(3.9)	(3.1)	(0.4)
8	61.0	39.0	9.9	90.1	32.9	4.6	62.5	21.3	3.1	55.4	20.2
	(2.9)	(2.4)	(2.8)	(3.0)	(2.4)	(2.0)	(1.8)	(5.7)	(5.2)	(3.3)	(0.4)
12	60.9	39.1	9.9	90.1	32.9	4.7	62.4	20.9	3.0	55.7	20.4
	(2.9)	(2.4)	(3.2)	(3.4)	(2.4)	(2.0)	(1.8)	(6.1)	(5.7)	(3.5)	(0.4)
24	60.9	39.1	9.9	90.1	32.9	4.7	62.4	20.7	2.9	55.8	20.6
	(2.9)	(2.4)	(3.7)	(3.9)	(2.5)	(2.0)	(1.8)	(6.8)	(6.3)	(3.9)	(0.5)

Panel B. Whole Period (1874–1995)

	Variables Explained										
	y_t		d_t		ϵ_t			p_t			
	Innovations in										
Forecast Horizons	e_{1t}	e_{2t}	e_{1t}	e_{2t}	e_{1t}	e_{2t}	$e_{\epsilon t}$	e_{1t}	e_{2t}	$e_{\epsilon t}$	e_{nt}
			%								
1 year	64.5	35.5	83.9	16.1	30.5	1.1	68.4	44.4	2.0	43.4	10.2
	(1.5)	(1.2)	(7.1)	(6.1)	(2.0)	(1.6)	(1.4)	(1.8)	(1.5)	(1.0)	(0.2)
2	69.7	30.3	89.6	10.4	32.4	4.4	63.2	51.4	1.4	36.1	11.1
	(2.1)	(1.7)	(6.3)	(5.2)	(2.1)	(1.8)	(1.4)	(2.1)	(1.7)	(1.1)	(0.2)
3	73.5	26.5	92.5	7.5	32.9	4.2	62.9	50.9	1.2	35.8	12.2
	(2.3)	(1.9)	(5.0)	(4.1)	(2.2)	(1.8)	(1.5)	(2.4)	(2.0)	(1.3)	(0.2)
4	76.5	23.5	94.0	6.0	33.0	4.2	62.8	51.0	1.0	35.5	12.5
	(2.2)	(1.8)	(4.3)	(3.5)	(2.2)	(1.9)	(1.5)	(2.5)	(2.0)	(1.3)	(0.2)
8	84.3	15.7	96.8	3.2	32.9	4.6	62.5	59.6	0.6	29.2	10.6
	(2.1)	(1.7)	(3.5)	(2.8)	(2.4)	(2.0)	(1.6)	(2.6)	(2.1)	(1.3)	(0.2)
12	88.3	11.7	97.9	2.1	32.9	4.7	62.4	68.6	0.5	22.7	8.2
	(2.1)	(1.6)	(3.1)	(2.5)	(2.4)	(2.0)	(1.6)	(2.6)	(2.1)	(1.3)	(0.2)
24	93.4	6.6	99.0	1.0	32.9	4.7	62.4	83.1	0.2	12.2	4.5
	(2.1)	(1.6)	(2.7)	(2.1)	(2.4)	(2.0)	(1.6)	(2.4)	(1.9)	(1.1)	(0.2)

(continued on next page)

TABLE 6 (continued)

Relative Importance of Permanent (e_{1t}), Temporary (e_{2t}), and the Excess Stock Returns (e_ϵ) Innovations and Non-Fundamental Innovations (e_{nt}) in Forecasting Four Variables of Model III.B, $z_t = [\Delta y_t, s_{1t}, \epsilon_t, s_{2t}]'$

Panel C. The Prewar Period (1874–1940)

Forecast Horizons	Δy_t		s_{1t}		ϵ_t			s_{2t}			
	e_{1t}	e_{2t}	e_{1t}	e_{2t}	e_{1t}	e_{2t}	$e_{\epsilon t}$	e_{1t}	e_{2t}	$e_{\epsilon t}$	e_{nt}
			%								
1 year	68.3	31.6	14.9	85.1	40.3	3.2	56.6	53.3	1.4	33.9	10.8
	(2.7)	(1.9)	(2.5)	(3.4)	(5.2)	(3.7)	(2.2)	(5.2)	(3.7)	(1.8)	(0.3)
2	65.2	34.8	16.4	83.6	40.1	13.5	46.4	37.7	12.8	30.9	18.7
	(5.0)	(4.0)	(2.8)	(3.6)	(5.5)	(4.1)	(2.1)	(13.5)	(11.1)	(4.2)	(0.8)
3	62.4	37.6	16.2	83.8	40.6	13.4	46.0	29.1	12.7	36.0	22.1
	(6.1)	(4.8)	(3.4)	(4.1)	(6.1)	(4.7)	(2.3)	(15.5)	(12.8)	(4.9)	(0.8)
4	62.2	37.8	16.2	83.8	40.6	13.5	45.9	25.9	10.8	39.7	23.5
	(6.8)	(5.4)	(3.4)	(4.2)	(6.5)	(4.9)	(2.4)	(14.8)	(11.3)	(4.4)	(0.7)
8	62.2	37.8	16.1	83.9	40.6	13.6	45.8	25.3	8.6	41.7	24.4
	(7.0)	(5.6)	(3.5)	(4.2)	(6.9)	(5.3)	(2.5)	(11.3)	(9.3)	(3.6)	(0.6)
12	62.2	37.8	16.1	83.9	40.6	13.6	45.8	25.5	8.9	41.4	24.2
	(7.1)	(5.7)	(3.5)	(4.2)	(6.9)	(5.4)	(2.5)	(10.8)	(8.9)	(3.4)	(0.6)
24	62.2	37.8	16.1	83.9	40.6	13.6	45.8	25.5	9.0	41.3	24.1
	(7.1)	(5.7)	(3.5)	(4.2)	(6.9)	(5.4)	(2.5)	(10.7)	(8.8)	(3.4)	(0.6)

Variables Explained; Innovations in

Panel D. The Prewar Period (1874–1940)

Forecast Horizons	y_t		d_t		ϵ_t			p_t			
	e_{1t}	e_{2t}	e_{1t}	e_{2t}	e_{1t}	e_{2t}	$e_{\epsilon t}$	e_{1t}	e_{2t}	$e_{\epsilon t}$	e_{nt}
			%								
1 year	68.4	31.6	82.4	17.6	40.3	3.2	56.6	53.3	1.9	33.9	10.8
	(2.7)	(1.9)	(12.8)	(10.4)	(5.4)	(4.2)	(2.2)	(5.2)	(3.5)	(1.8)	(0.3)
2	75.7	24.3	90.1	9.9	40.1	13.5	46.4	66.4	0.9	20.4	12.3
	(5.1)	(3.5)	(11.9)	(8.9)	(5.7)	(4.5)	(2.2)	(6.7)	(4.4)	(2.0)	(0.4)
3	79.9	20.1	93.5	6.5	40.6	13.4	46.0	63.7	0.9	22.0	13.5
	(5.6)	(3.9)	(9.5)	(6.8)	(6.4)	(5.0)	(2.4)	(7.8)	(5.3)	(2.3)	(0.4)
4	82.7	17.3	95.1	4.9	40.6	13.5	45.9	62.5	0.7	23.1	13.7
	(5.3)	(3.6)	(8.1)	(5.6)	(6.7)	(5.3)	(2.5)	(7.7)	(5.3)	(2.3)	(0.5)
8	89.2	10.8	97.6	2.4	40.6	13.6	45.8	67.9	0.9	19.7	11.5
	(5.2)	(3.4)	(6.5)	(4.2)	(7.2)	(5.7)	(2.7)	(7.7)	(5.2)	(2.3)	(0.4)
12	92.1	7.9	98.5	1.5	40.6	13.6	45.8	75.8	0.9	14.7	8.6
	(5.1)	(3.2)	(5.9)	(3.8)	(7.2)	(5.7)	(2.7)	(7.3)	(4.8)	(2.1)	(0.4)
24	95.6	4.4	99.2	0.8	40.6	13.6	45.8	88.0	0.5	7.2	4.2
	(5.0)	(3.1)	(5.4)	(3.3)	(7.2)	(5.7)	(2.7)	(6.3)	(4.0)	(1.7)	(0.3)

Variables Explained; Innovations in

(continued on next page)

TABLE 6 (continued)

Relative Importance of Permanent (e_{1t}), Temporary (e_{2t}), and the Excess Stock Returns (e_ϵ) Innovations and Non-Fundamental Innovations (e_{nt}) in Forecasting Four Variables of Model III.B, $z_t = [\Delta y_t, s_{1t}, \epsilon_t, s_{2t}]'$

Panel E. The Postwar Period (1947–1995)

	Variables Explained										
	Δy_t		s_{1t}		ϵ_t			s_{2t}			
	Innovations in										
Forecast Horizons	e_{1t}	e_{2t}	e_{1t}	e_{2t}	e_{1t}	e_{2t}	$e_{\epsilon t}$	e_{1t}	e_{2t}	$e_{\epsilon t}$	e_{nt}
			%								
1 year	32.1	67.9	0.1	99.9	10.9	4.6	84.5	23.9	1.3	66.5	8.2
	(1.9)	(4.0)	(2.1)	(6.6)	(1.9)	(3.4)	(5.1)	(1.7)	(2.3)	(4.1)	(0.4)
2	31.9	68.1	2.6	97.4	10.6	21.7	67.7	15.0	13.7	60.0	11.4
	(3.0)	(6.3)	(2.6)	(7.4)	(3.3)	(6.6)	(8.1)	(2.5)	(4.5)	(6.1)	(0.6)
3	28.9	71.1	4.2	95.8	9.8	20.3	69.9	12.5	26.6	48.7	12.2
	(2.8)	(5.8)	(3.1)	(8.3)	(3.6)	(7.2)	(8.9)	(2.6)	(4.9)	(6.1)	(0.6)
4	27.4	72.6	4.6	95.4	9.8	20.8	69.5	12.6	32.2	43.3	11.9
	(2.9)	(6.2)	(3.2)	(8.6)	(3.6)	(7.2)	(8.9)	(2.7)	(5.3)	(6.6)	(0.6)
8	27.3	72.7	4.6	95.4	9.6	20.6	69.8	11.4	40.9	37.3	10.4
	(3.7)	(7.8)	(3.4)	(8.9)	(3.8)	(7.5)	(9.2)	(3.3)	(6.6)	(8.3)	(0.7)
12	27.3	72.7	4.6	95.4	9.6	20.6	69.8	11.4	41.0	37.3	10.4
	(3.7)	(7.9)	(3.4)	(9.0)	(3.8)	(7.6)	(9.4)	(3.9)	(7.8)	(9.9)	(0.9)
24	27.3	72.7	4.6	95.4	9.6	20.6	69.8	11.4	41.0	37.3	10.4
	(3.7)	(7.9)	(3.4)	(9.0)	(3.9)	(7.8)	(9.7)	(4.6)	(9.4)	(11.9)	(1.1)

(continued on next page)

to non-fundamental factors; iii) the hypothesis that dynamic dividend behavior is primarily determined by some measure of permanent earnings rather than current earnings seems to be supported by the findings; and iv) modeling of stock return behavior as a response to unexpected changes in earnings may provide a very limited description of the relationship without allowing for a time-varying discount factor.

D. Decomposition of Stock Prices into Four Components

Since stock prices are represented as a linear combination of four types of shocks (e_1, e_2, e_ϵ, and e_n), I can decompose the price series into four components by setting three types of innovations at a time equal to zero. I present in Figure 3 the decomposition of historical values of the log of stock prices over the period 1875–1995. The figure shows the comparison between the actual series and each component.

The permanent component appears to mimic the long-term stochastic trend of prices. It appears to be a smoothed version of the actual price series, ignoring many of the short-term cycles in prices. The temporary component represents little, if any, variation in prices. The excess stock return (i.e., third) component appears to mimic much of the short-term price movements that are not

TABLE 6 (continued)

Relative Importance of Permanent (e_{1t}), Temporary (e_{2t}), and the Excess Stock Returns (e_{ϵ}) Innovations and Non-Fundamental Innovations (e_{nt}) in Forecasting Four Variables of Model III.B, $z_t = [\Delta y_t, s_{1t}, \epsilon_t, s_{2t}]'$

Panel F. The Postwar Period (1947–1995)

Forecast Horizons	y_t: e_{1t}	y_t: e_{2t}	d_t: e_{1t}	d_t: e_{2t}	ϵ_t: e_{1t}	ϵ_t: e_{2t}	ϵ_t: $e_{\epsilon t}$	p_t: e_{1t}	p_t: e_{2t}	p_t: $e_{\epsilon t}$	p_t: e_{nt}
			%								
1 year	32.1	67.9	99.9	0.1	10.9	4.6	84.5	23.9	1.3	66.5	8.2
	(2.0)	(4.2)	(10.0)	(16.1)	(1.9)	(3.3)	(5.8)	(1.8)	(2.4)	(4.1)	(0.3)
2	32.5	67.5	99.9	0.1	10.6	21.7	67.7	28.9	10.7	50.8	9.6
	(3.0)	(5.7)	(10.4)	(16.9)	(3.2)	(6.3)	(8.3)	(2.9)	(4.5)	(5.5)	(0.5)
3	39.9	60.1	99.9	0.1	9.8	20.3	69.9	31.8	19.9	38.6	9.7
	(3.6)	(6.9)	(9.6)	(15.9)	(3.5)	(7.0)	(9.1)	(4.0)	(6.8)	(7.3)	(0.7)
4	48.8	51.2	99.9	0.1	9.8	20.8	69.5	34.2	23.0	33.6	9.2
	(3.7)	(6.9)	(8.7)	(14.4)	(3.5)	(7.0)	(9.1)	(4.6)	(7.9)	(8.3)	(0.8)
8	71.1	28.9	99.9	0.1	9.6	20.6	69.8	51.8	21.3	21.0	5.9
	(5.8)	(10.4)	(8.2)	(13.9)	(3.6)	(7.3)	(9.5)	(5.3)	(9.1)	(9.2)	(0.8)
12	79.8	20.2	99.9	0.1	9.6	20.6	69.8	64.2	15.9	15.6	4.4
	(6.4)	(11.4)	(8.1)	(13.9)	(3.7)	(7.4)	(9.7)	(5.7)	(9.6)	(9.6)	(0.8)
24	89.4	10.6	99.9	0.1	9.6	20.6	69.8	79.7	9.0	8.9	2.5
	(7.7)	(13.7)	(8.6)	(15.1)	(3.8)	(7.6)	(9.9)	(6.5)	(11.2)	(11.3)	(0.9)

Variables Explained; Innovations in.

This table reports the relative importance of each innovation ($e_{1t}, e_{2t}, e_{\epsilon t}, e_{nt}$) in explaining the four variables in Model III.B ($\Delta y_t, s_{1t}, \epsilon_t, s_{2t}$) for various (1 through 24 years) forecasting horizons, which are shown in the first column. Innovations $e_{1t}, e_{2t}, e_{\epsilon t}$, and e_{nt} denote innovations in permanent and temporary fundamentals, the excess stock return innovations, and non-fundamental innovations, respectively. Variables $\Delta y_t, s_{1t}, \epsilon_t$, and s_{2t} denote growth rates in earnings, the spread between dividends and earnings, the excess stock return over short debt, and the spread between prices and dividends, respectively. Panels A, C, and E present the results for the four variables in Model III.B, and Panels B, D, and F present the results for the level of y_t (the log of real earnings), d_t (the log of real dividend), ϵ_t (the excess stock return), and p_t (the log of real stock price) series by expanding variables in Model III.B. Panels A and B report the results for the whole sample period (1874–1995), Panels C and D for the prewar period (1874–1940), and Panels E and F for the postwar results (1947–1995). The numbers in parentheses are standard errors, which are computed by using a Monte Carlo integration due to Kloek and Van Dijk (1978). The Monte Carlo results are based on 1000 simulations and take into account the identifying restrictions. For example, at one-year horizon, 44.4% of the forecast error variance of p_t is explained by e_{1t}, 2.0% by e_{2t}, 43.4% by $e_{\epsilon t}$, and 10.2% by e_{nt} (Panel B).

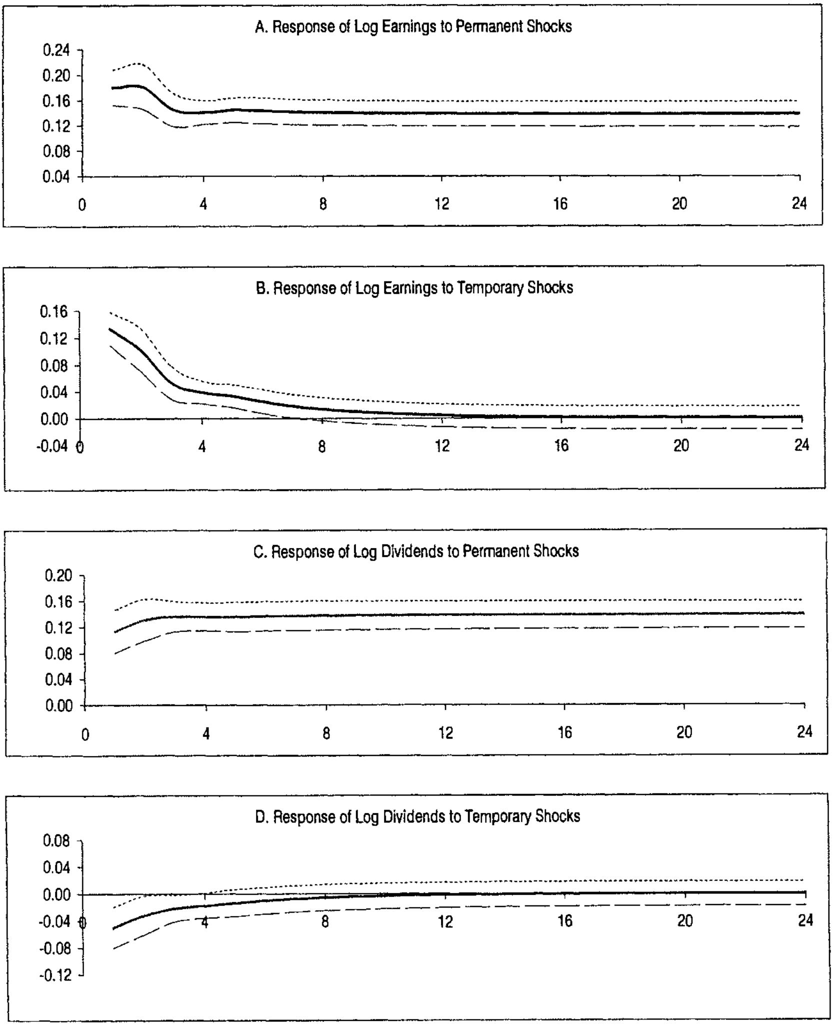
explained by the permanent component. It is noted, however, that the excess return component was positive during the Great Depression period.

The non-fundamental component appears to explain many of the medium/long-term cycles that the fundamental component does not capture. For example, the Great Depression and subsequent recoveries in the 1930s and the major

FIGURE 1

Responses of Log Earnings, Log Dividends, and Excess Stock Returns to Permanent, Temporary, and Excess Stock Return Innovations with a Standard Error Band. Upper (- - - - - -) and Lower (— — — — — — — — —) Band

This figure illustrates the responses to a one-standard deviation innovation over 24 years of forecast horizons.



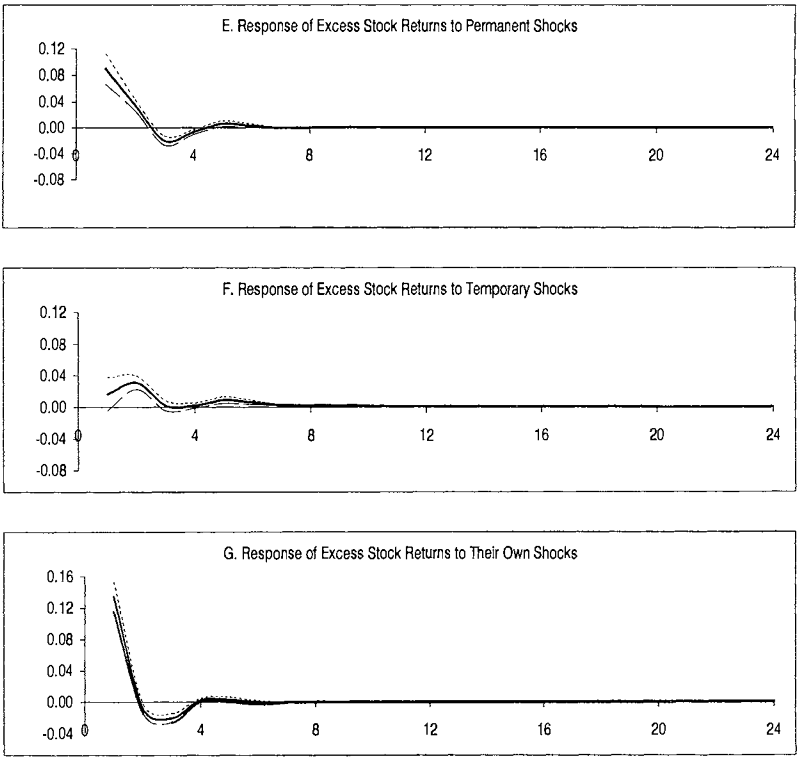
boom and bust of the 1940s through the 1980s not captured by the fundamental component appear to be explained by the non-fundamental component.[16]

[16]Correlation between logged prices and their permanent component is 0.89, between detrended logged prices and the temporary component is 0.15, between the first difference in logged prices and the excess return component is 0.25, between detrended logged prices and the non-fundamental component is 0.61.

FIGURE 1 (continued)

Responses of Log Earnings, Log Dividends, and Excess Stock Returns to Permanent, Temporary, and Excess Stock Return Innovations with a Standard Error Band. Upper (- - - - - -) and Lower (– – – – – – – – –) Band

This figure illustrates the responses to a one-standard deviation innovation over 24 years of forecast horizons.



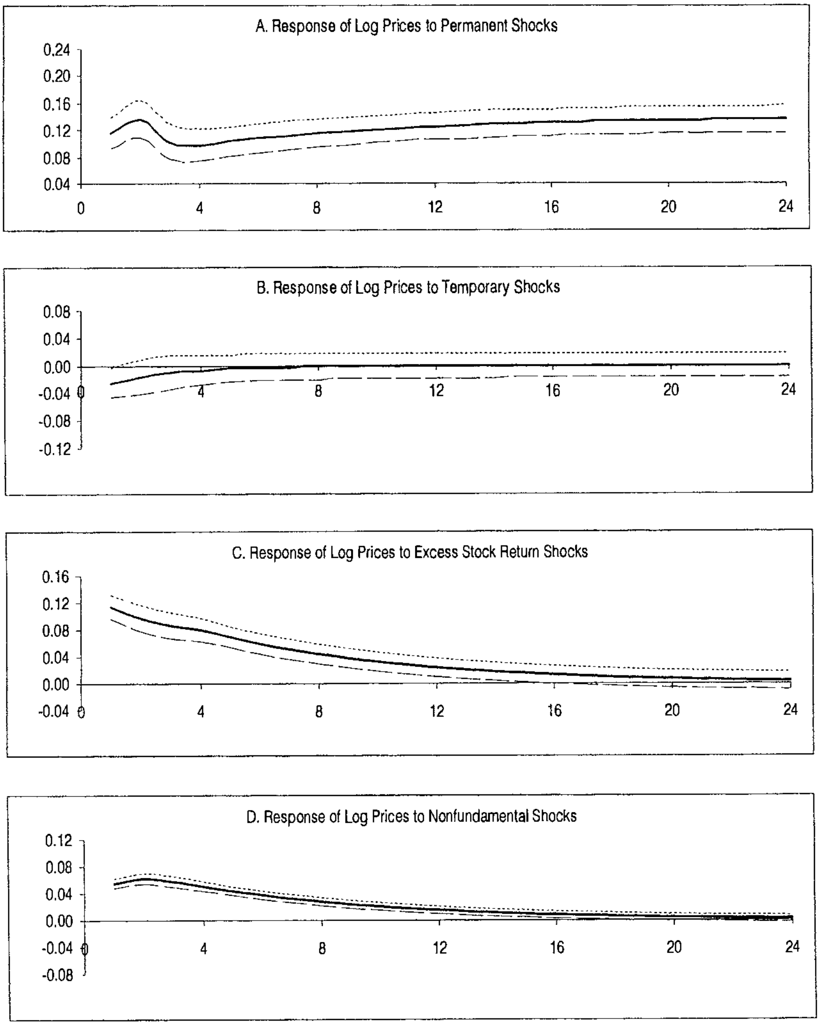
E. Subperiod Analyses

Given the long period of my sample, some of the unexplained variation in stock prices is likely due to unidentified trends in exogenous variables or regime changes. For example, Fama and French (1988) and Kim, Nelson, and Startz (1991) document that the mean reversion is mostly due to the prewar period. To examine possible structural changes in fundamentals and non-fundamentals, I present a subperiod analysis in Panels C–F of Table 6 dividing the sample into the prewar (1874–1940) and postwar (1947–1995) periods.

In the postwar period, the temporary component in earnings is more important than the permanent component in short horizons. However, dividends (the spreads s_1) are dominated by the permanent (temporary) changes in earnings in both periods. A smaller fraction of the variation in the excess stock returns is accounted for by e_1 and e_2 in the postwar period. A substantially larger fraction of price variation is due to the excess stock returns, but a marginally smaller

FIGURE 2

Responses of Log Prices to Permanent, Temporary, Excess Stock Return, and Non-Fundamental Innovations with a Standard Error Band. Upper (- - - - -) and Lower (— — — — — — — —) Band

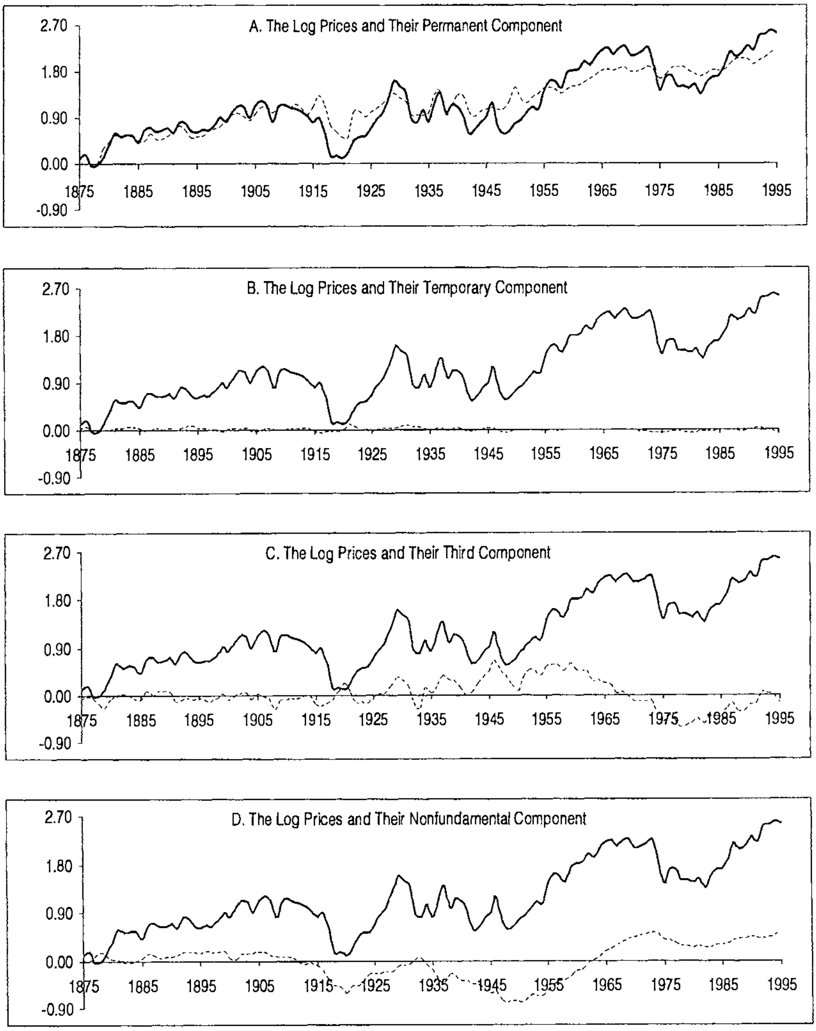


fraction is due to non-fundamentals in the postwar period. Overall, there is some evidence of a structural change between the two subperiods with the time-varying excess stock returns playing a relatively more important role, and earnings and dividends a relatively less important role in the postwar period.

FIGURE 3

Decomposition of Log Prices into Their Permanent, Temporary, Excess Stock Return, and Non-Fundamental Components for the sample period of 1875–1995.

Log Price Series (————) Each Component Series (- - - - - -)



V. Summary and Concluding Remarks

This paper has investigated whether the rejection of the simple present value relation and the mean reversion in stock returns can be explained by either time-varying discount factors or non-fundamental factors. By allowing for time-varying discount factors and a non-fundamental component in the model, I have identified various components of stock prices and examined the stock price responses to various types of innovations: permanent and temporary innovations in earnings and dividends, discount factor innovations, and non-fundamental innovations. The identification of these innovations is achieved by imposing restrictions on the models of earnings, dividends, discount factors, and stock prices that take into account cointegrations between these variables. Time-series models of earnings, dividends, discount factors, and stock prices, which are broadly consistent with the restrictions of the four types of innovations, are provided.

I have found that, although the long-term trend in stock prices is due to the permanent changes in fundamentals, the short-term volatility is largely due to the discount factor changes reflected in excess stock return changes and partly due to non-fundamental factors. The deviation of stock prices from fundamentals declines eventually as time horizon increases. This suggests that the over-reaction of the stock market and the mean reversion in stock returns are primarily in response to the excess return changes and partly in response to non-fundamental factors (see DeBondt and Thaler (1985) and Summers (1986)). This finding seems more consistent with a fad interpretation than a bubble interpretation. It also suggests that the model of stock returns based only on unexpected changes in earnings may provide a limited description of stock return dynamics.

Although a significant fraction of earnings changes is due to temporary changes, I find that dividend behavior is accounted for primarily by permanent changes in earnings. This finding lends evidence to the hypothesis that dividend decisions are made on the basis of permanent, not current, earnings.

Appendix A. Proof of Proposition 1

For notational efficiency, I use the lag operator L (i.e., $L^n x_t = x_{t-n}$) and the polynomial in the lag operator, $C(L) = [C_{ij}(L)] = \Sigma_k c_{ij}^k L^k$, for $i,j = 1, 2$, and 3. Then (9) can be rewritten as

$$z_t = C(L)e_t. \tag{A-1}$$

First, comparison of (3) with z_t in (9) shows that

$$C_{12}(1) = 0 \left[\Sigma_k c_{12}^k = 0\right] \text{ and } C_{13}(L) = 0 \left[c_{13}^k = 0 \text{ for all } k\right]. \tag{A-2}$$

In solving the present value term in (8), I presume that managers forecast future changes in earnings, Δy_{t+j} for $j > 0$, using two different components of earnings. To compute (8), I use the following lemma, whose proof can be found in Hansen and Sargent (1980) (see also Lee (1995)).

Lemma. Given a stochastic process $x_t = a(L)\epsilon_t$,

$$E_t \Sigma_j \beta^j x_{t+j} = [a(L)L - a(\beta)\beta](L-\beta)^{-1}\epsilon_t. \tag{A-3}$$

Applying this lemma to the two components of the spread s_{1t} in (8), I obtain

$$\begin{aligned} s_{1t} &= E_t \Sigma_j \gamma^j \Delta y_{t+j} = E_t \Sigma_j \gamma^j \left[\Delta y_{t+j}^p + \left(y_{t+j}^s - y_{t+j-1}^s\right)\right] \\ &= [q_1(L)L - q_1(\gamma)\gamma](L-\gamma)^{-1} e_{1t} \end{aligned} \tag{A-4}$$

$$
\begin{aligned}
& + \left\{(1-\gamma)\left[q_2(L)L - q_2(\gamma)\gamma\right](L-\gamma)^{-1} - q_2(L)L\right\} e_{2t} \\
= \; & \left[q_1(L)L - q_1(\gamma)\gamma\right](L-\gamma)^{-1} e_{1t} \\
& + \left[q_2(L)\left(L-L^2\right) - \left(\gamma-\gamma^2\right) q_2(\gamma)\right](L-\gamma)^{-1} e_{2t} \\
= \; & C_{21}(L)e_{1t} + C_{22}(L)e_{2t} + C_{23}(L)e_{nt}.
\end{aligned}
$$

As expected from the stationarity of the spread s_{1t}, (A-4) shows that neither of the two types of innovations has a permanent effect on the spread and that

$$
\text{(A-5)} \qquad C_{23}(L) \;=\; 0\left[c_{23}^k = 0 \text{ for all } k\right].
$$

By using the lemma in (A-3) and the definition of s_{1t}, I obtain

$$
\begin{aligned}
\text{(A-6)}\; \Delta d_t &= \Delta y_t + \Delta s_{1t} \\
&= q_1(L)e_{1t} + (1-L)q_2(L)e_{2t} + (1-L)C_{21}(L)e_{1t} + (1-L)C_{22}(L)e_{2t} \\
&= \left[q_1(L) + (1-L)C_{21}(L)\right] e_{1t} + (1-L)\left[q_2(L) + C_{22}(L)\right] e_{2t} \\
&= f_1(L)e_{1t} + (1-L)f_2(L)e_{2t}.
\end{aligned}
$$

By using a procedure similar to the one used to compute s_{1t}, I obtain

$$
\begin{aligned}
\text{(A-7)} \quad s_{2t} \;=\; & E_t\Sigma_j\rho^j\Delta d_{t+j} + \eta_t \;=\; \left[f_1(L)L - f_1(\rho)\rho\right](L-\rho)^{-1} e_{1t} \\
& + \left[f_2(L)\left(L-L^2\right) - \left(\rho-\rho^2\right) f_2(\rho)\right](L-\rho)^{-1} e_{2t} \\
& + \delta_3(L)e_{nt} \\
=\; & C_{31}(L)e_{1t} + C_{32}(L)e_{2t} + C_{33}(L)e_{nt}.
\end{aligned}
$$

Again, as expected from the stationarity of the spread s_{2t}, (A-7) shows that neither of the two types of innovations has a permanent effect on the spread s_{2t}. Combining (A-2) and (A-5) yields identifying restrictions (10).

For Model II with $z_t = [\Delta d_t, \Delta dr_t, s_{2t}]'$, I only need to model as follows,

$$
\begin{aligned}
\Delta d_t &= f(L)e_{1t}, \\
\Delta dr_t &\equiv \Delta d_t - r_t = f(L)e_{1t} - \left[h_1(L)e_{1t} + h_2(L)e_{rt}\right], \quad \text{and} \\
s_{2t} &= p_t - d_{t-1} = E_t\Sigma_j\rho^j\Delta d_{t+j} + \eta_t,
\end{aligned}
$$

where $\eta_t = \delta_3(L)e_{nt}$. Then, I obtain the restrictions in (14) on the trivariate model of $z_t = [\Delta d_t, \Delta dr_t, s_{2t}]' = C(L)e_t$.

For Model III.A with $z_t = [\Delta y_t, s_{1t}, \Delta dr_t, s_{2t}]'$, I model each variable as follows,

$$
\begin{aligned}
\Delta y_t &= q_1(L)e_{1t} + (1-L)q_2(L)e_{2t}, \\
s_{1t} &= d_t - y_t = E_t\Sigma_j\gamma^j\Delta y_{t+j}, \\
\Delta dr_t &\equiv \Delta d_t - r_t = \left[f_1(L)e_{1t} + (1-L)f_2(L)e_{2t}\right] \\
&\qquad - \left[h_1(L)e_{1t} + h_2(L)e_{2t} + h_3(L)e_{rt}\right], \quad \text{and} \\
s_{2t} &= p_t - d_{t-1} = E_t\Sigma_j\rho^j\left[\Delta d_{t+j} - r_{t+j} - \epsilon_{t+j}\right],
\end{aligned}
$$

where $\epsilon_t = g_1(L)e_{1t} + g_2(L)e_{2t} + g_3(L)e_{rt} + g_4(L)e_{nt}$.

For Model III.B with $z_t = [\Delta y_t, s_{1t}, \epsilon_t, s_{2t}]'$, I only need to replace Δdr_t with $\epsilon_t = h_1(L)e_{1t} + h_2(L)e_{2t} + h_3(L)e_{\epsilon t}$.

Appendix B. Proof of Proposition 2

Using the polynomial in the lag operator, $A(L) = [A_{ij}(L)] = \Sigma_k a_{ij}^k L^k$, for $i,j = 1,2$, and 3, I can rewrite (11) as

(B-1) $$z_t = A(L)z_{t-1} + u_t.$$

By inverting this TVAR of z_t, I obtain a TMAR of z_t,

(B-2) $$z_t = [I - A(L)L]^{-1}u_t,$$

where I is the identity matrix of rank 3.

By comparing the TMAR in (9) (or (A-1)), $z_t = C(L)e_t$, with that in (B-2) (or equivalently with the TVAR in (B-1)), estimates of the MAR coefficients, $C(L)$, can be obtained by noting that

(B-3) $$C^0 e_t = u_t, \quad \text{and}$$

(B-4) $$z_t = C(L)e_t = [I - A(L)L]^{-1}u_t,$$

where $C^0 = [c_{ij}^k]$ with $k = 0$. Using (B-3), (B-4) implies that

(B-5) $$C(L) = [I - A(L)L]^{-1}C^0.$$

This implies that, given an estimate of $A(L)$, I only need an estimate of C^0 to calculate $C(L)$. This can be obtained by taking the variance of each side of (B-3),

(B-6) $$C^0 C^{0\prime} = \Omega = [\sigma_{ij}] \quad \text{for } i,j = 1,2, \text{ and } 3.$$

In the trivariate model of z_t, I obtain six restrictions (equations) for the nine elements of C^0. Hence, I need at least three additional restrictions to just identify the nine elements of C^0. My trivariate models of z_t in Section II.B with restrictions in (10) provide restrictions for the identification.

The same procedure applies to Model II. For Model III, I obtain 10 restrictions for the 16 elements of C^0 so that I need at least six additional restrictions to just identify the 16 elements of C^0.

References

Akaike, H. "A New Look at the Statistical Identification Model." *IEEE Transactions Auto. Control,* 19 (1974), 716–723.

Bernard, V., and J. Thomas. "Evidence That Stock Prices Do Not Fully Reflect the Implications of Current Earnings for Future Earnings." *Advances in Behavioral Finance,* R. Thaler ed. Russel Sage Foundation (1989).

________________. "Post-Earnings Announcement Drift: Delayed Price Response or Risk Premium?" *Journal of Accounting and Economics,* 7 (1990), 151–174.

Blanchard, O. J., and D. Quah. "The Dynamic Effects of Aggregate Demand and Supply Disturbances." *American Economic Review,* 79 (1989), 655–673.

Brown, S. J.; W. N. Goetzmann; and S. A. Ross. "Survival." *Journal of Finance,* 53 (1995), 853–873.

Campbell, J. Y. "A Variance Decomposition for Stock Returns." *Economic Journal,* 101 (1991), 157–179.

Campbell, J. Y., and J. Ammer. "What Moves the Stock and Bond Markets? A Variance Decomposition for Long-Term Asset Returns." *Journal of Finance,* 48 (1993), 3–37.
Campbell, J. Y., and R. J. Shiller. "Cointegration and Tests of Present Value Models." *Journal of Political Economy,* 95 (1987), 1062–1088.
________________. "Stock Prices, Earnings and Expected Dividends." *Journal of Finance,* 43 (1988), 661–676.
________________. "The Dividend-Price Ratio and Expectations of Future Dividends and Discount Factors." *Review of Financial Studies,* 1 (1989), 195–228.
Cochrane, J. H. "Volatility Tests and Efficient Markets." *Journal of Monetary Economics,* 27 (1991), 463–485.
________________. "Explaining the Variance of Price-Dividend Ratios." *Review of Financial Studies,* 5 (1992), 243–280
________________. "Permanent and Transitory Components of GNP and Stock Prices." *Quarterly Journal of Economics,* 109 (1994), 241–265.
Cowles, A. *Common Stock Indexes,* 2nd ed. Bloomington, IN: Principia (1939).
DeBondt, W. F. M., and R. Thaler. "Does the Stock Market Overreact?" *Journal of Finance,* 40 (1985), 793–808.
Dickey, D. A., and W. A. Fuller. "Distribution of the Estimators for Autoregressive Time Series with a Unit Root." *Journal of the American Statistical Association,* 74 (1979), 427–431.
Fama, E. F., and K. R. French. "Permanent and Temporary Components of Stock Prices." *Journal of Political Economy,* 96 (1988), 246–273.
Flavin, M. A. "Excess Volatility in the Financial Markets: A Reassessment of the Empirical Evidence." *Journal of Political Economy,* 91 (1983), 929–956.
Flood, R. P., and R. J. Hodrick. "On Testing for Speculative Bubbles." *Journal of Economic Perspectives,* 4 (1990), 85–101.
Foster, G.; C. Olsen; and T. Shevlin. "Earnings Release, Anomalies, and the Behavior of Security Returns." *Accounting Review,* 59 (1984), 574–603.
Froot, K. A., and M. Obstfeld. "Intrinsic Bubbles: The Case of Stock Prices." *American Economic Review,* 81 (1991), 1189–1214.
Fuller, W. A. *Introduction to Statistical Time Series.* New York, NY: John Wiley (1976).
Goetzmann, W. N. "Patterns in Three Countries of Stock Market Prices." *Journal of Business,* 66 (1993), 249–270.
Goetzmann, W. N., and P. Jorion. "Testing the Predictive Power of Dividend Yields." *Journal of Finance,* 47 (1993), 663–679.
________________. "A Longer Look at Dividend Yields." *Journal of Business,* 68 (1995), 483–508.
Hansen, L. P., and T. J. Sargent. "Formulating and Estimating Dynamic Linear Rational Expectations Models." *Journal of Economic Dynamics and Control,* 2 (1980), 7–46.
Hodrick, R. J. "Dividend Yields and Expected Stock Returns: Alternative Procedures for Inference and Measurement." *Review of Financial Studies,* 5 (1992), 357–386.
Kim, M.; C. Nelson; and R. Startz. "Mean Reversion in Stock Prices? A Reappraisal of the Empirical Evidence." *Review of Economic Studies,* 58 (1991), 515–528.
Kleidon, A. W. "Variance Bounds Tests and Stock Price Valuation Models." *Journal of Political Economy,* 94 (1986), 953–1001.
Kloek, T., and H. K. Van Dijk. "Bayesian Estimates of Equation System Parameters: An Application of Integration by Monte Carlo." *Econometrica,* 46 (1978), 1–20.
Lee, B. S. "The Response of Stock Prices to Permanent and Temporary Shocks to Dividends." *Journal of Financial and Quantitative Analysis,* 30 (1995), 1–22.
________________. "Time-Series Implications of Aggregate Dividend Behavior." *Review of Financial Studies,* 9 (1996a), 589–618.
________________. "Comovements of Earnings, Dividends, and Stock Prices." *Journal of Empirical Finance,* 3 (1996b), 327–346.
LeRoy, S. F., and R. D. Porter. "The Present Value Relation: Tests Based on Implied Variance Bounds." *Econometrica,* 49 (1981), 557–574.
Macaulay, F. "Some Theoretical Problems Suggested by the Movements of Interest Rates, Bond Yields and Stock Prices in the United States Since 1856." *National Bureau of Economic Research,* New York (1938).
MacDonald, R., and D. Power. "Stock Prices, Dividends and Retention: Long-Run Relationships and Short-Run Dynamics." *Journal of Empirical Finance,* 12 (1995), 135–151.
Mankiw, N. G., and M. D. Shapiro. "Do We Reject Too Often?" *Economics Letters,* 20 (1986), 139–145.

Mankiw, N.G.; D. Romer; and M. D. Shapiro. "Stock Market Forecastability and Volatility: A Statistical Appraisal." *Review of Economic Studies,* 58 (1991), 455–477.
Marsh, T. A., and R. C. Merton. "Dividend Variability and Variance Bounds Tests for the Rationality of Stock Market Prices." *American Economic Review,* 76 (1986), 483–498.
________________. "Dividend Behavior for the Aggregate Stock Market." *Journal of Business,* 60 (1987), 1–40.
Nelson, C. R., and M. J. Kim. "Predictable Stock Returns: The Role of Small Sample Bias." *Journal of Finance,* 48 (1993), 641–661.
Phillips, P. C. B., and P. Perron. "Testing for a Unit Root in Time Series Regression." *Biometrika,* 75 (1988), 335–346.
Poterba, J. M., and L. H. Summers. "Mean Reversion in Stock Prices: Evidence and Implications." *Journal of Financial Economics,* 22 (1988), 27–59.
Richardson, M. "Temporary Components of Stock Prices: A Skeptic's View." *Journal of Business and Economic Statistics,* 11 (1993), 199–207.
Richardson, M., and T. Smith. "Tests of Financial Models in the Presence of Overlapping Observations." *Review of Financial Studies,* 4 (1991), 227–254.
Schwarz, G. "Estimating the Dimension of a Model." *Annals of Statistics,* 6 (1978), 461–464.
Shiller, R. J. "Do Stock Prices Move Too Much to be Justified by Subsequent Changes in Dividends?" *American Economic Review,* 71 (1981), 421–436.
________________. "Stock Prices and Social Dynamics." *Brookings Papers on Economic Activity,* (1984), 457–498.
________________. *Market Volatility.* Cambridge, MA: The MIT Press (1989).
Stambaugh, R. F. "Bias in Regression with Lagged Stochastic Regressors." CRSP Working Paper No. 156, Univ. of Chicago (1986).
Summers, L. H. "Does the Stock Market Rationally Reflect Fundamental Values?" *Journal of Finance,* 41 (1986), 591–601.
West, K. D. "Dividend Innovations and Stock Price Volatility." *Econometrica,* 56 (1988a), 37–61.
________________. "Bubbles, Fads and Stock Price Volatility Tests: A Partial Evaluation." *Journal of Finance,* 43 (1988b), 636–656.