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# An Empirical Examination of the Price-Dividend Relation with Dividend Management

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## ABSTRACT

Some recent empirical evidence suggests that stock prices are not properly modelled as the present discounted value of expected dividends. In this paper we estimate a present value model of stock price that is capable of explaining the observed long-term trends in stock prices. The model recognizes that firm managers control cash dividend payments. The model estimates indicate that stock price movements may be explained by managerial behavior.

**An Empirical Examination of the Price-Dividend**

**Relation with Dividend Management**

This paper empirically examines the relationship between stock price and cash dividends. Despite much research into the determinants of stock price fluctuations, economists continue to debate whether changes in stock prices reflect rational responses to changes in fundamentals. We show that the observed relationship between aggregate stock price and dividends may be explained by how managers choose dividend payout.

Early research on the speculative behavior of stock prices strongly supports the efficient markets hypothesis.[1] The economic rationale for such behavior is that, in competitive markets, the actions of well-informed participants are reflected asset prices. Since the influential paper by Lucas (1978), who constructed an equilibrium model that linked asset prices to their underlying dividend processes, the efficiency of the stock market has generally been equated with the notion that the price of a stock is equal to the present discounted value of its dividends.[2] The view that stock prices are determined by so-called fundamentals like earnings and dividends has its origins in the early works of Graham and Dodd (1934) and Williams (1938).

More recently, compelling empirical evidence suggests that the view that a stock's value is intrinsically equal to the present value of its dividends is incomplete. Perhaps the strongest evidence against the present value model is the apparent excess volatility of stock prices.[3] LeRoy and Porter (1981), Shiller (1981), and West (1988a), among others, reject the simple present value model based on the results of variance-bound inequality tests. Their tests indicate that stock prices are too volatile to be determined by the present value of dividends. Numerous attempts at parsimonious improvements to the present value model resulted.

Although the observed deviations in stock prices from prices predicted by the simple present value model are large, no simple alternative to the present value model has received wide-spread support. Proposed alternatives include models of rational bubbles.[4] For example, Froot and Obstfeld (1991a) use a rational ‘intrinsic’ bubble to model stock price. Their model is appealing because deviations from present-value prices are driven by changes in fundamental value. Although rational bubbles models have the potential to explain observed patterns in stock prices, they soon fell into disfavor for various theoretical and empirical reasons.[5]

In response to the evidence of excess volatility in stock prices, other studies focus on the specification of variance-bound tests. Some dispute the validity of the tests and their assumptions (e.g., Flavin, 1983; Kleidon, 1986a; Marsh and Merton, 1986; Mattey and Meese, 1986).[6] For example, Fama (1991) argues that because variance-bound tests assume constant expected returns, they provide no information concerning market efficiency. Instead, violations of variance-bound inequalities simply provide evidence of time-varying expected returns. In contrast, Ackert and Smith (1993) point out that previous volatility tests use dividends narrowly defined to include only those cash flows distributed to shareholders as ordinary dividends. Yet, the finance literature recognizes that firms distribute cash through other methods (Miller and Modigliani, 1961; Shoven, 1986; Bagwell and Shoven, 1989). Ackert and Smith show that West's (1988a) variance-bound test results reverse if cash distributions to shareholders are defined to include other distributions such as those made through share repurchases and takeovers. Thus, the level of stock price volatility is not excessive when the present value relation is tested using a better cash flow measure.[7]

Managers have almost complete discretion and control over the choice of dividend policy because there are few, if any, legal and accounting constraints on the firm's policy (Marsh and

Merton, 1986).[8,9] No theory of dividend policy fully describes managerial behavior though Lintner's (1956) classic study provides a foundation. His empirical documentation of the tendency of managers to engage in dividend smoothing is supported by others (Fama and Babiak, 1968; Marsh and Merton, 1986, 1987; Kleidon, 1986a, 1986b; and Lee, 1996). Nevertheless, researchers have only recently proposed models of economic behavior that predict smoothing of cash dividends by managers (Warther, 1994; Fudenberg and Tirole, 1995). In addition to ordinary cash dividends, the importance of other cash flows to shareholders has been documented (Shoven, 1986; Bagwell and Shoven, 1989; Ackert and Smith, 1993). Although management has sole responsibility for and control over the dividends paid by the firm and can influence the intrinsic value of the firm by its investment decisions, management has little, if any, control over stochastic or unanticipated changes in the intrinsic value of the firm's shares.

The extant literature provides an incomplete explanation of the relationship between dividends, fundamentals, and stock prices. As Marsh and Merton argue "(s)ince management's choice of dividend policy clearly affects the time-series variation in observed dividends, the development of the relation between the volatility of dividends and rational stock prices requires analysis of the linkage between the largely controllable dividend process and the largely uncontrollable process for intrinsic value" (1986, p. 488).[10] Ackert and Hunter (1999) propose a model of dividend control as an alternative to the standard dividend smoothing model which recognizes that the cash dividends paid by a firm are not necessarily equal to the firm's intrinsic value. In their model stock price is a function of unobservable fundamental value and observed, ordinary cash dividends are managed by the firm.

In this paper, we further examine whether the empirical measure of dividends can explain why we observe large and persistent deviations in stock prices from the prices predicted by the present value model. To do so, we estimate Ackert and Hunter's present value model of stock price that, in line with the empirical evidence, takes as given managers' ability to control ordinary cash dividend payments. In examining the responsiveness of stock prices to changes in intrinsic value or fundamentals, it is important to recognize that unanticipated changes in fundamentals are not necessarily identical to unanticipated changes in ordinary cash dividends because these dividends are controlled by managers. Thus, what appears to be evidence against the present value model may be a result of improper empirical measurement of fundamentals.

The paper is structured as follows. In section 1, we describe the discounted present value model of stock price. In section 2, we discuss the empirical methods employed, describe the data used in the analysis, and report the estimates. Section 3 offers a conclusion and interpretation of the results.

## 1. Bubbles, Dividend Control, and the Present-Value Model

The intrinsic value of the firm's shares under the present-value model is obtained by discounting the expected future dividend stream, i.e.,

$$P_t = E[\int_0^\infty D_{t+s} e^{-ks} ds] \tag{1}$$

where $P_t$ is the time t real stock price, $D_t$ is the true real dividend or fundamental per share paid over time t, E is the expectations operator, and k is the discount rate. With constant growth in dividends ($\mu$) and in the absence of dividend management, equation (1) has the familiar simple solution

$$P_t = \frac{D_t}{k - \mu} \qquad (2)$$

where k > μ.

Deviations in actual stock prices from those predicted by the simple present value model are large and persistent. Froot and Obstfeld (1991a) propose an intrinsic bubbles model that provides "a more plausible empirical account of deviations from present-value pricing than do the traditional examples of rational bubbles" (page 1189). Froot and Obstfeld model stock price using a rational 'intrinsic' bubble which depends exclusively on economic fundamentals, i.e., aggregate dividends, and not on the extraneous or extrinsic factors which often underlie bubble terms. The Froot and Obstfeld model is

$$P_t = \frac{D_t}{k - \mu} + \alpha D_t^{\beta_1}. \qquad (3)$$

Intrinsic bubbles are appealing because they are able to generate persistent deviations from present-value prices, but the deviations are driven exclusively by changes to fundamental value. Despite this appeal, the intrinsic bubbles model has not ended the search for alternatives to the simple present value model. These bubbles are arbitrary and problematic in that their existence depends on rather stringent assumptions about investor behavior and the dynamic inefficiency of the economy. Froot and Obstfeld assert that "(e)ven if one is reluctant to accept the bubble interpretation, the apparent nonlinearity of the price:dividend relation requires attention" (1991a, p. 1208).

Using a model of regulated Brownian motion, Ackert and Hunter (1999) show that dividend control gives a present value model that is observationally equivalent to the intrinsic bubbles model proposed by Froot and Obstfeld given in (3) above.[11] In the case of dividend management, a problem arises when empirically evaluating the present value relation in equation (1) because the true dividend or fundamental ($D_t$) is unobservable. Instead, we observe the managed dividend process ($d_t$). As shown by Ackert and Smith (1993) (see also Shoven (1986) and Bagwell and Shoven (1989)) the observed dividend stream ($d_t$) is much less volatile than the cash flows received by shareholders. In addition, stock prices are underpredicted by ordinary cash dividends alone. Ackert and Hunter show that the stock price equation

$$P_t = \frac{d_t}{k - \mu} + \alpha d_t^{\beta_1} + \gamma d_t^{\beta_2} \tag{4}$$

results after specifying the relationship between observed dividends ($d_t$) and intrinsic value ($D_t$), where $\beta_1$ and $\beta_2$ are the positive and negative roots of the quadratic equation

$$\tfrac{1}{2}\sigma^2 \beta(\beta - 1) + (k - \mu)\beta - k = 0 \tag{5}$$

(Harrison (1985), Bentolila and Bertola (1990)). Although (4) is observationally equivalent to the intrinsic bubbles model proposed by Froot and Obstfeld given in (3), this model of stock price is based on observables. Furthermore, the nonlinearities in the model arise from a documented managerial behavior rather than from arbitrary bubbles.[12]

Equation (4) implies that $dP_t/dd_t > 1/(k-\mu)$ so that the responsiveness of price to changes in ordinary smoothed dividends is greater than that predicted by the simple present value model when dividend control is ignored. The long term trends implied by the model in (4) do not depend on bubbles but instead result from the control of dividend payments by managers.

## 2. Model Estimates Using U.S. Stock Market Data

In this section we report estimates of (4) using Standard and Poor's stock price and dividend index series. In order to test (4) we first generalize the specification following Froot and Obstfeld (1991a) by allowing error in the present value relation. The estimable model is

$$P_t = \frac{d_t}{k - \mu} + \alpha d_t^{\beta_1} + \gamma d_t^{\beta_2} + e_t \qquad (6)$$

where $e_t$ is the present value of the errors in the present value relation. Due to collinearity in the right hand side variables in equation (5) we estimate

$$P_t / d_t = c_0 + c_1 d_t^{\beta_1 - 1} + c_2 d_t^{\beta_2 - 1} + \eta_t \qquad (7)$$

The model of dividend management and the simple present value model suggest that the constant term ($c_0$) equals $1/(k\text{-}\mu)$. The dividend management model also implies that $c_1$ is positive and $c_2$ is negative, whereas the simple present value model suggests that both $c_1$ and $c_2$ equal zero. The validity of the null hypothesis of no dividend management is examined using a joint test of restrictions on the coefficients, i.e., $H_0$: $c_0 = 1/(k\text{-}\mu)$, $c_1 = 0$, $c_2 = 0$.

We estimate equation (7) using Standard and Poor's stock price and dividend index series from the **Securities Price Index Record** as extended by Alfred Cowles and Associates (1939) and reported in Shiller (1989). The full length of the series runs from 1872 through 1987. We extended the series to 1998 with additional data obtained from Standard and Poor's and the Bureau of Labor Statistics. Following Froot and Obstfeld (1991a), we deflated January stock prices by the January producer price index (PPI) and annual dividends by the average PPI for the year. We report estimates for three sample periods. Although the series run from 1872 through 1998, we report results based on the 1900-1998 sample period. The number of stocks included in the index was limited in the early sample years so these years are excluded from the analysis (Froot and Obstfeld, 1991a, footnote 17).[13] We also report estimates for two subperiods of this sample: 1900-1949 and 1950-1998. As pointed out by Kleidon (1986b), the importance of dividend smoothing appears to have increased around 1950. We examine whether the model fit is substantially different for the two subperiods.

Table 1 reports point estimates of the growth rate ($\mu$) and variance of real dividends ($\sigma^2$), the real return on stock (k), and the roots of the quadratic equation (5) for each sample period. The point estimates of the roots of the quadratic equation, $\beta_1$ and $\beta_2$, were obtained using the point estimates of k and the parameters of the dividend process, $\mu$ and $\sigma^2$.

In order to test the dividend management model, we estimated equation (7) using ordinary least squares (OLS) techniques.[14] We used Newey and West's (1987) autocorrelation and heteroskedasticity consistent covariance matrix estimation to correct the estimates for autocorrelation.[15,16] We did not estimate the parameters simultaneously using an unrestricted estimation technique such as nonlinear least squares. Equation (7) is likely to be a poorly identified regression function whatever the true parameters values may be, but particularly so when the true value of one of the parameters $c_0$, $c_1$, $\beta_1 - 1$, or $\beta_2 - 1$ is close to zero (Davidson and MacKinnon, 1993). It is very difficult to estimate the parameters of such a regression function with precision.[17] Instead, we estimated equation (7) using OLS with $\beta_1$ and $\beta_2$ constrained to equal the point estimates reported in Table 1. We then used a Gauss-Newton regression (GNR) in order to gauge the accuracy of our estimates.

Express the nonlinear regression model as

$$y = x(\delta) + residual \tag{8}$$

where δ is a k-vector of unknown parameters and x(δ) is a nonlinear regression function. Then the GNR is

$$y - x^{*} = X^{*}(b) + residual \tag{9}$$

where X ≡ Dx(δ) is a matrix of the derivatives of x(δ) with respect to δ, b is a k-vector of coefficients, and the asterisks denote estimates. Whether the OLS estimates of δ are sufficiently accurate can be gauged by estimating the GNR and testing whether each element of b differs significantly from zero. The GNR for equation (7) is

$$\begin{aligned} &P_t/d_t - c_0^{*} - c_1^{*} d_t^{\beta_1 - 1} - c_2^{*} d_t^{\beta_2 - 1} = \\ &b_0 + b_1 d_t^{\beta_1^{*} - 1} + b_2 (c_1^{*} \log d_t) d_t^{\beta_1^{*} - 1} + b_3 d_t^{\beta_2^{*} - 1} + b_4 (c_2^{*} \log d_t) d_t^{\beta_2^{*} - 1} + residual \end{aligned} \tag{10}$$

If $b_0$, $b_1$, $b_2$, $b_3$, and $b_4$ do not differ significantly from zero, the parameter estimates are close the nonlinear least squares estimates (Davidson and MacKinnon, 1993).

Table 2 reports the OLS estimates of equation (7) with t-statistics for tests of the null hypothesis that each coefficient equals zero in parentheses. The second column of Table 2 reports the estimate of the constant term in equation (7) for each sample period. We also report a t test of the null hypothesis that $c_0 = 1/(k-\mu)$. As the results of this test in the fifth column show, the null is rejected in all three sample periods. In all three cases the estimated constant exceeds the hypothesized value. The third and fourth columns of Table 2 report the estimates of the coefficients of the nonlinear terms involving the positive and negative roots, $\beta_1$ and $\beta_2$. Five out of six estimates differ significantly from zero. Although the coefficients are not always significant, the estimated signs are consistent with the model's predictions ($c_1 > 0$, $c_2 < 0$) when the coefficient estimates differ significantly from zero.

Additional analysis provides insight into the fit of the model of dividend management. Table 2 reports the results of three F-tests. The first is an F test (F test: No) of the null hypothesis of no dividend management ($c_0 = 1/(k-\mu)$, $c_1 = 0$, $c_2 = 0$). The null is rejected for all three sample periods at the one-percent significance level. The seventh column reports a test (F test: No Slope) of the null hypothesis that the slope coefficients are zero ($c_1 = 0$, $c_2 = 0$). This hypothesis is rejected at the five-percent significance level for all sample periods. The final F-test (F test: Model) compares the mean squared error of the model of dividend management to that of the simple present value model. Rejection of the null hypothesis favors the model of dividend management. For the 1900-1998 and 1950-1998 sample periods the model of dividend management provides superior fit, but for the earlier time period, the simple present value model is favored. Additional tests indicated that the coefficients are significantly different across the various sample periods.

We next gauged the accuracy of the OLS estimates of the nonlinear model of dividend management. As discussed above, when any of the parameters are close to zero (as the estimates in Table 2 indicate), nonlinear least squares estimation is extremely imprecise. Table 3 reports OLS estimates of the GNR given in equation (10). Reported below each estimated coefficient is the t-statistic for a test of the null that the coefficient equals zero. We used standard errors that are corrected for first-order autocorrelation following Newey and West (1987).[18] If the coefficients do not differ significantly from zero, we can have confidence in the accuracy of the restricted OLS estimates for equation (7), as reported in Table 2. For the 1900-1998 and 1950-1998 sample periods the GNR regression results indicate that the estimates are sufficiently accurate. However, all estimated coefficients are significantly different from zero for the 1900-1949 period which indicates that the restricted OLS regression may not be properly specified for this sample period.

Figures 1 through 3 lend further insight into the relationships between actual stock price and predicted stock prices under the model of fundamentals with managed dividends and the simple present value model. These figures plot the actual real stock price, the stock price predicted by the dividend management model estimates reported in Table 2 (managed price), and the stock price predicted by the simple present value model in the absence of dividend control (PV price). Figures 1, 2, and 3 show the time paths of each price series for the 1900-1998, 1900-1949, and 1950-1998 periods, respectively. Overall, the predictions of the dividend control model (managed price) better reflect actual stock price movements than the price predictions based on the simple present value model (PV price). What is also apparent from these figures is that both models performed equally poorly prior to 1950. However, since 1950 the dividend management model is superior to the simple present value model at reflecting movements in real stock prices. This is consistent with our results reported in Tables 2 and 3 and earlier studies of the relationship between dividends and stock prices. Prior research has recognized that prices and dividends moved together prior to 1950 (Froot and Obstfeld, 1991a) and changes in dividends are much smoother than changes in prices since around 1950 (Kleidon, 1986b). In addition, Brittain (1968), Miller (1985), Marsh and Merton (1987), and Lee (1996) report a shift in dividend policy though they suggest that the change occurred somewhat earlier in the 1930's and 1940's.

Taken together, the results suggest that the nonlinearities in stock price behavior and the break-down in the relationship between prices and ordinary cash dividends that occurred around 1950 may be a direct result of dividend management by firms. Stock price moves more than predicted by a present value model that ignores dividend management because ordinary cash dividends are controlled and fundamentals are not.

## 3. Concluding Remarks

The nonlinearity in the relationship between prices and dividends may arise from how managers choose dividend payout. In this paper we examined a model of dividend management which can explain observed long-term trends in stock prices but does not depend on the existence of intrinsic or extrinsic bubbles. We estimated the model using Standard and Poor's stock price and dividend index series for the 1900-1998 time period. The model recognizes that ordinary cash dividends may not properly represent intrinsic value yet estimation of the model does not require measurement of (possibly unobservable) fundamentals. The estimates provide support for the dividend management model and indicate that the nonlinear relationship between prices and dividends may be explained by managerial behavior.

We also showed that the simple present value model seems to track movements in actual stock price prior to 1950 as well as the model of dividend control. However, since 1950 the importance of dividend management has increased. A missing piece to the puzzle is an explanation of why managerial control of ordinary cash dividends became more prevalent around 1950.

## Notes

1. See Fama (1970) and Samuelson (1973) for reviews of the early literature.

2. In the Lucas model, economic agents maximize the expected utility of lifetime consumption in a one good pure exchange economy. Within this framework, a current period asset price is equal to the conditional expectation of the asset's next period price *cum* dividend payment weighted by the marginal rate of substitution between current and next period consumption.

3. Other stock price behavior casts additional doubt on the present value model. For example, Mehra and Prescott (1985), using calibration techniques, demonstrate that the expected utility maximization framework does not explain the 'equity premium' which is defined to be the difference between the real return to equity and the real risk-free interest rate. Fama and French (1988), Lo and Mackinlay (1988), and Poterba and Summers (1988) all report evidence consistent with the presence of mean reversion in asset prices. See also the papers by Cecchetti, Lam, and Mark (1990) and Lehmann (1990).

4. See, for example, the symposium on bubbles in the *Journal of Economic Perspectives* which included papers by Flood and Hodrick (1990) and White (1990).

5. See, for example, the review articles by West (1988b), Camerer (1989), and Flood and Hodrick (1990).

6. See also the reviews by West (1988b) and Cochrane (1991).

7. Donaldson and Kamstra (1996a, 1996b) develop a procedure to forecast future cash flows which are in turn used to construct present value prices. The model uses a nonlinear ARMA-ARCH artificial neural network. Based on the results of excess volatility tests, Donaldson and Kamstra also reject bubbles in stock prices.

8. In selecting a dividend policy, managers do face a cash flow accounting identity which applies to dividends paid net of any purchases of its outstanding securities, i.e., the dividend policy must be consistent with providing a current intrinsic value per share equal to the discounted present value of expected future real cash flows of the firm that will be available for distribution to each of the shares currently outstanding. Clearly, for any given intrinsic value, there are an uncountable number of dividend policies which will satisfy this constraint (see Marsh and Merton, 1986, p. 487).

9. The variety of dividend policies observed among U.S. corporations attests to the discretion available to managers and is consistent with the fact that unlike consumer choice theory, there is no generally accepted theory of optimal dividend policy.

10. Marsh and Merton (1986) showed that if dividend policy can be described by their model of dividend smoothing, nonstationarity of the stock price process results. Under nonstationarity, Shiller's (1981) variance-bound test is invalid. Marsh and Merton do not empirically examine whether dividend smoothing can explain the time path of stock prices. See also Mattey and Meese (1986) who examine the affect of dividend smoothing on tests of present value relations.

11. The derivation of equation (4) which follows, where the true dividend or fundamental per share paid over time, $\{D_t\}$, is assumed to follow a continuous time geometric Brownian motion process with a constant drift or mean growth rate, i.e., a standard Ito process, is extremely complicated and lengthy. As noted in Ackert and Hunter (1999), the solution can be derived derived using the methods outlined by Harrison (1985, Chapters 2 and 5)). Bentolila and Bertola (1990, page 386) using the methods outlined in Harrison, provide a comprehensive derivation of the discounted present value of a generalized regulated Brownian motion process of the type we use to represent true cash dividends in this paper. The derivation of our equation (4) follows directly from the

derivation given by Bentolila and Bertola. Froot and Obstfeld (1991b) propose a similar representation to express the relationship between exchange rates and fundamentals in the presence of target zones.

12. The second nonlinear term in (4) is included in the general solution to the Froot and Obstfeld model.

13. Including these observations in the analysis does not affect the results.

14. Under complete markets the discount rate and the risk-free interest rate are equal. Clearly, however, this assumption does not strictly hold. We used the average real return as our discount rate to obtain the estimates of equation (7) reported subsequently because the real return is a better reflection of individuals' subjective discount rate. We also performed the analysis using the real commercial paper rate as the discount rate and inferences are unaffected.

15. Statistical inferences may be invalid in the presence of autocorrelation. As autocorrelation is not ruled out by the model, its possible presence must be taken into consideration in estimation.

16. The reported standard errors are corrected for first-order autocorrelation. An examination of the residuals indicated the presence of significant first-order autocorrelation but no significant higher-order autocorrelation. We also estimated (7) allowing for up to fourth-order autocorrelation and statistical inferences were not affected.

17. In their footnote 28, Froot and Obstfeld reported that they estimated an extended version of their model (13) which is our (7). They found that the coefficient of the second nonlinear term was estimated imprecisely and that there was no evidence that this second term explained movements in stock prices. We found that all coefficients were imprecisely estimated using unrestricted estimation techniques, regardless of whether the second term was included in the model.

18. We also estimated (10) allowing for up to fourth-order autocorrelation with no change in the results.

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**Table 1: Parameter Estimates**

| Time Period | $\mu$ | $\sigma^2$ | k | $\beta_1$ | $\beta_2$ |
|---|---|---|---|---|---|
| 1900-1998 | 0.0170 | 0.0142 | 0.0901 | 3.4670 | -3.6705 |
| 1900-1949 | 0.0107 | 0.0246 | 0.0708 | 2.6974 | -2.1298 |
| 1950-1998 | 0.0235 | 0.0037 | 0.1097 | 5.4933 | -10.9423 |

Notes: The table reports the mean growth rate ($\mu$) and variance ($\sigma^2$) of real dividends and the mean real return on stocks (k) over each time period. Also reported are estimates of the positive ($\beta_1$) and negative ($\beta_2$) roots of the quadratic equation (5) using these point estimates.

**Table 2: Estimates of Equation (7)**

| Time Period | $c_0$ | $c_1$ | $c_2$ | t test | F test: No | F test: No slope | F test: Model | $R^2$ | DW prob | df |
|---|---|---|---|---|---|---|---|---|---|---|
| 1900-1998 | 17.960 (22.36)*** | 0.748 (10.73)*** | -0.690 (-1.78)* | 5.31*** | 128.97*** | 75.00*** | 63.41*** | 0.67 | 0.000 | 96 |
| 1900-1949 | 20.410 (9.65)*** | -0.135 (-0.17) | -2.034 (-2.33)** | 1.79* | 9.26*** | 4.72** | 1.32 | 0.08 | 0.000 | 47 |
| 1950-1998 | 24.063 (19.43)*** | 0.031 (8.70)*** | -2112.90 (-4.85)*** | 10.05*** | 218.87*** | 97.14*** | 28.21*** | 0.65 | 0.000 | 46 |

Notes: The table reports OLS estimates of the parameters of equation (7), with t-statistics reported below in parentheses. These t-statistics use standard errors that are corrected for first-order serial correlation following Newey and West (1987). The fifth column reports the results of a t test of whether the constant term is indistinguishable from the value predicted by the simple present value model. Three F-statistics are reported in the following columns. The sixth column reports the results of an F test of the null hypothesis of noividen management($c_0 = 1/(k-\mu)$, $c_1 = 0$, $c_2 = 0$) and the seventh column reports a test of the null hypothesis that the slope coefficients are zero ($c_1 = 0$, $c_2 = 0$). The final F-test compares the mean squared error of the model of dividend management to that of the simple present value model. The DW prob is the probability of rejecting the null hypothesis of no positive autocorrelation when autocorrelation is present. The final column reports the degrees of freedom.

***, **, * Significant at the 1%, 5%, and 10% levels, respectively.

**Table 3: Estimates of Equation (10)**

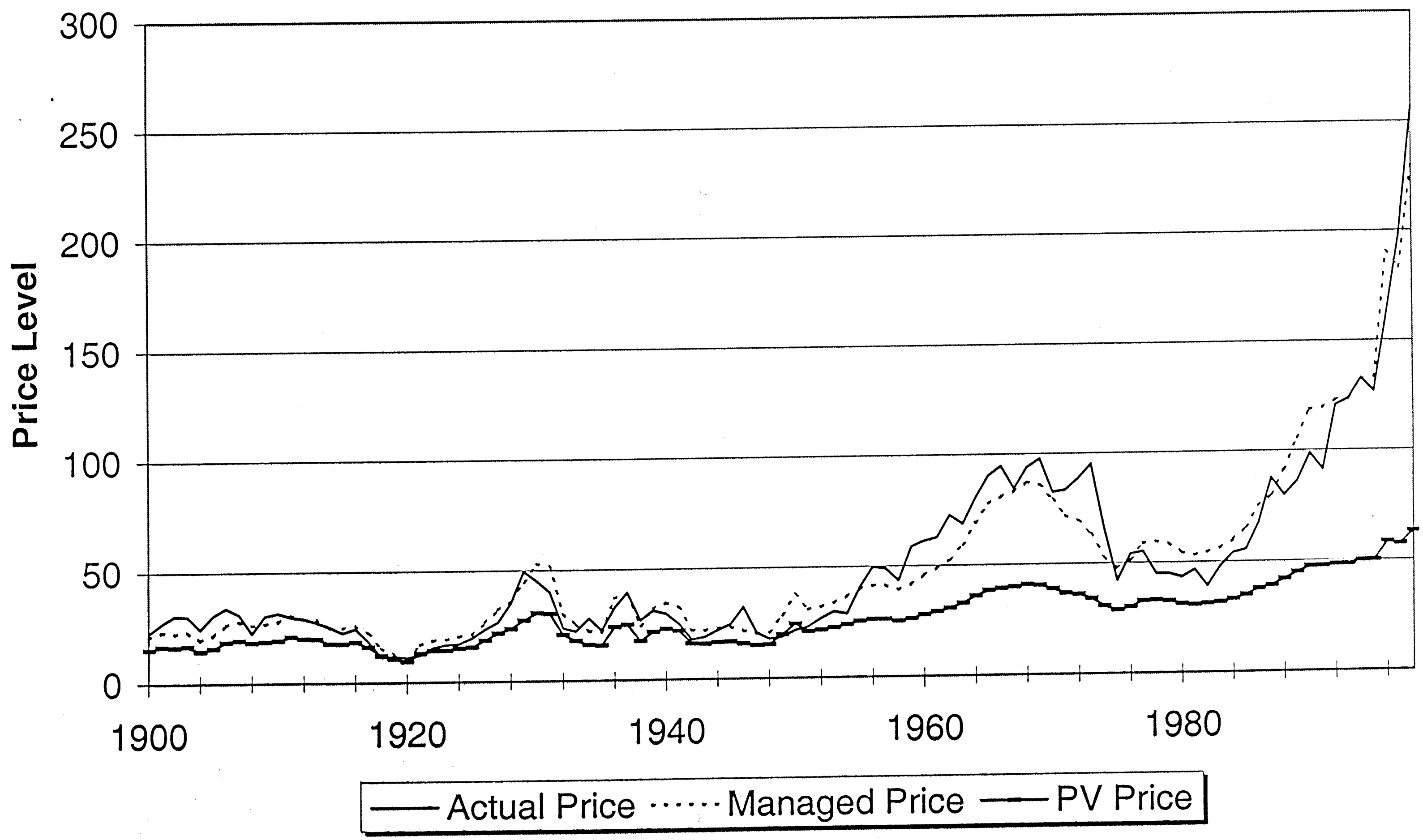
| Time Period | $b_0$ | $b_1$ | $b_2$ | $b_3$ | $b_4$ | F test | $R^2$ | df |
|---|---|---|---|---|---|---|---|---|
| 1900-1994 | 1.408<br>(0.49) | -0.313<br>(-0.38) | 0.255<br>(0.35) | -1.752<br>(-0.60) | 6.690<br>(0.65) | 0.25 | 0.00 | 94 |
| 1900-1949 | 100.090<br>(2.60)** | -57.444<br>(-2.53)** | -314.860<br>(-2.51)** | -43.857<br>(-2.75)*** | 33.715<br>(2.89)*** | 5.83*** | 0.08 | 45 |
| 1950-1994 | 1.806<br>(0.61) | -0.036<br>(-0.54) | 0.718<br>(0.53) | 12456.000<br>(1.40) | 13.249<br>(1.34) | 1.53 | 0.04 | 44 |

Notes: The table reports OLS estimates of the parameters of equation (10), with t-statistics reported below in parentheses. These t-statistics use standard errors that are corrected for first-order serial correlation following Newey and West (1987). The following column reports the results of an F test of the null hypothesis that the coefficients jointly equal zero. The table also reports the regression $R^2$ and degrees of freedom.

***, **, * Significant at the 1%, 5%, and 10% levels, respectively.

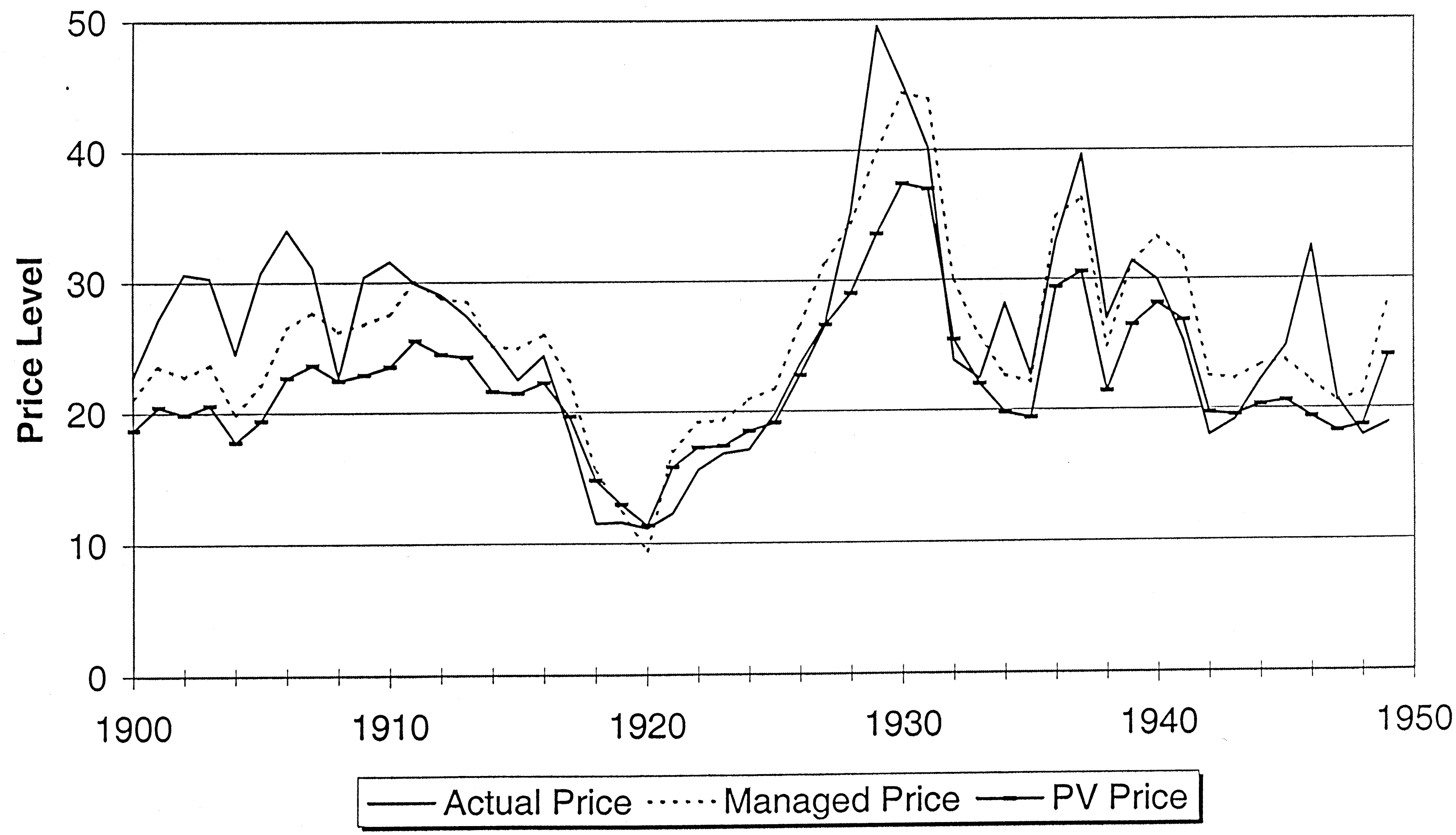
## Figure 1: Actual and Predicted Prices

1900-1998



# Figure 2: Actual and Predicted Prices

1900-1949



## Figure 3: Actual and Predicted Prices

1950-1998