Intrinsic Bubbles: The Case of Stock Prices: Comment

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Deviations in stock prices from those predicted by the simple present-value model based on constant discount rates, ordinary cash dividends, and rational expectations appear to be substantial and persistent over time. However, until a paper in this *Review* by Kenneth A. Froot and Maurice Obstfeld (1991a), no other parsimonious model of stock price has found empirical support. 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. Intrinsic bubbles are appealing because they are able to generate persistent deviations from present-value prices, but the deviations are driven exclusively by changes in 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).

As noted by Terry A. Marsh and Robert C. Merton (1986), managers have almost complete discretion and control over the choice of dividend policy because there are few, if any, legal or accounting constraints on the firm's dividend policy. In this Comment we show that Froot and Obstfeld's intrinsic-bubbles model is observationally equivalent to a simple model of stock price that incorporates control over dividends by managers. In their paper Froot and Obstfeld clearly recognize that nonbubble alternatives can explain their results, including regime-shift models.[1] Our purpose is to propose another interpretation of their results. However, there is an important theoretical distinction between their alternative hypotheses and the model of dividend regulation we outline. The model we offer is not suggestive of short-run speculative profit opportunities nor does it imply that "the market is literally stuck for all time on a path along which price:dividend ratios eventually explode" (Froot and Obstfeld, 1991a p. 1190). To explain the apparent nonlinear relationship between stock prices and dividends, we appeal to observed managerial behavior.

There is no generally accepted theory of optimal dividend policy. In fact, the pioneering work of Merton H. Miller and Franco Modigliani (1961) shows that dividend policy is irrelevant in the absence of taxes and transactions costs. John Lintner's (1956) classic study, which suggests that dividends are a distributed lag on earnings, provided a foundation for our understanding of how firms choose dividends. Empirical studies by Eugene F. Fama and Harvey Babiak (1968), R. Richardson Pettit (1972), Ross Watts (1973), Marsh and Merton (1987), and Bong-Soo Lee (1996) provide empirical support for Lintner's model though models of economic behavior that predict dividend smoothing by managers have only recently been proposed by Vincent A. Warther (1994) and Drew Fudenberg and Jean Tirole (1995). Yet, Robert J. Shiller (1984) points out that the Lint-

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[1] See Froot and Obstfeld (1991a footnote 4), in particular, where they discuss models of fads and bubbles that are consistent with their results. John Driffill and Martin Sola (1998) show that a stock-price formulation based on a dividend-switching model better explains stock prices than a bubble model. Our model can be viewed as another interpretation and is compatible with Froot and Obstfeld's conceptualization.

ner model may not provide a good description of dividends.

In the following section, we propose a model of dividend regulation or control as an alternative to the standard dividend-smoothing model. We argue that our simple model (and its extensions) is observationally equivalent to the intrinsic-bubbles model offered by Froot and Obstfeld. Our purpose is not to propose a model that perfectly describes managerial behavior. Rather, our goal is to provide a simple, parsimonious model of managerial control of dividends that is able to explain the relationship between prices and dividends. Although our model may not seem to appropriately describe dividend policy at the firm-specific level, it is a reasonable representation for an aggregate index of firms. See Marsh and Merton (1987) for motivation of studies on aggregate-dividend behavior.

In our model price is a function of fundamentals alone; however, fundamental values are unobservable. Instead, we observe a managed dividend series. We show that the observable effect of dividend control on the price-dividend relation is identical to the effect of intrinsic bubbles. Thus, the nonlinear relation between prices and dividends may be attributable to how managers choose to manage dividends which, in effect, makes Froot and Obstfeld's intangible bubble tangible. This result improves our understanding of the relationship between prices and dividends.

The Comment is structured as follows. In Section I, we posit a simple, discounted present-value model of stock price. Section II provides concluding remarks.

I. Dividend Control in a Present-Value Model

We posit the following continuous-time stochastic process for dividends

$$dD_t = \mu D_t dt + \sigma D_t dz_t \tag{1}$$

where the true dividend or fundamental per share paid over time t, $\{D_t\}$, follows a continuous-time geometric Brownian motion process with constant drift or mean growth rate, μ, and standard deviation, σ, and z_t is a standard Weiner process with independent, normally distributed increments. By the above definitions and the properties of the Wiener increment dz_t, the dividend process given in equation (1) is Markov and the probability distribution of D_t increments depends only on its current level and the parameters.

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

$$P_t = E\left[\int_0^\infty D_{t+s} e^{-ks}\, ds\right] \tag{2}$$

where P_t is the time t stock price, E is the expectations operator, and k is the discount rate. With a constant growth rate in dividends (μ) and in the absence of dividend regulation by management, equation (2) has the familiar simple solution

$$P_t = \frac{D_t}{k - \mu} \tag{3}$$

where $k > \mu$. In the case of dividend regulation or control, a problem arises when evaluating the present-value relation in equation (2) because the true dividend or fundamental $\{D_t\}$ is unobservable. Instead, we observe the managed dividend process $\{d_t\}$.[2]

The dividend management process we envision is one in which actual cash dividends depend on the firm's underlying earnings capacity. In setting future dividends, management must essentially determine if a change in the firm's earnings capacity is permanent or temporary. When establishing next period's dividend, management assesses whether the last dividend paid

[2] The observed, ordinary cash dividend is not the only cash flow received by shareholders. The finance literature has long recognized that firms distribute cash flows to shareholders through other methods (Miller and Modigliani, 1961). The importance of other cash payments to shareholders, in addition to ordinary cash dividends, is well documented (see, for example, John B. Shoven, 1987; Laurie Simon Bagwell and Shoven, 1989; Ackert and Brian F. Smith, 1993). The difference between the fundamental and ordinary cash dividend may reflect other cash distributions such as share repurchases and takeover distributions, among others.

is consistent with the firm's current and future earnings capacity. Management may choose to hold the dividend constant if future earnings capacity is sufficient to support the dividend. However, if the assessment of future earnings capacity implies that the current dividend level cannot be supported, the dividend is reduced to a level that is consistent with the permanently lower earnings capacity. Similarly, if future earnings capacity is deemed sufficient to support a permanently higher dividend, the dividend is increased above the current level. Earnings in excess of total dividends paid are retained in the firm at a given reinvestment rate.

As is well known, most firms exhibit a bias against lowering cash dividends which suggests that managers place a lower bound on the level of cash dividends. This bound represents a barrier below which management is reluctant to reduce dividends, even when earnings capacity is consistent with a lower payout level. The firm may resort to liquidating assets in order to maintain the level of dividend payment. However, if the level of dividend payment cannot be supported by earnings, management may choose to shift the lower barrier downward to accommodate the change in fundamentals. Ordinarily, this lower barrier serves as a reflecting barrier for the dividend process.

On the up side, evidence regarding a firm's actual cash payments suggests that management has the flexibility to increase dividends if earnings capacity supports the increase. However, beyond some level, dividend increases must be justified by strong evidence of a permanent increase in the firm's earnings capacity. The upper bound for the dividend process can be viewed in continuous time as a reflecting barrier. If the firm's earnings capacity is judged to be sufficiently favorable to justify a dividend above the upper barrier, the upper barrier is increased to accommodate the permanent increase in earnings capacity.

To model this behavior in a continuous-time optimal-control framework, we assume that observed dividends $\{d_t\}$ follow the Ito process given in equation (1), as long as they remain strictly interior to a fluctuation band given by $[l, u]$, $u > l$. The fluctuation band for managed cash dividends has lower, l, and upper, u, reflecting barriers. In this specification, $\{d_t\}$ is a regulated geometric Brownian motion process with dynamics given by equation (1) in the absence of regulation. As a result of dividend management, when the dividend process $\{D_t\}$ reaches the upper barrier (u) or the lower barrier (l), the observed dividend process $\{d_t\}$ is reflected back towards the interior of the band $[l, u]$. Thus, the dynamics of dividends suggested by this model are quite different from those suggested by Lintner.

Following Samuel Bentolila and Giuseppe Bertola (1990 p. 386), the managed dividend stream $\{d_t\}$ can be related to the true dividend process $\{D_t\}$ as follows

$$d_t = D_t U_t / L_t \tag{4}$$

where $\{L_t\}$ is a lower regulator defined as the unique, nondecreasing, continuous process which increases only when d_t equals l keeping $d_t \geq l$ and $\{U_t\}$ is an upper regulator defined as the unique, nondecreasing, continuous process which increases only when d_t equals u keeping $d_t \leq u$ (see also J. Michael Harrison, 1985 p. 20). In our model, the barriers, u and l, are exogenously specified.

The stock price can be expressed as a function of managed cash dividends following Bentolila and Bertola (1990), who apply Harrison's (1985) methodology to the case of regulated geometric Brownian motion.[3] The solution to the present-value model under regulated or managed dividends, as described above, is given by[4]

$$P_t = A d_t^{\beta_1} + B d_t^{\beta_2} + \frac{d_t}{k - \mu} \tag{5}$$

where A and B are constants determined by boundary conditions and β_1 and β_2 are the

[3] The solution given in (5) requires that Paul R. Krugman's (1991) "smooth pasting" conditions hold. As Froot and Obstfeld (1991b pp. 211–12) point out, these conditions are, in effect, conditions on asset-price continuity.

[4] The solution to various forms of equation (5), including more complicated forms, are well known in the exchange-rate target-zone models literature. See, for example, the references cited in the article by Lars E. O. Svensson (1992).

positive and negative roots to the quadratic equation

$$(6)\quad Q \equiv \tfrac{1}{2}\sigma^2\beta(\beta - 1) + (k - \mu)\beta - k = 0,$$

and the other variables are as previously defined. Our formulation rests on the simplifying assumption that incremental retained earnings resulting from the dividend management process earn exactly the capitalization rate, k. In this case, a stockholder is indifferent between receiving the incremental earnings (which may be negative) and the capitalized cash flow in some future period. On this indifference see Myron J. Gordon (1962 Ch. 5). As the reader can verify, equation (5) is equivalent to the general solution provided by Froot and Obstfeld (1991a, footnote 8 p. 1192) for their intrinsic-bubbles model. Although our general solution includes two nonlinear terms, Froot and Obstfeld exclude the second nonlinear term in their estimation because the estimate of the second term was imprecise and its inclusion did not contribute to explaining movements in stock price. In our empirical examination of the model we also find that estimates vary widely, though the coefficients of both nonlinear terms are significantly different from zero in some sample periods (Ackert and Hunter, 1996).

More general models with multiple (nonfixed) barriers yield solutions with multiple nonlinear bubble terms. Essentially, for each new barrier, a new nonlinear "bubble term" is added to the empirical specification. Each shift in the upper or lower reflecting barrier effectively generates a new growth path for dividends (dependent on the firm's given reinvestment rate). For a more rigorous discussion of the mathematical properties of regulated Brownian motion, including the formulation of models with regulating barriers, see Harrison (1985). While this type of model may be more realistic, the analysis of such models is extremely complex.

II. Concluding Remarks

Froot and Obstfeld proposed a model of stock price that includes intrinsic bubbles and showed that the intrinsic-bubbles model is superior to a simple constant growth-rate model in predicting changes in actual stock prices. Their model is better able to track changes in actual stock prices because of the inclusion of a nonlinear bubble. However, as Froot and Obstfeld recognize, the rational-bubbles specification is not the only one that can explain stock-price movements. In this extension of their analysis, we show that the nonlinearity in the relationship between prices and dividends may arise from how managers choose dividend payout. In particular, we propose a model of managed dividends which can explain observed long-term trends in stock prices. In contrast to Froot and Obstfeld, the long-term trends implied by the model we develop do not depend on bubbles, but instead result from observed management behavior. As Froot and Obstfeld's intrinsic-bubbles model and the dividend-control model described herein are observationally equivalent, the same gains in predicting actual stock prices that arise in the bubbles model can be derived from the model of dividend control.

REFERENCES

Ackert, Lucy F. and Hunter, William C. "An Empirical Examination of the Price-Dividend Relation." Working paper, Federal Reserve Bank of Atlanta, November 1996.

Ackert, Lucy F. and Smith, Brian F. "Stock Price Volatility, Ordinary Dividends, and Other Cash Flows to Shareholders." *Journal of Finance,* September 1993, *48*(4), pp. 1147–60.

Bagwell, Laurie Simon and Shoven, John B. "Cash Distributions to Shareholders." *Journal of Economic Perspectives,* Summer 1989, *3*(3), pp. 129–40.

Bentolila, Samuel and Bertola, Giuseppe. "Firing Costs and Labour Demand: How Bad Is Eurosclerosis?" *Review of Economic Studies,* July 1990, *57*(3), pp. 381–402.

Driffill, John and Sola, Martin. "Intrinsic Bubbles and Regime Switching." *Journal of Monetary Economics,* October 1998, *42*(2), pp. 357–73.

Fama, Eugene F. and Babiak, Harvey. "Dividend Policy: An Empirical Analysis." *Journal of the American Statistical Association,* December 1968, *63*(324), pp. 1132–61.

Froot, Kenneth A. and Obstfeld, Maurice. "Intrinsic Bubbles: The Case of Stock Prices."

American Economic Review, December 1991a, *81*(5), pp. 1189–214.

______. "Exchange-Rate Dynamics Under Stochastic Regime Shifts: A Unified Approach." *Journal of International Economics*, November 1991b, *31*(3–4), pp. 203–29.

Fudenberg, Drew and Tirole, Jean. "A Theory of Income and Dividend Smoothing Based on Incumbency Rents." *Journal of Political Economy*, February 1995, *103*(1), pp. 75–93.

Gordon, Myron J. *The investment, financing, and valuation of the corporation.* Westport, CT: Greenwood Press, 1962.

Harrison, J. Michael. *Brownian motion and stochastic flow systems.* New York: Wiley, 1985.

Krugman, Paul R. "Target Zones and Exchange Rate Dynamics." *Quarterly Journal of Economics*, August 1991, *106*(3), pp. 669–82.

Lee, Bong-Soo. "Time-Series Implications of Aggregate Dividend Behavior." *Review of Financial Studies*, Summer 1996, *9*(2), pp. 589–618.

Lintner, John. "Distribution of Incomes of Corporations Among Dividends, Retained Earnings, and Taxes." *American Economic Review*, May 1956 (*Papers and Proceedings*), *46*(2), pp. 97–113.

Marsh, Terry A. and Merton, Robert C. "Dividend Variability and Variance Bounds Tests for the Rationality of Stock Market Prices." *American Economic Review*, June 1986, *76*(3), pp. 483–98.

______. "Dividend Behavior for the Aggregate Stock Market." *Journal of Business*, January 1987, *60*(1), pp. 1–40.

Miller, Merton H. and Modigliani, Franco. "Dividend Policy, Growth, and the Valuation of Shares." *Journal of Business*, October 1961, *34*(4), pp. 411–33.

Pettit, R. Richardson. "Dividend Announcements, Security Performance, and Capital Market Efficiency." *Journal of Finance*, December 1972, *27*(5), pp. 993–1007.

Shiller, Robert J. "Stock Prices and Social Dynamics." *Brookings Papers on Economic Activity*, 1984, *2*, pp. 457–98.

Shoven, John B. "The Tax Consequences of Share Repurchases and Other Non-dividend Cash Payments of Equity Owners," in Lawrence H. Summers, ed., *Tax policy and the economy*, Vol. 1. Cambridge, MA: MIT Press, 1987, pp. 29–54.

Svensson, Lars E. O. "An Interpretation of Recent Research on Exchange Rate Target Zones." *Journal of Economic Perspectives*, Fall 1992, *6*(4), pp. 119–44.

Warther, Vincent A. "Dividend Smoothing: A Sleeping Dogs Explanation." Working paper, University of Southern California, January 1994.

Watts, Ross. "The Information Content of Dividends." *Journal of Business*, April 1973, *46*(2), pp. 191–211.