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# Stock Price Volatility, Ordinary Dividends, and Other Cash Flows to Shareholders

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**ABSTRACT**

This paper shows that the results of variance-bound tests depend on how cash distributions to shareholders are measured. As in prior studies, we find apparent evidence of excess volatility when a narrow definition of cash flow (dividends only) is applied. However, we are unable to reject the hypothesis of market efficiency when the cash flow measure also includes share repurchases and takeover distributions in addition to ordinary cash dividends.

ACADEMICS AND PRACTITIONERS HAVE long debated whether the volatility in stock price reflects rational responses to changes in fundamentals. Some would argue, as did Keynes (1964), that investment can be likened to a game of chance where investors simply try to anticipate average expectations. At the other extreme, the simple market efficiency hypothesis implies that movements in stock prices are due to either changes in the discount rate or to new information concerning future cash flows, and at any point in time stock prices reflect all available information. Empirical tests of this hypothesis take many forms (Fama (1970, 1991)).

Tests of market efficiency that focus on stock price volatility were first proposed by LeRoy and Porter (1981) and Shiller (1981). These variance-bound tests examine restrictions on the volatility of actual stock price implied by the efficient markets hypothesis. Because stock price appears to be too volatile to be determined by the expected discounted value of cash dividends, the hypothesis is rejected. Later volatility tests also support this finding (West (1988a), Cochrane (1991)). In empirically testing the present value relation, these studies narrowly define the dividends or cash flows received by shareholders as ordinary cash dividends. However, within the finance literature, dividends include all cash distributions to shareholders. For example, in the seminal work of Miller and Modigliani (1961), cash distributed through share repurchases has the same economic role as ordinary cash dividends.

Kleidon (1986b) and Marsh and Merton (1986) discuss the problems that arise from testing present value relations when ordinary dividends do not properly represent cash flows. In addition, smoothing of ordinary dividends

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(Lintner (1956), Fama and Babiak (1968)) raises concerns because such behavior "implies changes in a future residual dividend that do not show up in the currently observed dividend series" (Kleidon (1986b), p. 977). Thus, tests which rely on a narrow definition of dividends may incorrectly reject the present value relation. Kleidon (1986c, p. 265) concludes that aggregate dividend smoothing by companies is central to explaining the apparent excess stock price volatility:

> Prices and earnings show similar percent changes for the period 1926–1979, and both are similar to dividend changes until about 1950. However, since that time, dividend changes appear much smoother than those of either prices or earnings. It is conceivable that this phenomenon is the basic puzzle, and that its resolution will explain much of what remains of the apparent evidence against the present value relation.

The potential for problems, arising from a narrow definition of dividends, has become more acute with the rapid growth of share repurchases and cash payments in mergers and acquisitions. Shoven (1986) and Bagwell and Shoven (1989) show that in recent years ordinary dividends represent less than half of the total cash distributed to shareholders. These total cash flows are also more volatile than ordinary cash dividends.

This paper shows that variance-bound test results are consistent with the efficient markets hypothesis when other cash distributions are included. We use the variance-bound test methodology of West (1988b) to test the hypothesis that stock price is not too volatile. Our data are from the Toronto Stock Exchange (TSE) for the period January 1950 to February 1991. We first analyze monthly and annual series of ordinary cash dividends and find results comparable to those of West (1988b), i.e., stock price appears overly volatile. The same test is then performed on broadly defined series of monthly and annual cash flows, where the series include ordinary dividends and cash generated by share repurchases and cash mergers and acquisitions. The results indicate that stock price volatility is consistent with the discounted value of expected dividends when differencing is required to induce stationarity.

The rest of the paper is organized as follows. In Section I, we briefly review the literature. In Section II, we document the explosive growth and increasing importance of cash distributions other than ordinary dividends and discuss how such cash distributions should be incorporated in the variance-bound tests. The data and estimation methods are described in Sections III and IV, respectively. In Section V we report the results of the variance-bound test. The final section provides conclusions.

## I. Literature

In an efficient market, all available information is fully reflected in the price of a security. If we further assume that the discount rate is time

invariant, stock price at the beginning of time $t$ can be written as

$$P_t = \gamma E_t(P_{t+1} + D_{t+1}) \tag{1}$$

where the discount factor, $\gamma = (1 + r)^{-1}$, is positive and constant, $D_{t+1}$ is the dividend received at the beginning of time $t + 1$, and $E_t(\cdot)$ denotes the mathematical expectation conditional on information available at time $t$. The validity of the model can be examined by testing its restrictions.

Shiller (1981) and LeRoy and Porter (1981) develop tests of market efficiency that focus on stock price variance. These variance-bound tests compare the variance of actual stock price to an upper bound, the variance of a function of actual dividends. Shiller's variance-bound inequality is[1]

$$\sigma(P_t) \leq \sigma(P_t^*) \tag{2}$$

where $\sigma(\cdot)$ is the standard deviation, $P_t$ is actual stock price, and $P_t^*$ is the ex post rational stock price. The ex post rational stock price is the present discounted value of actual dividends. Under the efficient markets model, actual stock price is the conditional mathematical expectation of ex post rational price. Shiller tests (2) using two data sets containing annual observations of a deflated stock price index and the associated dividends and concludes that stock price is too volatile to be determined by the present discounted value of dividends.[2]

The validity of these tests has been called into question. The early tests reject market efficiency, but assume a constant discount rate and stationarity of the price process. Researchers have concluded that it is doubtful that time-varying discount rates can explain the rejection (Shiller (1981), West (1988b)). However, there is evidence that stock prices and dividends are nonstationary (Kleidon (1986b)). Marsh and Merton (1986) show that nonstationarity results if dividend policy can be described by their particular model of dividend smoothing. In addition, Flavin (1983), Kleidon (1986a), and Mattey and Meese (1986) argue that these tests are biased toward rejection because of small sample bias.

Tests that do not rely on stationarity have come to be known as second-generation volatility tests (Merton (1987)). One such test, West (1988b), places an upper bound on the variance of the innovation in stock price. This upper bound is the variance of the innovation in a stock price forecast that uses a subset of the market's information set. As in West (1988b), we define

[1]The error in an agent's forecast is $e_t = P_t^* - P_t$. Because $e_t$ is uncorrelated with the optimal forecast, $P_t$, the variance of $P_t^*$ is greater than the variance of $P_t$ (Shiller (1981)).

[2]The LeRoy and Porter (1981) variance-bound tests are similar in spirit to Shiller's. The tests differ, however, in that Shiller's test gives a simple point estimate and LeRoy and Porter are able to attach significance levels. LeRoy and Porter also reject the model but the rejections are not always statistically significant due to large confidence intervals.

$I_t$ as the market's information set and $H_t$ as a subset of $I_t$ that contains at least current and past values of dividends, $D_t$. Also, we let

$$P_{tH} = \lim_{j \to \infty} P\left( \sum_{i=0}^{j} \gamma^{i+1} D_{t+i} | H_t \right) \tag{3}$$

and

$$P_{tI} = \lim_{j \to \infty} P\left( \sum_{i=0}^{j} \gamma^{i+1} D_{t+i} | I_t \right) \tag{4}$$

where $P(\cdot|\cdot)$ denotes linear projections (Hansen and Sargent (1980)). West proves that

$$E(P_{tH} - P(P_{tH}|H_{t-1}))^2 \geq E(P_{tI} - P(P_{tI}|I_{t-1}))^2. \tag{5}$$

That is, the variance of the innovation in price is larger when less information is used to forecast. A test of inequality (5) does not rely on level stationarity, and because a perfect foresight price is not needed, it avoids the small sample bias induced by highly autocorrelated perfect foresight prices.[3] Defining $H_t$ as the set containing current and past values of dividends, West (1988b) analyzes the Standard and Poor's and modified Dow Jones price and dividend series, and rejects the efficient markets model.

The validity of second-generation volatility tests has also been disputed. The debate centers on the assumptions of a constant discount rate and that movements in stock prices are due to new information concerning future dividends. Because of these assumptions, Fama (1991) argues that variance-bound tests are not tests of market efficiency, but instead simply provide evidence of time-varying expected returns. In addition, Cochrane (1991) shows that volatility tests are equivalent to Euler equation or conventional regression tests, and because of estimation advantages, he argues that Euler equation tests are preferable.

The volatility tests we perform are tests of a discounted cash flow model with a constant discount rate. We argue that these test results shed light on the efficiency debate: stock price volatility is not driven by shocks to current ordinary cash dividends per se, but by shocks to the firm's ability to generate cash flows in the future, i.e., by changes in fundamentals. Thus, the level of stock price volatility may be consistent with a discounted cash flow version of the efficient markets hypothesis if a better proxy for cash flows is used in testing.[4]

[3]As noted by Gilles and LeRoy (1991), West's estimates are consistent only when linear differencing induces stationarity.

[4]Although there is considerable evidence that discount rates are not constant (Fama (1991)), we do not use a model allowing time-varying discount rates. Shiller (1981) and West (1988b) find that the volatility of discount rates would have to increase dramatically to explain violations of variance bounds.

## II. A Broader Definition of Dividends

While the focus of previous studies has been on improving the specification of variance-bound tests, less attention has been given to the appropriate measure of cash receipts by shareholders. In empirical tests, researchers narrowly define the cash flows received by shareholders as ordinary cash dividends. However, ordinary cash dividends are only a subset of a shareholder's expected future cash flows. The rapid increase in cash payments via acquisitions and share repurchases is documented in Shoven (1986) and Bagwell and Shoven (1989).[5,6] These studies report that by the mid-1980s the total dollar amount of ordinary dividends paid was less than the sum of the other two types of cash distributions. Because of the size and volatility of these other cash distributions, the level and volatility of stock returns are grossly underpredicted by ordinary cash dividends alone.

Figure 1 contains plots of cash distributions, narrowly and broadly defined, for the period 1950 through 1990 for firms listed on the TSE. The figure illustrates that cash distributions broadly defined are more volatile than ordinary cash dividends.

If a dividend series that does not reflect fundamentals is used to test a variance-bound relationship, the inequality may be violated even when price can properly be regarded as the present value of future dividends (Kleidon (1986b, 1986c)). Thus, a proper test of the efficient markets model should include all cash flows in the empirical definition of dividends. In the following section we discuss the construction of a broadly defined cash flow series that we use to test the efficient markets hypothesis.

## III. Data

The TSE/University of Western Ontario database provides information on prices, dividends, and shares outstanding from January 1950 through February 1991. Our data is from the TSE because we have access to detailed records on mergers and acquisitions dating back to 1950. With this information, we construct real price and narrowly and broadly defined dividend time series. For every firm listed on the TSE, we estimate, monthly, the total amount of ordinary cash dividends, repurchases, cash distributions through merger and tender offers, and changes in month-end market capitalization due to stock price appreciation. These amounts are aggregated across all firms listed in a given month and divided by the beginning of the month total TSE market capitalization to determine percentage returns through ordinary

[5]Additional methods firms might use to transfer benefits in cash or in kind to shareholders can be envisioned. For example, Scholes and Wolfson (1989) document the benefits received by shareholders who participate in dividend reinvestment and stock purchase plans.

[6]Shoven collected information on cash via acquisitions and share repurchases using the Center for Research in Security Prices database for the period January 1970 through December 1985. Bagwell and Shoven (1989) collected information on such cash distributions over the period 1977 through 1987 using the COMPUSTAT database.

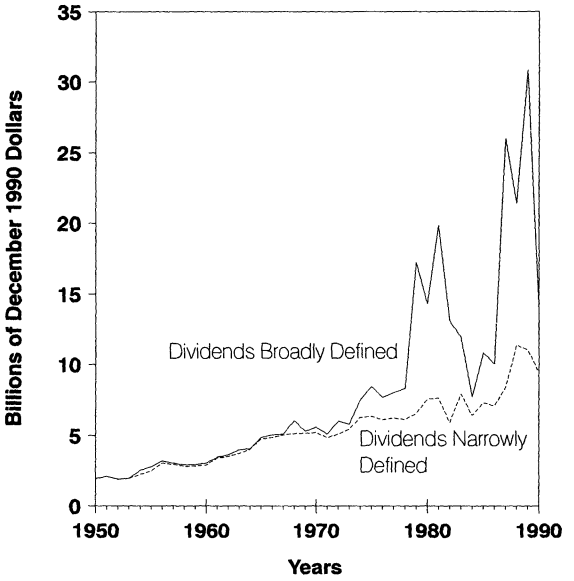


**Figure 1. Annual cash dividends on the TSE for the years 1950 to 1990.** The narrowly defined dividend series includes cash dividends alone, whereas the broadly defined dividend series includes cash generated by share repurchases and takeovers in addition to ordinary dividends. The figure shows that broadly defined dividends are more volatile than dividends narrowly defined.

cash dividends, share repurchases, cash mergers and acquisitions, and stock price changes. Price series associated with narrowly and broadly defined dividends are then constructed. The price series differ because the broadly defined dividend series is constructed on the basis of immediate consumption by shareholders of cash generated through share repurchases and takeovers, whereas the construction of a narrowly defined dividend series implicitly assumes that such amounts are immediately reinvested. To construct real monthly stock price indices, the price series are adjusted for inflation with the *Consumer Price Index*.[7] Correspondingly, indices of real monthly dividends and other cash distributions are determined.

As in Shoven (1986), we estimate share repurchases for a firm in a given month by multiplying the decrease in the number of shares outstanding during the month by the average of the opening and closing monthly prices. Estimates of share repurchases in excess of ten million dollars are checked by comparing them to changes in capital stock reported on the *Financial Post* Information Service securities database, a secondary information source. No significant discrepancies exist.

[7]Matrix 1922 of the CANSIM (Canadian Socio-Economic Information Management System) database of Statistics Canada contains the *Consumer Price Index* series.

Cash distributions through mergers and acquisitions are also estimated following Shoven (1986). We first identify all stocks that were delisted from the TSE during the period January 1950 to February 1991 using the TSE and Western stock database. To establish which of these delisted firms involved cash takeover payments, we reviewed the files of the TSE Surveillance Department, the *Canadian Business Index*, the *Financial Post* Information Service securities database, and annual financial statements.[8] We exclude those cases that involved either an exchange of securities or a reclassification of one class of common equity into another class of common equity of the same company. The total amount paid to target shareholders in the acquisitions is estimated by taking the product of the share price and number of shares outstanding at the last month-end prior to delisting.[9] A comparison of amounts actually paid out and estimates based on closing month-end target firm share prices indicates that the estimation method provides a close approximation. This follows from the fact that the price effect of the acquisition is generally fully impounded at the time of announcement which is usually at least a month before delisting. As reported in Smith and Amoako-Adu (1992), the timing and level of the price impact on target firm shares on the TSE is very similar to that of the U.S. exchanges.

## IV. Estimation

Using the TSE data described in the preceding section, we estimate West's (1988b) variance-bound inequality in order to gauge the effects on stock price volatility when cash flows other than cash dividend payments are included in estimation. In order to emphasize that our empirical test of market efficiency is based on cash distributions in addition to ordinary dividends, we rewrite (1) as

$$P_t = \gamma E_t(P_{t+1} + CF_{t+1}) \tag{6}$$

where $CF_{t+1}$ is the dividend, broadly defined, at the beginning of time $t + 1$. Substituting $CF_{t+i}$ for $D_{t+i}$, West's inequality (5) follows directly and an upper bound on the variance of the innovation in stock price is given by the variance of the innovation in a stock price forecast. Thus, a test of the efficient markets model as specified in equation (6) can be conducted by comparing these two variances.

The variance of the innovation in actual stock price is estimated following McCallum (1976) and Hansen and Singleton (1982) as described in West

[8]Cases in which target shareholders receive securities redeemable for a specific amount of cash within a short period of time are considered cash distributions.

[9]Our estimate of the cash distributions in takeovers is conservative as it excludes partial acquisitions. However, an analysis of a sample of 206 takeovers on the TSE in the period 1977 to 1989 reveals that the cash distributed through partial acquisitions represent only 11 percent of that through complete tender offer or merger resulting in delisting. Consequently, the degree of underestimation is not large.

(1988b). First rewrite equation (6) as

$$P_t = \gamma(P_{t+1} + CF_{t+1}) - \gamma[P_{t+1} + CF_{t+1} - E(P_{t+1} + CF_{t+1}|I_t)],$$
$$= \gamma[P_{t+1} + CF_{t+1}] + u_t \tag{7}$$

where

$$\text{Var}(u_t) = \gamma^2 E[P_{t+1} + CF_{t+1} - E(P_{t+1} + CF_{t+1}|I_t)]^2. \tag{8}$$

Because the explanatory variables are correlated with the error term, ordinary least squares estimation of equation (7) will not give consistent parameter estimates. We easily obtain consistent estimates using instrumental variables estimation. The variance on the right-hand side of inequality (5) is then estimated by $\gamma^{-2}\,\text{Var}(u_t)$.

We estimate the upper bound on the variance of the innovation in actual stock price following West (1988b) and Hansen and Sargent (1980). First we include in $H_t$, the subset of the market information set, current and lagged values of cash distributions to shareholders. Assuming that $d^s CF_{t+1}$ is a stationary stochastic process, we then estimate the coefficients of the cash flow process, $\alpha$ and $\phi_i$, $i = 1, \ldots q$,

$$d^s CF_{t+1} = \alpha + \phi_1 d^s CF_t + \cdots + \phi_q d^s CF_{t-q-1} + \nu_{t+1} \tag{9}$$

where $d$ is the difference operator, i.e., $d^s(x_t) = (x_t - x_{t-s})$, and $s = 0$, $s = 1$, or $s = 12$. Equation (9) is estimated using ordinary least squares with the Newey-West (1987) covariance matrix correction for heteroskedasticity. This procedure gives consistent estimates of the variance of the residuals, $\sigma_v^2$, even when uncertainty exists as to the true process that generates these residuals. The estimate of the variance on the left-hand side of inequality (5) is then given by

$$\delta_1^{*2}\sigma_v^{*2} \text{ where } \delta_1^* = \left[(1 - \gamma^*)^s \left(1 - \sum_1^q \gamma^{*j}\phi_j\right)\right]^{-1} \tag{10}$$

where the asterisk denotes parameter estimates. The formula for $\delta_1^*$ follows Hansen and Sargent (1980) and $\gamma^*$ is the estimate of the discount rate from equation (7).

To test the null hypothesis of efficient markets, we compare the innovation variances. If our estimate of West's statistic (WS),

$$WS = \delta_1^2\sigma_v^2 - \gamma^{-2}\sigma_u^2, \tag{11}$$

is significantly negative, we reject the null hypothesis that stock price is the present discounted value of expected future cash distributions. We also calculate

$$SMF = -100\frac{(\delta_1^2\sigma_v^2 - \gamma^{-2}\sigma_u^2)}{(\gamma^{-2}\sigma_u^2)} \tag{12}$$

or West's measure of the severity of model failure (SMF). If (11) is less than zero, SMF gives an estimate of the percentage of the variation in stock price innovations that appears to be excessive.

As discussed above, we estimate (7) using two-stage least squares and (9) using ordinary least squares. The innovation variances, $\sigma_u^2$ and $\sigma_v^2$, are calculated from the associated residuals. The $q + 4$ parameters are $\gamma$, $\sigma_u^2$, $\mu$, $\phi_1, \ldots, \phi_q$, and $\sigma_v^2$. The variance-covariance matrix for the $(1 \times (q + 4))$ parameter vector is consistently estimated for any arbitrary ARMA processes for the residuals following Hansen (1982), Newey and West (1987), and West (1988b).[10]

Using these methods, the variances are estimated and compared as a test of the efficient markets hypothesis. If the variance of the innovation in the stock price forecast is less than the variance of the innovation in actual stock price, the hypothesis is rejected.

Expressions (11) and (12) are estimated for raw and deseasonalized, differenced, and undifferenced monthly time series dividends data.[11] While this approach does not require level stationarity, it does require that stationarity can be induced by linear differencing. The statistical evidence of nonstationarity discussed previously and our own evidence indicate that differencing is required for statistical inference. Two methods of differencing are applied: first differencing and seasonal differencing. Seasonal differencing is preferable because of large sample autocorrelations at multiples of 12 lags in the monthly series. In addition, we estimate the variance-bound relationship for annual time series, both differenced and undifferenced and where the lag length is specified as 2 and 4.

## V. Results

Tables I and II report results of variance-bound tests for the narrowly and broadly defined dividend series. In general, the narrowly defined dividend series results are consistent with those of West (1988b) in that when we estimate the variance-bound relationship based on ordinary cash dividends alone, we find statistically significant violations of the model. However, the variance bound is not violated when dividends are defined broadly, and the series are differenced.

[10] See West (1988b, appendix A) for details on the calculation of the consistent variance-covariance matrix.

[11] Because monthly stock index cash flow data are highly seasonal, the results for both series are reported. Many filters were examined in order to remove the seasonal component including seasonal dummies and filters based on Granger and Newbold's (1986) multiplicative model. The autocorrelation functions of the filtered series were then examined to see which filter performed the best. The seasonally adjusted series used in estimation is the residual series from the dummy variables regression as both filters seem to perform equally well in removing the "jumps" in the autocorrelation function.

Table I provides results for six specifications of the monthly dividend series.[12] West's test statistic (WS) is estimated for deseasonalized and not deseasonalized, undifferenced, first differenced, and seasonally differenced series. The lag length of the dividend autoregression is specified as 12.[13] The first six rows contain estimates when dividends are narrowly defined and the final six rows are based on the broadly defined dividend series.

In columns four and five of Table I we report the results of West's test of the present value relation and measure of the severity of model failure. For every specification of the ordinary cash dividend generating process, the evidence shown in the first six rows leads us to reject the efficient market hypothesis. The asymptotic $z$-statistics of expression (11), determined by the ratio of the parameter and asymptotic standard errors reported in column five, indicate rejection at the one percent level using a one-tailed test. Furthermore, the fraction of the variance of the price series that is excessive ranges from 56.3 to 99.6 percent. These results are consistent with those reported in West (1988b) for annual Standard and Poor's and modified Dow Jones stock price and dividend series.[14]

As shown in Table I, the bound is also violated for the undifferenced broadly defined dividend series. However, as previously discussed, studies such as Kleidon (1986b) have indicated that stock prices and dividends are not stationary.[15] In addition, the sample autocorrelations of the series do not damp out quickly, indicating that differencing is required for stationarity. As statistical inference requires stationarity, the results for the differenced series are more reliable. For the four differenced cash flow specifications, the estimates of West's statistic are positive and the variance bound is not rejected. Thus, when the data are differenced and we include other cash distributions in addition to ordinary cash dividends, we cannot reject the hypothesis that stock prices are determined by rational agents as the present value of expected cash flows.

Table II provides the corresponding results using annual time series data.[16] We report results for two specifications of the lag length in the dividend processes, $q = 2$ and $q = 4$, and for undifferenced and first differenced data sets.

[12] Interim estimation results for equations (7) and (9) can be obtained from the authors, upon request.

[13] Similar results are obtained when the lag length is specified as $q = 6$ and $q = 15$.

[14] Based on the ordinary cash dividend series, the $t$-statistics for the six specifications range from $-4.49$ to $-2.20$. West's $t$-statistics range from $-5.05$ to $-2.61$.

[15] Not all researchers conclude that unit roots are present. Campbell and Shiller (1989) cannot reject the hypothesis of a unit root in prices but do reject the null of a unit root in dividends. Although this seems inconsistent, it is possible that the dividend series examined results from management smoothing and does not reflect the expected values used in determining stock prices. In this case the stock price series can be nonstationary while the observed dividend series is stationary (Kleidon (1986b)).

[16] We construct the annual series from the monthly series as in Marsh and Merton (1987) and Campbell and Shiller (1989).

**Table I**

## Monthly Series Variance-Bound Statistics

The table reports the results of West's test of the null hypothesis of efficient markets:

$$H_0: WS \geq 0 \text{ where } WS = \delta_1^2\sigma_v^2 - \gamma^{-2}\sigma_u^2.$$

If West's statistic (WS) is significantly negative, we reject the null hypothesis. The variance of the innovation in actual stock price is $\gamma^{-2}\sigma_u^2$, where the parameters $\gamma$ and $\sigma_u^2$ are defined in equations (7) and (8). The upper bound on this variance is the variance of the innovation in a stock price forecast or $\delta_1^2\sigma_v^2$, where the parameters $\delta_1$ and $\sigma_v^2$ are defined in equations (9) and (10). The test is conducted using monthly data for firms listed on the TSE for the period January 1950 to February 1991. The first six rows report results for a test of the hypothesis that price is the expected present value of narrowly defined, or ordinary cash, dividends. The final six rows report results for a test of the hypothesis that price is the expected present value of dividends broadly defined to include cash received by shareholders via ordinary dividends, repurchases, and acquisitions. Asymptotic standard errors are provided in parentheses and the lag length of the dividend autoregression is specified as 12. The model is estimated for deseasonalized and not deseasonalized, undifferenced, first differenced, and seasonally differenced series. Also reported is our estimate of West's measure of the severity of model failure (SMF):

$$SMF = -100(\delta_1^2\sigma_v^2 - \gamma^{-2}\sigma_u^2)/(\gamma^{-2}\sigma_u^2).$$

| Definition of Dividends | Deseasonalized | Differenced | WS | SMF |
|---|---|---|---|---|
| Narrow | No | No | −1328.57* | 99.61 |
| | | | (365.05) | |
| Narrow | No | First | −862.52* | 64.51 |
| | | | (327.66) | |
| Narrow | No | Seasonally | −1169.03* | 87.88 |
| | | | (261.66) | |
| Narrow | Yes | No | −1329.28* | 99.67 |
| | | | (365.14) | |
| Narrow | Yes | First | −750.70* | 56.26 |
| | | | (340.76) | |
| Narrow | Yes | Seasonally | −1173.99* | 88.24 |
| | | | (261.36) | |
| Broad | No | No | −920.69* | 96.08 |
| | | | (195.46) | |
| Broad | No | First | 8156.03 | −849.52 |
| | | | (3646.57) | |
| Broad | No | Seasonally | 1135.41 | −119.08 |
| | | | (896.28) | |
| Broad | Yes | No | −923.64* | 96.38 |
| | | | (203.04) | |
| Broad | Yes | First | 7781.71 | −822.61 |
| | | | (3567.29) | |
| Broad | Yes | Seasonally | 1054.51 | −110.58 |
| | | | (857.64) | |

Asterisk indicates significance at the 95 percent level.

**Table II**

## Annual Series Variance-Bound Statistics

The table reports the results of a test of the null hypothesis of efficient markets:

$$H_0: WS \geq 0 \text{ where } WS = \delta_1^2\sigma_v^2 - \gamma^{-2}\sigma_u^2.$$

If West's statistic (WS) is significantly negative, we reject the null hypothesis. The variance of the innovation in actual stock price is $\gamma^{-2}\sigma_u^2$, where the parameters $\gamma$ and $\sigma_u^2$ are defined in equations (7) and (8). The upper bound on this variance is the variance of the innovation in a stock price forecast or $\delta_1^2\sigma_v^2$, where the parameters $\delta_1$ and $\sigma_v^2$ are defined in equations (9) and (10). The test is conducted using annual data for firms listed on the TSE for the period 1950 to 1990. The first four rows report results for a test of the hypothesis that price is the expected present value of narrowly defined, or ordinary, cash dividends. The final four rows report results for a test of the hypothesis that price is the expected present value of dividends broadly defined to include cash received by shareholders via ordinary dividends, repurchases, and acquisitions. Asymptotic standard errors are provided in parentheses. The model is estimated for undifferenced and first differenced series with autoregression lag lengths of $q = 2$ and $q = 4$. Also reported is our estimate of West's measure of the severity of model failure (SMF):

$$SMF = -100(\delta_1^2\sigma_v^2 - \gamma^{-2}\sigma_u^2)/(\gamma^{-2}\sigma_u^2).$$

| Definition of Dividends | Differenced | $q$ | WS | SMF |
|---|---|---|---|---|
| Narrow | No | 2 | −22103.92* | 99.91 |
| | | | (11116.12) | |
| Narrow | First | 2 | −21356.29* | 93.58 |
| | | | (6889.88) | |
| Narrow | No | 4 | −23401.57* | 99.92 |
| | | | (1148.96) | |
| Narrow | First | 4 | −22649.73* | 96.88 |
| | | | (7416.03) | |
| Broad | No | 2 | −15541.95* | 90.83 |
| | | | (3631.22) | |
| Broad | First | 2 | 11272.16 | −63.85 |
| | | | (19345.60) | |
| Broad | No | 4 | −17456.73* | 96.17 |
| | | | (5963.71) | |
| Broad | First | 4 | 115.71 | −0.65 |
| | | | (11063.27) | |

Asterisk indicates significance at the 95 percent level.

The first four rows of Table II present results of the test of the variance-bound inequality for the annual ordinary cash dividend series. As with the monthly narrowly defined dividend series and in West (1988b), the efficient markets model is rejected for all specifications. However, this is not the case when other cash distributions are included in the cash flows received by shareholders. Consistent with the results for the monthly series, West's statistic is positive for the differenced broadly defined dividend series and significantly negative for the undifferenced series. Because stationarity is

required for statistical inference and there is evidence indicting nonstationarity in the undifferenced series, we cannot reject the present value relation. Thus, there is evidence that stock prices are not too volatile to be determined by rational agents as the expected discounted value of all future cash flows, or broadly defined dividends.

## VI. Conclusions

This paper provides evidence that reconciles the findings of earlier studies of stock price volatility based on variance-bound tests with the efficient markets model. Consistent with previous studies such as LeRoy and Porter (1981), Shiller (1981), and West (1988b), we reject the efficient markets hypothesis when dividends are defined narrowly. Because stock prices should reflect the discounted value of total expected cash flows received by shareholders rather than just ordinary cash dividends, we reexamine the issue of apparent excess price volatility by incorporating cash distributions through share repurchases and cash payments in takeovers. Inclusion of additional cash distributions is of increasing importance due to the growth of such payments by corporations.

We conduct second-generation variance-bound tests based on monthly and annual series of cash distributions and find that stock prices are not too volatile to be explained by the discounted value of total cash flows. This finding reflects the fact that investors tend to receive their stock returns in the form of a relatively smooth stream of ordinary cash dividends and a more volatile series of stock repurchases and cash acquisition payments. Consequently, not only do these empirical results support the efficient markets model, but they demonstrate the importance of correctly specifying tests of restrictions implied by the efficient markets model. Actual stock prices are determined by rational agents as the expected present discounted value of all future cash flows received by shareholders.

## REFERENCES

Bagwell, Laurie Simon, and John B. Shoven, 1989, Cash distributions to shareholders, *Journal of Economic Perspectives*, 3, 129–140.

Campbell, John Y., and Robert J. Shiller, 1989, The dividend-price ratio and expectations of future dividends and discount factors, *Review of Financial Studies* 1, 195–228.

Cochrane, John H., 1991, Volatility tests and efficient markets: A review essay, *Journal of Monetary Economics* 27, 463–485.

Fama, Eugene F., 1970, Efficient capital markets: A review of theory and empirical work, *Journal of Finance* 25, 383–417.

———, 1991, Efficient capital markets: II, *Journal of Finance* 46, 1575–1618.

——— and Harvey Babiak, 1968, Dividend policy: An empirical analysis, *Journal of the American Statistical Association*, 63, 1132–1161.

Flavin, Marjorie A., 1983, Excess volatility in the financial markets: A reassessment of the empirical evidence, *Journal of Political Economy* 91, 929–956.

Gilles, C., and S. F. LeRoy, 1991, Econometric aspects of the variance-bounds test: A survey, *Review of Financial Studies*, 4, 753–791.

Granger, C. W. J., and Paul Newbold, 1986, *Forecasting Economic Time Series*, 2nd ed. (Academic Press, New York).

Hansen, L. P., 1982, Large sample properties of generalized method of moments estimators, *Econometrica* 50, 1029–1054.

——— and T. J. Sargent, 1980, Formulating and estimating dynamic rational expectations models, *Journal of Economic Dynamics and Control* 2, 7–46.

Hansen, L. P., and K. J. Singleton, 1982, Generalized instrumental variables estimation of nonlinear rational expectations models, *Econometrica* 50, 1269–1286.

Keynes, John Maynard, 1964, *The General Theory of Employment, Interest, and Money*, 1st Harbinger ed. (Harcourt Brace Jovanovich, New York).

Kleidon, Allan W., 1986a, Bias in small sample tests of stock price rationality, *Journal of Business* 59, 237–261.

———, 1986b, Variance bounds tests and stock price valuation models, *Journal of Political Economy* 94, 953–1001.

———, 1986c, Empirical assessment of present value relations—comment, *Econometric Reviews* 5, 261–265.

LeRoy, Stephen F., and Richard D. Porter, 1981, The present-value relation: Tests based on implied variance bounds, *Econometrica* 49, 555–574.

Lintner, John, 1956, Distribution of incomes of corporations among dividends, retained earnings, and taxes, *American Economic Review Papers and Proceedings* 46, 97–113.

McCallum, B. T., 1976, Rational expectations and the natural rate hypothesis: Some consistent estimates, *Econometrica* 44, 43–52.

Marsh, T. A., and R. C. Merton, 1986, Dividend variability and variance bound tests for the rationality of stock market prices, *American Economic Review* 76, 483–498.

———, 1987, Dividend behavior for the aggregate stock market, *Journal of Business* 60, 1–40.

Mattey, Joe, and Richard Meese, 1986, Empirical assessment of present value relations, *Economic Reviews* 5, 171–234.

Merton, Robert C., 1987, On the current state of stock market rationality, in Rudiger Dornbusch, Stanley Fisher, and Jason Bossons, eds.: *Macroeconomics and Finance: Essays in Honor of Franco Modigliani* (MIT Press, Cambridge, Mass.), pp. 93–124.

Miller, M., and F. Modigliani, 1961, Dividend policy, growth, and the valuation of shares, *Journal of Business* 34, 411–433.

Newey, Whitney K., and Kenneth D. West, 1987, A simple positive definite, heteroskedasticity and autocorrelation consistent covariance matrix, *Econometrica* 55, 703–708.

Scholes, Myron S., and Mark A. Wolfson, 1989, Decentralized investment banking: The case of discount dividend-reinvestment and stock-purchase plans, *Journal of Financial Economics* 23, 7–35.

Shiller, Robert J., 1981, Do stock prices move too much to be justified by subsequent changes in dividends?, *American Economic Review* 76, 421–436.

Shoven, John B., 1986, The tax consequences of share repurchases and other non-dividend cash payments to equity owners, in Lawrence Summers, ed.: *Tax Policy and the Economy*, vol. 1 (MIT Press, Cambridge, Mass.), pp. 29–54.

Smith, Brian F., and Ben Amoako-Adu, 1992, Minority buyouts and ownership characteristics: Evidence from the Toronto Stock Exchange, *Financial Management* 21, 41–51.

West, Kenneth D., 1988a, Bubbles, fads, and stock price volatility tests: A partial evaluation, *Journal of Finance* 43, 639–660.

———, 1988b, Dividend innovations and stock price volatility, *Econometrica* 56, 37–62.