Ex-Dividend Price Behavior of Common Stocks

John H. Boyd and Ravi Jagannathan*

ABSTRACT

This study examines common stock prices around ex-dividend dates. Such price data usually contain a mixture of observations—some with and some without arbitrageurs and/or dividend capturers active. Our theory predicts that such mixing will result in a nonlinear relation between percentage price drop and dividend yield—not the commonly assumed linear relation. This prediction and another important prediction of theory are supported empirically. In a variety of tests, marginal price drop is not significantly different from the dividend amount. Thus, over the last several decades, one-for-one marginal price drop has been an excellent (average) rule of thumb.

Introduction

The behavior of stock prices around ex-dividend dates is of interest to finance scholars for several reasons. It is one indicator of the relative valuation of dividends versus capital gains, a critical issue in corporate dividend policy. The topic is of considerable interest, too, to securities market participants—and for obvious reasons. Resultantly, there have been a considerable number of studies of ex-dividend price behavior. Following Elton and Gruber (1970), this literature initially concentrated on testing for the existence of tax effects on pricing, given the more favorable treatment of capital gains over dividends. Assuming that transactions costs can be ignored and that all traders prefer capital gains to dividends, it is easy to show that prices should theoretically drop by less than the amount of the dividend. In fact, a number of early studies did reach that conclusion. However, there was reason to question two key assumptions, and thus to question the interpretation of the early findings.

As Kalay (1982) and Miller and Scholes (1982) pointed out, transactions costs are not negligible when compared to the usual magnitude of cash dividends. Kalay (1982) also noted that it would be difficult to disentangle the transactions cost component and the differential tax component by looking at ex-day returns. He did make an effort to do so by computing a bound on transactions costs that would prevent arbitrage profits to short-term traders for whom dividends and capital gains are taxed at the same rate. However, Kalay ignored the possibility that transactions costs and the opportunity cost of capital depend on the stock as well as the market conditions prevailing at a point in time. (His bounds computations are discussed in Section I.D of this study). Karpoff and Walkling (1988, 1990) found that excess ex-day returns are positively related to transactions costs. Following from these and other studies, the current consensus seems to be that transactions costs are important and must be taken into account in empirical testing of ex-day price behavior.

It is unreasonable to assume (as was done in the early research on ex-day pricing) that all investors have a tax-induced preference for capital gains over dividends. There are now and have always been traders that face the same tax rates on both sources of income: pension funds, which are usually tax-exempt, and market makers, floor traders, etc., who face the same positive tax rate on dividends and capital gains. Corporate cash managers may also have an incentive to "capture" dividends because of tax treatment that excludes a large fraction of dividend income from corporate taxation. Although the corporate tax structure has been changed repeatedly over the years, this dividend exclusion is still in effect. In one form or another dividend capture programs have been employed for many years by U.S. corporations, by Japanese insurers, and by others.[1]

Eades, Hess, and Kim (1984) pointed out that there is a run-up in stock prices before the ex-date and a run-down after the ex-date. One way to interpret this evidence is that there may be information in price behavior around ex-dates, not just on the ex-date alone. However, we ignore this issue in our work which concentrates on ex-dividend pricing.

Eades, Hess, and Kim (1984) also studied the ex-date price behavior of preferred stocks which have a high dividend yield. The ex-dividend day excess return is smaller for such stocks (sometimes even negative), suggesting that dividend capture activities are likely to be the primary determinant of ex-date price behavior of high dividend yield stocks. This view was confirmed by Lakonishok and Vermaelen (1986) who found that abnormal trading volume around ex-date was related to dividend yield. Koski (1990) employed intraday transactions data and identified several distinct trading strategies depending on tax and regulatory status. Her work was the first to systematically investigate the price effects of trading by the Japanese insurance companies. Eades, Hess, and Kim (1991) studied the time-series variation in ex-dividend pricing and presented evidence suggesting that there is substantial variation over time in the amount of dividend capturing activity.

To summarize, the existing literature has isolated three important stylized facts about ex-dividend day price behavior. First, transactions costs affect pricing and must be taken into account in empirical research on this topic. Second, several classes of traders may trade around ex-dates, with systematically different taxes and/or transactions costs. Third, dividend capture activities represent a substantial amount of ex-day trading, primarily for high dividend yield stocks. Whereas there seems to be general agreement about these qualitative facts, there has been little consensus about many quantitative issues—especially the importance of (changes in) exogenous parameters such as transactions costs and tax rates. A complete review of this large literature is beyond the scope of this study. However, an excellent one may be found in Scholes and Wolfson (1992). As they put it, "The effect on stock prices of differences in taxation on dividends and capital gains remains an open question." (p. 368).[2]

How Is This Study Related to the Existing Literature?

This study takes explicit account of two of the stylized facts from the literature reviewed above: (i) transactions costs are important, and (ii) there are several different classes of traders with different transactions costs and/or tax treatments. We develop an equilibrium model in which transactions cost play a key role, and in which there are three classes of traders: taxable individuals, tax-advantaged dividend capturers, and tax-neutral arbitrageurs. We characterize the nature of an equilibrium and the equilibrium relation between expected percentage price drop and dividend yield. The third stylized fact—dividend capturing of high-yield stocks—is a property of the equilibrium. Previous work is not necessarily inconsistent with predictions of our theory; however, existing results do not provide an adequate test of that theory either. Therefore, following Poterba (1986) and Hayashi and Jagannathan (1990), we develop our own empirical tests.

Another way in which this study differs from most previous research is that we employ an extremely large sample, pooling over 25 years for a total of about 132,000 observations on ex-dividend dates. The reason for employing this procedure is the extremely high noise-to-signal ratio, which is documented in this study. As will be demonstrated, empirical tests employing data for one or a few years will be extremely imprecise. A significant drawback of our approach is that we can only examine average relations over a long time interval.

Outline of This Study

The rest of the study proceeds as follows. In Section I we develop the equilibrium theory. It predicts that for low dividend yield stocks, trading will generally take place between taxable individuals. Over some intermediate range of dividend yield, tax-neutral arbitrageurs may enter the market, buying from, and selling to, taxable individuals. For stocks with high dividend yields, dividend capture may be desirable, depending on other stock attributes besides yield. Each range of dividend yield is characterized by a different equilibrium pricing condition. The result is that the theoretically predicted relation between expected percentage price drop and dividend yield is a piece-wise linear convex function that will, in general, be indexed by prevailing market conditions. As we will show, this is true whether or not arbitrageurs enter the market.

A stock's suitability for arbitrage or dividend capturing trading depends on other features besides its dividend yield—especially its risk, transactions costs and the quantity of the stock available. These other attributes are either unknown or imperfectly observed by the researcher. What this means, for practical purposes, is that securities cannot be accurately assigned to the three theoretical ranges. Therefore, empirical estimates of ex-dividend price drop will necessarily be "mongrels" of the different underlying linear functions, that is, some weighted average of these

functions. The results obtained must unavoidably depend on the (unknown) relative sample weighting of the different groups and of different time periods.

The theory predicts that as a result of this sample mixing, there will be systematic deviations from a fitted linear regression of percentage price drop on dividend yield. The empirical tests presented in Section II support that prediction. Another test in Section II supports the predictions of the theory too. We alter sample composition by removing low dividend observations. That, according to our theory, should increase the fraction of data points at which dividend capture is occurring. Regression results change in exactly the manner predicted by theory.

Next, in Section III we show that these findings may be quite important for empirical tests which examine the pricing effects of exogenous regime changes—for example, changes in tax or commission rates. When such a change occurs, one effect is to alter the equilibrium (no-arbitrage) conditions. However, there is also another effect: arbitrage and/or dividend capture becomes feasible for a larger or smaller group of securities. Thus the mix of sample data between the different equilibrium pricing conditions changes also. Hereafter, we shall refer to the first effect as the *equilibrium condition effect* and the second as the *participation effect*. In the case of an exogenous change in commission rates, the predicted effects are of opposite sign. Our empirical examination of the switch to negotiated commission rates suggest that, in that instance, the participation effect was the dominant one of the two. Thus, if a researcher did not take account of that effect, the data might present a puzzle.

We argue that other factors besides dividend yield affect a stock's suitability for dividend capture. In Section IV we investigate some other candidate variables, or proxies for them. These tests suggest that at least one other factor is important—the volatility of a stock's price drop. This is an indicator of the risk to which dividend capturers may be exposed, and the tests suggest that they have been averse to such risk.

Section V documents a significant problem confronting researchers in this area—an extremely high noise-to-signal ratio. Dividend yields vary across stocks and over time, but their variability is minuscule compared to that of daily stock returns. As discussed in Section V, discreteness in stock price quotations compounds the problem. To illustrate these issues, we estimate price drop equations annually for each of the 25 years in our sample. Simply put, the results vary enormously from year to year. The implication is that inferences based on one or a few years' data will be extremely imprecise. One solution is to examine a very long time period as is done in this study. A final statistical problem, the bias in OLS standard errors, is considered in Appendix B.

The study concludes on a postscript in Section VI. In reviewing all the empirical results, we note that marginal ex-dividend price drop is almost always one-for-one with dividends (in the cross section). This result is obtained with a variety of different specifications and over a period of approximately 25 years. This finding is simply an empirical regularity (stylized fact). It is neither predicted by our theory, nor inconsistent with it. Whatever the explanation, our results suggest that one-for-one marginal price drop has been a good rule of thumb, at least on average, over the last 25 years.[3]

I. An Equilibrium Model of Ex-Dividend Share Pricing

We consider an environment in which transactions costs play an important role. As Kalay (1982) has pointed out, transactions costs are of the same order of magnitude as ex-dividend price declines. The decision problem facing an investor in the presence of taxes and transactions costs is inherently dynamic and complex. Investors will typically follow (S,s) type policies for deciding when to trade [see, for example, Constantinides (1986) and Grossman and Laroque (1990)]. Hence it is inappropriate to model the decision problem facing an investor (who has decided to trade at ex-dates) as a simple portfolio choice problem.

In what follows, we consider three distinct classes of traders. There are *taxable individuals*, who can be either *buyers* or *sellers*. Also, there are *dividend capturing, tax-advantage corporations.* These dividend capturers trade only around ex-dividend dates in order to receive cash dividends. Finally, there are *tax-neutral arbitrageurs*, who are either market makers or floor traders. They make a living by providing liquidity to the market. Since providing such a service takes time (that is, labor), the cost of lost opportunities can be significant for such arbitrageurs, even though explicit trading costs may be tiny. In addition, the opportunity costs for such traders are likely to vary substantially across time and security. Hence it would be inappropriate to model the trading decisions of the arbitrageurs as a simple portfolio choice problem.[4]

We assume, without loss of generality, that the decision to trade is exogenously determined for taxable individuals, both buyers and sellers. We further assume that both buyers and sellers come to the market to trade in a predetermined quantity. The only discretion they have is in deciding whether to trade on the cum-dividend date or on the ex-dividend date. In equilibrium, stock prices will adjust such that buyers/sellers will either be indifferent to trading on the ex-dividend or cum-dividend date or will strictly prefer trading on one of these dates. If their (weakly) preferred trading dates coincide, their trades will cross. If taxable individuals are not indifferent and their preferred trading dates differ, then arbitrageurs will enter the market. They will either be indifferent or strictly prefer to take up the order imbalance. Finally, in equilibrium, dividend capturers will either trade with buyers and sellers or simply not enter the market. In what follows, we expand these arguments and attempt to make them precise.

Define P = price per share, D = dividend per share, c = proportional transaction cost (inclusive of bid-asked spread), and t = date. τ_c = tax rate on capital gains, and τ_d = tax rate on dividends; these may vary across agents. Period 0 is the last trading day a stock sells cum-dividend, and period 1 is the ex-dividend date. Period b refers to some arbitrary date at which the stock was

previously acquired by a taxable individual ($b < 0$). Period s refers to some arbitrary future date when the stock will be sold by a taxable individual ($s > 1$). For simplicity of exposition we assume that dividends will be received and taxes will be paid at this same date, s. E is the expectations operator. All cash-flows are transformed into period 0 equivalents; δ is a multiplicative discount factor for futurity, and δ' is a multiplicative discount factor for futurity and risk. Thus $\delta'_t EP_t$ is the risk- and time-adjusted period 0 value of selling one share of stock in period t. δ and δ' will depend on the type of trader, type of stock, the quantities traded, and other market conditions. Finally, we assume that any capital losses can be fully offset against capital gains.[5]

A. Taxable Individuals, Buyers

At period 0 a taxable individual has decided to buy; the question is this: Should she buy today cum-dividend or wait until tomorrow and buy ex-dividend? If she buys today, planning to ultimately sell at $t = s$, the risk-adjusted expected return per share in period 0 dollars is

$$-P_0(1+c) + D\delta_s + EP_s(1-c)\delta'_s - \{EP_s(1-c) - P_0(1+c)\}\tau_c\delta'_s - D\tau_d\delta_s. \tag{1}$$

If she waits until tomorrow, her expected return is

$$-EP_1(1+c)\delta'_1 + EP_s(1-c)\delta'_s - \{EP_s(1-c) - EP_1(1+c)\}\tau_c\delta'_s. \tag{2}$$

Indifference between trading at $t = 0$ or 1 requires that (1) and (2) be equated and, after rearrangement, that

$$\frac{P_0 - EP_1}{P_0} = \frac{\delta'_1 - 1}{\delta'_1 - \tau_c\delta'_s} + \frac{D}{P_0}\left\{\frac{\delta_s(1-\tau_d)}{(1+c)(\delta'_1-\tau_c\delta'_s)}\right\}. \tag{3}$$

B. Taxable Individuals, Sellers

Suppose that in period 0 a holder of the stock has decided to sell. Employing the same logic as above, indifference between selling at $t = 0$ and $t = 1$ requires that

$$\frac{P_0 - EP_1}{P_0} = \frac{\delta_1' - 1}{\delta_1' - \tau_c \delta_s'} + \frac{D}{P_0}\left\{ \frac{\delta_s(1-\tau_d)}{(1-c)(\delta_1' - \tau_c \delta_s')} \right\}. \tag{4}$$

Conditions (3) and (4) are similar, differing only in the way the transaction cost enters the denominator of the slope coefficient. The intercept term is unambiguously negative (since $\delta_s' < \delta_1' < 1$, and $0 \leq \tau_c < 1$), but extremely close to zero. For stocks which pay no dividend, the price drop is negative (the price rises), and when $\tau_c = 0$, $(P_0 - EP_1)/P_0 = (\delta_1' - 1)/\delta_1'$, as would be expected due to the positive time value of money.

C. Dividend Capturing, Tax-Advantaged Corporations

Consider a tax-advantaged corporation that can buy the stock at the last cum-dividend date and sell at the ex-date, capturing the dividend in the process. Its alternative is to invest at the one period risky rate of interest, $(1-\delta_1')/\delta_1'$. Indifference between these strategies requires that the period 0 discounted value of the dividend capture strategy be zero or, after rearrangement, that

$$\frac{P_0 - EP_1}{P_0} = \frac{D}{P_0}\left\{ \frac{\delta_s - \tau_d \delta_s}{(1-c)(\delta_1' - \tau_c \delta_s')} \right\} + 1 - \frac{(1+c)(1-\tau_c \delta_s')}{(1-c)(\delta_1' - \tau_c \delta_s')}. \tag{5}$$

Noting that $(1-\tau_c \delta_s')/(\delta_1' - \tau_c \delta_s')$ is very close to unity (slightly greater), we assume this ratio is exactly 1.0, and (5) simplifies to

$$\frac{P_0 - EP_1}{P_0} = -\frac{2c}{1-c} + \frac{D}{P_0}\left\{ \frac{\delta_s(1-\tau_d)}{(1-c)(\delta_1' - \tau_c \delta_s')} \right\}. \tag{6}$$

The slope coefficient in (6) is exactly the same as in (4), and the intercept term is unambiguously negative but now of nontrivial magnitude. The left side of (6) gives the capital loss incurred by the tax-advantaged corporation. The right side gives the comparable (after taking the effect of taxes into account) dividend yield captured. For the tax-advantaged corporations to come out even or better, the right side should be greater than or equal to the left side, or

$$\frac{D}{P_0}\left\{\frac{\delta_s(1-\tau_d)}{(1-c)(\delta_1'-\tau_c\delta_s')}\right\} - \frac{P_0 - EP_1}{P_0} \geq \frac{2c}{(1-c)}. \tag{7}$$

Hence dividend capture activity will be attractive only if the dividend yield is sufficiently large to overcome transactions costs.

D. Tax-Neutral Arbitrageurs

Tax-neutral arbitrageurs are market professionals who face the same tax rates on dividends and capital gains and trade at relatively low transactions costs. The indifference condition for a long arbitrageur is exactly the same as (6) except, of course, that in this case $\tau_d = \tau_c$. For a short arbitrageur, the indifference condition is

$$\frac{P_0 - EP_1}{P_0} = \frac{2c}{(1+c)} + \frac{D}{P_0}\left\{\frac{\delta_s(1-\tau_d)}{(1+c)(\delta_1'-\tau_c\delta_s')}\right\}, \tag{8}$$

and again, we assume for simplicity that $(1-\tau_c\delta_s')/(\delta_1'-\tau_c\delta_s') = 1.0$. Note that conditions (6) and (8) are similar, except for the way that transactions costs enter.

Kalay (1982) derived conditions similar to (6) and (8), with the additional assumption that $\delta_t = \delta_t'$ (risk-neutrality). With this additional assumption, (6) and (8) define Kalay's (1982, p. 1062) no-arbitrage range

$$\left[1 - \frac{2c}{(D/P_0)}\right] \leq \frac{|(P_0 - EP_1)|/P_0}{D/P_0} \leq \left[1 + \frac{2c}{D/P_0}\right].$$

We prefer (6) and (8) to this simpler condition, since we are not comfortable with the risk-neutrality assumption. Especially in the case of short arbitrage, these positions may be risky and/or difficult to execute. Thus there is no reason to expect the two no-arbitrage conditions to be symmetric, as above.

E. Equilibrium

The indifference condition for any trader type can be written as

$$E\{(P_0 - P_1)/P_0 : \Omega\} = \alpha + \beta d, \tag{9}$$

where Ω denotes the information set of the market participants and the parameters α and β vary across the different classes of traders. We assume that tax rates, transactions costs, and risk aversion may differ across classes of traders, but not within classes.[6] Within classes, only Ω varies and the most optimistic member of a class will trade first. Also, by assumption, we are holding constant all securities attributes other than dividend yield and expected price drop. Market conditions such as the opportunity rate δ are also held constant, since an equilibrium is (only) defined for a single instant in time.

First, consider the hypothetical case in which only buyers and sellers trade. For both groups, $\alpha \approx 0$ in (9). By conditions (3) and (4) the slope coefficient for sellers is greater than that for buyers, and both slope coefficients are less than 1.0. The two indifference lines are shown as *0-seller* and *0-buyer* in Figure 1a. In the region below 0-seller the expected price drop is too small for indifference, and sellers strictly prefer to postpone the trade to date 1. Similarly, above the line 0-buyer, the expected price drop is too great for buyer indifference, and buyers strictly prefer to

postpone their trades. In the region between the two lines, 0-buyer and 0-seller, both prefer to postpone. Anywhere in this region buyers and sellers will trade directly, although it is not clear exactly where the market-clearing value of $E(P_0-P_1)/P_0$ will be.[7]

Next, let us consider arbitrageurs. For them $\alpha \approx \pm 2c$ and $\beta \approx 1.0$ (conditions 6 and 8). In Figure 1b the line labeled *Arb-sell* represents the expression $E(P_0-P_1)/P_1 \approx 2c + D/P_0$. If the expected price drop is above this line, the arbitrageur can profit by short-selling the stock cum-dividend and buying back at the ex-date. The line labeled *Arb-buy* represents the expression $E(P_0-P_1)/P_0 \approx -2c + D/P_0$, and by similar logic, below this line he can profit by buying cum-dividend and selling ex-dividend. The region between the two lines is one in which there are no arbitrage opportunities.

Figure 2a corresponds to the situation in which buyers, sellers, and arbitrageurs are all present. For dividend yields less than d^*, the equilibrium expected price drop will be in the shaded region.[8] However, above d^*, the equilibrium expected price drop will lie on the line a, Arb-buy. In this region sellers would like to accelerate to the cum-dividend date, but buyers would prefer to delay. Arbitrageurs enter the market, buying from sellers at the cum-date and selling to buyers on the ex-date. By assumption, competition among arbitrageurs drives the equilibrium to the Arb-buy line.

Figure 1c shows the indifference line for dividend capturers, Div-cap, (from condition 6). This will in general be steeper than the indifference lines for the other trader types and will have a smaller (more negative) intercept. In the region below the line Div-cap, it will be profitable for these traders to enter the market.

Figure 2b corresponds to the realistic situation in which all four classes of traders are active. As explained earlier, if the dividend yield is below d^*, $E(P_0-P_1)/P_0$ will be in the shaded region. For dividend yields between d^* and d^{**}, $E(P_0-P_1)/P_0$ will be on the line segment ab, with arbitrag-

eurs buying from sellers (early) and selling to buyers (late). Over this interval the expected price drop is too large for dividend capturers to enter the market. For dividend yields exceeding d**, dividend capturers have an advantage over arbitrageurs. Competition among dividend capturers will require that the equilibrium expected price drop lie along the line Div-cap.

Eventually, the Div-cap line will lie above the Arb-sell line (past e in Figure 2b). In that range there are two no-arbitrage conditions, and these cannot be simultaneously satisfied. Theory does not tell us much about what is likely to occur in this range of dividend yields (or, for that matter, if it actually exists). Therefore, equilibrium price drop must be determined by some factor(s) outside the model. Our intuition is that dividend capturers would tend to dominate in equilibrium price determination. We know from other research [for example, Koski (1990)] that for many high-yield stocks, dividend capturers take very large (long) positions. To significantly affect equilibrium price drop, tax-neutral arbitrageurs would have to take large (short) positions, and as is well known, that strategy may be difficult to execute and/or risky.

From inspection of Figure 2b, it should be clear that the theoretically predicted relation between $E(P_0-P_1)/P_0$ and dividend yield is nonlinear and rather messy. For dividend yields between 0 and d*, $E(P_0-P_1)/P_0$ is not precisely determined but must lie somewhere in the shaded region. From d* to d**, it will lie along the line segment ab. Above d**, it will lie along the Div-cap line. Finally, beyond the point e, there is another range in which $E(P_0-P_1)/P_0$ is not precisely determined by theory. However, unmodeled factors suggest that over this range, $E(P_0-P_1)/P_0$ is unlikely to deviate far from the Div-cap line.

In sum, the predicted relation between dividend yield and expected percentage price drop depends on market conditions that prevailed at the given point in time and is, to a first order, piecewise linear and convex. Obviously, if one approximated the true relation by a straight line, deviations would not be random. Observations corresponding to low (high) dividend yields would

plot above the line, and middle ones below it. This is an empirical implication of the theory which will be investigated shortly.[9]

Finally, recall that the chart in Figure 2b corresponds to a particular security at a given point in time. The expected price drop on a particular ex-dividend day for a given security would correspond to one point in such a chart. That chart is chosen from a collection of charts and the selection rule picks a particular chart based on the prevailing market conditions. In the empirical implementation, therefore, we will be pooling data points drawn from many such charts. Since the econometrician does not observe market conditions, from his or her perspective it is appropriate to view the observations as being drawn from some weighted average of the piecewise linear functions in these charts. As the number of observations increases, such a weighted average of piecewise linear functions can be approximated by a smooth curve. It therefore appears reasonable to expect that the set of equilibrium expected price drop-dividend yield pairs will be described by a smooth, nonlinear convex function.[10]

II. Empirical Results

A. Econometric Specifications

In order to empirically examine equation (9), let us write it as

$$r_{it} = \alpha_{it} + \beta_{it}d_{it} + \epsilon_{it}, \tag{10}$$

where

$$r_{it} = \frac{P_{iot} - P_{ilt}}{P_{iot}}, \quad d_{it} = \frac{D_{it}}{P_{iot}}.$$

In equation (10) the subscripts i and t denote the ith stock going ex-dividend on date t. In general, transactions costs and discount factors will depend both on the trading date and the attributes of the traders as well as the particular stock (for example, the supply and demand for that security and the

liquidity in its market). Also, tax rates will change over calendar time. Let ϵ_{it} denote the term, $r_{it} - Er_{it}$, where expectations are conditioned on the information set of agents at time $t - 1$. Note that two different dividend announcements, i and j, could occur on the same calendar date. In that case, the innovations ϵ_{it} and ϵ_{jt} are likely to be correlated. However, there is no reason to suspect that the innovations ϵ_{ia} and ϵ_{jb} (a $\neq$ b) will be correlated when the corresponding announcements occur on different dates. There is also no reason to suspect that the dividend yield d_{it} and the innovation ϵ_{it} will be correlated with each other in the cross section or over time.

For estimation purposes, write equation (10) as

$$r_{it} = \alpha + \beta d_{it} + \epsilon_{it} + (\alpha_{it} - \alpha) + (\beta_{it} - \beta)d_{it},$$

that is,

$$r_{it} = \alpha + \beta d_{it} + u_{it}, \tag{11}$$

where u_{it} denotes the composite error term, and α and β are the averages of the corresponding date and stock specific terms. OLS estimates of the parameters will be consistent if $(\alpha_{it} - \alpha) + (\beta_{it} - \beta)d_{it}$ is uncorrelated with d_{it}. We will first assume that this is valid and then examine the residuals to see if the evidence suggests that this is violated. The composite error term will exhibit conditional heteroscedasticity even when ϵ_{it} does not. However, the magnitude of this conditional heteroscedasticity is very small when compared to the variance of ϵ_{it} and hence can be ignored.[11]

B. Sample Characteristics

We use daily closing prices for individual stocks for the period July 1962 to December 1987 from the CRSP Daily Master, along with information regarding the date on which the stock went ex-dividend and the amount and tax status of the dividends. The sample is limited to ordinary, taxable, cash dividends. There were a total of 142,589 such dividends. For some of the stocks that paid cash dividends, part of the dividend was taxable and part tax-exempt. Also, for some stocks that

were going ex-dividend, there was more than one type of dividend being paid.[12] We omitted 10,532 ex-dividend days which had this feature. This left a total of 132,057 ex-dividend days.

Table 1 presents summary statistics for these data. The average price per share was $28.61, and the average ex-dividend price drop was $0.196. The average dividend was $0.256 per share. The average dividend yield was about 1 percent. By comparison, Kalay (1982) examined the ratio of ex-dividend day price drop to the amount of the dividend and found an average ratio of 71 percent. Similarly, in our data the average price drop is about 77 percent of the amount of the average dividend. The average ex-day percentage price drop is 0.8 percent which is 80 percent of the average dividend yield of 1 percent.

Panels B and C of Table 1 report the day of the week and seasonal patterns in the occurrence of ex-dividend days. Monday is, by far, the most common day of the week. Relatively larger fraction of the ex-days occur in the months of February, May, August, and November. This quarterly pattern is expected since, for a relatively large fraction of stocks, fiscal and calendar quarters coincide. For such firms the ex-dividend days tend to occur one month after the end of the quarter.

C. The Basic Linear Model

We first estimated the parameters α and β in equation (10) by pooling the ex-day information on all stocks and all calendar dates. These results are presented in Table 3, Panel A, and appear plausible. At the margin, prices drop by $0.98 for an additional dollar of dividend. After we allow for sampling error, it appears that for the marginal investor on ex-days, dividends and capital gains are taxed about the same. However, it is rather difficult to make a direct comparison of our results with those reported elsewhere in the literature. As mentioned earlier, our procedures are quite

different than those employed elsewhere. Methodologically closest to our work are studies by Poterba (1986) and Hayashi and Jagannathan (1990).[13]

D. Kurtosis

Not only are these results difficult to compare with others; there are several problems in interpreting them. It is widely recognized that daily price-change distributions are fat-tailed. And, with our data set, that turns out to be true of the dividend distribution as well. To reduce the sensitivity of our estimates to outliers, we use the following simple procedure. First, we subdivide the data into 20 dividend yield classes, chosen so that there is an equal number of observations in each. Then we find the average price drop and the average dividend within each class. Before averaging, the kurtosis is 9,563 for the percentage price drop, r, and 2,368 for the dividend yield, d. After, the kurtosis of the dividend yield in each class is 2.05, and the corresponding number for price drop for the 20 classes is 3.60. Clearly, this simple procedure is effective at "normalizing" the data. Summary statistics for each of the 20 classes are given in Table 2.

To justify this averaging procedure, we can sum the left and the right side of equation (11) over ex-days in each class so that

$$\frac{1}{N_j} \sum_{\in J} r_{it} = \alpha + \beta \frac{1}{N_J} \sum_{\in J} d_{it} + \frac{1}{N_J} \sum_{\in J} u_{it}, \quad J = 1, 2, ..., 20, \tag{12}$$

where J represents one of the 20 dividend classes, and N_J, the number of observations in dividend class J. We therefore obtain

$$r_J = \alpha + \beta d_J + u_J, \quad J = 1, 2, ..., 20, \tag{13}$$

where $r_J = (1/N_J)\Sigma_{\in J} r_{it}$, and d_J and u_J are analogously defined.

Using data for the 20 dividend classes to estimate the OLS parameters α and β, the results are presented in Table 3, Panel B. As might be expected, the R-square increases substantially to

0.987. The slope coefficient is not statistically significantly different from 1; however, it is significantly different from the ratio of average ex-day percentage price drop to the average dividend yield (which is 0.80).[14] The intercept is negative and significantly different from zero, suggesting the presence of dividend capture trading.[15]

E. A Nonlinear Relation?

A scatter plot of the points corresponding to the 20 dividend classes and the fitted line are given in Figure 3. The vertical line centered at each of the points denotes the two standard deviation band around the percentage price drop for that dividend. The standard deviation of the mean percentage price drops were computed allowing for correlation between returns that occurred on the same trading date.

Note that in Figure 3 the residuals are not evenly distributed around the fitted line. The first four points (corresponding to the lowest four dividend classes), as well as the last two points (corresponding to the highest two dividend classes), all plot above the fitted line. All but 3 of the interior 14 points plot below. In other words, there is evidence of a nonlinear relation between dividend yield and percentage price drop.

Although other explanations are possible, this finding is consistent with the equilibrium theory summarized in Figure 2b. For low dividend yield stocks, buyer and sellers are likely to be the only traders. For high dividend yield stocks, dividend capturers are likely to be active. And over some interior range of d, arbitrageurs may (depending on other parameter values) be trading. Thus points corresponding to relatively high (low) dividend yields would deviate from the fitted straight line in a systematic way.

F. Mongrel Estimates? Another Test of the Theory

An intuitively appealing next step would be to partition the data according to dividend yield and then estimate the separate linear segments in Figure 2b. The problem with doing this step is that several factors besides dividend yield would be expected to determine a stock's suitability for dividend arbitrage, particularly riskiness and liquidity. (We investigate some of these other factors in a following section.) The point is this: there are probably no unique values of d* and d** in the data (Figure 2b). It does seem likely that for sufficiently low values of D/P_0, the probability of arbitrage and dividend capture will be low. Therefore, as an additional test of the theory, we reestimated our basic equation, omitting all observations with small dividends of less than $0.125. This reduced the number of data points from 132,057 to 92,367 and produced the results shown in Table 3, Panel C, with the data again grouped into 20 dividend classes. Consistent with expectations, α is smaller than was obtained with the full sample (-0.00223) and β is larger than that obtained with the full sample (1.00024). In fact, these changes are statistically significant at conventional levels. The pattern of deviations around the fitted line (not reproduced here) also remains very similar to that in Figure 3. This indicates that even with the reduced sample, the data still contain a mixture of stocks, and underscores the difficulty of trying to statistically identify d* and d**.

III. Interpreting Responses to Parameter Shifts

Results thus far presented suggest a serious potential problem in testing for the effects of exogenous changes in parameters, such as tax rates or commission costs. The *equilibrium condition effect* of such changes will be to alter the indifference conditions for investors. However, there will also be a *participation effect*, on the profitability of arbitrage and/or dividend capture. As will be shown, ignoring the participation effect could result in serious confusion.

It is generally believed that trading costs were substantially higher prior to the introduction of negotiated commissions. Hence we divided the sample into two parts, one corresponding to the pre-negotiated commission period, July 1962 to April 1975, and the second corresponding to the period May 1, 1975, to December 31, 1987.

Examination of condition (6) suggests that when transactions costs decline, the slope coefficient, β, should get smaller and the intercept, α, should get larger. From (6) (for dividend capturers), $d\alpha/dc = \{1/(1-c)\}\{-2 + 2c/(1-c)\}$, which is clearly negative for any reasonable value of c. According to conditions (3) and (4) (for buyers/sellers), the intercept, α, is unaffected by changes in transactions costs. However, transactions costs enter the slope coefficient, β, with opposite signs in (3) and (4), so the predicted effect is ambiguous. Negotiated commission rates should not have had much effect on the transactions cost of tax-neutral arbitrageurs.

In sum, the theory would seem to predict that β should get smaller and α get larger. However, these predictions implicitly assume that the amount of dividend capture activity does not change. And condition (7) suggests that that assumption will be invalid: rather, as transactions costs decline dividend capture should become more profitable, *ceteris paribus*. And, as we have just seen, as the fraction of the sample data points with dividend capture activity increases, the predicted effects are exactly opposite. That is, the estimated slope coefficient, β, will increase, and the intercept, α, will decrease.

Empirical tests comparing pre- and post- negotiated commissions unambiguously indicate that *the dominant of these two effects was the participation effect*. Consider the first regressions in Table 4. In the period before negotiated commissions, the intercept term is larger than in the later negotiated commission regime, and the slope coefficient is smaller. These differences are statistically significant at a high confidence level. The second regressions in Table 4 display the same tests with low dividend stocks (less than $0.125) omitted. Results are qualitatively the same in that after

negotiated commission rates, the intercept declines and the slope coefficient increases. Note that in both subperiods, omitting the low dividend stocks has the same effect that we observed with the full sample; the estimated intercept term declines and the slope coefficient increases.

IV. Other Factors Which Affect Dividend Capture Activity

We have argued that attributes other than dividend yield affect the suitability of specific stocks for dividend capture. In this section, we attempt to determine if that is so, albeit with very imprecise measurement of these other attributes.

For this purpose we limited attention to stocks that had paid dividends continuously for at least 40 quarters. The choice of 40 observations per stock was arbitrary, and it reduced the number of firms in our sample to 1,066 from 1,376. However, we required some minimum number of observations for each stock to characterize its ex-day behavior.

The summary statistics for the 1,066 estimated intercept and slope coefficients are presented in Table 5. The estimated slope coefficients (βs) have a mean of 0.81 and a standard deviation of 1.03. In interpreting the value of 0.81 and comparing it with the slope of 1.0043 obtained from the cross-sectional regression, we need to exercise caution for several reasons. First, the slope coefficient, β_{it} in equation (10), is likely to vary substantially over time, even for the same stock [see Eades, Hess, and Kim (1991)]. Hence the estimated value of the slope coefficient is likely to be a downward-biased estimator of $E(\beta_{it})$. Second, the sampling errors associated with the estimated slope coefficient for different stocks are likely to be positively correlated, and the standard error of the average of the estimated betas is likely to be substantially larger than $0.0315 = 1.03/\sqrt{1066}$.[16] We next examined the association between the estimated αs and βs and the following explanatory variables:

- dividend yield, d,

- StdDev($\Delta P/P_0$),

- the amount of the dividend, D and,

- cum-day price, P_0.

The logic of employing dividend yield as an explanatory variable is obvious. The standard deviation of the price drop is included to represent the capital risk confronting potential dividend capturers. If these traders are corporate cash managers, for example, they are likely to be quite sensitive to the risk of capital losses.[17] Dollar dividends are also included as an explanatory variable, because they may indirectly capture the effect of transactions costs. That is, it is entirely possible that some very low-priced stocks have relatively high dividend yields. Because there is a minimum bid-asked spread, however, such stocks may be unattractive for dividend arbitrage, their high dividend yield notwithstanding. Finally, stock price is included as a separate explanatory variable because [as argued in Hayashi and Jagannathan (1990)], it may be inversely correlated with transactions costs.

The univariate regression results are given in Table 6. As can be seen, these results are generally consistent with expectations. The slope coefficient, β, is significantly positively related to the dividend yield as well as the amount of the dividend and significantly negatively related to StdDev($\Delta P/P_0$). The intercept, α, is negatively and significantly related to dividend yield and the amount of the dividend. It is significantly positively related to StdDev($\Delta P/P_0$). We interpret that to mean that such stocks are relatively less attractive for dividend capture.

Since the explanatory variables are correlated with each other, we also examined the multiple regression of α and β on all four, and these results are given in Table 7. It appears that StdDev($\Delta P/P_0$), which possibly captures the risk the dividend capturer takes on, is the major determinant of β and dividend yield, d, the primary determinant of α. *Ceteris paribus*, stocks which

are less risky (that is, with relatively low StdDev($\Delta P/P_0$)) and have relatively large dividend yields appear to be candidates for dividend capture.

V. Difficulties in Measuring the Expected Price Drop

In this study, we use over 25 years of data to examine the nature of the relation between the amount of dividend and the expected ex-day price drop. There are three reasons for using such a long time series.

1. Sampling Error

Stock prices are extremely volatile. Hence the variance of the average price drop is also large, and expected price drop can only be measured precisely using a large number of observations.

To see this more clearly, consider a representative stock with a cum-dividend price of $30.00 and a dividend of $0.30. Suppose that there are no frictions other than taxes and that the after-tax value of a $1.00 dividend is the same as that of $0.90 of capital gains. Then suppose that the expected price drop is 90 percent of the amount of the dividend, that is, $0.27. The econometrician may want to distinguish between the hypothesis that the price drop is $0.27 and the hypothesis that it is $0.30—that is, that there is no tax effect. Hence he would be interested in measuring a $0.03 difference in expected price drop.

In a typical year there are about 5,000 ex-dividend dates. If these are classified into 20 dividend classes, there would be about 250 stock-ex-day combinations within each class. Since the standard deviation of the daily return on a stock could easily be 1.5 percent, the standard deviation of the average price drop on these 250 observations could easily be $0.028[18] which is of the same order as the quantity the econometrician is trying to estimate. To reduce the sampling errors to meaningful levels, say a third of $0.028, it would be necessary to work with at least ten times as many observations. In fact, we use 26 times as many in this study.

2. Discreteness in Price Changes

Measurement problems are confounded by the fact that prices are restricted to change in discrete ticks, the typical tick size being an eighth of a dollar. For about 30 percent of the 132,057 observations in this study, the dividend per share was less than an eighth of a dollar. Of these, over 25 percent had a dividend of less than $0.05 per share.

To understand why discreteness causes problems in measuring the relation between the amount of the dividend and the expected price drop, suppose the dividend is $0.05. If prices were allowed to vary continuously, markets were frictionless, and taxes were nonexistent, the stock price would drop by exactly $0.05 (absent any other informational event). However, if prices were required to change in discrete ticks (of one eighth of a dollar) only, the price drop could be either $0.125 or zero. The price drop would be $0.05 only on average; hence discreteness introduces noise even in the absence of other informational events.

In the above example, the probability of a price drop should be 0.4 and the probability of the price not changing should be 0.6, in order that the expected price drop equals $0.05. The standard deviation of the average price drop (over 250 events) will be $(\$0.125)\sqrt{(0.4 \times 0.6)}/\sqrt{250} = \$0.0039$, which is 7.8 percent of the amount of the dividend. It would be hard to distinguish between the hypothesis that the expected price drop is the same as the dividend from the hypothesis that the expected price drop is 90 percent of the amount of the dividend, even if there were no other informational event. Hence discreteness is an issue for about a third of the observations.

3. Stability of the Parameters Over Time

For practical purposes, inferences made using data for relatively short periods will be rather imprecise. To illustrate this point, we examined the stability of α and β over time on an annual basis. Let d_t denote the average dividend yield on trading day t during which there were at least 10

stocks going ex-dividend. Let r_t denote the corresponding average percentage price drop. For each year, we estimated α and β using observations d_t and r_t for that year. This sample had 25½ years, and on 6,099 of the trading days during this period, there was at least one stock that went ex-dividend. On 3,949 of these days, there were at least 10 stocks that went ex-dividend. Hence, on average, there were 155 observations per year.

Plots of the estimated slope and intercept terms are given in Figure 4. The average slope was 0.9337 (standard error = 0.0861), and the average intercept was −0.0017 (standard error = 0.0009). Notice that the estimated values of α and β vary enormously over time. The lowest estimated β was 0.02 (in 1975), and the largest estimated β was 1.88 (in 1977).

As discussed above, the approach taken in this study to precisely measure the nature of the relation between dividend amount and expected ex-day price drop is to employ a very large sample. A disadvantage of this approach is that we can only examine the average relation over a very long time interval. An alternative approach, employed by Eades, Hess, and Kim (1991) and by Michaely and Vila (1993), is to introduce additional explanatory variables which help reduce unexplained variations in stock prices.

VI. A Postscript

The results we have presented largely serve to underscore the difficulty of empirically investigating ex-dividend price drop. However, we would like to conclude by noting a regularity in the data, which may be of some independent interest. In reviewing all of our results, it is striking that at the margin, percentage price drop is almost exactly equal to dividend yield. This result was obtained in a number of different tests—the only significant exception being those tests after negotiated commission rates and with low dividend yield data points excluded (see Table 3). On average, however, ex-dividend percentage price drop moves almost exactly one-for-one with dividend

yield. Of course, this finding is simply an empirical regularity (stylized fact). It is neither predicted by the theory, nor inconsistent with it. Whatever the explanation, our results suggest that one-for-one marginal price drop has been a good rule of thumb, at least on average, over the last two and one-half decades.

Appendix A:

More Share Pricing Arithmetic: Fixed Transaction Costs

The form of indifference conditions (3), (4), and (6) depends on the assumption that transactions costs are strictly proportional to price. This need not be entirely correct, due both to minimum commissions and discrete bid-asked spreads. If we rewrite indifference condition (6), assuming a fixed transaction cost per share, c_f, independent of price, and further assume δ_1' and δ_1 are sufficiently close to unity, then equation (6) becomes

$$P_0 - EP_1 = -2c_f + [(\delta_d - \tau_d \delta_s)/(1 - \tau_c \delta_s')]D. \tag{A1}$$

Note that equation (A1) is linear in the levels. [This is also true of indifference conditions (3) and (4), if similarly modified.] Recall that when transactions costs are assumed to be proportional, indifference conditions are linear in the percentage price change and dividend yield. Both structural forms were employed when we began statistical tests. However, we found that the proportional form gave the most satisfactory explanation of the data, suggesting that proportional transactions costs are the closer approximation to reality.

Appendix B:

Examining the Bias in the OLS Standard Errors

It is well known that the OLS standard errors are likely to understate the true standard errors, even if the true relation is indeed linear [for example, Miller and Scholes (1982)]. To overcome this problem we follow a different estimation strategy. On each trading date on which there was at least one stock going ex-dividend, we found the average percentage price drop, r_t, and the average dividend yield, d_t, for that day. There were 6,099 such trading days. The estimated intercept and slope coefficients with these daily observations are

Parameter	Estimate	Standard Error	R-Square	n
α	−.0019	.0004	.0972	6,099
β	.9520	.0370		

The standard error of the estimated slope coefficient is now 0.0370, larger than the 0.02706 obtained with 20 dividend classes. Hence ignoring the correlation among ex-day returns that occur on the same trading date does appear to understate the true standard errors by about 27 percent. The estimated slope coefficient of 0.9520 is smaller than the estimate of 1.0002 obtained when stocks are pooled into 20 dividend yield classes. We believe that this is due to a few outlying observations being given relatively large weights. This occurs because each trading date observation is given equal weight in the regression, even though on some dates there are relatively few stocks going ex-dividend. We therefore dropped those dates at which there were less than 10 stocks going ex-dividend. There were 3,949 such days in our sample (that is, 65 percent of all the trading days). The revised estimated parameter values are

Parameter	Estimate	Standard Error	R-Square	n
α	−.0023	.0005	.0914	3,949
β	1.0043	.0504		

These coefficient estimates are consistent with the results obtained with the 20 dividend yield classes.

It also appears that the OLS standard errors for the dividend class regression are understating the true

standard errors.

Footnotes

[1]Until 1989 Japanese insurance companies were active in dividend capture programs because of a legal restriction which allowed them to distribute dividend income but not capital gains.

[2]Several other interesting studies deserve mention. Barclay (1987) found that prices on average fell by the full amount of the dividend before the enactment of the federal income tax. Since dividend capture activity is unlikely to have taken place during this period, α should be zero and β should equal one to a first order—that is, prices should fall, on average, by the full amount of the dividend, which is consistent with Barclay's findings.

Poterba (1986) estimated β to be 0.79 (standard error = 0.08) for Citizens Utilities using time-series data. Even though he studied only one firm, he was able to obtain a precise estimate of β by making use of the fact that Citizens Utilities has two types of stocks which are identical, except that one paid cash dividends while the other paid stock dividends. One possible explanation for his finding is that for some reason (price risk, liquidity, etc.), dividend capturers did not find Citizens Utilities to be attractive.

[3]This result is similar to that obtained by Hayashi and Jagannathan (1990) in their study of the Japanese stock market.

[4]In view of this we follow a different strategy than the one adopted by Michaely and Vila (1993).

[5]For modeling simplicity, we are abstracting from some features of the tax code. An example is the asymmetric treatment of short-term and long-term capital gains realizations. Another is the tax-timing option that has been available to many investors. Also, we are simplifying by assuming strictly proportional transactions costs (see Appendix A).

[6]Over our long sample period 1962–87, tax rates were changed many times; however, certain features of the code were true throughout. For corporations, most cash dividends received favorable

relative treatment so that $\tau_d < \tau_c$. For tax-neutral arbitrageurs, $\tau_d = \tau_c$. For noncorporate taxable investors, capital gains, or at least some fraction thereof, received favorable treatment so that $\tau_c < \tau_d$.

[7]Suppose that, absent transactions costs, both buyers and seller were indifferent between trading on the cum-dividend and ex-dividend dates. Now, we have assumed proportional transactions costs. As a result, both buyers and sellers would prefer to postpone trading to the ex-date. That must result in a smaller total transactions costs since there are no transactions costs on dividends.

[8]In this region, the marginal investor is taxed differently on dividend income than on capital gains. The slope coefficient in the linear relation between ex-day return and dividend yield will be less than unity and will, to a first order, provide a measure of the differential tax rate between dividend income and capital gains. Hence it will be consistent with the estimates obtained by Litzenberger and Ramaswamy (1979).

[9]In this analysis, we have assumed that d** lies to the right of d*, which will always be the case if dividend capturers' transaction costs (including opportunity costs) are sufficiently large. If that is not true, however, the range ab in Figure 2b will not exist. Even in that case, however, the theoretically predicted relationship between dividend yield and expected price drop would remain nonlinear and convex as stated in the text.

[10]Therefore, one could fit a nonlinear relation between the percentage price drop and the dividend yield. However, theory does not tell us the exact form of the nonlinear function except that it would be convex to the origin. Hence any particular parametric nonlinear function would only be an approximation—just like a linear function. No particularly interesting additional insight would likely be gained from such an exercise.

A more appealing strategy would be to estimate the relation between percentage price drop and dividend yield using nonparametric techniques. In our empirical work we group the data into

20 dividend classes, and there are 6,603 observations in each class. A plot of the average percentage price drop against the average dividend yield for these 20 dividend classes can be viewed as a nonparametric estimate of the nonlinear functional relation between these two variables.

[11]The error u_{it} can be decomposed into two components: one that is related to the return on the market (index) portfolio and the other that is firm-specific. If we can identify the market-related component, we can reduce the sampling error in our estimates. Since we do not know the market-related component, it has to be estimated. The estimation error in the market-related component will have to be traded off with the improved precision that is obtained by being able to control for the market-related component of the firm's return. We assumed that the market model given by $r_{it} = \gamma_{0i} + \gamma_{1i}r_{mt} + \epsilon_{it}$ describes the return-generating process for every firm, i, with $\gamma_{1i} = 1$. The estimated values of the parameters obtained in this way were very close to the numbers reported in the various tables in this paper.

[12]We thank Pat Hess for pointing this out to us.

[13]Hayashi and Jagannathan (1990) study the ex-day behavior of Japanese stock prices. In Japan most stocks go ex-dividend on the same day. Hence the term corresponding to the intercept, α, is the negative of the March dummy for stocks in Hayashi and Jagannathan (1990). They report an estimated value for the dummy of 0.69 percent for the entire sample and 1 percent for high volume stocks (Table V, p. 419). The corresponding estimates for the slope coefficients are 0.78 and 0.94. Since dividend capture is more likely for high volume stocks, these findings for Japan are similar to those reported here for the United States. The relatively small value (of -1 percent) they report for α, however, is hard to interpret without further analysis.

[14]As is well known, OLS standard errors are likely to understate the true standard errors (see Appendix B).

[15]It is useful to compare the results in our Table 2 and Kalay's (1982) Table II. In the latter, the average price drop is larger than the amount of the dividend for the largest 4 of the 20 dividend classes, as well as the 2nd, 3rd, and 11th (that is, 7 of the 20 classes). In our Table 2, for all 20 dividend classes the average price drop is less than the dividend. The largest ratio of price drop to dividend amount in Kalay is 1.689 and this occurs for the third class (corresponding to a mean dividend yield of 0.46 percent).

These differences can be reconciled by noting that Kalay used only 2,540 cash dividends paid during the period April 1966 to March 1967. Hence each dividend class in Kalay's Table II has about 127 observations. Each dividend group in our Table 2 has 6,603 observations. The standard deviation of $\Delta P/D$ is about 7.9 (see Kalay's Table I); that is, the standard deviation of the average $\Delta P/D$ over 127 observations is about 0.61. Hence one cannot rule out the possibility that the patterns observed (especially the amount of the drop being larger than the amount of the dividend for some dividend classes) are entirely due to chance. As Kalay himself noted, the only conclusion one can draw is that there is a positive correlation between dividend yield and the ratio of price drop to dividend, which is statistically significant. This is consistent with our findings. Even if transactions costs are constant (that is, they do not vary over time or stocks, and the price drop at the margin is one-for one), $\Delta P/D$ will increase as dividends increase—which is what we find.

Eades, Hess, and Kim (1984) find that the ex-day excess return for taxable distributions by preferred stocks is significantly negative. This implies that the price drop is statistically significantly more than the amount of the dividend for these stocks. We do not find this happening for common stocks in our sample.

[16]As pointed out in earlier discussions, the true relation between expected price drop and dividend yield is unlikely to be linear in the cross section; that is, the slopes are likely to vary across stocks. The weights assigned to different stocks in the cross-sectional regression will not correspond

to the average of the slopes from time-series regressions. However, our objective is not to estimate $E(\beta_{it})$ in this particular exercise but to determine which variables help to explain cross-sectional variation in β_i.

[17]During much of the sample period, corporate dividend capturers could avoid any risk of capital loss by entering into repo transactions or by similar hedging devices. However, in 1984 the IRS imposed an *at-risk rule,* the intent of which was to disqualify such hedged arbitrage for favorable tax treatment. Of course, even when such hedging could be done, it involved some cost.

[18]That is, ($0.015/\sqrt{250}$) $\times$ 30.

References

Barclay, M. J., 1987, "Dividends, Taxes and Common Stock Prices: The Ex-Dividend Day Behavior of Common Stock Prices before the Income Tax," *Journal of Financial Economics*, 19, 31–44.

Constantinides, G. M., 1986, "Capital Market Equilibrium with Transactions Costs," *Journal of Political Economy*, 94, 842–862.

Eades, K. M., P. J. Hess, and E. H. Kim, 1984, "On Interpreting Security Returns during the Ex-Dividend Period," *Journal of Financial Economics*, 13, 3–34.

Eades, K. M., P. J. Hess, and E. H. Kim, 1991, "Time-Series Variation in Dividend Pricing: A Reinterpretation of the Ex-Dividend Day Anomaly," Working Paper 30, University of Minnesota.

Elton, E. J., and M. J. Gruber, 1970, "Marginal Stockholder Tax Rates and the Clientele Effect," *Review of Economics and Statistics*, 52, 68–74.

Grossman, S. J., and G. Laroque, 1990, "Asset Pricing and Optimal Portfolio Choice in the Presence of Illiquid Durable Consumption Goods," *Econometrica*, 58, 25–51.

Hayashi, F., and R. Jagannathan, 1990, "Ex-Day Behavior of Japanese Stock Prices: New Insights from New Methodology," *Journal of the Japanese and International Economy*, 4, 401–427.

Kalay, A., 1982, "The Ex-Dividend Day Behavior of Stock Prices: A Re-Examination of the Clientele Effect," *Journal of Finance*, 37, 1059–1070.

Karpoff, J. M., and R. A. Walkling, 1988, "Short-Term Trading around Ex-Dividend Days," *Journal of Financial Economics*, 21, 291–298.

Karpoff, J. M., and R. A. Walkling, 1990, "Dividend Capture in NASDAQ Stocks," *Journal of Financial Economics*, 28, 39–65.

Koski, J. L., 1990, "Market Segmentation and the Identification of Marginal Traders on Ex-Dividend Days: A Microstructure Analysis," working paper, Stanford University.

Lakonishok, J., and T. Vermaelen, 1986, "Tax-Induced Trading around Ex-Dividend Days," *Journal of Financial Economics*, 16, 287–319.

Litzenberger, R. H., and K. Ramaswamy, 1979, "The Effect of Personal Taxes and Dividends on Capital Asset Prices: Theory and Empirical Evidence," *Journal of Financial Economics*, 7, 163–195.

Michaely, R., and J. Vila, 1993, "Investors' Heterogeneity and Prices and Value around the Ex-Dividend Day," working paper, MIT.

Miller, M. H., and M. S. Scholes, 1982, "Dividends and Taxes: Some Empirical Evidence," *Journal of Political Economy*, 90, 1118–1141.

Poterba, James M., 1986, "The Market Valuation of Cash Dividends: Citizens Utilities Case Reconsidered," *Journal of Financial Economics*, 15, 395–406.

Scholes, M. S., and M. A. Wolfson, 1992, *Taxes and Business Strategy: A Planning Approach*, Prentice Hall, Englewood Cliffs, New Jersey.

Table 1

Descriptive Statistics

PANEL A

Summary Statistics, Sample Size = 132,057

Variable	Mean	Standard Deviation
D	.256	.227
P_0	28.612	23.375
$P_0 - P_1$	.196	.682
$(P_0 - P_1)/D$	.707	5.693
$(P_0 - P_1)/P_0$	.008	.028
D/P_0	.010	.007

*D = dividend per share, P_0 = price per share on day before ex-day, P_1 = price per share on ex-day.

PANEL B

Distribution of Ex-Dividend Dates by Day of the Week

Weekday	Number	Percent
Monday	43,383	32.85
Tuesday	32,884	24.90
Wednesday	17,640	13.36
Thursday	15,726	11.91
Friday	22,424	16.98
TOTAL	**132,057**	**100.00**

PANEL C

Distribution of Ex-Dividend Dates by Month

Month	Number	Percent
January	6,470	4.90
February	14,334	10.85
March	12,422	9.41
April	6,610	5.01
May	14,485	10.97
June	11,645	8.82
July	6,669	5.05
August	15,342	11.62
September	10,760	8.15
October	7,606	5.76
November	13,826	10.47
December	11,888	9.00
TOTAL	**132,057**	**100.00**

Table 2

Dividend Yield and Percentage Price Drop,

by Dividend Yield Class

Dividend Class	Number of Ex-Days	Number of Calendar Days	Range of Dividend Yield	D/P_0 Mean	$(P_0-P_1)/P_0$	
					Mean	Std. Dev. of Means × 100
1	6,602	3,115	0.0001...0.0025	0.0017	0.0010	0.0404
2	6,603	3,112	0.0025...0.0036	0.0030	0.0014	0.0362
3	6,603	3,143	0.0036...0.0044	0.0040	0.0021	0.0385
4	6,603	3,100	0.0044...0.0052	0.0048	0.0029	0.0365
5	6,603	3,138	0.0052...0.0060	0.0056	0.0034	0.0377
6	6,603	3,241	0.0060...0.0067	0.0070	0.0052	0.0366
7	6,602	3,242	0.0067...0.0073	0.0070	0.0052	0.0347
8	6,603	3,158	0.0073...0.0080	0.0077	0.0050	0.0341
9	6,603	3,169	0.0080...0.0086	0.0083	0.0052	0.0333
10	6,603	3,162	0.0086...0.0093	0.0090	0.0071	0.0317
11	6,603	3,142	0.0093...0.0100	0.0096	0.0070	0.0343
12	6,603	3,145	0.0100...0.0107	0.0103	0.0077	0.0330
13	6,603	3,200	0.0107...0.0114	0.0110	0.0086	0.0318
14	6,602	3,115	0.0114...0.0122	0.0118	0.0094	0.0365
15	6,603	3,175	0.0122...0.0132	0.0127	0.0095	0.0314
16	6,603	3,100	0.0132...0.0143	0.0137	0.0114	0.0324
17	6,603	3,036	0.0143...0.0156	0.0149	0.0120	0.0335
18	6,603	2,796	0.0156...0.0176	0.0165	0.0135	0.0994
19	6,603	2,607	0.0176...0.0210	0.0191	0.0171	0.0353
20	6,603	2,630	0.0210...0.8805	0.0275	0.0269	0.0618

*D = dividend per share, P_0 = price per share on day before ex-date, P_1 = price per share on ex-date.

Table 3

Regression Results

Panel A: The Basic Linear Model

$$r_{it} = \alpha + \beta d_{it} + \epsilon_{it}$$

Parameter	Estimate	Standard Error	R-Square	n
α	−.002	.0001	.067	132,057
β	.977	.0100		

Panel B: The Model With Twenty Dividend Classes

$$r_j = \alpha + \beta_{dj} + u_j$$

Parameter	Estimate	Standard Error	R-Square	n
α	−.0022	.0003	.987	20
β	1.0002	.0271		

Panel C: The Model With Small (Less than 12.5¢)
Dividends Excluded and Grouped into
Twenty Dividend Classes

$$r_j = \alpha + \beta_{dj} + u_j$$

Parameter	Estimate	Standard Error	R-Square	n
α	−.00316	(.00028)		
β	1.09605	(.02134)	.9932	20

Table 4

Regression Results for Twenty Dividend Classes: Before and After

Negotiated Commission Rates

Description	Parameter	Value	Standard Deviation	R-Square	Sample Size Before Grouping[3]
All Dividends Included					
Full Period	α	−.00223	.00032		
	β	1.00024	.02706	.987	132,057
1st Subperiod[1]	α	−.00153	.00025		
	β	.90639	.02332	.988	65,295
2nd Subperiod[2]	α	−.00252	.00041		
	β	1.04393	.03184	.984	66,762
Dividends Less Than $0.125 Excluded					
Full Period	α	−.00316	.00028		
	β	1.09065	.02134	.993	92,367
1st Subperiod[1]	α	−.00260	.00024		
	β	1.03443	.02069	.993	46,605
2nd Subperiod[2]	α	−.00348	.00043		
	β	1.11759	.02981	.987	45,762

[1]June 1, 1962, through April 30, 1975.

[2]May 1, 1975, through December 31, 1987.

[3]After grouping, n = 20.

Table 5

Individual Stock Regressions Using Time-Series Data

Summary Statistics for 1066 Estimated

Intercept and Slope Coefficients*

Parameter	Mean	Standard Deviation	Minimum	Maximum
$\alpha(\times 100)$	$-.09$	.89	-4.71	5.77
β	.81	1.03	-12.35	4.31

*Limited to stocks which paid dividends consecutively for at least forty quarters.

Table 6

Price Drop Coefficients Regressed on Variables
That May Determine A Stock's Suitability
for Dividend Capture*

Dependent Variable	Independent Variable	Intercept	Slope	R-Square (percent)
α	StdDev($\Delta P/P_0$)	−.00216 (−5.46)	.0558 (3.948)	1.95
β	StdDev($\Delta P/P_0$)	1.2708 (30.68)	−19.869 (−13.43)	14.5
α	D/P_0	.0020 (2.24)	−.2807 (−3.43)	1.10
β	D/P_0	.1432 (1.42)	64.1864 (6.88)	4.25
α	D	.0006 (.97)	−.0054 (−2.69)	.68
β	D	.5065 (7.02)	1.0714 (4.62)	1.97
α	P_0	−.0004 (−.64)	−.0000 (−.95)	.08
β	P_0	.8850 (12.43)	−.0026 (−1.22)	.14

*α, β = regression coefficients from percentage price drop equations. D = dividend per share, P_0 = price per share on day before ex-day, P_1 = price per share on ex-day.

Table 7

Price Drop Coefficients Regressed on Variables

That May Determine A Stock's Suitability

for Dividend Capture*

Dependent Variable	×100 Intercept	×100 StdDev($\Delta P/P_0$)	d	D (×100)	P_0 (×100)	R-Square (%)
α	.13 (.83)	.05 (3.66)	−.27 (−1.79)	.45 (1.01)	−.00 (−1.68)	1.59
β	71.20 (4.33)	−19.47 (−13.07)	54.55 (3.49)	−69.60 (−1.50)	.59 (1.55)	15.79

*D = dividend per share, P_0 = price per share on day before ex-day, P_1 = price per share on ex-day, α, β = regression coefficients from percentage price drop equations.
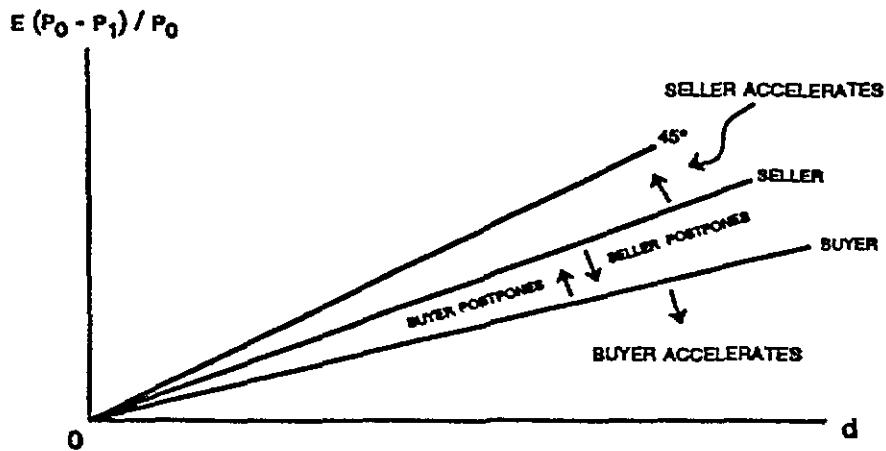
FIGURE 1-a
BUYERS AND SELLERS

$E(P_0 - P_1)/P_0$
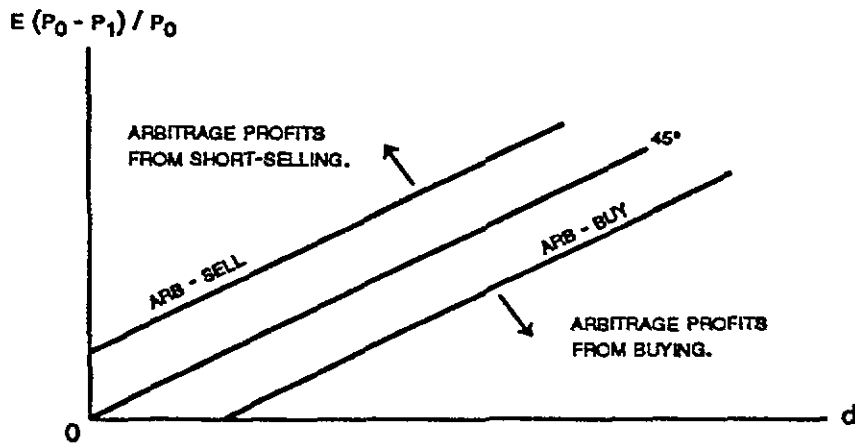
SELLER ACCELERATES

45°

SELLER

SELLER POSTPONES

BUYER POSTPONES

BUYER

BUYER ACCELERATES

0

d

FIGURE 1-b
ARBITRAGEURS

$E(P_0 - P_1)/P_0$

ARBITRAGE PROFITS
FROM SHORT-SELLING.

45°

ARB - SELL

ARB - BUY

ARBITRAGE PROFITS
FROM BUYING.

0

d

FIGURE 1-c
DIVIDEND CAPTURERS

$\dfrac{E(P_0 - P_1)}{P_0}$

DIV - CAP

45°

NO DIVIDEND
CAPTURE

DIVIDEND
CAPTURE

0

d

-2c
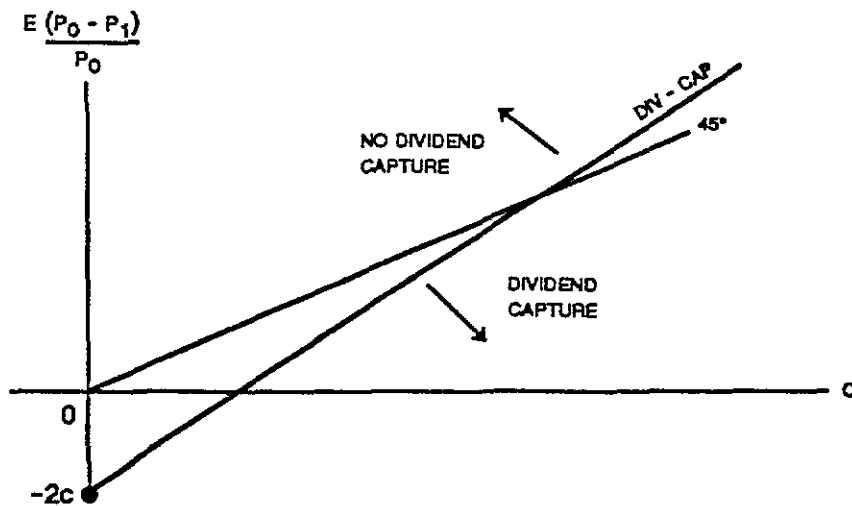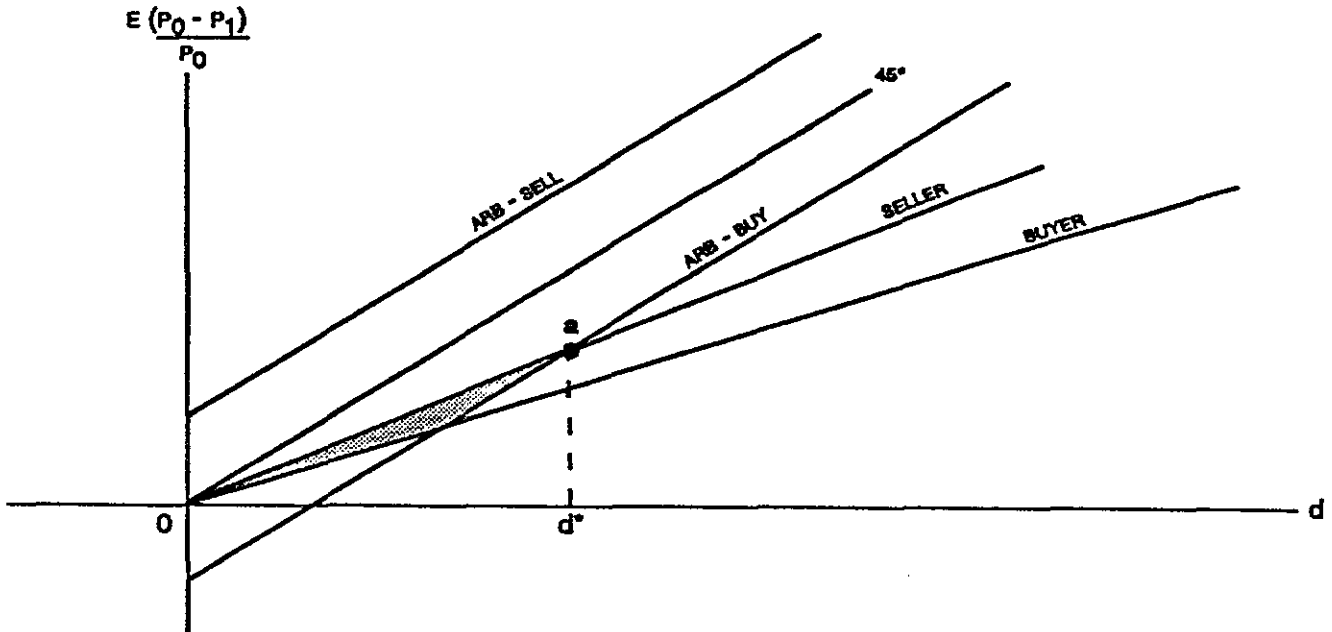
FIGURE 2-a
BUYERS, SELLERS, AND ARBITRAGEURS

FIGURE 2-b
ALL CLASSES OF TRADERS ACTIVE
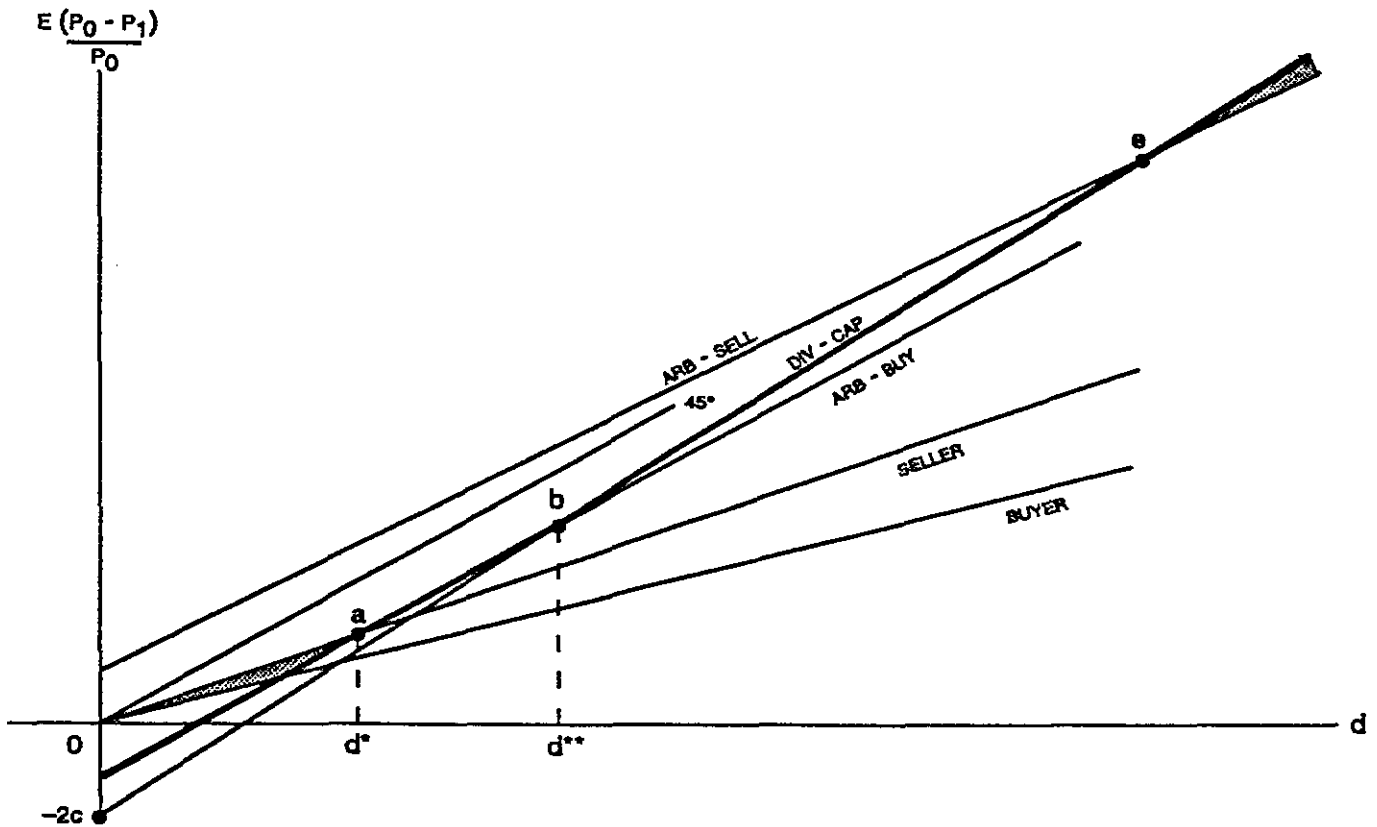
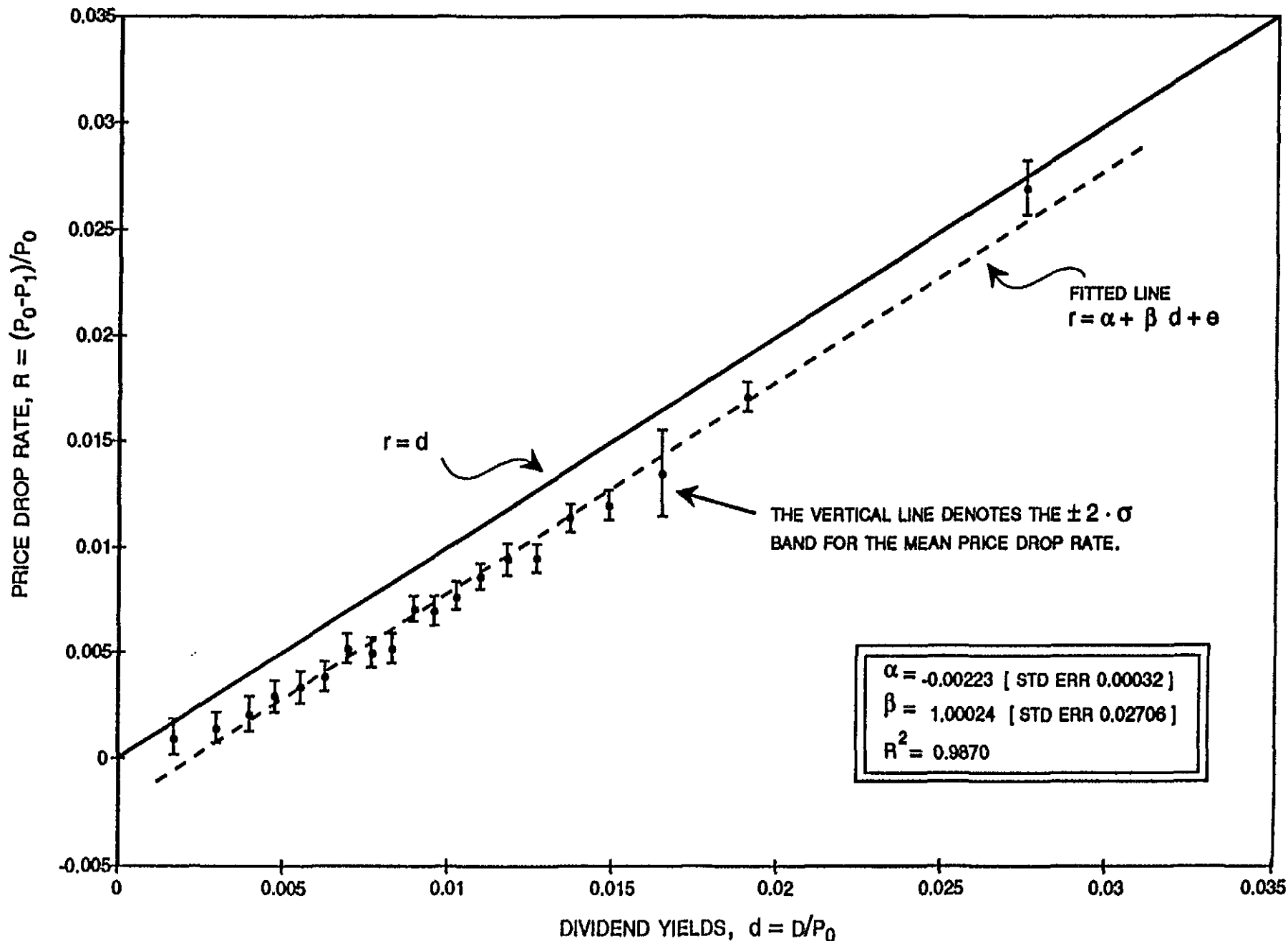# FIGURE 3

REGRESSION RESULTS, TWENTY DIVIDEND CLASSES

FITTED LINE
$r = \alpha + \beta\,d + e$

$r = d$

THE VERTICAL LINE DENOTES THE $\pm\,2\cdot\sigma$
BAND FOR THE MEAN PRICE DROP RATE.

$\alpha = $ -0.00223 [STD ERR 0.00032]
$\beta = $ 1.00024 [STD ERR 0.02706]
$R^2 = $ 0.9870

PRICE DROP RATE, $R = (P_0 - P_1)/P_0$
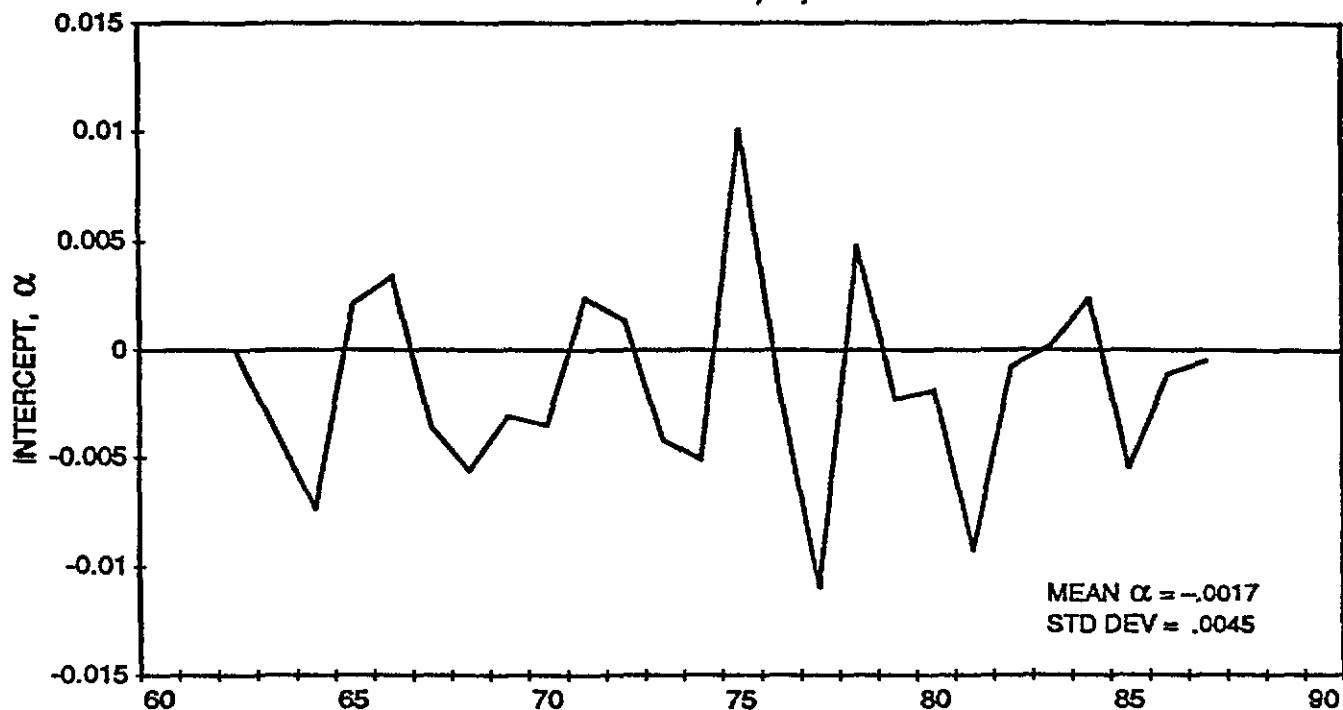
DIVIDEND YIELDS, $d = D/P_0$

D = DIVIDEND PER SHARE, P_0 = PRICE PER SHARE ON DAY BEFORE EX DAY, P_1 = PRICE PER SHARE ON EX DAY.

FIGURE 4

REGRESSION COEFFICIENTS ESTIMATED ANNUALLY

INTERCEPT, α, BY YEAR*

MEAN α = −.0017
STD DEV = .0045

SLOPE COEFFICIENT, β, BY YEAR*

MEAN β = .9337
STD DEV = .4391
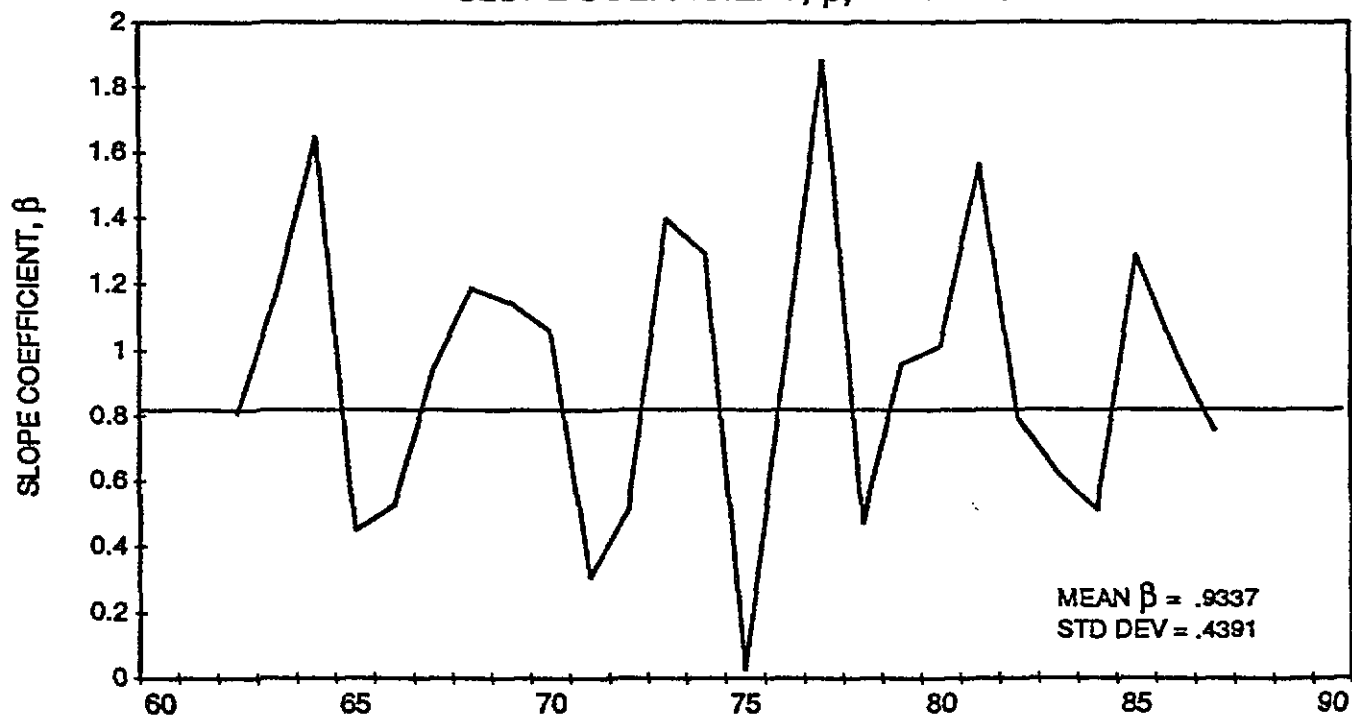
*JUNE 1, 1962 TO DECEMBER 31, 1987