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Are ex-day dividend clientele effects dead? Dividend yield versus dividend size

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Abstract

We devise an approach to determine whether market microstructure or taxes influence ex-dividend behavior. We find that microstructure effects of automated limit order adjustments strongly influence ex-day prices for dividends less than or equal to a tick. For these dividends, after controlling for dividend size, we find no relation between price-drop-to-dividend ratio and dividend yield. For larger dividends, both microstructure and tax effects are found: Consistent with the microstructure story we find that between ticks, as dividend sizes increase (hence dividend yields increase), price-drop-to-dividend ratios decrease. However, consistent with the tax clientele hypothesis, when dividend size is fixed, a positive relation between price-drop-to-dividend ratio and yield is still seen.

JEL classification: G10
Keywords: Ex-dividend day price drop; Tax clienteles; NYSE Rule 118

1. Introduction

In a perfect capital market, the share price following a dividend should fall by exactly the amount of the dividend paid on each share. However, empirical works on this issue consistently find that, on average, stock prices actually drop by less than the dividend amount on the ex-dividend date (e.g., Elton and Gruber, 1970; Michaely, 1991; Eades et al., 1994). Elton and Gruber hypothesize that since investors care only about after-tax returns, a higher tax on dividend income

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than on capital gains will result in an ex-dividend day price drop that is smaller than the dividend. As an extension to this tax-based theory, Elton and Gruber suggest that tax clienteles form for different levels of dividend yields. These tax clienteles produce a positive relation between dividend yield and the price-drop-to-dividend ratio.

While many papers find empirical support for the tax clientele hypothesis (e.g., Elton and Gruber, 1970; Litzenberger and Ramaswamy, 1979; Lakonishok and Vermaelen, 1986; Karpoff and Walkling, 1990; Michaely and Vila, 1995; Green and Rydqvist, 1999; McDonald, 2001; Bell and Jenkinson, 2002; Graham et al., 2003; Elton et al., 2004), a substantial body of evidence also calls the tax clientele hypothesis into question (e.g., Kalay, 1982; Lakonishok and Vermaelen, 1983, 1986; Dubofsky, 1992; Kato and Loewenstein, 1995; Bali and Hite, 1998; Frank and Jagannathan, 1998; Jakob and Ma, 2004). Many of the papers that question the tax clientele hypothesis indicate that transactions costs and market microstructure may provide other feasible explanations for observed anomalous ex-day price behavior.

Even with well over 100 papers published in the ex-dividend day literature, there still remains a lack of consensus on whether transactions costs, microstructure or tax effects are the basis of anomalous ex-day stock price behavior. In this paper, we revisit the heavily studied U.S. ex-dividend day data, but we devise a new approach to determine to what extent transactions costs, microstructure or taxes influence ex-dividend day price changes. We base our analysis on the techniques used by Fama and French (1992) in their seminal paper that examines whether beta or some other factor explains the cross-section of expected stock returns.

Fama and French (1992) find that size and book-to-market equity, and not beta, combine to capture the cross-sectional variation in average stock returns. Fama and French recognize that size and the betas of size portfolios are highly correlated, so tests on size portfolios are unable to disentangle size effects and beta in average returns. To allow for variation in beta that is unrelated to size, they subdivide each size decile into 10 portfolios based on the stocks' pre-ranking betas. With the double-sorted portfolios they find a strong relation between average return and size, but no relation between average return and beta.

In this paper we recognize that dividend sizes and dividend yields are highly correlated. For example, in our initial sample of 156,947 observations (described in Section 3), the correlation between dividend amounts and dividend yields is 0.497, which is significant at better than the 1% level. This correlation occurs because most firms prefer to keep the level of their stock prices within a certain range. For example, Lakonishok and Lev (1987) find that firms use stock splits to restore their stock prices to a "normal range." Thus a larger dividend most often means a higher dividend yield. The observation of this strong correlation is important because dividend size is the most important factor in the microstructure explanation of the ex-day anomaly, whereas dividend yield plays a crucial role in the tax clientele hypothesis.

To disentangle the impact of dividend size and dividend yield on ex-day behavior, we collect data only for the most frequent dividend amounts, and then subdivide dividend size groups into portfolios on the basis of dividend yield. This analysis allows for variation in dividend yield that is completely unrelated to the dividend size. Using the double-sorted portfolios, we test whether dividend yield (the tax clientele hypothesis) or dividend size (the microstructure hypothesis) determines the level of the ex-day price drop relative to the dividend.

The results for the \$0.05, \$0.10, and \$0.125 dividends sharply contradict the predictions of the tax clientele hypothesis. For each of these dividend sizes the market-adjusted price-drop-to-dividend ratio is flat across dividend yield deciles. For the \$0.05 dividends, the yields for all deciles also are relatively low, but the price-drop-to-dividend ratios are greater than one (i.e., ex-day abnormal returns are negative). These results contradict the tax clientele hypothesis that dividend yield and ex-day price-drop-to-dividend ratio are positively correlated. They strongly support Dubofsky's (1992) market microstructure hypothesis about the ex-day stock price behavior.

For dividends greater than one tick (i.e., \$0.125), the evidence from the sorted portfolio analyses is mixed. We find that between ticks, as dividend size increases, dividend yields increase (as expected), but price-drop-to-dividend ratios decrease. This is consistent with Dubofsky's market microstructure model and inconsistent with the tax explanation. However, for these larger dividends, after controlling for dividend size, we continue to see a positive relation between dividend yield and the ex-day price-drop-to-dividend ratio. This finding appears consistent with Elton and Gruber's tax clientele hypothesis, but it can also be explained by transactions costs. We note that this relation is not stable across dividend sizes, contradicting the tax clientele hypothesis. The mixed evidence suggests that microstructure, transactions costs and taxes all appear influential for the ex-day price behavior of larger dividends in our sample.

In the next section we present the competing tax clientele and microstructure models. We also discuss how transactions costs can influence the outcomes in each of these model settings. In Section 3 we describe our sample. Section 4 presents the empirical results. Section 5 concludes the paper.

2. The models

2.1. The tax clientele model

Elton and Gruber (1970) initially derived the Tax Effect Model. According to their model, the ex-dividend behavior of a corporation's common stock should be related to the tax rates of its marginal stockholders. Imagine a shareholder who has decided to sell his shares but is contemplating whether to sell the shares before the stock goes ex-dividend or after. For this shareholder to be indifferent to the timing of the sale, the wealth received from either course of action must be the same. Following this premise they derive the following expression.

Let
P_B = Price on the day before the stock goes ex-dividend
P_A = Price of the stock on the ex-dividend day
P_C = Price at which the stock was purchased
t_o = The tax rate on ordinary income
t_c = The capital gains tax rate
D = The amount of the dividend

$$P_B - t_c(P_B - P_C) = P_A - t_c(P_A - P_C) + D(1 - t_o) \tag{1}$$

Rearranging Eq. (1) they get

$$\frac{P_B - P_A}{D} = \frac{1 - t_o}{1 - t_c} \tag{2}$$

With this analysis the price-drop-to-dividend ratio, $(P_B - P_A)/D$, always reflects the relative marginal tax rates of the stockholders of the firm's common stock. According to Elton and Gruber (1970), they should therefore be able to infer the relative tax rates by observing the price-drop-to-dividend ratio of the common stock. In the analysis of ex-day behavior they find that the average price-drop-to-dividend ratio is 0.778. This implies a preference for capital gains over dividends and is consistent with the tax structure in the United States. As an extension to their main analysis, Elton and Gruber break up the sample into deciles based on dividend yield, D/P_{B}, and find that the price-drop-to-dividend ratio tends to increase with yield.[1] They interpret this finding as consistent with a dividend clientele effect. For higher dividend yields the clientele will likely prefer dividend income to capital gain income, leading to higher price-drop-to-dividend ratios. According to this tax clientele hypothesis, dividend yield—not dividend size—should determine the level of the price-drop-to-dividend ratio.

As an extension to Elton and Gruber's model, various studies examine the interaction of taxes and transactions costs (e.g., Kalay, 1982; Lakonishok and Vermaelen, 1983; 1986; Karpoff and Walkling, 1988, 1990; Boyd and Jagannathan, 1994; Michaely et al., 1997). These "tax hypothesis with transactions costs models" suggest that when transactions costs are high, the ex-day price drop should reflect the relative taxation of dividends and capital gains, as predicted by the tax hypothesis. When transactions costs are low, however, arbitrage trades will drive the price-drop-to-dividend ratio toward one.

The tax hypothesis with transactions costs model can explain the observed positive relation between dividend yield and the ex-day price-drop ratio without assuming that there is tax clientele. Since for higher dividend yield stocks, transaction costs are relatively lower, arbitrage can more heavily drive the price-drop-to-dividend ratios towards unity. This implies a higher price-drop-to-dividend ratio since this ratio is always lower than one, according to the tax hypothesis. Hence the tax hypothesis with transactions costs model predicts a positive relation between dividend yield and the price-drop ratio without assuming that there are tax clienteles.

2.2. The limit order adjustment model

The original ex-dividend day limit order adjustment model was derived in Dubofsky (1992, 1997) and substantiated in Jakob and Ma (2004). The key feature of the model is the exchange-mandated price adjustment for existing limit orders on the ex-dividend day. According to NYSE Rule 118, on the ex-day all existing limit buy orders are reduced by the dividend amount, and if the resulting price is not a multiple of a tick, the limit buy price is further reduced to the next tick. Existing limit sell orders are not adjusted. Dubofsky's model gives an exact prediction of the ex-day price drop only under the following restrictive assumptions:

Assumption A. On the ex-day, bid and ask prices are fully constrained to the adjusted limit order prices.

Assumption B. On both the cum- and the ex-day, trades occur on the bid and ask sides of the quotes with an equal probability of 50%.

If we use $\overline{D}$ to denote the tick multiple that is greater than or equal to the dividend amount, ΔP_{a} to denote the drop in ask price from cum- to ex-day, ΔP_{b} the drop in bid price, and ΔP the drop in transaction price, then under Assumptions A and B, the model makes the following predictions about ex-day price drops:

$$\Delta P_{\mathrm{a}} = 0, \tag{3a}$$

$$\Delta P_{\mathrm{b}} = \overline{D}, \tag{3b}$$

$$\Delta P = (\Delta P_{\mathrm{a}} + \Delta P_{\mathrm{b}})/2 = \overline{D}/2. \tag{3c}$$

[1] In Elton and Gruber's (1970) analysis the price-drop-to-dividend ratio does not increase monotonically with yield. In their Table 3, the price-drop-to-dividend ratio decreases with yield between deciles 1 and 2 and between deciles 7 and 8.

It is important to note that Dubofsky (1992, 1997) and Jakob and Ma (2004) recognize that Assumptions A and B will not be fully satisfied in most cases. They suggest that for the smallest of dividends the prices will conform most closely to the assumptions. However, as dividend size increases, the outstanding limit sell orders (which are not adjusted according to the exchange rules) will more likely be adjusted manually by investors or replaced by newly submitted limit sell orders and specialist interventions. The new or revised limit sell orders will be added to the limit order book and, if these orders offer better prices (i.e., lower) than the current ask price, the quote will be adjusted. This action will violate Assumption A because the quoted ask price will no longer be constrained to the original unadjusted limit sell orders.

Specialist interventions can take place in two important ways. First, specialists can behave exactly like a better limit sell order and adjust the quoted ask price lower (again violating Assumption A). Alternatively, specialists can leave the limit order book unadjusted but make trades at better prices than the quoted ask price. This behavior will violate Assumption B, because trades will no longer be evenly distributed between the bid and the ask price. In all of the cases, the specialist and limit order activities will reduce the transaction price for buy initiated transactions, and this will make ΔP greater than $\bar{D}/2$. According to the limit order adjustment model, dividend size should be the most important determinant of the level of the price-drop-to-dividend ratio.

As with the case of the tax hypothesis, transactions costs can be introduced to the limit order adjustment model as well. We envision that the transactions costs consideration predicts only a no-arbitrage boundary. This means that whatever the other model (e.g., the limit order adjustment model) for price-drop-to-dividend ratios may be, as long as there are sufficient amounts of tax-exempt traders who only face transaction costs, prices are driven towards a no-arbitrage interval around the frictionless market prediction that the price drop equals to the dividend, and they are driven away from the predictions from that particular model. This occurs more so for very liquid, high dividend yield, and low transaction cost stocks. For less liquid, low dividend yield, or high transaction cost stocks, the price-drop-to-dividend ratios are likely to deviate more from one and more closely follow the prediction of that particular model (e.g., the limit order adjustment model).

In particular, according to the pure limit order adjustment model, for a fixed dividend amount, the price drop is also fixed; hence the price-drop-to-dividend ratio should be independent of the dividend yield. However, if we integrate transactions costs into the limit order adjustment model, then even with fixed dividend amount, as dividend yields increase (equivalently, stock prices drop), price-drop-to-dividend ratios will increase. The reason is that, as stock prices drop, transactions costs drop since the round-trip transaction costs are typically positively related to the price, therefore arbitrage can more heavily drive the price-drop-to-dividend ratios towards unity. When the dividend is larger than the tick size, the limit order adjustment model always predicts price-drop ratios less than one. Hence driving the ratio towards one is equivalent to driving up the ratio. Consequently, considering transactions costs implies a higher price-drop ratio for higher dividend yield, even if the dividend amount is fixed.

In summary, we consider four competing models: the original Elton and Gruber tax hypothesis; the tax hypothesis with transactions costs model; the limit order adjustment model; and the limit order adjustment with transactions costs model.

3. Data

Our data come from the CRSP database. We extract the data following a procedure similar to Bali and Hite (1998). We identify all cash dividends in the CRSP file with taxable distribution codes of 1232 or 1238 (i.e., ordinary, cash, and taxable quarterly dividends) that were paid by

NYSE or AMEX firms with ex-dates between July 2, 1962, and December 31, 1994. Our sample stops at 1994 because some stocks switched to 1/16th tick-size pricing after this time; we want the tick size to be 1/8th of a dollar throughout our analysis so that the effect of the limit order adjustment mechanism remains the same during the sample period. We require the cum-day price to be greater than or equal to \$5.00. We exclude cases in which on the ex-date (a) the CRSP event file lists other corporate events or (b) there are dividend distributions that have distribution codes other than 1232 and 1238.

We then combine multiple dividends for a single stock having the same ex-date into a single observation. This gives us 156,947 observations. From this sample, we collect only the 11 most frequent dividend amounts: \$0.05, \$0.10, \$0.125, \$0.15, \$0.20, \$0.25, \$0.30, \$0.35, \$0.40, \$0.45, and \$0.50. This gives us 74,235 observations. From the data we compute the cum-day close to ex-day close price drop for each dividend. We also calculate a market-adjusted ex-day price drop based on the stock price and overall market movement on the ex-dividend day. The adjusted ex-day price drop is:

$$\varDelta P_{\mathrm{adj}} = P_{\mathrm{B}}{*}(1+\mathrm{r_m}) - \mathrm{P_A} \tag{4}$$

Here P_{B}, P_{A}, and r_{m} are the cum-day and ex-day close prices and the ex-day equal-weighted market return as reported by CRSP, respectively. This same adjustment is also adopted by Elton et al. (2004). The market-adjusted price-drop-to-dividend ratio is then simply the ratio between ΔP_{adj} and the dividend amount, and Eq. (2) becomes

$$\frac{P_{\mathrm{B}} \times (1+r_{\mathrm{m}}) - P_{\mathrm{A}}}{D} = \frac{1-t_{\mathrm{o}}}{1-t_{\mathrm{c}}}, \tag{5}$$

which is also employed in Elton et al. (2004).

Finally, since ex-dividend price drops are rather noisy, we trim out the top and bottom 0.5% of the observations in the ratio of market-adjusted price drop to cum-day price. This gives us the final sample of 73,493 observations.

4. Empirical results

4.1. The relation among dividend yield, dividend size, and ex-day price drop

Before analyzing the dividends sorted by size, we first verify that the price-drop-to-dividend ratios for our sample are consistent with those presented in prior studies that lend support to the tax clientele hypothesis. In Table 1 we separate our 73,493 observations into 10 deciles sorted on dividend yield. Consistent with the Elton and Gruber (1970) tax hypothesis, we find that the ratio $\Delta P/D$ generally increases with dividend yield. The exceptions in our sample are the two lowest dividend yield deciles. However, we note that in Elton and Gruber the ratio does not increase monotonically with yield either.

Table 1 reports two other statistics for each decile: $\Delta P_{\mathrm{adj}}/D$ and abnormal return. According to the tax hypothesis, $\Delta P_{\mathrm{adj}}/D$ should increase whereas abnormal returns should decrease with dividend yield. These relations predicted by the tax hypothesis are less visible. Graham et al. (2003, Table 5) break their samples into yield quintiles and also report that abnormal returns show no clear pattern across dividend yield groups.

To give a formal statistical test about whether dividend yield is the key factor in determining ex-day stock price drops, we regress the three dependent variables, $\Delta P/D$, $\Delta P_{\mathrm{adj}}/D$, and abnormal

Table 1
Price-drop-to-dividend ratios and abnormal returns for the full sample separated into dividend yield deciles

Dividend yield decile	Number of observations	Mean dividend yield (%)	Mean $\Delta P/D$	Mean $\Delta P_{adj}/D$	Mean abnormal return (%)
1-Low	7370	0.2685	0.8724	0.9414	0.0285
2	7325	0.4538	0.7013	0.7827	0.0972
3	7365	0.5877	0.6902	0.7643	0.1384
4	7345	0.7079	0.6916	0.7524	0.1748
5	7343	0.8224	0.7014	0.7555	0.2017
6	7365	0.9402	0.7988	0.8364	0.1543
7	7331	1.0686	0.8137	0.8609	0.1479
8	7354	1.2212	0.8141	0.8457	0.1884
9	7355	1.4269	0.8645	0.8880	0.1602
10-High	7340	1.9155	0.9323	0.9368	0.1178

The sample includes the 11 most popular dividend sizes of ordinary cash taxable dividend distributions made to NYSE and AMEX firms from July 2, 1962, to December 31, 1994, as recorded by CRSP. D is the dividend amount, ΔP is the price drop from cum- to ex-day, ΔP_{adj} is the market-adjusted price drop from cum- to ex-day, dividend yield is D divided by the cum-day price.

returns, on dividend yield. However, because different stocks may have their dividend payouts on the same date and the general market condition on that date could affect the ex-day return of all dividend payouts on that date, the error terms will be correlated if we treat each dividend payout as one observation in the regression. To avoid this problem, we follow the approach of Boyd and Jagannathan (1994) and Jakob and Ma (2004). For each day where there are dividend payouts, we first calculate the average dividend yield, average price-drop-to-dividend ratio, and average abnormal return for all the dividend payouts on that date, and then use the daily averages in our regression. Because different dates may have different numbers of dividend payouts, the regression using daily averages is likely to have different error variances on different dates. Therefore, we use the White's (1980) heteroskedasticity-consistent standard errors to calculate the t-values. Table 2 presents the results for these three regression analyses.

Table 2
Regressions of price-drop-to-dividend ratio and abnormal returns on dividend yield

Dependent variable	Intercept (t-value)	Dividend yield (t-value)	Adj. R^2
$\Delta P/D$	0.7920**	− 0.2257	− 0.0001
	(5.53)	(− 0.02)	
$\Delta P_{adj}/D$	1.0439**	− 17.493	0.0005
	(8.65)	(− 1.57)	
Abnormal return (%)	0.0206	0.0986**	0.0009
	(0.48)	(2.18)	
$\Delta P/P_B$	− 0.0013**	0.9252 [a]	0.0559
	(− 2.54)	(− 1.40)	

The sample includes ordinary cash taxable dividend distributions made to NYSE and AMEX firms from July 2, 1962, to December 31, 1994, as recorded by CRSP. Daily averages of the variables are used in the regression (this gives 7572 observations). D is the dividend amount, ΔP is the price drop from cum- to ex-day, ΔP_{adj} is the market-adjusted price drop from cum- to ex-day, P_B is the cum-day price, dividend yield is D/P_B, the price drop to dividend ratio is $\Delta P/D$, and the adjusted price drop to dividend ratio is $\Delta P_{adj}/D$. The dependent variables are $\Delta P/D$, $\Delta P_{adj}/D$, abnormal return, and $\Delta P/P_B$ in the four rows, respectively. The independent variable is dividend yield. The t-values are calculated using White's (1980) heteroskedasticity-consistent standard errors. ** indicates the estimate is significant at 95% confidence level.

[a] Here the t-test is whether the coefficient is significantly different from one.

The first two rows of Table 2 show that with $\Delta P/D$ or $\Delta P_{\mathrm{adj}}/D$ as the dependent variables, the coefficients on dividend yield have the opposite sign than predicted by the tax hypothesis or the tax hypothesis with transactions costs model, though they are not significant at the usual confidence level. When abnormal return is the dependent variable, the results are significant at the one percent level, and again the sign of the coefficient is in the opposite direction than the prediction of the tax hypothesis and the tax hypothesis with transactions costs model.

To further examine whether our sample is consistent with what has generally been found using similar data, Table 2 also presents another regression result, where the dependent variable is $\Delta P/P_{\mathrm{B}}$. (Recall that P_{B} is the cum-day stock price.) This regression specification is exactly the same as that used in Table 3 of Boyd and Jagannathan (1994). For this regression Boyd and Jagannathan's empirical finding is that the intercept is negative and statistically significant, while the slope coefficient is not significantly different from one. The last row of our Table 2 shows the same empirical patterns for both the intercept and the slope coefficient. This result suggests that our sample is similar to the data used in prior studies.

Our initial price-drop-to-dividend ratio findings for the overall sample lend some support to the two tax hypothesis based models, but the additional regression results suggest that these models do not appear to fully explain the data.

4.2. The relation between dividend yield and ex-day price drop controlling for dividend size

As we discussed earlier, to disentangle the impact of dividend size and dividend yield on ex-day behavior we subdivide dividend size groups into portfolios on the basis of dividend yield. In Table 3 Panels A–K we examine the price drop behavior for the 11 most frequent dividend sizes in our sample. The panels are presented in the order of increasing dividend size. For each specified dividend amount we divide the sample into deciles ranked by dividend yield. (Note that each decile does not contain exactly the same number of observations since many observations have identical yields.) For each yield decile we report the number of observations, the mean dividend yield, the mean market-adjusted price-drop-to-dividend ratio, and the mean abnormal return. The panels in Table 3 allow us to examine whether the dividend yield impacts ex-day price drop behavior while holding dividend size constant. According to the tax clientele hypothesis, regardless of dividend size, we should see a clear positive relation between dividend yield and the market-adjusted price-drop-to-dividend ratio, and a clear negative relation between dividend yield and abnormal returns. Dubofsky's microstructure argument, on the other hand, suggests that dividend size is the main factor that determines the level of the price-drop-to-dividend ratio.

The results for the \$0.05 dividends in Table 3, Panel A, sharply contradict the predictions based on the tax hypothesis in two aspects. First, the market-adjusted price-drop-to-dividend ratio is nearly flat across all dividend yield deciles with no clear increasing trend as dividend yield increases. Second, nine out of ten of the dividend yield deciles have adjusted price-drop-to-dividend ratios greater than one and abnormal returns below zero. According to the tax clientele hypothesis the relatively low yields observed for the \$0.05 dividend size should result in price-drop-to-dividend ratios well below one with large abnormal returns. In fact, deciles 1 and 2 for the \$0.05 dividends have the lowest average yields of any deciles in the entire data set, but their adjusted price-drop-to-dividend ratios are both well above one. The results are also inconsistent with the tax hypothesis with transactions costs model, because this model would still predict a less than unity price-drop-to-dividend ratio.

The price-drop ratios and abnormal returns for the \$0.05 dividends are consistent with Dubofsky's limit order adjustment model. According to that model the price drops for these

Table 3
Price drop for the most common dividend sizes separated into yield deciles

Dividend yield decile	Mean dividend yield (%)	Mean $\Delta P_{adj}/D$	Mean abnormal return (%)	Number of observations
Panel A: dividend size is \$0.05				
1-Low	0.1103	1.161	− 0.0091	582
2	0.1957	1.212	− 0.0358	587
3	0.2521	1.248	− 0.0667	600
4	0.3030	1.226	− 0.0684	557
5	0.3613	1.014	− 0.0430	604
6	0.4339	0.880	0.0537	592
7	0.5094	1.315	− 0.1509	546
8	0.5985	1.448	− 0.2651	593
9	0.7171	1.298	− 0.2172	593
10-High	0.8905	1.136	− 0.1348	580
All	0.4369	1.193	− 0.0894	5834
Panel B: dividend size is \$0.10				
1-Low	0.2337	0.771	0.0613	1015
2	0.3473	0.883	0.0463	1007
3	0.4320	0.895	0.0445	1019
4	0.5178	0.921	0.0358	1015
5	0.6077	0.591	0.2475	1018
6	0.7024	0.753	0.1708	1008
7	0.8133	0.795	0.1695	1010
8	0.9629	0.745	0.2516	1010
9	1.155	0.837	0.1886	1018
10-High	1.533	0.838	0.2645	1012
All	0.7305	0.803	0.1481	10,132
Panel C: dividend size is \$0.125				
1-Low	0.2439	1.000	0.0369	465
2	0.3758	0.868	0.0476	467
3	0.4733	0.464	0.2598	464
4	0.5625	0.810	0.1106	452
5	0.6711	0.977	0.0170	457
6	0.7933	0.493	0.4035	487
7	0.9105	0.682	0.2920	443
8	1.056	0.802	0.2121	472
9	1.2549	0.822	0.2314	461
10-High	1.6799	0.769	0.4142	470
All	0.8033	0.767	0.2038	4638
Panel D: dividend size is \$0.15				
1-Low	0.3018	0.802	0.0821	911
2	0.4377	0.667	0.1428	906
3	0.5373	0.728	0.1500	924
4	0.6336	0.711	0.1849	934
5	0.7346	0.897	0.0713	895
6	0.8444	0.905	0.0784	931
7	0.9697	0.947	0.0516	907
8	1.1202	0.931	0.0795	914
9	1.3270	0.957	0.0549	909
10-High	1.812	1.006	− 0.0051	905
All	0.8705	0.854	0.0894	9136

Table 3 (*continued*)

Dividend yield decile	Mean dividend yield (%)	Mean $\Delta P_{adj}/D$	Mean abnormal return (%)	Number of observations
Panel E: dividend size is \$0.20				
1-Low	0.3674	0.721	0.1011	820
2	0.5327	0.582	0.2229	803
3	0.6485	0.767	0.1512	823
4	0.7557	0.682	0.2425	813
5	0.8606	0.827	0.1481	835
6	0.9780	0.885	0.1129	826
7	1.107	0.786	0.2373	823
8	1.240	0.788	0.2653	778
9	1.427	0.844	0.2280	831
10-High	1.887	0.929	0.1522	811
All	0.9795	0.782	0.1856	8163
Panel F: dividend size is \$0.25				
1-Low	0.3853	0.659	0.1319	1113
2	0.5734	0.590	0.2388	1105
3	0.6939	0.635	0.2551	1136
4	0.8022	0.641	0.2871	1126
5	0.9081	0.798	0.1837	1106
6	1.013	0.797	0.2066	1091
7	1.133	0.838	0.1817	1136
8	1.288	0.759	0.3086	1088
9	1.4827	0.803	0.2916	1147
10-High	1.980	0.862	0.2715	1111
All	1.026	0.738	0.2357	11,159
Panel G: dividend size is \$0.30				
1-Low	0.4672	0.566	0.2003	782
2	0.6514	0.798	0.1315	782
3	0.7686	0.717	0.2200	791
4	0.8664	0.766	0.1924	787
5	0.9651	0.846	0.1479	793
6	1.073	0.896	0.1094	783
7	1.191	0.862	0.1654	770
8	1.327	0.968	0.0430	789
9	1.527	0.983	0.0247	796
10-High	2.027	0.959	0.0708	785
All	1.087	0.837	0.1304	7858
Panel H: dividend size is \$0.35				
1-Low	0.4609	0.468	0.2235	497
2	0.6864	0.682	0.2181	492
3	0.8044	0.588	0.3317	505
4	0.9076	0.697	0.2741	503
5	0.9978	0.801	0.1969	486
6	1.091	0.942	0.0652	488
7	1.197	0.786	0.2568	498
8	1.326	0.882	0.1585	509
9	1.515	1.002	−0.0043	495
10-High	1.994	0.944	0.0977	498
All	1.098	0.779	0.1823	4971

(*continued on next page*)

Table 3 (*continued*)

Dividend yield decile	Mean dividend yield (%)	Mean $\Delta P_{adj}/D$	Mean abnormal return (%)	Number of observations
Panel I: dividend size is \$0.40				
1-Low	0.5393	0.837	0.1251	480
2	0.7386	0.879	0.0924	486
3	0.8579	0.783	0.1885	493
4	0.9641	0.770	0.2212	478
5	1.064	0.950	0.0544	476
6	1.171	0.947	0.0595	488
7	1.300	0.936	0.0831	485
8	1.441	0.959	0.0586	476
9	1.635	1.039	− 0.0655	494
10-High	2.164	1.123	− 0.2738	483
All	1.188	0.922	0.0542	4839
Panel J: dividend size is \$0.45				
1-Low	0.5696	0.541	0.2691	306
2	0.7676	0.570	0.3261	308
3	0.8873	0.867	0.1163	305
4	0.9967	0.874	0.1247	312
5	1.102	0.810	0.2098	298
6	1.213	0.836	0.1969	316
7	1.335	0.882	0.1561	296
8	1.486	0.881	0.1794	318
9	1.693	0.952	0.0836	306
10-High	2.138	0.987	− 0.0127	304
All	1.219	0.820	0.1652	3069
Panel K: dividend size is \$0.50				
1-Low	0.5675	0.661	0.1734	368
2	0.7811	0.700	0.2317	370
3	0.9085	0.725	0.2521	368
4	1.013	0.796	0.2052	376
5	1.110	0.795	0.2254	364
6	1.209	0.913	0.1059	373
7	1.332	0.823	0.2358	368
8	1.496	0.819	0.2690	366
9	1.758	0.921	0.1358	378
10-High	2.277	0.881	0.2557	363
All	1.244	0.804	0.2086	3694

The sample includes ordinary cash taxable dividend distributions made to NYSE and AMEX firms from July 2, 1962, to December 31, 1994, as recorded by CRSP. D is the dividend amount, ΔP_{adj} is the market-adjusted price drop from cum- to ex-day, dividend yield is D divided by the cum-day price.

small dividends should be close to $\bar{D}/2$. With the tick size fixed at 1/8th of a dollar the expected average price drop is \$0.125/2 = \$0.0625. Since D = \$0.05, the predicted price-drop-to-dividend ratio is 1.25. This theoretical ratio is independent of the dividend yield and is larger than one. The empirically observed average price-drop-to-dividend ratio for the entire \$0.05 dividend sample is 1.193. We note that the empirical value for the ratio is slightly closer to one than the theoretical ratio. This is consistent with the combined prediction of the limit order adjustment with transactions costs model where the ratio should be driven towards one by arbitrage traders.

Table 3, Panels B and C, contains the results for the \$0.10 and \$0.125 dividends. In these two panels the expected trend of the tax clientele hypothesis is still not visible. That is, the price-drop-to-dividend ratio does not increase with dividend yield once dividend size is fixed. These findings contradict the tax hypothesis and its combination with the transactions costs model. The limit order hypothesis under the strict assumptions presented earlier again predicts a price drop of $\bar{D}/2=$ \$0.125/2 = \$0.0625. Similar to the discussion before, this implies a flat relation between dividend yield and the price-drop-to-dividend ratio. When $D=$\$0.10 or \$0.125 the limit order adjustment model's predictions for the price-drop-to-dividend ratios are 0.625 and 0.5, respectively. The empirically observed average price-drop-to-dividend ratios are 0.803 and 0.767, respectively. Consistent with the integration of transactions costs, we find the empirical values for the ratios are closer to one than the theoretical ratios based on the limit order adjustment model.

Table 3, Panels A, B, and C, suggests that the ex-day behavior of dividends that are less than or equal to one tick is controlled by the limit order adjustment mechanism coupled with the transactions costs model and not tax-based market imperfections. It is worth noting that in our final sample of 73,493 observations, dividends that are one tick or less in value account for 28.0% of the sample. For the initial sample of 156,947 observations, 47,117 of the dividends (30%) are no greater than \$0.125. Therefore, dividends that are no greater than one tick make up a sizable portion of all dividend distributions, and the tax clientele hypothesis is inconsistent with the ex-day price behavior of these dividends.

Table 3, Panels D–K, presents the results for the remaining dividend sizes in our sample. These dividends range from \$0.15 to \$0.50 and are larger than the prevailing 1/8th of a dollar tick size during the sample period. In these panels we begin to see a positive relation between the price-drop-to-dividend ratio and dividend yield. Examining each panel separately the results are consistent with the tax clientele hypothesis (or its combination with the transactions costs model) and are inconsistent with the pure limit order adjustment model. However, these observations could also be attributed to the limit order adjustment with transactions costs model.

4.3. The relation between dividend yield and ex-day price drop across different dividend sizes

According to the tax clientele hypothesis, the positive relation between dividend yield and the price-drop-to-dividend ratio should hold regardless of dividend size. This relation can be analyzed by examining the prior data across panels. Looking, as an example, at Panels D and E for the \$0.15 and \$0.20 dividends we see that this relation does not appear to be consistent across the two panels. For the \$0.15 dividends the decile yields range from 0.3018% to 1.812%, and for the \$0.20 dividends the decile yields range from 0.3674% to 1.887%. For every decile in the \$0.15 dividend group, the corresponding decile in the \$0.20 group has a higher average dividend yield. According to the tax clientele hypothesis we should, therefore, expect the adjusted price-drop ratios to be larger for the corresponding dividend yield decile in the \$0.20 dividend group. However, the data do not illustrate this trend. On the contrary, nine out of ten deciles from the \$0.20 dividends have smaller adjusted price-drop ratios than those from the corresponding \$0.15 dividend deciles. For example, Decile 1 for the \$0.15 dividend group has an adjusted price-drop ratio of 0.802, while Decile 1 for the \$0.20 dividend group has an adjusted price-drop ratio of only 0.721, even though the average dividend yield in the former is 0.3018%, while the yield in the latter is 0.3674%. Comparisons between Panels E (dividend = \$0.20) and F (dividend = \$0.25) lead to the same conclusion, as do comparisons between Panels G (dividend = \$0.30) and H (dividend = \$0.35); Panels I (dividend = \$0.40) and J (dividend = \$0.45); and Panels J (dividend = \$0.45) and K (dividend = \$0.50).

These findings also appear to conflict with the tax hypothesis with transactions costs model. As dividend sizes increase, the relative sizes of transactions costs decrease. This should lead to a higher price-drop-to-dividend ratio. The findings are inconsistent with this prediction.

We return to Panels D and E to determine whether these cross-panel findings are consistent with the limit order adjustment model. Under Assumptions A and B presented earlier, the average price drop for both the \$0.15 and \$0.20 dividends should be \$0.25/2 (that is, D= \$0.25 for both \$0.15 and \$0.20 dividends). Hence under Assumptions A and B, the price-drop-to-dividend ratios for the \$0.15 dividends should be larger than those for the \$0.20 dividends. Even if Assumptions A and B are violated in reality, the prediction that the price-drop-to-dividend ratios for the \$0.15 dividends should be larger than the ratios for the \$0.20 dividends is still likely to hold.

The same discussion applies to the comparison between Panels E (dividend = \$0.20) and F (dividend = \$0.25); Panels G (dividend = \$0.30) and H (dividend = \$0.35); Panels I (dividend = \$0.40) and J (dividend = \$0.45); and Panels J (dividend = \$0.45) and K (dividend = \$0.50). For each dividend size pair in the comparison, the predicted price drop will be the same under Assumptions A and B: D is \$0.25 for both \$0.20 and \$0.25 dividends; \$0.375 for both \$0.30 and \$0.35 dividends; and \$0.50 for the \$0.40, \$0.45, and \$0.50 dividends.

With these uniform findings between tick sizes, one may begin to believe that the observed patterns are merely the result of some mechanical artifact. However, this is not likely the case, because when we examine pairs of dividends that are on either side of a tick multiple completely different patterns emerge. The opposite pattern of increasing price-drop-to-dividend ratio shows up between Panels C (dividend = \$0.125) and D (dividend = \$0.15); Panels F (dividend = \$0.25) and G (dividend = \$0.30); and Panels H (dividend = \$0.35) and I (dividend = \$0.40). Both observed patterns are consistent with the limit order adjustment model, because $\bar{D}$ stays the same in each pair within the tick interval, while $\bar{D}$ jumps from the first panel to the second panel in each pair in the second case when tick intervals are surpassed.

Table 4 expands on the analysis of the relation between dividend yield and the price-drop-to-dividend ratio across all different dividend sizes in our sample. The table is divided into four panels based on the dividend size relative to the tick size. Panel A contains dividends that are less than or equal to one tick; Panel B contains dividends that are larger than one tick but less than or equal to two ticks, and so on. Two patterns are worth noting. First, within each panel, as dividend size increases, the average dividend yield always increases (and these increases are always significant except in one case, where the t-statistics is 1.37). This is to be expected. But as dividend size increases within a tick interval, the average price-drop-to-dividend ratios always drop, as shown in the fourth column (the t-tests in column five show that some of these declines are statistically significant). This phenomenon is qualitatively consistent with Dubofsky's prediction. Recall that Eq. (3c) states that under strict assumptions the average price drop will be one half of the tick multiple that is greater than or equal to the dividend, $\bar{D}/2$. In each panel of Table 4, $\bar{D}$ is the same. Hence, the ex-day price drop will be the same regardless of the dividend size. Therefore, as dividend size increases, dividend yield increases but the price-drop-to-dividend ratio should decrease.

Second, as dividend size moves from one Panel to the next, the dividend yield always becomes significantly higher, as expected. At the same time, the price-drop-to-dividend ratio always rises significantly. For example, when dividend size moves from \$0.125 to \$0.15, dividend yield increases (as expected) from 0.8033 to 0.8705, and the market-adjusted price-drop-to-dividend ratio also increases from 0.767 to 0.854. The opposite direction of the changes in the price-drop ratio within tick intervals and across tick intervals is consistent with Dubofsky's prediction and inconsistent with the tax clientele hypothesis or its combination with the transactions costs model.

Table 4
Average dividend yield and price-drop-to-dividend ratio for different dividend size groups

Dividend size	Dividend yield (%)	Test of equality of dividend yield	Mean $\Delta P_{adj}/D$	Test of equality of $\Delta P_{adj}/D$	Observations
Panel A: dividend ≤ one tick					
\$0.05	0.4369	n.a.	1.193	n.a.	5834
\$0.10	0.7305	60.1**	0.803	− 2.38*	10,132
\$0.125	0.8033	9.78**	0.767	− 0.81	4638
Panel B: dividend > one tick and dividend ≤ two ticks					
\$0.15	0.8705	8.67**	0.854	2.11*	9136
\$0.20	0.9795	16.1**	0.782	− 1.46	8163
\$0.25	1.026	7.18**	0.738	− 1.33	11,159
Panel C: dividend > two ticks and dividend ≤ three ticks					
\$0.30	1.087	8.95**	0.837	3.46**	7858
\$0.35	1.099	1.37	0.779	− 1.37	4971
Panel D: dividend > three ticks and dividend ≤ four ticks					
\$0.40	1.188	9.93**	0.922	3.77**	4839
\$0.45	1.219	2.78*	0.820	− 2.63*	3069
\$0.50	1.244	2.31*	0.804	− 0.50	3694

The sample includes ordinary cash taxable dividend distributions made to NYSE and AMEX firms from July 2, 1962, to December 31, 1994, as recorded by CRSP. D is the dividend amount, ΔP_{adj} is the market-adjusted price drop from cum- to ex-day, dividend yield is D divided by the cum-day price. The third column gives t-tests of equal mean dividend yield (using Satterthwaite method) for one dividend size group with the previous dividend size group. The fifth column does the same for the equal mean of $\Delta P_{adj}/D$. * and ** indicate significant at 5% and 1% levels, respectively.

Combining the findings of Subsections B and C for these larger dividends of \$0.15 to \$0.50, we see that the evidence is consistent with Dubofsky's limit order model in certain key aspects. Although Elton and Gruber's tax clientele hypothesis predicted a positive relation between the price-drop-to-dividend ratio and dividend yield, this result can also be attributed to the limit order adjustment with transactions costs model. The results suggest that ex-day stock price behavior for larger dividends may be affected by the limit order adjustment mechanism, transactions costs, and taxes.

4.4. A regression analysis

The data for each dividend size in Table 3 were separated into deciles and visually examined for trends related to the tax clientele hypothesis and the limit order adjustment model. In this section we again separate the dividends into subsets based on dividend size, but we use regression analysis to examine the relation between (a) price-drop-to-dividend ratio and dividend yield and (b) abnormal return and dividend yield. Since the results on the relation between abnormal return and dividend yield are consistent with those between price-drop-to-dividend ratio and dividend yield, we will only report the latter. Table 5 presents the price-drop-to-dividend ratio regression results for the 11 dividend size subsets. Again to alleviate the problem of correlated errors in the regression, we first take daily averages (across dividend distributions) of the relevant variables and then use the daily averages to perform regression analysis. We use the White's (1980) heteroskedasticity-consistent standard errors to calculate the t-values.

Table 5
Regression of price-drop-to-dividend ratio on dividend yield

Dividend size	Intercept (*t*-value)	Dividend yield (*t*-value)	Adj. R^2	No. of daily obs.
\$0.05	0.638	105.83	0.0002	3402
	(0.53)	(0.86)		
\$0.10	0.900	− 11.715	− 0.0001	4719
	(0.6)	(− 0.66)		
\$0.125	0.811	− 6.688	− 0.0003	2798
	(0.92)	(− 0.36)		
\$0.15	0.676**	22.271	0.0009	4290
	(2.43)	(1.88)		
\$0.20	0.681**	12.074	0.0002	3833
	(2.33)	(1.06)		
\$0.25	0.640**	9.280	0.0002	4416
	(3.33)	(1.10)		
\$0.30	0.720**	13.38**	0.0011	3696
	(3.22)	(2.08)		
\$0.35	0.514**	26.107**	0.0044	2919
	(4.16)	(2.98)		
\$0.40	0.695**	19.612**	0.0035	2882
	(3.31)	(3.11)		
\$0.45	0.622**	18.092**	0.0029	2131
	(3.15)	(2.23)		
\$0.50	0.669**	11.317	0.0014	2392
	(3.14)	(1.67)		

The sample includes ordinary cash taxable dividend distributions made to NYSE and AMEX firms from July 2, 1962, to December 31, 1994, as recorded by CRSP. We first take daily averages of the variables and then use them to run the regression. D is the dividend amount, ΔP_{adj} is the market-adjusted price drop from cum- to ex-day, dividend yield is D divided by the cum-day price, and the price drop to dividend ratio is $\Delta P_{\mathrm{adj}}/D$. The standard errors are White's heteroskedasticity consistent ones. For the "Intercept" column, the *t*-value is that for a one-tailed test of the intercept is greater than 1; for the "Dividend yield" column, the *t*-value is the usual one. The ** indicates the associated *t*-test is significant at 95% confidence level.

The first three rows of Table 5 contain the results for the \$0.05, \$0.10, and \$0.125 dividends. These dividends are all less than or equal to the prevailing tick size of 1/8th of a dollar. In these first three rows, the expected trend of the tax clientele hypothesis or the tax hypothesis with transactions costs model is absent. In all three cases the coefficient on the dividend yield variable is insignificant. Once dividend size is controlled for, increasing dividend yield does not significantly increase the market-adjusted price-drop-to-dividend ratio for the \$0.05, \$0.10, and \$0.125 dividend groups.

The limit order hypothesis, under the strict assumptions presented earlier, predicts a price drop of $\bar{D}/2$ and an adjusted price-drop-to-dividend ratio above one for the \$0.05 dividends and below one for the \$0.10 and \$0.125 dividends. Although the three intercept parameter estimates in the first three rows of Table 5 are all less than one, the numbers in the table also show that we cannot reject the hypothesis that the first intercept is greater than one and the next two are lower than one. The coefficient estimates also mean that the coefficients on dividend yields are not different from zero. This is consistent with the microstructure explanation and contradicts the tax clientele explanation.

The remaining portions of Table 5 present the regression results for the \$0.15 to \$0.50 dividends. For all of these larger dividend sizes in Table 5 we find positive relations between price-drop-to-dividend ratios and dividend yield; however, in only four of the eight cases are the coefficients on dividend yield positive and significant. These statistically significant price-drop-to-dividend ratio results are consistent with the tax clientele hypothesis, but they are also consistent with the tax hypothesis with transactions costs model and the limit order adjustment with transactions costs model.

For the larger dividends, the statistically significant relations are qualitatively consistent with the tax clientele hypothesis. However, the parameter estimates for the intercepts and the coefficients on the dividend yield fluctuate dramatically across the different panels in Table 5. According to the tax clientele hypothesis dividend size is irrelevant, so the intercepts and the dividend yield coefficients should be the same across all dividend sizes.

We now perform a formal test of this hypothesis. Since the \$0.05, \$0.10, and \$0.125 dividends appear to be strongly affected by the limit order adjustment mechanism, we do not use dividends in this size range for the analysis. We only use the data from dividends greater than or equal to \$0.15. Therefore, our analysis focuses on the set of data where we did see a positive relation between dividend yield and the price-drop-to-dividend ratio. We perform the following regression:

$$\Delta P_{\mathrm{adj}}/D = \sum_{d} (\alpha_d + \beta_d y) \times I_d(D), \tag{6}$$

where y is dividend yield, the subscript d takes values in 0.15, 0.20, 0.25, 0.30, 0.35, 0.40, 0.45 and 0.50, D denotes a dividend amount, $I_d(D)$ is an indicator function that equals 1 if $D=d$, and 0 otherwise. Then we test the hypothesis that the α's are all the same and the β's are also all the same. We use the White's heteroskedasticity-consistent covariance matrix in performing this test. The test statistic is 82.33. Under the null, this test statistics is asymptotically a χ^2 distribution with 14 degrees of freedom. As a result, this hypothesis is rejected at better than the 1% confidence level.[2] These results indicate that while tax clientele effects may play a role in ex-day behavior for larger dividends, the effects are not stable as dividend size varies. This fact means that factors other than the tax clientele effects, such as transactions costs and the limit order adjustment mechanism, are also required to explain the ex-day price behavior.

5. Conclusion

We present a new approach to examine ex-day stock price behavior. We recognize that dividend sizes and dividend yields are highly correlated, and we discuss how dividend *yield* plays a crucial role in the tax clientele hypothesis, whereas dividend *size* is the key factor in the microstructure explanation of the ex-day anomaly. To disentangle the impacts of yield and size on ex-day returns we select the most frequent dividend amounts and then subdivide dividend size groups into portfolios on the basis of dividend yield. By selecting only the most frequent dividend amounts, we

[2] One caveat is that the tax clientele hypothesis does not specifically state that the relation between price-drop-to-dividend ratio and dividend yield is linear, while we estimated a linear relation. But if the true relation does not depend on the size of the dividend, then a linear approximation of it around the same range of dividend yield also should be independent of the dividend size. Table 5 shows that the range of dividend yields is about the same for the \$0.40, \$0.45, and \$0.50 dividend sizes. Hence, we expect that if we linearly approximate the true relation in the range of the \$0.40 dividends we will get the same linear relation as in the range of the \$0.45 and \$0.50 dividends. Then a rejection that the linear relations are the same for the three dividend sizes is a rejection that the true relation is independent of dividend size. To that end, we tested the same hypothesis that the α's are all the same and the β's are also all the same in Eq. (6), but using only the \$0.40, \$0.45, and \$0.50 dividends. The test statistics is 30.99, and it follows a χ^2 distribution with 4 degrees of freedom under the null hypothesis. Again the hypothesis is rejected at better than the 1% significance level.

can examine the relations between the price-drop-to-dividend ratio and dividend yield with dividend amounts completely fixed.

We find that for small dividends that are less than or equal to one tick, the results are consistent with the limit order adjustment mechanism based market microstructure model. For these small dividends, dividend yield does not influence the ex-dividend day price-drop-to-dividend ratio. Therefore, taxes do not appear to play a key role in the ex-dividend day behavior of these dividends. These findings are important since dividends of this magnitude make up 30% of the dividends distributed during the sample period. For these dividends our results suggest that the automated order adjustment system strongly influences ex-dividend day activity.

For dividends larger than one tick the findings are mixed. On one hand we find that between ticks, as dividend size increases, dividend yields increase (as expected) but price-drop-to-dividend ratios decrease. Again, this is consistent with Dubofsky's model and inconsistent with the tax explanation. On the other hand, for each dividend size greater than one tick, we find a positive relation between dividend yield and the ex-day price-drop-to-dividend ratio. This positive relation is consistent with the tax clientele hypothesis (with or without considering transactions costs), but it is also consistent with the limit order adjustment with transactions costs model. The positive relation between dividend yield and the price-drop ratio is not stable across different dividend size groups, contradicting the tax clientele hypothesis. Taken together, the evidence suggests that for larger dividends the limit order adjustment mechanism, transactions costs, and taxes may all play important roles in the behavior of stock prices on ex-dividend days.

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