THE JOURNAL OF FINANCE • VOL. XLV, NO. 3 • JULY 1990

Stock Dividends, Stock Splits, and Signaling

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ABSTRACT

This paper provides evidence that firms signal their private information about future earnings by their choice of split factor. Split factors are increasing in earnings forecast errors, after controlling for differences in pre-split price and firm size. Furthermore, price changes at stock dividend and split announcements are significantly correlated with split factors, holding other factors constant, and with earnings forecast errors. These correlations suggest that management's choice of split factor signals private information about future earnings and that investors revise their beliefs about firm value accordingly. The analysis also suggests, however, that announcement returns are significantly correlated with split factors after controlling for earnings forecast errors. This suggests that earnings forecast errors measure management's private information about future earnings with error, that split factors signal other valuation-relevant attributes, or that a signaling explanation is incomplete.

RESEARCHERS HAVE LONG PUZZLED over the role of stock splits and stock dividends. A stock dividend or split increases the number of equity shares outstanding but has no effect on shareholders' proportional ownership of shares. It is therefore puzzling that firms engage in these transactions, and even more so that stock prices rise on average when these transactions are announced, as Grinblatt, Masulis, and Titman (1984) document. The significant positive announcement effects led Grinblatt, Masulis, and Titman (hereafter GMT) to hypothesize that firms signal information about their future earnings or equity values through their split decisions. To date, this hypothesis has met with limited support. GMT conclude that "the announcement returns cannot be explained by forecasts of imminent increases in cash dividends" because they observe similar stock price behavior in firms that do not pay dividends. Our study provides further evidence on the signaling hypothesis by testing whether stock dividends and splits convey information about future earnings, and by testing whether the split factor itself is the signal.

The notion that the split factor may act as a signal has institutional as well as theoretical support. Practitioners have long contended that the purpose of stock splits is to move a firm's share price into an "optimal trading range." Baker and Gallagher (1980), who surveyed chief financial officers of firms that split their shares, report that 94% of their sample indicated their stock splits moved their

* Graduate School of Business, Stanford University and The Wharton School, University of Pennsylvania, respectively. We appreciate the helpful comments of Stan Baiman, Michael Brennan, Stephen Brown, George Foster, Mike Gibbons, Allan Kleidon, Mort Pincus, Peter Reiss, Katherine Schipper, Ken Singleton, Eric Terry, Rex Thompson, Sheridan Titman, Brett Trueman, and Peter Wilson. We are grateful to Mark Grinblatt, Ron Masulis, and Sheridan Titman for providing us with their data set of stock splits and dividends. Maureen McNichols also gratefully acknowledges the support of the Stanford Business School Trust.

share price into an "optimal trading range." Woolridge and Chambers (1983) and GMT discuss a version of the "trading range" hypothesis that incorporates asymmetric information and permits a signaling explanation for the increase in share prices when firms announce stock splits. According to this hypothesis, managers use their private information about the firm to set the split factor, and this allows investors to make inferences about the managers' private information from the observed split factor. However, if there are no costs to falling below the "desired trading range," a separating equilibrium will not be achieved by choice of split factor because, in the absence of such costs, firms will have an incentive to split by a factor greater than their private information, desired trading range, and pre-split stock price would warrant.[1]

A recent paper by Brennan and Copeland (1988) suggests that firms do not split by a factor larger than is warranted by their stock price and private information. In their model, transaction costs per dollar are a decreasing function of share prices and of firm size. The firm's manager observes the true value of the firm's discounted future cash flows and trades off the discounted value of increased transaction costs against the benefit derived from an earlier increase in the firm's share price. In the signaling equilibrium that results, the more favorable the manager's information about the value of the firm, the greater the split factor.[2] Managers not in possession of favorable information about their firms' shares are unwilling to split "falsely" because they will incur higher expected transaction costs if they do, reducing the value of the shares that they retain.

The hypothesis that the choice of split factor is affected by information about future earnings appears to be well accepted by investment banking firms. For example, in a proposal to Midlantic Banks Inc., Shearson Lehman Brothers Inc. (1983) made the following recommendations:

1. In light of the substantial increase in Midlantic's stock price during the last year, we recommend that the Company consider exercising a stock split in order to bring its stock price into a more popular trading range.
2. Since a split would be viewed by investors as an indication of management's optimism as to the prospects of the Company and its stock, an increase in the common stock dividend should be considered at the same time as a stock split. Taken together, over the near term, a split and a dividend may have a beneficial effect on Midlantic's market price. In addition to its value as a positive signal to the market, a lower priced stock tends to be more attractive to retail investors and stockbrokers (who receive higher commissions). On the basis of these technical and psychological reasons, we recommend that Midlantic exercise a stock split.
3. Based on Midlantic's current market price (about $40), we believe a 3-for-2 or a 2-for-1 split is appropriate, since it will result in a stock price of

[1] If the cost of falling below the "optimal range" is substantial, very few firms should fall below the range, in equilibrium. Our data are consistent with this in that only 11 of the 3,015 observations in our sample are reverse splits.

[2] Strictly speaking, the Brennan and Copeland manager chooses a target price, which is defined as the pre-split price dividend by one plus the split factor.

approximately \$20 to \$27 per share. However, a larger split (2-for-1) should be based on a strong assessment of the future prospects for Midlantic.

Note that in the second point, they suggest that higher transaction costs may be an advantage of a stock split and in the third point, they contend that the split factor should depend on management's optimism about the firm's future prospects.

Although the anecdotal evidence is suggestive, there are few formal tests of the asymmetric information version of the "trading range hypothesis." The purpose of our study is to assess the empirical validity of this explanation for the positive market response documented at stock dividend and split announcements. In this paper we report the design and results of three tests concerning the characteristics of a signaling equilibrium. The layout of the paper is as follows. Signaling theory and hypotheses related to stock splits are discussed in Section I. Section II describes the data, and Section III presents some preliminary descriptive statistics. The research design and primary results are described in Section IV. Section V concludes the paper with interpretations and suggestions for future research.

I. Theory and Hypotheses

In this section we describe our hypotheses concerning stock dividends and stock splits (*SD*'s).[3] The central questions that we address are whether firms that announce these distributions thereby signal favorable information about their future earnings and whether the split factor acts as the signal. The notion of signaling we use here is that of Spence (1973) and Riley (1979). They show that three relations hold in a fully revealing signaling equilibrium: the level of the signal corresponds to the level of the unobservable attribute, agents' inferences about the unobservable attribute correspond to the level of the signal, and, consequently, inferences about the level of the unobservable attribute correspond to the level of the unobservable attribute. Our hypothesis tests are based on these three implications.

Our tests of the signaling hypothesis assume that there are costs associated with different share price ranges, and that these costs may vary inversely in relation to management's private information. The literature in finance is beginning to propose explanations of the nature of these costs. In the Brennan and Copeland (1988) model, the costs correspond to the transaction costs of trading in the firm's shares, which they find are decreasing in share price for a given dollar value transaction. A potentially offsetting consideration is that, after the split, the higher commissions paid to stockbrokers may yield more publicity for the firm, and greater demand for the firm's shares, in the spirit of GMT's "attention hypothesis." A potential loss of prestige associated with a "low" share price has also been suggested, as in Shearson Lehman Brothers recommendation

[3] We refer to both forms of stock distributions, stock dividends and stock splits, collectively as *SD*'s. Except in cases where we are discussing differences between stock dividends and stock splits, we will also refer to firms announcing either stock dividends or stock splits as splitting firms.

to Midlantic Banks:

> Our view is that Midlantic can split its stock 2-for-1 and not suffer any loss of prestige. We would be somewhat more concerned if Midlantic faced any possibility of its stock going below $12, since a stock price in this range is not befitting a company of Midlantic's stature and industry position. . . . We feel that the current stock price is strongly supported on the basis of dividend yield and price-earnings multiple but advise management to carefully assess the Company's earnings outlook and general market conditions at the time that a split decision is made.

It has also been suggested that a lower range of share prices enhances the liquidity of a firm's shares. For example, Baker and Gallagher (1980) report that 98% of their sample of chief financial officers indicated that their stock split enhanced the liquidity of their firms's shares. However, the findings of studies testing for increased post-split volume are mixed. Copeland (1979) and Defeo and Jain (1989) provide evidence that share volume declines subsequent to stock splits. On the other hand, a New York Stock Exchange (1981) study concludes that there is a significant increase in share volume in the year of the split that is sustained in years after the split, relative to firms that did not split their shares. The price range of a firm's shares has also been hypothesized to affect the mix of investors holding the stock by reducing institutional holdings and increasing the holdings of individual investors.[4] Lamoureux and Poon (1987) document that the average number of stockholders increases by 34.65% in the year of a split, whereas their control sample of nonsplitting firms exhibits a decline of 2.11%. The substantive issue that remains unresolved is whether wider stock ownership is valued per se, or whether it is a by-product of stock splits rather than a motivating factor. Although the costs and benefits of a particular trading range are not fully understood, we think it is plausible to assume they deter firms from splitting by too great a factor relative to their stock price and private information, and leave the characterization of these costs and benefits to future research.

The first hypothesis we test is whether the choice of split factor reflects management's private information about future earnings. We focus on private information about future earnings because of the large literature documenting the relation between earnings and firm value (Ball and Brown (1968), Beaver, Clarke, and Wright (1979), Beaver, Lambert, and Morse (1980)), as well as the anecdotal support for a relation between split factor choice and future earnings. Management's private information about earnings is proxied by analysts' earnings forecast error, measured as the percent difference annual earnings reported after the split and the median analysts' pre-split earnings forecast.[5] We first estimate a tobit model in which management's split factor choice depends on two variables suggested by the trading range hypothesis, the pre-split share price and the market value of the firm's equity. We then test whether our proxy for

[4] In Baker and Gallagher's survey, 98.4% of their sample agreed that stock splits make it "easier for small stockholders to purchase round lots," and 85.7% of their sample agreed that stock splits ultimately increase the number of shareholders in the firm.

[5] The denominator for the forecast error is the median analysts' pre-split earnings forecast.

management's private information, analysts' earnings forecast error, explains any of the residual variation in split factors.

Our second and third hypotheses concern the inferences of investors. In a signaling equilibrium, inferences about the valued attribute correspond to the level of the signal and to the level of the unobservable attribute. Inferences about the signaled attributes of sample firms are measured by security return prediction errors in the stock distribution announcement period. We test the second hypothesis that investors' inferences correspond to the split factor signals by testing for a positive correlation between announcement period return prediction errors and an estimate of the split factor signal. Our third hypothesis is that there is a relation between revision of investors' beliefs about the value of the firm and the firm's future earnings. Our test of this hypothesis focuses on the association between security return prediction errors at *SD* announcements and earnings forecast errors measured relative to analysts' pre-*SD* expectations.

II. Data Description and Measurement of Variables

The sample is comprised primarily of stock dividends and splits occurring from 1976–1983, because machine-readable earnings forecast data (described below) were available for these years. For the period 1977–1983, announcements of all stock dividends and stock splits were obtained from the CRSP Daily Master Tape.[6] The data for 1976, provided by GMT, include all announcements of stock distributions on the CRSP Daily Master file with split factors greater than or equal to 10%. The split factor (*SPFAC*), the number of shares outstanding before the *SD* and the share price 10 days before the *SD* announcement (*PRICE*) were also obtained from the CRSP Daily Master Tape; the market value of the firm's equity (*MVE*) is computed by multiplying *PRICE* by the number of shares outstanding prior to the *SD*. Using the procedures described below, we also collected data on whether *SD* announcements were accompanied by other announcements to assess whether the results depend on the presence of announcements other than *SD*'s. Because the sample of *SD*'s with no contemporaneous announcements was relatively small, we also include 86 observations[7] with no contemporaneous announcements from the 1967–1975 time period for which earnings forecast data were available. As noted in Table I, the steps above yielded a sample of 3,015 *SD* observations.

Our definition of event time follows that of GMT. The distribution event date (day 0) is defined as the earlier of the declaration date of the event on the CRSP Daily Master Tape or the announcement date in *The Wall Street Journal.* A search was made of *The Wall Street Journal Index* for all 1977–1983 stock distributions to identify *The Wall Street Journal* announcement date, and to determine if the distribution announcement occurred in conjunction with disclosure of other events. Observations with no other announcements in *The Wall*

[6] In all of the analysis which follows, we have excluded the observations with negative split factors. There were only 11 such observations from 1976–1983, and they were excluded for lack of data on the variables analyzed.

[7] These observations were provided to us by GMT.

Table I

Firm-Split Observations in Each Analysis

1. Stock distribution observations in earnings forecast error analysis	
1976–1983 distributions	2929
1967–1975 distributions	86
1967–1983 distributions	3015
Observations with earnings forecast error data	1376
2. Stock distribution observations in returns analysis	
1976–1983 distributions with announcement period returns	2780
3. Intersection of 1 and 2:	
SD observations with earnings forecast error and returns data	1308
SD announcements only subsample	225
4. Control sample	
Initial matches	1000
Observations with earnings forecast error and returns data	810

Street Journal Index on days −3 to +1 were initially considered the "stock distribution announcement only" subsample. *The Wall Street Journal* article for each observation initially included in this subsample was then read to verify that no announcements had been omitted from *The Wall Street Journal Index* description of the article. We also compared each *SD* announcement date with cash dividend announcement dates from the CRSP Daily Master file and quarterly earnings announcement dates from the Quarterly Compustat Industrials file. If cash dividends or earnings were announced on event days −3 to +1, the observation was excluded from the subsample announcing only a stock distribution.

An earnings forecast error (*FE*) is computed as the first annual earnings reported after the *SD* less the median analysts' pre-*SD* earnings forecast, scaled by the median analysts' pre-*SD* earnings forecast.[8] Earnings data were obtained from the 1984 Compustat Annual Industrials Tape and forecast data were obtained from two sources, the Institutional Brokers Estimate System (IBES) "Summary History Tape"[9] and Standard and Poor's *Earnings Forecaster.* If available, the median analysts' earnings forecast in the month immediately preceding the *SD* announcement was collected from the IBES file; if an earnings forecast was not available from IBES and the *SD* observation had no contemporaneous announcements, the most recent pre-*SD* analyst's forecast in Standard

[8] Because none of the conclusions of our study are affected when earnings forecast errors are scaled by the pre-split price, we report only the results based on percent earnings forecast errors. We also conducted tests based on two-year ahead earnings forecast errors, with results similar to those reported here. Because two-year ahead forecasts are available for only 60% of the sample with one-year ahead forecasts, the results reported in this paper are based on one-year ahead forecasts.

[9] A detailed description of the I.B.E.S. data base is given by Brown, Foster, and Noreen (1985).

and Poor's *Earnings Forecaster* was collected if available.[10] These steps provided a sample of 1,376 *SD* observations for which earnings forecast errors could be measured.

A control sample was chosen by matching *SD* observations with non-*SD* observations with the same 2-digit SIC code and fiscal year. This procedure was motivated by evidence that analysts' earnings forecast errors exhibit systematic tendencies within industries and years.[11] Matching on these variables provides a control for these sources of variation in earnings forecast errors. All firms included in both the IBES and Compustat files for any part of the 1976–83 period were eligible for the non-*SD* sample. For each *SD* observation, a potential match was rejected if it announced an *SD* within the two-year period centered on the *SD* announcement date or if it was already assigned to another *SD* observation with an earnings forecast horizon that overlapped with the forecast horizon of the second *SD* firm. If a potential match was rejected, the above steps were repeated until a match was found or there were no remaining firms in the industry. The above matching procedure yielded a sample of 1,000 non-*SD* observations with earnings forecast errors and 810 observations with earnings forecast errors and data on all the other variables used in this study.

Finally, the announcement return prediction error (*ANNRET*) and preannouncement returns (*RUNUP*) are based on market model parameters:

$$R_{it} = a_i + b_i R_{mt} + r_{it}$$

where

r_{it} = the continuously compounded return prediction error for security i from day $t - 1$ to day t,

R_{it} = the continuously compounded return for security i from day $t - 1$ to day t, and

R_{mt} = the continuously compounded equal-weighted CRSP return from day $t - 1$ to day t.

Parameters a_i and b_i are the OLS estimates of the intercept and slope respectively in the regression of R_{it} on R_{mt}. Based on the specification above, we measure

ANNRET = the sum of the continuously compounded return prediction errors for the three days surrounding the *SD* announcement. Return prediction errors are based on a market model estimated for days −221 to −22.[12]

[10] Earnings forecasts from IBES and Standard and Poor are widely used in accounting research as proxies for expected earnings. While we know of no direct evidence comparing these two sources, studies separately comparing the accuracy of IBES and Standard and Poor earnings forecasts with time-series prediction models, such as O'Brien (1988), Brown, Foster, and Noreen (1985) and Fried and Givoly (1982), have comparable findings, suggesting that both data sources provide reasonable proxies for available information about future earnings.

[11] See O'Brien (1988) and Brown, Foster, and Noreen (1985).

[12] Standardized return prediction errors were also estimated, as in Patell (1976). Because the results using standardized errors were virtually identical to the results based on unstandardized return prediction errors, the results based on standardized prediction errors are not reported.

RUNUP = the sum of continuously compounded return prediction errors from days −120 to −2. These return prediction errors are based on market model parameters estimated using days −320 to −121.

III. Announcement Period Return Prediction Errors and Other Sample Characteristics

Before proceeding to the formal hypothesis tests, we provide descriptive evidence on security return prediction errors at *SD* announcements, and on the *SD* and control samples. Table II extends the Grinblatt, Masulis, and Titman (1984) findings to the 1976–1983 time period and reports return prediction errors measured for the *SD* announcement date and 3-day intervals surrounding the announcement date.[13] Although announcement return prediction errors are significantly positive for the *SD* sample, the errors associated with announcements of small stock dividends (with split factors less than 10%) are significantly smaller than those associated with large stock dividends or stock splits.[14] The *t*-value for the difference between the 3-day return prediction error of the small stock dividend subsample and the large stock dividend subsample is 6.6. The results for firms with no contemporaneous announcements, shown in the right panel of Table II, display a similar pattern. The results in Table II are consistent with those of GMT, in that they also find greater average price reactions for large stock dividends than for stock splits.[15]

Return prediction errors cumulated over a 180-day period surrounding the stock distribution announcement are plotted in Figures 1–4 by the size of the stock distribution. The plots reinforce the interpretations drawn from Table II: small stock dividends have correspondingly small announcement effects and large stock dividends have more pronounced announcement effects than small stock dividends or stock splits. The plots and Table II thus indicate that announcement returns are not strictly increasing in split factors. Hence, if split factors signal management's private information about future earnings, the relation between announcement returns and split factors must depend on other variables as well.

In Table III, we present descriptive statistics for the 1,308 *SD* and 810 control observations with complete data on all variables. The average split factor for the *SD* sample is 62%. The average earnings forecast error is 5.2% of the median analysts' earnings forecast for the *SD* sample and −1.7% for the non-*SD* sample; the *t*-statistic for the difference in means is 6.08, indicating that earnings forecast errors are significantly more positive for firms that announce *SD*'s. The *SD* sample's market value of equity is comparable to that of the non-*SD* sample, providing assurance that differences we observe between the *SD* and non-*SD*

[13] All observations with announcement dates from 1976–1983 for which CRSP returns data are available are in the left panel of Table 2. All *SD*'s announced with no contemporaneous disclosures and for which CRSP returns are available are in the right panel of Table II.

[14] We refer to *SD*'s with split factors of 10–20% as large stock dividends and *SD*'s with split factors greater than 20% as stock splits.

[15] The *t*-value is 2.98 for the hypothesis that the difference in return prediction errors of firms announcing large stock dividends and of firms announcing stock splits is zero.

Table II

Average Return Prediction Errors Around Stock Distribution Announcements

This table reports return prediction errors (t-values in parentheses) for all stock dividends and splits of AMEX and NYSE firms occurring during 1976–83. Return prediction errors are estimated using market model parameters estimated over days −221 to −22 relative to day 0, the stock dividend or split announcement date. Day 0 is the earlier of the declaration dates in the *Wall Street Journal* or in the CRSP daily master file. Three-day return prediction errors are measured from day −1 to day +1.

	All Announcements			Subsample with *SD* Announcements Only		
	Sample size	Day 0 return prediction error	3-day return prediction error	Sample size	Day 0 return prediction error	3-day return prediction error
Full sample	2780	0.014	0.028	397	0.015	0.030
		(21.3)	(26.2)		(8.4)	(10.3)
Stock splits	1472	0.015	0.030	251	0.014	0.030
		(18.4)	(26.2)		(6.6)	(8.4)
Stock dividends ≥10%	594	0.020	0.038	92	0.024	0.038
		(13.6)	(17.2)		(5.6)	(6.1)
Stock dividends <10%	714	0.007	0.016	54	0.005	0.014
		(4.7)	(6.7)		(1.1)	(1.9)

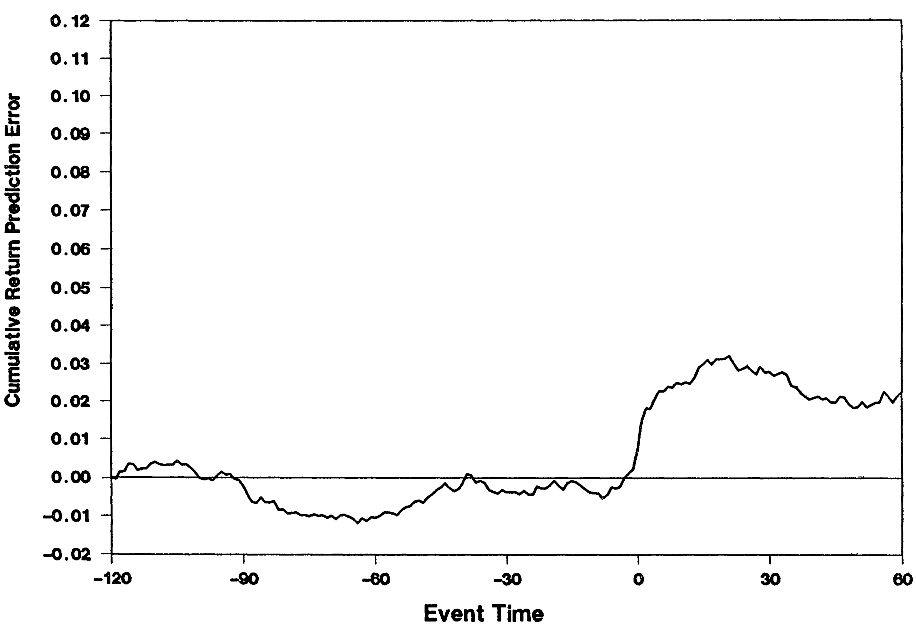

Figure 1. Plot of cumulative daily return prediction errors for an equal-weighted portfolio of 648 stock dividends with split factor less than 10%. Event day 0 is the announcement date of the stock distribution.

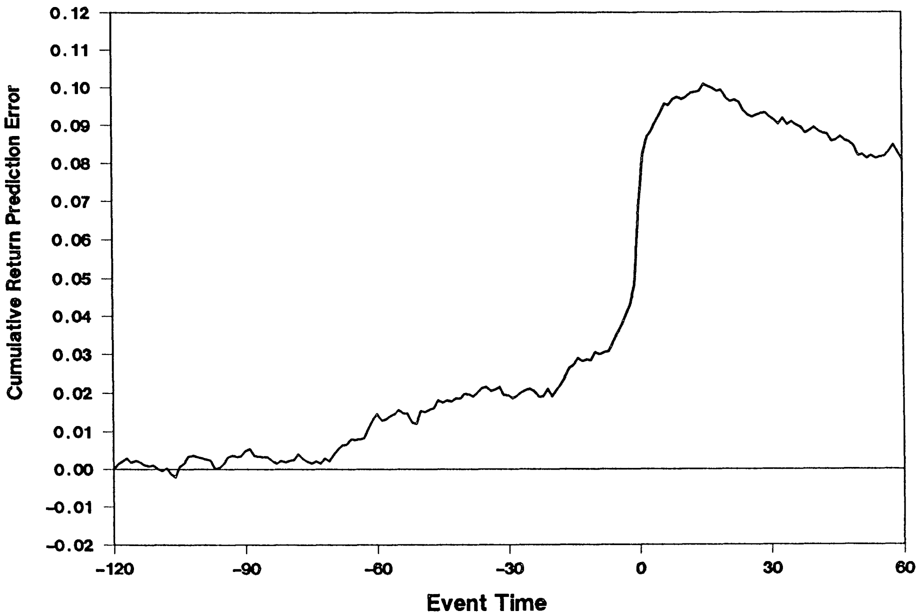

Figure 2. Plot of cumulative daily return prediction errors for an equal-weighted portfolio of 645 stock dividends with split factor between 10% and 20%. Event day 0 is the announcement date of the stock distribution.

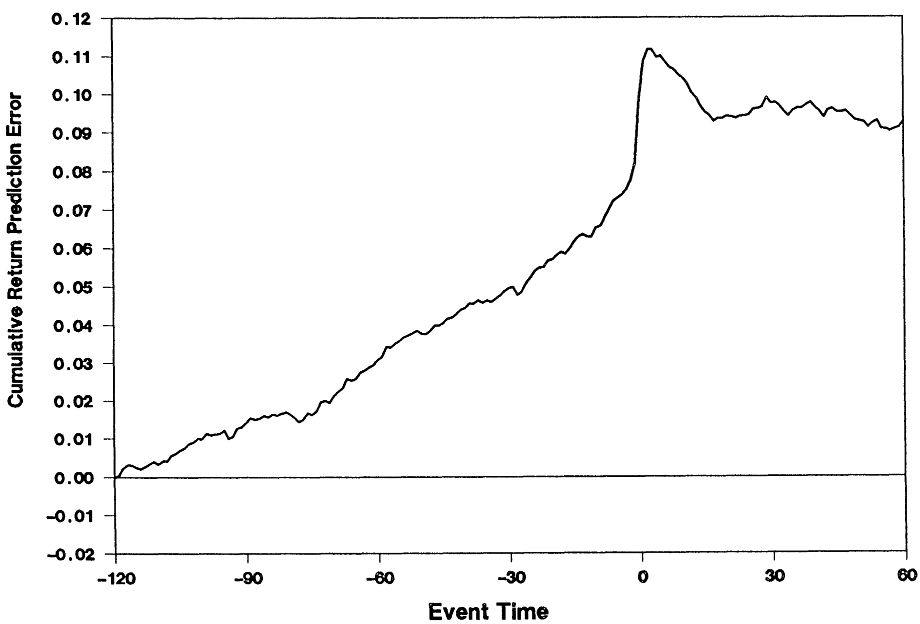

Figure 3. Plot of cumulative daily return prediction errors for an equal-weighted portfolio of 698 stock splits with split factor less than 100%. Event day 0 is the announcement date of the stock distribution.

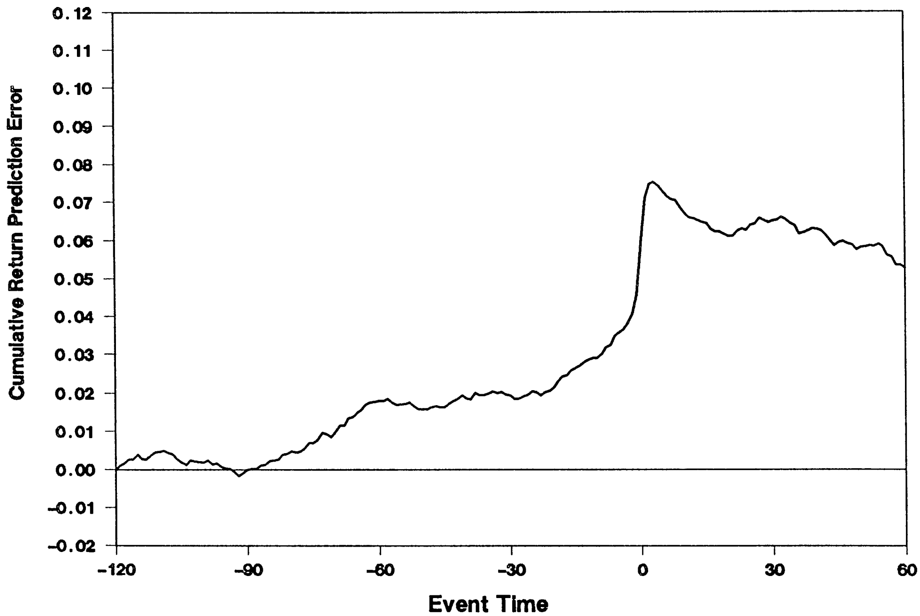

Figure 4. Plot of cumulative daily return prediction errors for an equal-weighted portfolio of 836 stock splits with split factor 100% or greater. Event day 0 is the announcement date of the stock distribution.

Table III

Descriptive Statistics for Selected Variables: *SD* and Control Samples

The *t*-values below test the null hypothesis that the mean of the *SD* stock distribution) sample equals that of the control sample against the alternative that the mean of the *SD* sample is greater. These statistics are based on 1308 *SD* and 810 control observations with data available on all of the variables shown.

	SD Sample		Control Sample		
	Mean	Standard deviation	Mean	Standard deviation	*t*-value
Split factor (*SPFAC*)	0.62	0.49	0.00	0.00	
Earnings forecast error (*FE*)	0.052	0.26	−0.017	0.25	6.08
Market value of equity (*MVE*) (in $ millions)	661.40	1831.71	730.24	1832.68	−0.83
Pre-*SD PRICE*	38.88	23.54	26.76	14.82	14.54

samples are not due to differences in firm size. The mean pre-*SD* stock price of firms that split, $38.88, is significantly higher than the mean price for the non-*SD* sample, $26.76, consistent with the results of Defeo and Jain (1989). Taken as a whole, these findings are consistent with the asymmetric information version of the trading range hypothesis: firms that engage in *SD*'s have more favorable earnings forecast errors and higher pre-split share prices than firms that do not.

IV. Hypothesis Tests and Results

This section describes the hypothesis tests and presents the primary results of this study. In conducting these tests we assume that investors use all available public information to form their expectations of the firm's value; therefore, components of firm value that are predictable using public information are not signaled by management's split factor choice. Similarly, split factor components that are predictable using available public information cannot signal management's private information.

A. A Model of Split Factor Choice

The first hypothesis concerns whether manager's split factor choices reflect their private information about future earnings.[16] The signaling interpretation of the "trading range" hypothesis predicts that split factors will be associated with earnings forecast errors if earnings forecast errors are correlated with the attribute signaled. We begin by specifying a model of other factors that influence split factor choice, to enhance the power of our test and to reduce the potential for omitted variables that are correlated with earnings forecast errors.

Both the trading range argument and prior research suggest variables that should be controlled for in a model of split factor choice. In the trading range argument, firms condition their split factor choice on the current level of their share price as well as their private information about the firm's future prospects. Thus, in testing for the association between split factors and earnings forecast errors, pre-split share price should be controlled. Stoll and Whaley (1983) document a strong positive association between firm size and share price, which suggests that larger firms prefer to maintain higher share prices. To control for this, we also include the pre-split market value of equity in our model of split factor choice.

The previous arguments motivate the following tobit model of split factor choice:[17]

$$SPFAC = \begin{cases} a_1 + a_2PRICE + a_3MVE + spfac, & \text{if } RHS > 0; \\ 0, & \text{otherwise,} \end{cases} \tag{1a}$$

where $RHS = a_1 + a_2PRICE + a_3MVE + spfac$. The residual split factor, *spfac*, represents the component of the announced split factor that is unexpected at the *SD* announcement data given available public information; it is our proxy for the signal of management's private information inferred by the market when observing *SPFAC*. We assume *spfac* is normally distributed, independent of *PRICE* and *MVE*, and has a mean of zero. Given the discussion above, we expect the coefficient on *PRICE* to be positive and the coefficient on *MVE* to be negative.

[16] Lakonishok and Lev (1987) document that the short-term earnings growth of firms issuing stock distributions (henceforth *SD* firms) exceeds that of firms not issuing stock distributions. Their analysis does not clarify whether the earnings growth of their sample was signaled by the *SD* announcement or disclosed to investors before or with the announcement. By measuring analysts' earnings forecasts immediately prior to the *SD*, we are able to make this distinction.

[17] See Amemiya (1973) for further discussion of this model.

Model (1a), which is estimated for the splitting and non-splitting samples, explicitly recognizes the selection bias of *SD* observations. We use Manski and Lerman's (1977) weighted exogenous sample maximum likelihood estimator, a procedure which weights the log likelihoods for different choices by the proportion of the population making that choice divided by the proportion of the sample making that choice.[18] As Manski and Lerman show, their estimator yields consistent coefficient estimates when the populations for different choices are sampled with different proportions.[19] Manski and Lerman also derive the covariance matrix of the weighted exogenous sampling maximum likelihood estimator, which we use for hypothesis testing.

The first panel of Table IV shows the estimation results for equation (1a) and provides strong support for the trading range hypothesis. The coefficients on pre-split price and the market value of equity are both of the predicted sign and are highly significant, as indicated by asymptotic *t*-values of 44.67 and -21.84 respectively. The data are therefore consistent with the notion that firms set split factors to achieve a target range for their share price and that the target range is greater for larger firms. We have examined the sensitivity of the results to other specifications and find the results in Table 4 to be quite robust.[20]

Having documented that firms' split factor choices are strongly associated with both their pre-split share price and their market value of equity, we next examine whether private information about future earnings, as proxied by earnings forecast errors, explains any of the remaining variation in split factors. In conducting this test, we include a third control variable, preannouncement returns, which is motivated by prior research on stock splits and the market's anticipation of earnings. Fama, Fisher, Jensen, and Roll (1969) document unusually high cumulative returns on splitting shares in the months prior to the split announcement. They interpret these return prediction errors as reflecting "the market's anticipation of substantial increases in dividends which, in fact, usually occur." More generally, for splitting and nonsplitting firms, several papers in the

[18] For discussion of the issues associated with choice-based sampling, see Manski and Lerman (1977), Manski and McFadden (1981), and Cosslett (1981). For an application of this estimator in a logit context, see Palepu (1986).

[19] Approximately 10% of firms listed on the CRSP Daily Returns tapes split their shares in any given year in the 1976–1983 period. There are 1,308 observations in the *SD* sample with complete data on all variables, and 810 observations in the non-*SD* sample. The log likelihoods of the *SD* observations were weighted by 0.16 (0.1/(1,308/2,118)) and 2.35 (0.9/(810/2,118)). The estimation results to be reported were quite insensitive to the weighting scheme applied. Qualitatively similar results were obtained with weights 0.1 (*SD*) and 0.9 (non-*SD*), and with equal weighting for each group.

[20] We estimated an OLS specification of equation (1a), and a probit specification replacing the dependent variable with a binary variable indicating whether or not an *SD* was announced. The maximum likelihood tobit estimates were greater than the OLS estimates which is to be expected given the results of Greene (1981); he shows that OLS estimates of tobit model coefficients are biased toward zero. We also estimated equation (1) as a probit model using the weighted exogenous sampling maximum likelihood estimator, and as a logit model. The weighted exogenous sampling maximum likelihood estimator affects only the intercept for the logit model, providing a check that our results are not influenced by our choice-based sampling approach. The results are very similar to the tobit results and, in the interests of brevity, are not reported here.

Table IV

Split Factor Model Estimation Results

This table reports the estimation results (with asymptotic t-values in parentheses) for Model (1), using the weighted exogenous sampling maximum likelihood tobit estimator. The sample is comprised of the 2118 observations with complete data on all variables (1308 *SD* and 810 control observations). The χ^2 value shown is for the likelihood ratio test of the hypothesis that all the parameters in the model are equal to zero. The statistic is significant at less than 0.00001 for both models.

RHS = The right-hand side of model (1).
SPFAC = Split factor (for stock dividends and splits).
PRICE = Closing stock price 10 days prior to stock dividend or split announcement.
MVE = Market value of the firm's equity, measured 10 days prior to the *SD* announcement, in $ millions.
RUNUP = Cumulative residual returns measured from day −120 to day −2.
FE = One-year-ahead percent earnings forecast error.
spfac = Unexpected split factor, assumed to be normally distributed with a mean of zero.
uspfac = The portion of *spfac* that is not explained by earnings forecast errors after controlling for pre-announcement returns.

$$SPFAC = \begin{cases} a_1 + a_2 PRICE + a_3 MVE + a_4 RUNUP + a_5 FE + \text{error}, & \text{if } RHS > 0; \\ 0, & \text{otherwise.} \end{cases}$$

Model	a_1	a_2	a_3	a_4	a_5	*error*	Model χ^2
(1a)	−0.383	0.019	−0.000074			*spfac*	1024.1
	(−16.65)	(44.67)	(−21.84)				
(1b)	−0.383	0.020	−0.000089	0.086	0.169	*uspfac*	1032.5
	(−15.95)	(45.32)	(−27.82)	(1.65)	(3.11)		

accounting literature document that prices anticipate earnings changes prior to their public announcement (Ball and Brown (1969), Beaver, Lambert, and Morse (1980), Brown, Foster, and Noreen (1985), Atiase (1985) and O'Brien (1988)). Preannouncement returns are thus a variable that is likely to be correlated with earnings forecast errors.[21] We therefore include cumulative returns in the preannouncement period (*RUNUP*) as an independent variable to control for the component of earnings forecast errors that was known before the *SD* announcement date.

Our test of the association between earnings forecast errors and split factor choice is based on the following model of split factor choice:

$$SPFAC = \begin{cases} a_1 + a_2 PRICE + a_3 MVE + a_4 RUNUP & \\ + a_5 FE + uspfac, & \text{if } RHS > 0; \\ 0, & \text{otherwise.} \end{cases} \quad (1b)$$

The residual split factor, *uspfac*, is assumed to be independent of *PRICE*, *MVE*, *RUNUP* and *FE* and to be normally distributed with a mean of zero. Our alternate hypothesis is that a_5, the coefficient on *FE*, is positive.[22]

The estimation results for model (1b) are in the second panel of Table IV. Similar to the estimation results for model (1a), *PRICE* and *MVE* remain important predictors of split factor choice. In addition, the coefficient on the earnings forecast error variable, controlling for *RUNUP*, has a probability value less than 0.001. These results support the notion that managers incorporate their private information about future earnings in setting the split factor.

B. The Relation Between Announcement Period Returns and Split Factors

The second characteristic of a signaling equilibrium we examine is that inferences about valued attributes are associated with the level of the signal. The hypothesis we consider is that market inferences about firm values are associated with the unexpected split factor, conditional on existing public information. This hypothesis test is based on the following population equation:

$$ANNRET = b_1 + b_2 spfac + e_2 \quad (2a)$$

Announcement returns (*ANNRET*) reflect investors' response to the *SD* announcement conditional on available public information. Our estimate of the split factor signal is $spfac_a$, the residual split factor from model (1a), which controls for cross-sectional differences in pre-split share prices and firm size.[23]

[21] In fact, unreported regression results for our sample document a significant correlation between *RUNUP* and *FE*, suggesting that investors have information about future earnings beyond that reflected in analysts' forecasts at the *SD* date.

[22] The forecast horizon for each non-*SD* firm matches the forecast horizon of its respective *SD* firm. The *SD* firm's announcement date is used to determine the interval for measurement of *RUNUP*.

[23] We subscript estimates by the parameter estimates they are based on to distinguish them from population values. In other words, *spfac* is the population value and $spfac_a$ is our estimate. We could also have estimated the split factor signal as $a_5 FE + uspfac$, from model (1b) if we assumed that the

To estimate (2a), we regress announcement period return prediction errors on $spfac_a$ using OLS. Equation (2a) thus tests for an association between the revision of investors' beliefs about firm value and the split factor signal, both including effects attributable to the fact that a split occurred and to the split factor chosen given that a split occurred.

Taken together, equations (1a) and (2a) comprise a recursive system (Intriligator (1978)). Under the additional assumptions that $E(spfac_2) = E(spfacX) = E(e_2X) = 0$, where X is defined as the matrix of independent variables in equation (1a), the first-stage and second-stage estimators can both be expressed as generalized method of moments estimators. The generalized method of moments orthogonality condition for OLS in the second stage is $E(spfac\ e_2) = 0$, which ensures consistent estimates of the parameters in equation (2a). Furthermore, the assumptions underlying Newey's (1984) result on the variance-covariance matrix of the second stage estimates are satisfied.[24] Because the expectation of the derivative of ($spfac\ e_2$) with respect to the model (1a) parameter estimates is zero, the variance-covariance matrix of the second stage parameter estimates is the same as it would be if *spfac* were known and, therefore, OLS standard errors are asymptotically consistent.[25] The t-values reported are based on White's (1980) consistent covariance estimator for regressions for which White's test indicated heteroskedasticity with a probability value greater than 0.5; otherwise the t-values are based on OLS standard errors. Our test that investors view firms with greater split factors as having more favorable private information is a test of the null hypothesis that $b_2 = 0$ against the alternate that $b_2 > 0$.

We estimate equation (2a) for all *SD* observations to characterize the relation between returns and the split factor signal, conditional on a split taking place. Note that for equation (2a), conditioning on the occurrence of a stock dividend or split limits variation in *spfac*, the independent variable, rather than the dependent variable as would be the case in equations (1a) and (1b). OLS estimation of equation (2a) therefore provides consistent estimates of the regression coefficients. To control for potentially confounding announcements, we also estimate equation (2a) for the "*SD* announcement only subsample."

As shown in the first panel of Table V, both the intercept and the correlation between announcement period return prediction errors and our estimate of the split factor signal are highly significant. The t-value for the null hypothesis that the coefficient on *spfac* is zero is 5.97; for the subsample with *SD* announcements only, the t-value is 2.13. The probability values for the t-statistics are less than

split factor signals private information about future earnings. By estimating the signal using (1a), we are testing more generally whether the split factor is the signal, and leave open the possibility that it signals something other than future earnings. As an empirical matter, the coefficient estimates are essentially the same for both measures.

[24] For a related application and extension of Newey's results, see Wilson (1986).

[25] The key assumptions are that $E(spfacX) = 0$ and that $E(e_2X) = 0$. The first assumption is valid given that the weighted exogenous sampling maximum likelihood tobit estimator can be expressed as a generalized method of moments estimator. The second assumption seems plausible since the X variables represent information which should be in the market's information set prior to the *SD* announcement date and therefore should not explain announcement period return prediction errors.

Table V

Announcement Period Return Prediction Errors and Split Factor Signals: Regression Results

This table reports the estimation results for equations (2a) and (2b) for the samples indicated. The t-values (reported in parentheses) were computed using White's (1980) consistent covariance estimator if White's test indicated heteroskedasticity with probability > 0.5, and using OLS standard errors otherwise.

ANNRET = Return prediction error cumulated from the day before to the day after the stock dividend or split announcement.

spfac = Unexpected split factor, controlling for pre-split price and market value of equity.

spfac1 = The expected split factor given that an *SD* occurred less the expected split factor.

spfac2 = The unexpected split factor given that an *SD* occurred, measured as the split factor minus the expected split factor given that an *SD* occurred.

$$ANNRET = b_1 + b_2\, spfac + e_2 \quad (2a)$$

Sample	b_1	b_2	Adj. R^2	F
Stock distribution sample (n = 1308)	0.017 (10.98)	0.023 (5.97)	0.04	57.7
Stock distribution sample with no other announcements (n = 225)	0.016 (3.38)	0.016 (2.13)	0.02	4.5

$$ANNRET = b'_1 + b'_2\, spfac1 + b'_3\, spfac2 + e'_2 \quad (2b)$$

Sample	b'_1	b'_2	b'_3	Adj. R^2	F
Stock distribution sample (n = 1308)	0.007 (2.93)	0.056 (6.25)	0.021 (5.39)	0.06	40.3
Stock distribution sample with no other announcements (n = 225)	0.001 (0.17)	0.068 (2.94)	0.016 (2.10)	0.04	5.1

0.00001 and 0.02, respectively, and thus provide strong support for the hypothesis that investor belief revisions are significantly associated with split factor signals.

We also partition our estimate of the split factor signal, *spfac*, into two components, the signal associated with the decision to split (*spfac*1) and the signal associated with the split factor chosen given that a split occurred (*spfac*2). These measures are based on Amemiya's (1973) result that, for the standard tobit model

$$Y = \begin{cases} X\beta + u, & \text{if } X\beta + u > 0; \\ 0, & \text{otherwise,} \end{cases}$$

the expectation of Y for observations above the limit is

$$E(Y \mid Y > 0, X\beta) = X\beta + \frac{\sigma f(z)}{F(z)},$$

where $z = \frac{X\beta}{\sigma}$, σ is the standard deviation of u and $f(z)$ and $F(z)$ are the unit normal density and cumulative normal distribution function, respectively. We use this result to compute the expected split factor given that a split occurred, and then compute:

$$spfac1 = E(SPFAC \mid SPFAC > 0, PRICE, MVE) - E(SPFAC \mid PRICE, MVE),$$

and

$$spfac2 = SPFAC - E(SPFAC \mid SPFAC > 0, PRICE, MVE).$$

The second panel of Table V contains estimation results for model (2b), where the split factor signal is decomposed into *spfac*1 and *spfac*2. These results show that both components of the split factor signal are strongly associated with announcement returns of *SD* firms, for the complete sample and the "*SD* announcement only" subsample. The coefficient on *spfac*1, the signal in the decision to split, is greater than the coefficient on *spfac*2, the signal in the level of the split factor given the split occurred. However, the strength of response to each of these components suggests there is considerable information content in both the decision to split and the split factor announced given the decision to split.

The strength of the results for models (2a) and (2b) is interesting in light of the findings that GMT report in their Table V. They regressed announcement date return prediction errors on split factors for four subsamples of stock dividends and stock splits with no other announcements. The t-values for their split factor coefficients were 1.51 for 210 stock splits and 1.23 for 74 stock dividends. For the subsamples that pay cash dividends, they reported t-statistics of 2.64 for 106 stock splits and 1.15 for 26 stock dividends. Although their results are suggestive of the stronger associations that we report, three factors cause their design to provide a less powerful test of the trading range hypothesis. First, by modeling split factor choice, we are able to explain a substantial amount of the variation in split factors, yielding a more precise measure of the split factor signal. Second, by estimating equations (2a) and (2b) for the complete sample, we are able to confirm that the results are stronger in the full sample.[26] In contrast, GMT's coefficients on the split factor for the larger subsamples are insignificantly different from zero, suggesting that the effect documented in the subsample paying cash dividends may not be robust. Third, GMT partition their data into stock dividend and stock split subsamples, reducing variation in the split factor and thereby reducing the power of their test.

We conducted several checks on the validity of these results. First, we examined whether the results were sensitive to our inclusion of small stock dividends, which have generally been excluded in prior studies, such as GMT. We observe

[26]Documenting that results hold up in an "*SD* announcement only" subsample is important if other announcements could drive the relation tested for. At the same time, it is inefficient to disregard full sample information and can lead to false inferences about the conclusions to be drawn from a small sample.

the same pattern of significant correlations when observations with split factors less than 0.20 are excluded, providing assurance that small stock dividends are not driving our results. We also considered the possibility that the correlations documented in Table V are due to omitted variables that are correlated with split factors and pre-split price. To test whether the correlations between return prediction errors and split factors are spurious, we estimated equation (2a) with randomly drawn return prediction errors for *SD* firms in a non-event period. The results for the complete sample indicate an insignificant positive association between *spfac* and non-announcement returns; for the pure events subsample, the correlation between non-announcement return prediction errors and *spfac* is weakly negative. These nonevent results suggest that the association we observe between split factors and announcement period returns is not driven by factors common to the event and nonevent periods.

C. The Relation Between Announcement Period Returns and Earnings Forecast Errors

Our third test concerns the relation between the revision of investor beliefs and management's private information about the firm's future earnings. If a stock split signals information about the firm's future earnings, then revision of investor beliefs at the announcement date should correspond to the firm's earnings forecast error. Our test of this hypothesis is based on equations (1b) and (3) and is closely related to equation (2a) (repeated here):

$$SPFAC = \begin{cases} a_1 + a_2 PRICE + a_3 MVE + a_4 RUNUP \\ + a_5 FE + uspfac, & \text{if } RHS > 0; \\ 0, & \text{otherwise.} \end{cases} \tag{1b}$$

$$ANNRET = b_1 + b_2\, spfac + e_2, \tag{2a}$$

$$ANNRET = c_1 + c_2\, FE + c_3\, uspfac + e_3. \tag{3}$$

Equation (1b) provides an estimate of *uspfac*, the component of the split factor signal that is uncorrelated with earnings forecast errors. Equation (2a) examines the association between announcement returns and the split factor signal and equation (3) tests whether the association in (2a) is due to the component of the split factor signal that is correlated with *FE*, the uncorrelated component or both. We have again a two-stage estimator, similar to that in equation (2a); accordingly, we can apply Newey's (1984) result to equation (3), and therefore, OLS standard errors are asymptotically equivalent to the standard errors we would obtain if *uspfac* were known rather than estimated in the first stage. Equation (3) provides a direct comparison of the extent that announcement period return prediction errors are explained by earnings forecast errors versus other components of the split factor signal. The null hypothesis is that c_2 is zero and the alternate is that it is positive.

The first panel of Table VI contains the estimation results for equation (3) for all *SD* observations with complete data on the required variables. The t-value

Table VI

Announcement Period Return Prediction Errors, Split Factor Signals, and Earnings Forecast Errors: Regression Results

This table reports the estimation results (with t-values in parentheses) for equation (3), which examines the explanatory power of earnings forecast errors and the unexplained split factor after controlling for earnings forecast errors and trading range variables.

ANNRET = Return prediction error cumulated from the day before to the day after the stock dividend or split announcement.
FE = One-year-ahead percent earnings forecast error.
uspfac = Unexplained split factor, after controlling for pre-split price, market value of equity, pre-announcement returns, and earnings forecast errors.

$$ANNRET = c_1 + c_2\, FE + c_3\, uspfac + e_3 \qquad (3)$$

Sample	c_1	c_2	c_3	Adj. R^2	F
Stock distribution sample ($n = 1308$)	0.016 (10.46)	0.017 (2.70)	0.023 (6.09)	0.05	24.0
Stock distribution sample with no other announcements ($n = 225$)	0.018 (3.93)	0.016 (2.11)	0.016 (2.14)	0.03	4.0

for the coefficient on *FE* is 2.70, indicating that announcement period return prediction errors are significantly associated with our proxy for management's private information about future earnings. However, the t-value for the coefficient on *uspfac* is 6.09, indicating that the component of the split factor signal that is uncorrelated with *FE* has considerable explanatory power. This could arise for several reasons. First, to the extent that there is error in our measure of management's private information about future earnings, the split factor signal may continue to have explanatory power. A second possibility is that the "unexplained" portion of the split factor reflects information about other attributes that are valued by investors. A third possibility is that the signaling story for the market's reaction to stock split announcements is an incomplete explanation.

Because many firms announce earnings or cash dividends with their *SD*'s, these other announcements could explain revision of expectations about earnings that would otherwise be attributed to stock splits and dividends, enhancing the coefficient on *FE*. At the same time, it is not obvious that contemporaneous disclosures fully explain the strength of this correlation. For a sample of 1,260 earnings announcements, O'Brien (1988) documents a less significant association between earnings forecast errors and 5-day returns (centered on the earnings announcement dates) than we find at *SD* announcements. To rule out the effects of other announcements, we examine the estimation results for the "*SD* announcements only" subsample. As the second panel of Table VI shows, the coefficients on *FE* and the unexplained portion of the split factor have t-values of 2.11 and 2.14 with probability values less than 0.02. These results indicate that investors revise their beliefs about firm values at *SD* announcements in a manner that corresponds with the firm's subsequent unexpected earnings. However, as we saw for the complete sample, the component of the split factor signal that is uncorrelated with earnings forecast errors also explains some of the variation in announcement returns.

V. Summary and Interpretations

In this paper, we conduct three tests of the hypothesis that managers signal their private information through split factor choice. Our tests of the signaling hypothesis rely on the notion that managers prefer their firms' shares to trade in a certain price range. We begin by documenting the split factors are increasing in pre-split share prices (t = 44.7) and decreasing in the pre-split market value of equity (t = −21.8). The first relation is consistent with the notion that firms split their shares to bring them into a specific range, and the second is consistent with the idea that larger firms prefer a higher trading range, as Stoll and Whaley's (1983) evidence suggests. The first of our three tests examines whether managers use their private information about future earnings in choosing their split factor. We find that when pre-*SD* stock price and market value of equity are controlled, split factors are significantly correlated with earnings forecast errors (t = 3.11), suggesting that firms incorporate their private information about future earnings in choosing their split factor. However, the explanatory power of the price and market value of equity variables is considerably greater than that of earnings forecast errors, suggesting that they are more fundamental to split factor choice than management's private information or that earnings forecast errors measure managers' private information with error.

Our second test examines the association between announcement returns and our measure of the split factor signal (the split factor, holding pre-split price, and firm size constant). We find a strong statistical association between announcement returns and split factor signals, which suggests that investors' inferences about firm value do correspond to firms' split factor choices. Our third test partitions the split factor signal into a component that is correlated with earnings forecast errors and an uncorrelated component; here we find that both components are significantly associated with announcement date returns. The correlation between earnings forecast errors and announcement returns suggests that investors interpret *SD* announcements as signals about future earnings. The significant coefficient on the uncorrelated split factor component suggests that other attributes are also signaled through split factor choice, that earnings forecast errors measure management's private information about earnings with considerable error, or that a signaling explanation is incomplete.

Our study indicates two directions for future research. First, our results strongly support the "trading range" hypothesis. The puzzle that emerges is why a particular trading range may be advantageous, and how firms are deterred from falling below the trading range. The relations between a firm's share price range and investors' transaction costs, brokers' incentives to sell their shares, the liquidity of the firm's shares, and the "prestige" of the firm merit further investigation. Second, in spite of the strength of the association between announcement return prediction errors and our measure of the split factor signal, only a small portion of this association is explained by firms' earnings forecast errors. This suggests that the investigation of other valuation-relevant attributes signaled or affected by stock splits and stock dividends is warranted.

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