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Stock Prices and the Supply of Information

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ABSTRACT

We develop a model in which the dependence of the brokerage commission rate on share price provides an incentive for brokers to produce research reports on firms with low share prices. Stock splits therefore affect the attention paid to a firm by investment analysts. Managers with favorable private information about their firms have an incentive to split their firm's shares in order to reveal the information to investors. We find empirical evidence that is consistent with the major new prediction of the model, that the number of analysts following a firm is inversely related to its share price.

THE CLASSICAL THEORY OF finance assigns great importance to the aggregate market value of the equity of a firm, but has no role for the number of shares in a firm's capital stock, or for the price of a single share. Consequently, the attention paid to this seemingly irrelevant variable by firms, investors, and brokers, as well as by legal and regulatory authorities, has so far defied plausible explanation. It is clear that firms attempt to manage the unit price of their shares by stock splits and occasional reverse splits, and there is a strong relation between the price per share and the size of the firm.[1] Moreover, investors pay attention to stock splits, the abnormal return consequent on a split announcement being strongly related to the projected post-split share price. This reaction has been explained by Brennan and Copeland (1988a) as the rational response to a costly signal by the firm. The basis of their argument is that it is costly for a firm to reduce its share price by splitting because the structure of brokerage commissions makes it more costly to trade in low priced shares. The relation between splits and trading

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[1] Stoll and Whaley (1983) show that, based upon portfolios formed on firm size, average price per share is monotonically increasing in size, and both the mean portfolio return and beta are monotonically decreasing in size.

costs has been acknowledged in the business press,[2] and the signaling argument finds support in the work of McNichols and Dravid (1990) and others who show that stock splits are followed by unexpected increases in earnings. Less easy to explain is the change in stock price behavior following the date the split becomes effective. Ohlson and Penman (1985) observe an increase in the variance of returns following the split ex-date, and Brennan and Copeland (1988b) find that the systematic risk of firms also increases following the split.

The Brennan and Copeland signaling model is at best a partial explanation of the stock price reaction to split announcements, for it relies on the observed structure of brokerage commissions which is taken as exogenous. Yet why should brokerage commissions depend on such a seemingly irrelevant variable as the share price? And why should legal and regulatory authorities also be concerned about the level of the price per share?[3] In this paper we present a model with an equilibrium in which different firms choose different share prices, smaller firms have lower share prices, brokerage commissions depend on share prices, share prices react to split announcements, the share price behavior and bid-ask spread may change following the split, the number of shareholders increases after a split, and there is cross-sectional variation in the number of analysts following different firms.

We argue that managers with favorable private information will find it advantageous to have independent third parties produce information about their firms for investors.[4] In order to avoid obvious moral hazard considerations, it is necessary that the information producers be independent of the firm.[5] This poses the problem of compensating the information producers for their efforts. We argue that the role of information producer is assumed by brokers who make earnings forecasts about individual firms and receive compensation for their efforts in the form of brokerage commissions from the investors who trade in the particular stocks. Following Merton (1987), we assume in our model that investors will only purchase stocks that they "know about", and that this knowledge is provided in the form of brokers' earnings forecasts. Thus earnings forecasts generate brokerage commissions

[2] ' "Stock splits are the biggest ripoff on Wall Street," contends Hans R. Reinisch, a New York investor. "The only thing that changes with a split is the brokerage commissions, and they often go up sharply. If you're an active investor, you have to take into account the transaction costs." ' (*Wall Street Journal*, October 13, 1989).

[3] For example, margin loans are not permitted on stock transactions in which the share price is less than $5.

[4] Diamond (1985) argues that firms have an incentive to make information available to shareholders in order to reduce the costs of private information acquisition.

[5] The lack of credibility of information produced by investment bankers in the employ of the corporation was discussed in a recent *Wall Street Journal* article. An associate research director at Drexel reported "The research department did our darndest to resist pressure from corporate finance. We made it clear when we had a bias, when we had an underwriting relationship. As a result, the thinking was that institutional investors using the Drexel research reports had a red flag, and unless they were completely stupid, they'd do a double check with someone with less involvement." ("Wall Street Grows Treacherous for Analysts Who Speak Out," April 5, 1990)

because investors trade only in those stocks for which the brokers forecast earnings.

In deciding whether to forecast earnings, a broker compares the cost of the forecast with the commission revenue it will generate, which depends on the size of the firm and the total number of brokers making forecasts. Given the commission rate, competition among brokers will determine the equilibrium number of brokers who make forecasts about a particular firm. We consider an equilibrium in which brokers offer a commission schedule which depends on the share price. This permits managers to influence the number of brokers who make earnings forecasts about their firms by changing the share price through a split.[6]

The major new prediction of the model, that the flow of information about firms is an increasing function of firm size and a decreasing function of the share price, is tested by examining the relation between the number of brokerage firm analysts who report earnings forecasts for a firm and its share price and size.[7] We find that the number of analysts is related to both share price and size in the predicted manner.

In the following section we summarize the previous empirical studies of splits. In Section II we present a formal model of the effect of share prices on the flow of information about a firm provided by stockbrokers. Section III discusses the data and reports the result of the empirical tests of the supply of information hypothesis. Section IV concludes.

I. Empirical Evidence on Stock Splits

There have been extensive empirical studies documenting an association between stock splits and various economic variables. We summarize here the empirical regularities that a theory of share prices must address.

Not surprisingly, stock splits follow periods of rising stock prices.[8] However, there also is extensive evidence that share prices rise further on the announcement of a split and fall on the announcement of a reverse split,[9] suggesting that the split announcement serves as a signal of management's

[6] A referee has suggested to us an alternative explanation for stock splits and for our empirical results. He argues that small investors who prefer low priced stocks are necessary to provide liquidity in low capitalization stocks, leading to a correlation between size and stock price. Furthermore, "a lower share price corresponds to a wider ownership and implies more potential trading commissions and therefore, more analyst following." However, this argument does not explain the observed relation between splits and subsequent earnings increases (see footnote 11).

[7] Note that our theory relates only to brokerage house analysts whose compensation depends upon stock trading commissions, and not to analysts employed by other financial institutions such as insurance companies.

[8] Fama, Fisher, Jensen, and Roll (1969) find that shares of splitting firms earned abnormal returns for 29 months prior to the split, and Lakonishok and Lev (1987) report that the shares rise by about 70% more than those of their control sample over the four years preceding the split announcement.

[9] See Grinblatt, Masulis, and Titman (1984); Eades, Hess, and Kim (1984); Lamoureux and Poon (1987); and Asquith, Healy, and Palepu (1989).

private information.[10] This notion is confirmed by the finding that stock splits are associated with unexpected increases in earnings.[11] Grinblatt et al. (1984) find that the abnormal announcement return is negatively related to the size of the firm and to a measure of information leakage over the previous week; and they interpret this evidence as consistent with an "attention hypothesis" according to which undervalued firms split their stock in order to attract attention. Arbel and Swanson (1989) find that firms that split had been followed by fewer analysts prior to the split than all firms on average, and conclude that these neglected firms split in order to attract attention from analysts. They also find that the magnitude of the price response to the firm's split announcement is negatively related to the number of analysts following the firm. Brennan and Copeland find that, as predicted by their signaling theory, the announcement return is negatively related to the target post-split share price, which they define as the pre-split price divided by the split factor.

It is commonly claimed that the purpose of stock splits is to improve liquidity and increase the number of shareholders. Despite this, several authors (e.g., Copeland (1979)) have found a decrease in trading volume following a split. However, Lakonishok and Lev (1987) show that it is the trading volume prior to the split which is abnormally high, and that it returns to normal within two months of the split. Conroy and Flood (1989) find that, despite the decline in the dollar volume of trade, there is an increase in the number of transactions, which implies that the average transaction size falls. They also find an increase in the number of individual shareholders subsequent to the split.

Stock splits also appear to be associated with increases in risk.[12] While Amihud and Mendelson (1988) attribute this finding to the discreteness of stock prices and increases in the bid-ask spread following splits, Sheikh (1989) finds an increase in the volatility implied by option prices following the split ex-date, which suggests that the phenomenon is real rather than due to measurement error. Brennan and Copeland (1988b) report a major increase in the beta coefficient on the ex-date (but not on the announcement date). Wiggins (1990) finds that the magnitude of this increase is sensitive to the return measurement interval, and explains the Brennan and Copeland finding as the result of a more rapid response of security returns to market information following the split date.

The Brennan and Copeland signaling model relies on the fact that brokerage commissions depend upon share prices. Table I summarizes the results of a study by Coler and Schaefer (1988) which compares typical commissions charged by full service brokers with those charged by discount brokers. Not

[10] More puzzling is the finding of additional abnormal returns on the ex-date of the split. See Grinblatt, Masulis, and Titman (1984).

[11] See Lakonishok and Lev (1987), Doran and Nachtmann (1988), and McNichols and Dravid (1990). Asquith, Healy, and Palepu (1989) find that large increases in earnings prior to the split are not reversed in the four years following the split.

[12] See Ohlson and Penman (1985), French and Dubofsky (1986), and Dravid (1987).

Table I

Typical Full Service Brokerage Commissions as Per Cent of Trade Value for Selected Transactions* (Average Discount Broker Commissions in Parentheses)

	Share Price				
Size of Trade	10	20	30	40	50
$3,000			2.600 (1.180)		
$4,000		2.625 (1.101)		2.225 (0.922)	
$5,000	2.980 (1.086)				1.940 (0.755)
$6,000			2.233 (0.846)		
$8,000				2.100 (0.700)	
$9,000			2.089 (0.716)		
$10,000		2.040 (0.734)			1.870 (0.589)
$12,000				1.850 (0.587)	
$15,000					1.720 (0.499)

*Constructed from Table 2 in Coler and Schaefer (1988).

only is the discount broker commission (in parentheses) about one-third that of the full service broker, but, for both types, the commission charged as a proportion of the trade declines as a function both of the size of the trade and of the price of the shares traded.[13] Branch (1985) argues that, although some processing fees and costs paid by brokers do depend upon the number of shares traded, these are of relatively minor importance, and the bulk of the costs to be recovered are fixed costs. He concludes that there is no justification for the current system which discourages trading in low priced stocks, and remarks that "While a company's per share price is essentially arbitrary, as a matter of practice companies with low priced stocks tend to be smaller, younger and more prone to be owned by individual investors" (op. cit., p11). He concludes that the current system discourages trading in low priced stocks. This leaves open the question why these companies choose to have low priced shares.

Since full service brokers survive the competition from discounters, they must provide additional services. According to Coler and Schaefer, the most significant consideration is that, unlike the full service broker, the discounter

[13] See Smidt (1990) for an historical perspective on New York Stock Exchange commission rates. Commission rates depended on share prices from 1919 until the end of the fixed commissions era. In 1964, the commission rate on $20 shares was 4.58 times that on $200 shares.

will not provide security recommendations or research analyses, or offer access to new stock issues. Thus it seems that the additional charge of the full service broker is to cover research costs, and that these brokers are able to prevent investors from free riding by meting out the quantity and timeliness of research they provide to customers according to their volume of trading. If the commission schedule were as arbitrary as Branch suggests, it is difficult to see how it could withstand competition. Thus, according to the evidence in Table I, a full service broker charges \$97 for a \$5000 transaction in a \$50 stock, and an extra \$52 ($= (0.298 - .0194) \times 5000$) for the same size transaction in a \$10 stock. The discounter however charges only \$16.55 extra ($= (0.01086 - 0.00755) \times \$5000$) for the transaction in the low priced stock. Therefore, assuming that this represents the incremental execution costs of both types of brokers,[14] it is apparent that the full service broker is making an additional profit of \$35.45 ($= 52 - 16.55$) on the low priced stock. It seems unlikely that this could persist in equilibrium unless there is some additional cost incurred by the full service broker for the low priced stock. In our model, this is an additional cost of research per dollar of transaction.

In summary, there is substantial evidence that stock splits serve as signals of management's private information about future earnings. They also lead to an increase in the number of shareholders, wider bid-ask spreads, and higher brokerage commissions. After the split becomes effective, the variance is higher and the response to market-wide information is more rapid.[15] However, the only attempt to explain how a split announcement can serve as a credible signal is the transaction cost model of Brennan and Copeland which is incomplete because it offers no rational justification for the dependence of brokerage commission rates on stock prices. In the following section we develop a more complete model.

II. An Equilibrium Model of the Supply of Information

In order to capture the notion that full service stockbrokers are compensated for their research costs by commissions on share transactions,[16] we consider an economy in which investors only invest in the securities of firms that they "know about",[17] and that the only way in which investors get to know about firms is through their personal brokers. Investors are loyal and

[14] Execution costs may be higher for small illiquid companies which typically have low share prices.

[15] Kryzanowski and Zhang (1990) find similar security price behavior for a sample of Canadian firms.

[16] "For years, big institutional investors such as pension funds and insurers have paid for Wall Street research reports by directing stock trades to the brokerage firms that produce them. The four to six cents in trading commissions that Allstate and other institutions dole out serve as payment for a variety of services, from trading expertise to research reports on the food industry." (from "Challenge to Wall Street: What's Research Worth?" *Wall Street Journal*, December 14, 1989)

[17] For a similar assumption see Merton (1987) and Arbel and Swanson (1989).

remain with brokers, receiving information from them and trading through them, as long as the charges of the broker are competitive.[18] In particular, we shall assume that brokers who charge more than the average commission charged by full service brokers lose all of their clients; moreover, clients conjecture that brokers who offer commissions less than the average of full service brokers are not providing *bona fide* forecasts. Consequently, in equilibrium all full service brokers charge identical commissions.[19] For simplicity we assume that the volume of trading done by an individual investor is determined by life-cycle considerations and is therefore insensitive to the level of brokerage commissions. The expected rate of return on a security, however, will reflect the cost of transacting in the security, so that securities in which it is expensive to trade will have low prices *ceteris paribus*.[20]

Let f denote the cost to an individual broker of making an earnings forecast for a particular firm and let t denote the present value of the total brokerage revenues to be earned from trading in the shares of the firm as a proportion of its end of period value, x. We assume that the marginal cost of transacting is zero to brokers, and consider an equilibrium in which all investors are identical, and all brokers charge the same commission and have the same number of clients. Then, since investors are loyal to their brokers and trade only in shares they know about, the total brokerage commissions will be divided equally among the brokers who make forecasts. Competition among brokers ensures that total brokerage revenue is equal to the total cost of making forecasts, so that N, the equilibrium number of brokers making forecasts for a firm with end of period value $\tilde{x}$, is given by

$$N = E[t\tilde{x}]/f \tag{1}$$

where $E[\,]$ denotes the expectations operator.[21] Thus the equilibrium number of brokers making a forecast about a particular company depends on both the size of the company as measured by its expected end of period value, $E[\tilde{x}]$, and the brokerage commission rate, t.[22]

[18] In practice brokers restrict the flow of information to investors who do not trade through them.

[19] "Also, the lack of variation in trading commissions assumes that one firm's research is as good as another." (*Wall Street Journal*, December 4, 1989)

[20] For a similar assumption see Brennan and Copeland (1988a); for empirical evidence that equilibrium rates of return do depend on the cost of transacting see Amihud and Mendelson (1987).

[21] Implicit in expression (1) is the assumption that trading volume is invariant to the commission rate. A weaker sufficient condition for what follows is that aggregate commissions be increasing in the commission rate. This condition is consistent with Copeland's (1979) finding that aggregate brokerage revenue increased following a split, despite the decrease in trading volume.

[22] A further reason that increased commissions may attract more analysts is that at many brokerage houses, trading commissions generated by analysts are used to determine the annual bonuses, which can account for more than 50% of the analysts' compensation. ("Are Analysts Putting Their Mouths Where the Money Is?" *Business Week*, December 18, 1989, p118)

Consistent with observed commission schedules discussed in the preceding section, we assume that the brokerage commission depends on the price, P, at which an individual share of the security trades, $t(P)$, where $t'(P) < 0$. Then companies with low share prices will have relatively high commission costs, and for their size, will have a relatively large number of brokers making forecasts about them. Conversely, firms that have high share prices will, for their size, have a relatively small number of brokers making forecasts about them. Moreover, by choosing the price at which their shares trade by splitting, managers are able to control the attention paid to their firms by the brokerage industry.[23]

Consider now the problem faced by the manager of a company who has private information about its future earnings and wishes to communicate it to the market. Let us suppose that there exists no credible mechanism by which the private information can be communicated costlessly to the market. One possibility is for the manager to incur communication costs, for example by employing a third party (such as an auditor) to verify the signal. However, if the third party is paid directly by the manager there is a moral hazard problem which reputational considerations will only partially alleviate.[24] The only alternative that we consider here is the manager's decision to change the stock price by means of a split. Splits affect the incentive of brokerage houses to provide earnings forecasts which serve to reveal the manager's private information, with a precision which is proportional to the number of earnings forecasts.[25]

We assume that initially all investors and the manager of the firm have homogeneous beliefs about the end of period value of the firm. The manager receives a private signal about the end of period value and decides whether to split. If a decision is made to split, the manager announces the new number of shares to be outstanding after the stock split. The stock split will change the stock price, P, which determines the rate of brokerage commission $t(P)$; and this in turn determines the number of analysts who make earnings forecasts according to relation (1). The timing of events is as follows:

τ_0: investors and the manager have homogeneous prior beliefs about the firm's final payoff, x.

τ_1: the manager receives a private signal about x and announces the new number of shares, n, through a stock split.

τ_2: N analysts gather information and announce forecasts of the end of period value.

[23] Note that it is the commission schedule that makes the attention hypothesis of Grinblatt, Masulis and Titman (1984) economically rational.

[24] Thakor (1982) models third-party information production by debt insurers in a similar setting of information asymmetry where moral hazard considerations preclude direct disclosure of default probabilities.

[25] The role of multiple analysts' forecasts is similar to that of multiple ratings for bond issuers. Hsueh and Kidwell (1988) find that 46% of their sample of municipal bonds had two bond ratings. They find that a second rating reduces borrowing costs.

τ_3: the end of period value is realized and analysts are compensated by the brokerage commission.

We assume that all individuals are risk neutral, that prior beliefs about x are represented by a normal distribution with mean x_0 and precision s_0,[26] and that the interest rate is zero. The market value of the firm at τ_0 then is

$$V_0 = x_0(1 - t). \tag{2}$$

At τ_1 the manager receives a noisy signal about the end of period value:

$$y_m = x + \tilde{\epsilon}_m, \tag{3}$$

where $\tilde{\epsilon}_m$ is normally distributed with mean zero and precision s_m. After observing the signal y_m the manager announces n, the number of shares that will be outstanding after the split. Knowing n, investors infer that the manager's signal was $\hat{y}_m(n)$. They then revise their beliefs about x in accordance with Bayes' Rule:

$$E(x \mid n) \equiv \hat{x}(n) = \frac{x_0 s_0 + \hat{y}_m(n) s_m}{s_0 + s_m}, \tag{4}$$

where $s_0 + s_m$ is the new precision. When n is announced, the market value of the firm changes to $V_1(n)$, which reflects the new information, the new commission, and the fixed administration costs of executing the split, C[27]:

$$V_1(n) = E[x(1 - t(x/n)) \mid n] - C. \tag{5}$$

In (5), x/n is the τ_3 share price. The expected aggregate brokerage commission, $T(n)$, is given by

$$T(n) = E[xt(x/n) \mid n]. \tag{6}$$

Assuming that $T(n)$ is monotonic,[28] the same information is conveyed by an announcement of T or of n, and it will be analytically convenient to assume that the manager announces T. Equation (5) then becomes

$$V_1(T) = \hat{x}(T) - T - C, \tag{7}$$

where $\hat{x}(T) = E[x \mid T]$ at τ_1.

Then, defining $F = f^{-1}$, the number of analysts who make forecasts is, from (1)

$$N(T) = FT. \tag{8}$$

The forecast of each analyst is y_i ($i = 1, \ldots, N(T)$), where

$$y_i = x + \tilde{\epsilon}_i, \tag{9}$$

[26] Precision is defined as the inverse of the variance.

[27] The administrative costs of splitting include the costs of printing and distributing new stock certificates, and the buying and selling of fractional shares.

[28] It is shown below that a sufficient condition for this is that aggregate brokerage commissions are increasing in firm size for a given number of shares.

and $\tilde{\epsilon}_i$ is drawn from an independent normal distribution with mean zero and precision s. Define $\bar{y}$ as the average value of y_i.

Then the value of the firm at τ_2, *after* all the analysts forecasts have been publicly revealed is $V_2(T, \bar{y})$ where

$$V_2(T, \bar{y}) = \frac{x_0 s_0 + \hat{y}_m(T) s_m + \bar{y} FTs}{s_0 + s_m + FTs} - E[xt(x/n) \mid T, \hat{y}_m, \bar{y}] - C. \quad (10)$$

Since the number of analysts making forecasts is increasing in T (from (8)), the effect of a higher commission T is to increase FTs, the precision of the average brokerage forecast, $\bar{y}$. Clearly then, the greater the number of analysts making earnings forecasts, the greater will be the weight that investors place on the average brokerage forecast in valuing the firm. This provides the motivation for a manager with good news to seek attention from analysts.

We assume that the objective of the manager at τ_1 is to choose the new number of shares n (or equivalently, the expected aggregate brokerage commission T), in order to maximize the expectation, conditional on his private information, of the value of the firm at τ_2 when all of the analysts' information will have been revealed. Note that

$$E[\bar{y} \mid y_m] = \frac{x_0 s_0 + y_m s_m}{s_0 + s_m} \quad (11)$$

and

$$E[\{xt(x/n) \mid T, \hat{y}_m, \bar{y}\} \mid y_m] = T. \quad (12)$$

After substituting (11) and (12) into (10), the manager's expectation at τ_1 of the τ_2 value of the firm is

$$E[V_2(T) \mid y_m] = \frac{x_0 s_0 + \hat{y}_m(T) s_m + \left\{\dfrac{x_0 s_0 + y_m s_m}{s_0 + s_m}\right\} FTs}{s_0 + s_m + FTs} - T - C. \quad (13)$$

Note that the numerator of (13) is a weighted average of the investors' prior beliefs, what they infer about the manager's current information, and what the manager believes about the future information to be provided by analysts. The objective of the manager then is to maximize expression (13) through the choice of the new aggregate brokerage commission T.

Combining the first order condition for a maximum of (13) with respect to T with the equilibrium condition that $\hat{y}_m(T) = y_m$ yields the following differential equation for the investors' inference schedule $\hat{y}_m(T)$.

$$\hat{y}'_m(T) = \frac{s_0 + s_m + FTs}{s_m}. \quad (14)$$

The solution to (14) is

$$\hat{y}_m(T) = \frac{s_0 + s_m}{s_m} T + \frac{Fs}{2 s_m} T^2 + K, \tag{15}$$

where K is a constant of integration.

Due to the fixed costs of administering a split, not all managers will find it advantageous to announce a split after receiving private information. In order to determine the value of K, it is necessary to determine the minimum y_m which is disclosed through a split announcement. Let n_0 be the number of shares initially outstanding and let y_m^s denote the signal level at which a manager is indifferent between announcing a split and not.[29] If the manager does not announce a split, the expected aggregate brokerage commission is $\overline{T} \equiv E[xt(x/n_0) \mid y_m \le y_m^s]$. Similarly, $T(n_0)$, the expected brokerage commission if the manager announces the minimum split factor of one, is defined by $T(n_0) \equiv E[xt(x/n_0) \mid y_m^s]$. Then the condition for the manager who receives a signal y_m^s to be indifferent to splitting is that the expected value of V_2 conditional on y_m and no split be equal to the expected value to be obtained by announcing the minimum split factor of one, less the costs of the split, or:

$$E\left[E\left(x \mid y_m \le y_m^s, \bar{y}\right) \mid y_m^s, s(\bar{y}) = F\overline{T}s\right] - \overline{T}$$
$$= \frac{x_0 s_0 + y_m^s s_m + y_m^s F T(n_0) s}{s_0 + s_m + FT(n_0) s} - T(n_0) - C. \tag{16}$$

The left-hand side of condition (16) is the expectation of the τ_2 value of the firm of a manager who has received the signal y_m^s, when the market infers from the absence of a split that $y_m < y_m^s$, *and* receives the average analyst forecast $\bar{y}$ which has precision $F\overline{T}s$. Condition (16) and the definition of $\overline{T}$ suffice to determine y_m^s, the signal of the marginal splitting firm: note that y_m^s depends upon the prior distribution of management signals. The constant of integration in (15) is then identified by considering the inference of investors for the minimum split factor of one. Since the manager who receives the signal y_m^s will announce $T = T(n_0)$, consistent inference requires that

$$\hat{y}_m(T = T(n_0)) = \left(\frac{s_0 + s_m}{s_m}\right) T(n_0) + \frac{Fs}{2 s_m} T(n_0)^2 - K \equiv y_m^s. \tag{17}$$

The solution for K from (17) is

$$K = \frac{Fs}{2 s_m} T(n_0)^2 + \frac{Fs}{2 s_m} T(n_0) - y_m^s. \tag{18}$$

[29] For simplicity we ignore the possibility of reverse splits, which we consider in the Appendix. We assume that even an incipient stock split in which the split factor is one cannot be accomplished without incurring the fixed administrative costs.

The second order condition for a maximum of (13) is always satisfied because $\partial^2 E[V_2(T) \mid y_m]/\partial T^2 = -Fs(s_0 + s_m + FsT) < 0$.

The investors' inference of y_m is an increasing and convex function of the expected aggregate brokerage commission T (for $T > \overline{T}$). Since the inference function (15) depends upon the prior precision s_0, it differs from the more common inference schedule in signaling models where investors ignore their prior beliefs when inferring the manager's information from the observed signal. A further departure from the standard signaling model is that the manager does not care about the current τ_1 value of the firm, but is maximizing the expectation of the future value when the analysts' information is revealed.

Since investors are able to infer the manager's signal y_m at τ_1, it follows that the value of the firm at τ_1 may be written as its expected value at τ_2, conditional on $\hat{y}_m$:

$$V_1(T) = E[V_2(T) \mid \hat{y}_m(T)] - C$$

$$= \frac{x_0 s_0 + \hat{y}_m(T) s_m + \left\{ \dfrac{x_0 s_0 + \hat{y}_m(T) s_m}{s_0 + s_m} \right\} FTs}{s_0 + s_m + FTs} - T - C \qquad (19)$$

$$= \frac{x_0 s_0 + \hat{y}_m(T) s_m}{s_0 + s_m} - T - C, \qquad (20)$$

which is identical to expression (7).

It remains to be shown that $T(n) \equiv E[xt(x/n) \mid n]$ is increasing in n as assumed. Under this assumption we have established that the distribution of x conditional on the announcement of n (or $T(n)$) is normal with mean $x_0 s_0 + \hat{y}_m(T) s_m$ and precision $s_0 + s_m$ as shown in expression (20). Therefore the effect of an increase in n (or $T(n)$) is to shift the distribution to the right. A sufficient condition for this to increase $T(n)$ is that $xt(x/n)$ is increasing in x, or that brokerage commissions be increasing in firm size for a given number of shares.

It is easy to show that $dV_1(T)/dT > 0$, so that the post-announcement value of the firm is monotonically increasing in the signal T. Since $T'(n) > 0$, and the projected share price x_0/n is negatively related to n, it follows that the market reaction to the split announcement will be negatively related to the target share price x_0/n, as found by Brennan and Copeland (1988a).

Consistent with the evidence discussed in Section I, the model also predicts that a split will be followed by an increase in the number of shareholders as more investors learn about the firm. After the split becomes effective and brokers communicate their information to investors to stimulate trade at the higher commission rates, there will be more private information in the market. This would explain the observed increases in the bid-ask spread and the variance of returns according to the theories of Copeland and Galai (1983) and Glosten and Milgrom (1985), and Holthausen and Verrecchia

(1990) respectively. On a more speculative note, the increased attention from analysts to splitting firms could lead to the more rapid response of security returns to market-wide information as found by Wiggins (1990). Since, for a given share price the number of analysts is increasing in firm size,[30] a smaller firm must choose a lower share price in order to gain the same analyst following as a larger firm. It is likely that this accounts for the observed positive correlation between share prices and firm size. The model also predicts that stock splits will be followed by an increase in the number of earnings forecasts provided by analysts. As there is no prior evidence on this hypothesis, in the next section we turn to consider the empirical relation between share prices, stock splits, and analyst following.

An extension of the model to include reverse stock splits appears in the Appendix. We find that reverse splits convey bad news about the firm, and should occur infrequently because of the associated administrative costs. The empirical evidence on reverse splits is consistent with these predictions.

III. Data and Empirical Tests

Data on the number of analysts following individual stocks were drawn from the I/B/E/S tape for the years 1976–1987.[31] Data on stock prices, returns, and numbers of shares were drawn from the CRSP NYSE-AMEX and NASDAQ tapes. The criteria for a stock to be included in the analysis in a given year were that it was included on both the CRSP and the I/B/E/S databases on December 31 of that year, and that it was reported in the same CRSP database at the end of each of the prior five years.

Descriptive statistics for the sample appear in Table II. There is significant cross-sectional variation in the number of analysts following individual firms. The modal number of analysts for the sample firms on all exchanges for all years is one, except for the NYSE in 1987 when it is two.[32] The maximum number of analysts following a single firm is 44, and the distribution shows considerable skewness. The increase in the number of firms followed by I/B/E/S analysts over the twelve years is 60% for NYSE, 198% for AMEX, and 555% for NASDAQ. The median number of analysts is greatest for NYSE firms, which is not surprising given that these firms are larger. It also appears that NASDAQ firms have a slightly larger following

[30] Bhushan (1989) suggests that large firms generate more transactions, and finds that the number of analysts is positively related to the size of the firm.

[31] The authors gratefully acknowledge Lynch, Jones, and Ryan for making this tape available. I/B/E/S was developed by Lynch, Jones, and Ryan in order to systematically collect and distribute earnings forecasts from Wall Street and Regional brokerage firms. Brown, Foster, and Noreen (1985) found that, as of 1984, over 80 brokerage firms provided earnings forecasts for more than 2700 firms.

[32] Since firms are included in the sample only if they are on the I/B/E/S database, each firm must be followed by at least one analyst.

Table II

Descriptive Statistics For the Sample for the Time Period 1976 to 1987

Number of analysts is defined as the number making one-year ahead forecasts of earnings in December as reported on the I/B/E/S database. Firm size is the total market value of equity in $ millions on December 31. Price per share is the share price on December 31.

	Number of Firms	Number of Analysts		Firm Size		Price per Share	
		Mean	Median	Mean	Median	Mean	Median
NYSE							
1976	702	7.0	4	785	314	$30.02	$26.69
1977	806	6.3	4	650	264	26.10	23.50
1978	1140	6.8	5	503	175	22.65	19.69
1979	1171	7.1	6	598	215	25.90	23.13
1980	1163	7.6	6	786	253	29.33	24.75
1981	1187	8.9	7	717	250	24.83	22.50
1982	1186	9.5	8	840	317	28.30	24.50
1983	1202	10.3	8	1011	408	29.98	26.69
1984	1202	10.5	8	1102	381	26.84	24.38
1985	1196	12.2	10	1390	436	31.48	27.25
1986	1207	12.1	10	1613	486	30.13	25.75
1987	1123	12.4	10	1731	522	25.40	21.63
AMEX							
1976	66	2.3	1	99	40	18.18	14.25
1977	82	2.1	1	86	42	17.93	17.07
1978	139	2.6	1	75	37	15.91	14.00
1979	152	2.9	1	104	50	19.35	17.76
1980	153	2.9	2	164	66	22.98	21.00
1981	173	3.0	2	112	52	17.23	15.75
1982	211	3.1	2	119	57	18.37	15.50
1983	222	3.5	2	156	79	19.06	17.07
1984	235	3.4	2	127	59	15.49	12.75
1985	218	3.9	2	165	75	17.97	13.88
1986	219	4.1	2	182	72	16.16	13.50
1987	197	4.0	2	191	63	13.51	10.25
NASDAQ							
1976	200	3.0	1	117	57	21.22	19.13
1977	265	2.8	1	90	53	20.26	17.88
1978	430	3.1	2	78	46	18.75	16.13
1979	439	3.5	2	107	58	22.27	19.31
1980	384	3.8	2	139	78	23.60	20.57
1981	476	4.2	3	130	75	20.52	18.38
1982	620	4.1	3	144	84	21.94	19.57
1983	865	4.1	3	154	80	20.14	17.63
1984	1142	4.0	2	121	60	15.90	13.00
1985	1150	4.6	3	164	77	18.70	15.50
1986	1276	4.6	3	177	75	16.53	13.50
1987	1309	4.8	3	170	60	12.91	10.25

than do AMEX firms although their size and stock price distributions do not differ significantly.

The NYSE firms are large compared to the other groups. The distributions of AMEX and NASDAQ firm sizes appear similar. The increase in average firm size over the twelve years is 121% for NYSE, 93% for AMEX, and 45% for NASDAQ, which may be due to NASDAQ firms moving onto the NYSE or AMEX as they grow.

The time-series growth in firm size is not matched by a comparable increase in share price. To show the effect of stock splits on stock prices, Figure 1 plots the time series of the logarithms of the annual CRSP equal weighted price relatives with and without adjustment for stock splits and stock dividends. It is apparent that stock prices decrease when the market goes down, but do not increase correspondingly when the market goes up. This is consistent with the prior evidence that stock splits tend to occur after a rise in stock prices.

Table III provides statistics about the firms for which there was a change in the cumulative split factor reported on the CRSP tape during the year.[33] Reverse stock splits are very rare, and stock splits occur more frequently than do stock dividends. It is clear from Table III that only a minority of firms split in any given year. These numbers appear to be consistent with the findings of Lakonishok and Lev (1987) who analyze all CRSP NYSE and AMEX firms for the years 1963-1982 and find that in most of the years, 5-10% of the firms split their stock.

In addition, as Lakonishok and Lev (1987) have found, splitting firms have higher than average share prices, with the median price for splitting firms in our sample being \$42.13 for NYSE, \$26.50 for AMEX, and \$24.75 for NASDAQ. As our theory predicts, prices for reverse splitting firms tends to

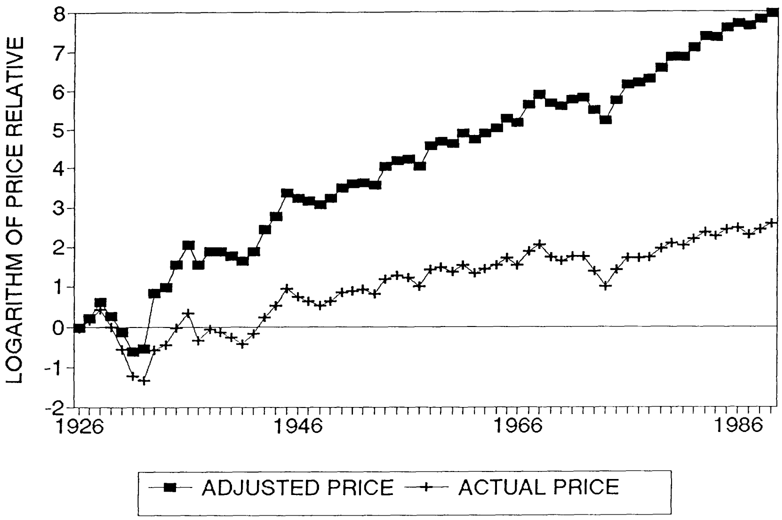

Figure 1. The effect of splits on average, 1926-1989. Logarithm of the CRSP equally weighted price relative with and without adjustment for stock splits.

[33] The data upon which Table III is based consists of *all* firms on the CRSP tape, not only those which are also carried by I/B/E/S.

Table III

Descriptive Statistics For Firms Listed on the CRSP Database Which Had a Change in The Split Factor in The Year

	Firms with Stock Splits					Firms with Reverse Splits					Firms with Stock Dividends				
			Change in Split Factor					Change in Split Factor					Change in Split Factor		
	No. of Splits	% of Total	Max	Min	Med	No. of Splits	% of Total	Max	Min	Med	No. of Divs	% of Total	Max	Min	Med
NYSE															
1976	114	7	3[a]	1.25	2	1	≈ 0	5[b]	5	5	97	6	1.20[c]	1.01	1.04
1977	107	7	3	1.25	1.55	1	0	4	4	4	87	6	1.20	1.01	1.05
1978	129	8	4	1.25	1.5	1	0	4	4	4	86	6	1.20	1.01	1.05
1979	141	9	5	1.25	1.5	0					74	5	1.20	1.02	1.05
1980	183	12	4	1.25	2	0					65	4	1.25	1.02	1.05
1981	197	13	5	1.25	2	1	0	2	2	2	60	4	1.20	1.02	1.05
1982	84	5	2	1.25	1.5	1	0	3	3	3	58	4	1.20	1.01	1.05
1983	246	16	10	1.25	2	2	0	5	4	5	53	4	1.20	1.02	1.05
1984	121	8	5	1.25	1.5	0					56	4	1.20	1.02	1.05
1985	129	9	3	1.25	2	1	0	2	2	2	42	3	1.20	1.02	1.05
1986	237	16	5	1.25	2	4	0	50	10	14	45	3	1.15	1.02	1.05
1987	213	14	5	1.25	2	6	0	50	2	10	38	2	1.20	1.02	1.05
AMEX															
1976	52	5	2	1.25	1.5	2	≈ 0	3	2	3	96	9	1.20	1.02	1.05
1977	52	5	3	1.25	1.5	1	0	5	5	5	94	9	1.20	1.02	1.05
1978	70	7	3	1.25	1.5	1	0	5	5	5	97	10	1.20	1.01	1.05
1979	69	8	5	1.25	1.5	1	0	3	3	3	101	11	1.20	1.01	1.07
1980	108	12	7	1.25	1.5	0					110	13	1.25	1.01	1.06
1981	96	11	10	1.25	1.5	2	0	10	7.14	10	88	10	1.20	1.02	1.05
1982	58	7	2	1.25	1.5	3	0	3	2	2	66	8	1.20	1.02	1.05
1983	133	16	5	1.25	1.5	1	0	3.33	3.33	3.33	75	9	1.20	1.01	1.05
1984	43	5	3	1.25	2	0					61	8	1.20	1.02	1.05
1985	68	9	4	1.25	1.5	3	0	15	3	5	47	6	1.20	1.02	1.05
1986	67	9	10	1.25	1.5	1	0	3	3	3	42	5	1.20	1.01	1.06
1987	63	8	4	1.25	1.5	4	1	6	2.5	5	33	4	1.20	1.04	1.07

Table III—*Continued*

	Firms with Stock Splits					Firms with Reverse Splits					Firms with Stock Dividends				
			Change in Split Factor					Change in Split Factor					Change in Split Factor		
	No. of Splits	% of Total	Max	Min	Med	No. of Splits	% of Total	Max	Min	Med	No. of Divs	% of Total	Max	Min	Med
NASDAQ															
1976	152	6	5	1.25	1.5	7	≈ 0	50	1.5	5	208	8	1.20	1.01	1.05
1977	170	7	3	1.25	1.5	4	0	10	4	10	222	9	1.22	1.01	1.06
1978	260	10	7	1.25	1.5	7	0	10	2	5	227	9	1.22	1.02	1.08
1979	167	7	10	1.25	1.5	5	0	25	2.5	10	243	10	1.21	1.01	1.10
1980	273	11	10	1.25	1.5	5	0	8	2	3	210	8	1.20	1.02	1.10
1981	344	13	10	1.25	1.5	12	0	10	2	5	208	8	1.20	1.01	1.10
1982	183	6	5	1.25	1.5	20	1	50	1.5	5	193	6	1.20	1.02	1.07
1983	521	17	5	1.25	2	32	1	50	1.33	5	178	6	1.20	1.01	1.06
1984	243	7	10	1.25	1.5	31	1	40	2	10	196	5	1.20	1.01	1.07
1985	390	10	20	1.25	1.5	36	1	100	2	8	183	5	1.20	1.02	1.07
1986	527	14	40	1.25	1.5	22	1	200	2	10	164	4	1.20	1.01	1.06
1987	383	9	10	1.25	1.5	61	1	200	2	10	177	4	1.20	1.02	1.10

[a] A change of 3 means that 3 new shares are issued in exchange for 1 old share.
[b] A change of 5 means that 1 new share is issued in exchange for 5 old shares.
[c] A change of 1.2 means that a 20% stock dividend was issued.

be very low: the median is \$1.25 for NYSE, \$1.50 for AMEX, and \$0.69 for NASDAQ.

In order to test the implication of the model that the number of analysts making earnings forecasts about a firm is negatively related to the share price, and positively related to the size of the firm, the following equation was estimated by ordinary least squares for each year from 1976 to 1987 for all firms in the sample.

$$N_{it} = a_{0t} + a_{1t}\text{Log Size}_{it} + a_{2t}(1/P_{it}) + a_{3t}\text{Var}_{it} + a_{4t}\text{Log } R_{it} + a_{5t}\text{Log } R_{it-1} + \cdots + a_{8t}\text{Log } R_{it-4} + e_{it}, \quad (21)$$

where

N_{it} = the number of analysts reporting a one-year ahead earnings forecast for firm i in December of year t

Size_{it} = the market value of the equity of firm i on December 31 of year t

P_{it} = the share price of firm i on December 31 of year t

Var_{it} = the variance of returns for firm i estimated over the last 200 days prior to December 31 of year t

R_{it} = the rate of return on the shares of firm i in year t, excluding dividends.

The first two terms in regression equation (21) are derived from the theory in the preceding section. We include the variance of returns because there is prior evidence[34] that the variance is positively related to the number of analysts and we wish to determine if the share price exerts an independent effect on the number of analysts.[35]

The lagged log returns are included in the regression to allow for a possible spurious relation between share price and analyst following due to a lagged relation between number of analysts and firm size. If the number of analysts reported on the I/B/E/S tape adjusts slowly to changes in firm size, then a firm that earns negative returns will tend to have a larger analyst following than that predicted on the basis of its current size (as measured by market value of equity). It will also have a relatively low stock price, thereby inducing a spurious relation between share price and number of analysts. Inclusion of the logarithm of the lagged (dividend adjusted) returns is equivalent to including lagged size variables to the extent that size changes are due to capital gains and losses rather than stock issues and retirements. In addition, while the model predicts a simultaneous change between share

[34] Bhushan (1989) includes the variance of returns in his empirical study of the determinants of analyst following. He hypothesizes that the value of private information should be positively related to return variability because it increases the conditional expected return.

[35] Our model assigns no role to the variance as influencing the number of analysts. However, Kim and Verrecchia (1990) show that the absolute value of price changes may be positively related to the volume of trading. Under our assumption about competition in the brokerage industry, an increase in the volume of trading will lead to an increase in the number of analysts.

price and analyst following, there is evidence that some of the I/B/E/S data may not be current.[36]

The regression results for equation (21) are presented by year for all firms in the sample in Table IV.[37] As Bhushan (1989) finds, the influence of the size variable is positive and highly significant, and in 10 of the 12 years, there is a significantly positive relation between analyst following and the variance

Table IV

Determinants of the Number of Analysts Forecasting Earnings for a Firm

Estimation of expression (21) for the entire sample of firms. N_{it} is the number of analysts reporting a one-year ahead earnings forecast for firm i in December of year t. Size_{it} is the market value of the equity of firm i on December 31 of year t. P_{it} is the share price of firm i on December 31 of year t. Var_{it} is the variance of returns for firm i estimated over the last 200 days prior to December 31 of year t. R_{it} is the rate of return on the shares of firm i in year t, excluding dividends. n is the sample size and t-statistics appear in parentheses.

$$N_{it} = a_{0t} + a_{1t}\text{Log Size}_{it} + a_{2t}(1/P_{it}) + a_{3t}\text{Var}_{it} + a_{4t}\text{Log } R_{it} + a_{5t}\text{Log } R_{it-1} + \cdots + a_{8t}\text{Log } R_{it-4} + e_{it}$$

t	n	a_0	a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8	R^2
1976	967	−34.02	3.24	10.58	98.15	−3.75	0.55	−1.27	0.35	0.59	0.59
		(21.45)	(28.60)	(2.43)	(3.10)	(7.53)	(1.67)	(4.00)	(1.16)	(2.23)	
1977	1152	−29.85	2.89	6.70	152.53	−1.98	−1.60	−0.03	−0.87	0.51	0.59
		(23.75)	(30.39)	(2.27)	(4.37)	(5.11)	(4.89)	(0.14)	(3.50)	(2.14)	
1978	1707	−33.06	3.29	7.50	59.00	−0.99	−0.68	−1.34	−0.05	−0.41	0.62
		(34.39)	(44.00)	(4.56)	(4.17)	(3.82)	(2.69)	(6.04)	(0.25)	(2.33)	
1979	1699	−31.29	3.16	4.22	66.89	−2.33	−0.16	−0.22	−0.92	0.38	0.65
		(38.86)	(50.26)	(3.52)	(4.05)	(11.32)	(0.77)	(1.11)	(4.79)	(2.35)	
1980	1699	−33.85	3.35	8.17	33.11	−1.62	−1.82	0.07	−0.19	−0.49	0.65
		(38.10)	(49.30)	(5.05)	(2.09)	(7.29)	(7.93)	(0.33)	(0.91)	(2.48)	
1981	1835	−37.84	3.71	9.80	3.44	−1.55	−0.69	−0.75	0.14	0.00	0.66
		(41.02)	(52.26)	(6.67)	(0.21)	(7.30)	(3.61)	(3.68)	(0.69)	(0.01)	
1982	2016	−41.95	4.04	8.29	8.76	−0.78	−0.66	−0.06	−0.18	0.07	0.67
		(48.11)	(59.09)	(6.61)	(0.94)	(5.10)	(3.51)	(0.37)	(0.98)	(0.48)	
1983	2288	−43.82	4.19	5.26	50.99	−0.85	−0.35	−0.43	0.08	0.07	0.67
		(50.33)	(61.77)	(4.70)	(4.29)	(5.73)	(2.47)	(2.66)	(0.52)	(0.44)	
1984	2577	−40.24	3.93	4.29	33.88	−1.43	−0.34	−0.23	−0.32	0.21	0.66
		(53.91)	(65.65)	(7.20)	(4.25)	(8.63)	(2.78)	(1.83)	(2.17)	(1.73)	
1985	2560	−46.39	4.55	0.91	29.75	−3.11	−0.94	−0.47	−0.33	−0.33	0.67
		(56.88)	(69.02)	(3.50)	(5.01)	(13.45)	(5.58)	(3.51)	(2.36)	(2.19)	
1986	2700	−44.51	4.33	3.35	23.45	−2.06	−1.07	−0.74	−0.30	−0.12	0.67
		(55.07)	(67.26)	(5.71)	(4.11)	(11.48)	(5.70)	(5.29)	(2.40)	(0.97)	
1987	2628	−43.81	4.26	3.00	24.69	−1.56	−0.62	−0.43	−0.53	−0.20	0.66
		(53.27)	(65.42)	(6.14)	(5.89)	(7.57)	(4.67)	(3.17)	(4.22)	(1.73)	

[36] O'Brien (1988) and Brown, Foster, and Noreen (1985) describe characteristics of the I/B/E/S data.

[37] Results for the individual exchanges, which were included in an earlier version of this paper, are available from the authors.

of stock price. The major new prediction of our model, that the number of analysts will be negatively related to share price, is strongly supported by the finding that the coefficient of the reciprocal of share price is positive and strongly significant in each year.[38] The coefficients of the lagged return variables are negative and strongly significant for short lags, which is consistent with the discussion above of slow analyst adjustment. Since the coefficient for a lag of five years is generally insignificant and of variable sign, it appears that the adjustment is complete after five years so that share price is not a proxy for a lagged size term.

Results for the individual exchanges are similar in nature, but less significant, due to reduced sample sizes. The coefficient on the reciprocal of share price is positive for NYSE firms in 10/12 years, for AMEX firms in 11/12 years, and in 12/12 years for NASDAQ firms.

While these results are consistent with the predictions of our model, it is possible that they are due to a common factor which is associated with low shares prices and a large analyst following—for example, an industry association. In such a case, the number of analysts following a firm would not be affected by a stock split, as we hypothesize. Therefore, a more direct test of the effect of a split on analyst following is a regression of the change in the number of analysts following a firm on current and lagged values of the split factor and the capital gains as follows.

$$\begin{aligned}\Delta \operatorname{Log} N_{it} = {} & a_{0t} + a_{1t}\,\Delta \operatorname{Log} F_{it} + a_{2t}\,\Delta \operatorname{Log} F_{it-1} + \cdots \\ & + a_{5t}\,\Delta \operatorname{Log} F_{it-4} + a_{6t} \operatorname{Log} R_{it} + \cdots + a_{10t} \operatorname{Log} R_{it-4} + e_{it},\end{aligned} \tag{22}$$

where $\Delta \operatorname{Log} F_{it}$ is the change in the CRSP split factor in year t and, as before, R_{it} is the capital gain on the stock in year t.[39]

Under the null hypothesis, $a_{1t} = a_{2t} = \cdots = a_{5t} = 0$, whereas our model and, more generally, the Attention Hypothesis of Grinblatt, Masulis, and Titman (1984), predicts that at least some of these coefficients will be positive.

Table V reports the results of estimating equation (22) by year together with an F-test of the null hypothesis that the coefficients on the lagged changes in the split factor are all equal to zero. The null hypothesis is rejected in 7 of the 12 years at the 1% level, and in 3 additional years at the 5% level. Weighting the parameter estimates for each year by their precisions, the point estimates suggest that a doubling of the split factor (i.e., a two-for-one split) is associated with a 24% increase in the number of analysts reported by I/B/E/S in the current year, and a 54% increase by the end of

[38] We obtained similar but slightly less consistent results when we replaced the reciprocal of the stock price with the logarithm of the stock price.

[39] We adopted the log specification because it allows for the effect on the number of analysts of price changes associated both with returns (and therefore with changes in size) and with stock splits in a simple additive fashion.

five years. The effect is relatively weak for NYSE firms where a doubling of the split factor is associated with only a 19% increase in the number of analysts after five years. The corresponding numbers for AMEX and NASDAQ firms are 130% and 36%. The effect seems most consistent for NASDAQ firms for which it is concentrated in the year of the split.

The timing of the increase in the number of analysts reflects not only the predicted influence of the split, but also the efforts of Lynch, Jones, and Ryan to increase the coverage of their database. An interesting feature of the results is the large and highly significant negative coefficient on R_{it}, the log of the current year's dividend-adjusted return. While this is consistent with our hypothesis that a lower share price will be associated with a larger number of analysts, the effect seems too great for this explanation. We conjecture that analysts tend to turn their attention from firms whose stocks have appreciated either because, a major source of value having been discovered, the future prospects for further value discoveries are relatively slight, or because such firms are more likely to be overvalued and analysts tend to avoid making sell recommendations.[40] Clearly this phenomenon bears further investigation.

IV. Summary and Conclusions

We assume that investors trade only in stocks that they "know about", and trade through brokers who analyze those firms which will generate the greatest trading volume and brokerage fees. A manager with private "good news" has an incentive to attract the attention of security analysts so that they will discover the good news and inform their clients through earnings forecasts. In our model the manager does this by announcing a stock split, thereby reducing the share price and increasing the trading commission revenue which will result from research activity by brokerage houses. Investors accordingly interpret a stock split as a signal that the manager has favorable information, which explains the positive abnormal returns observed around split announcements. The model also predicts that there will be an increase in the amount of information generated by analysts after the ex-date; this may account for the increase in price volatility observed after the ex-date, the wider bid-ask spread, and the increase in the number of shareholders.

The predictions of the model are tested and confirmed on a sample of firms listed on the I/B/E/S database during 1976–1987. The number of analysts making forecasts is negatively related to share price, and the change in analyst following is positively related to the magnitude of stock splits.

[40] There is some indirect evidence that analysts are less willing to make sell recommendations than buy recommendations. Lloyd-Davies and Canes (1978) identify 597 buy recommendations, but only 188 sell recommendations in their study. Some explanations for this reluctance are offered by Galant (1990).

Table V

Determinants of the Change in the Number of Analysts Forecasting Earnings for a Firm

Estimation of expression (22) for the entire sample of firms. N_{it} is the number of analysts reporting a one-year ahead earnings forecast for firm i in December of year t. Δ Log F_{it} is the change in the logarithm of the CRSP split factor in year t. R_{it} is the rate of return on the shares of firm i in year t, excluding dividends. n is the sample size and t-statistics appear in parentheses.

$$\Delta \text{ Log } N_{it} = a_{0t} + a_{1t}\,\Delta \text{ Log } F_{it} + a_{2t}\;\Delta \text{ Log } F_{it-1} + \cdots + a_{5t}\,\Delta \text{ Log } F_{it-4}$$
$$+\, a_{6t}\text{Log } R_{it} + \cdots + a_{10t}\text{Log } R_{it-4} + e_{it}$$

t	a_0	a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8	a_9	a_{10}	R^2	n
1976	−3.02	0.06	10.47	0.27	−0.23	0.16	−1.00	−3.27	−0.14	−0.02	−0.12	.08	967
	(46.06)	(0.36)	(2.34)	(1.82)	(0.48)	(1.09)	(7.62)	(3.23)	(1.46)	(0.05)	(1.40)	2.40^{*a}	
1977	−1.22	0.57	0.78	−0.13	−0.00	−0.22	−1.76	−0.11	−1.03	0.08	0.61	.05	1152
	(9.77)	(1.60)	(2.19)	(0.11)	(0.00)	(0.43)	(6.38)	(0.42)	(2.26)	(0.38)	(1.47)	1.43^{a}	
1978	−1.83	1.19	1.03	1.32	−1.98	0.11	−1.18	−0.51	−0.44	0.33	0.49	.04	1708
	(15.27)	(3.23)	(2.96)	(3.81)	(1.48)	(0.36)	(5.16)	(2.05)	(1.96)	(0.91)	(2.77)	7.35^{**a}	
1979	−0.13	0.31	0.51	0.39	0.41	−1.07	−0.87	−0.74	−0.48	−0.20	0.39	.06	1761
	(1.91)	(1.40)	(2.25)	(1.94)	(1.83)	(1.64)	(7.28)	(5.70)	(3.44)	(1.49)	(2.05)	3.36^{**a}	
1980	−0.18	0.44	0.18	0.54	0.18	−0.06	−0.40	0.04	−0.45	0.03	0.04	.03	1699
	(3.64)	(2.85)	(1.14)	(3.57)	(1.19)	(0.35)	(4.40)	(0.37)	(4.77)	(0.33)	(0.42)	4.75^{**a}	
1981	−0.36	−0.07	0.76	0.68	0.83	0.41	−0.45	−0.43	−0.21	−0.54	0.03	.05	1835
	(6.31)	(0.53)	(4.13)	(3.30)	(4.49)	(2.23)	(4.32)	(4.10)	(1.88)	(4.81)	(0.27)	10.23^{**a}	
1982	−0.15	0.08	0.07	−0.06	0.09	0.05	−0.73	0.06	−0.11	0.08	0.15	.12	2016
	(4.18)	(1.08)	(0.80)	(0.62)	(0.74)	(0.43)	(14.87)	(0.95)	(1.82)	(1.22)	(2.50)	0.55^{a}	
1983	−0.17	0.30	−0.12	0.12	0.12	−0.03	−1.07	0.35	−0.14	0.01	0.18	.22	2288
	(4.53)	(5.23)	(1.62)	(1.41)	(1.09)	(0.27)	(21.59)	(7.70)	(2.61)	(0.27)	(3.11)	7.02^{**a}	

Table V—*Continued*

t	a_0	a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8	a_9	a_{10}	R^2	n
1984	−0.42	0.29	0.12	−0.10	0.14	0.12	−0.79	−0.06	0.09	−0.08	0.05	.08	2577
	(12.80)	(4.64)	(1.96)	(1.25)	(1.61)	(1.21)	(14.41)	(1.25)	(1.98)	(1.51)	(1.12)	6.23**[a]	
1985	−0.01	0.19	0.10	0.09	0.06	0.11	−0.36	0.06	0.04	−0.01	0.09	.02	2562
	(0.49)	(2.71)	(1.94)	(1.81)	(0.96)	(1.63)	(6.82)	(1.48)	(1.16)	(0.20)	(2.43)	2.89*[a]	
1986	−0.27	0.38	0.15	0.05	−0.00	0.06	−0.71	0.14	−0.08	0.05	0.10	.11	2700
	(10.59)	(6.82)	(2.24)	(0.83)	(0.01)	(0.98)	(16.56)	(3.09)	(2.39)	(1.57)	(3.09)	9.95**[a]	
1987	−0.26	0.17	0.05	0.04	−0.01	0.05	−0.37	0.09	−0.02	0.03	−0.02	.03	2627
	(11.58)	(3.24)	(1.03)	(0.78)	(0.23)	(0.94)	(9.12)	(2.93)	(0.76)	(0.97)	(0.72)	2.51*[a]	

[a] F-statistic for the null hypothesis $a_1 = a_2 = \cdots = a_5 = 0$.
* Significant at the .05 level.
**Significant at the .01 level.

Appendix

Reverse Stock Splits

The model presented in Section II can be extended with minor modification to include reverse stock splits. We assume that there is a minimum brokerage commission $T_{\min}$ available to the firm, and that the next lowest commission is $T_1 = T_{\min} + \delta$, where δ is strictly positive.[41] Depending upon parameter values, there may exist several different types of equilibria. Figure 2 illustrates the inference schedule for the equilibrium in which the most information is revealed, given that there is a cost of splitting or reverse-splitting. The values of $\hat{y}_m(T)$ corresponding to $T \in [(T_1, T_2), (T_3, \infty)]$ satisfy equation (15) for $K = K_1$ and K_2, respectively. The constants of integration and y_m^0, y_m^r, y_m^s, T_2, T_3, and $\overline{T}$ are defined as follows.

The values of y_m^0 and K_1 follow from conditions analogous to those in equations (16) and (17): that is, that the firm with the signal y_m^0 is indifferent between remaining in the pool of firms selecting $T_{\min}$, and identifying itself by choosing T_1, and that investors make the correct inference. These conditions are:

$$E\left[E\left(x \mid y_m \le y_m^0, \bar{y}\right) \mid y_m^0, s(\bar{y}) = FT_{\min} s\right] - T_{\min} = \frac{x_0 s_0 + y_m^0 s_m + y_m^0 F T_1 s}{s_0 + s_m + F T_1 s} - T_1, \quad \text{(A-1)}$$

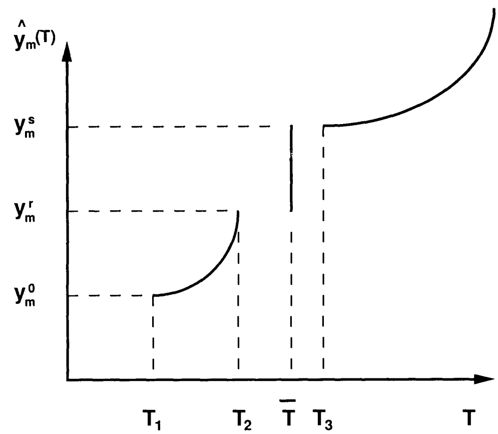

Figure 2. The inference schedule for a model of stock splits and reverse splits. T is the expected aggregate brokerage commission. $\hat{y}_m(T)$ is investors' inference of y_m based upon T. y_m^s is the signal of the marginal splitting firm. y_m^r is the signal of the marginal reverse splitting firm. $\overline{T}$ is the aggregate brokerage commission for a firm that does not split.

[41] It is necessary that δ be positive so that the pool of firms selecting $T_{\min}$ does not unravel. Since the inference schedule is convex and y_m is unbounded, a pool of firms must exist at the lower bound on T. Note that if y_m had a fixed support, the lower boundary condition for the inference schedule would be provided by the condition that the firm with the lowest possible signal would choose the minimum commission rate in equilibrium.

and

$$\hat{y}_m(T_1) = \left(\frac{s_0 + s_m}{s_m}\right)T_1 + \frac{Fs}{2s_m}T_1^2 - K_1 \equiv y_m^0. \tag{A-2}$$

The value of y_m^r, the signal level of the marginal firm to choose a reverse split, and T_2 are determined by the condition that (T_2, y_2) lies on the inference schedule, and that the firm with the signal y_m^r is indifferent to announcing a reverse split and remaining in the pool of firms choosing $\overline{T}$. The conditions are:

$$E\left[E\left(x \mid y_m^r \le y_m \le y_m^s, \bar{y}\right) \mid y_m^r, s(\bar{y}) = F\overline{T}s\right] - \overline{T}$$
$$= \frac{x_0 s_0 + y_m^r s_m + y_m^r F T_2 s}{s_0 + s_m + F T_2 s} - T_2 - C, \tag{A-3}$$

where $\overline{T} \equiv E[xt(x/n_0) \mid y_m^r \le y_m \le y_m^s]$, and

$$\hat{y}_m(T_2) = \left(\frac{s_0 + s_m}{s_m}\right)T_2 + \frac{Fs}{2s_m}T_2^2 - K_1 \equiv y_m^r. \tag{A-4}$$

Condition (A-3) depends upon y_m^s, the signal level of the marginal splitting firm. This, along with K_2, is identified by conditions analogous to (A-3) and (A-4). Finally, T_3 is defined by

$$T_3 \equiv E\left[xt(x/n_0) \mid y_m^s\right]. \tag{A-5}$$

For appropriate parameter values, the nonlinear set of equations can be solved to yield the inference schedule shown. An interesting feature of the equilibrium is that no firms choose brokerage commissions $T_2 < T < \overline{T}$.[42] It is therefore necessary to show that the equilibrium is supported by reasonable beliefs about out-of-equilibrium choices of T. It is readily shown that an equilibrium in which $\hat{y}_m(T) = y_m^r$ for $T \in (T_2, \overline{T})$ satisfies the Cho-Kreps (1987) Intuitive Criterion.

Reverse splits convey negative information in this equilibrium.[43] Firms do not announce small reverse stock splits because they also are costly. Large savings in commissions are required to offset the administrative and information costs of a reverse split. Small stock splits, however, do occur in equilibrium. This implication of the model is consistent with the empirical evidence presented in Table III.

Note that as $\overline{T}$ is reduced (by reducing $E(x/n_0)$, T_2 will approach T_1 until the first continuous portion of the inference schedule is eliminated. Finally, as $\overline{T}$ declines or C increases, reverse splits will disappear completely,[44] although regular splits will continue to occur. Thus the model is consistent with the empirical finding (see Table III) that reverse splits are much less frequent than regular splits.

[42] Note that values of T such that $T_{\min} < T < T_1$ or $\overline{T} < T < T_3$ are technically infeasible.

[43] Lamoureux and Poon (1987) report a negative abnormal return of 3% associated with reverse stock splits. Dravid (1987) finds a decrease in the variance of returns.

[44] A sufficient condition for the absence of reverse splits is that $\overline{T} > C$.

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