Stock Returns' Variance Behavior Surrounding Stock Splits:

Evidence From Trade-by-Trade Data 1978-1985

by

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(ABSTRACT)

Accepted financial theory holds that stock splits provide no wealth benefits to stockholders. The corporate management view is that stock splits add value by placing the stock in a more liquid price range. Empirical explanations of excess returns near the split rely principally upon an information effect. Other findings are that (1) an unexplained, sustained jump in returns' variance occurs at the split and (2) there appears to be a coincidental decrease in liquidity, not an increase.

Daily returns from CRSP and daily and intradaily returns and daily trading volumes and price change information from trade-by-trade data are used to examine the returns variance increase and any connection it may have with any liquidity change. Binomial probability comparisons of returns' variance measures each side of the split ex-date are used to examine the variance change and liquidity change phenomena. T-tests are also used to examine the mean variance change and the possible change in several liquidity measures. Linear regression is used to detect impact of the general market variance level, firm-specific variables, and microstructure measures, and liquidity measures upon the returns' variance change. Findings include: (1) the variance increase is significant and exhibits a firm size effect and is affected by the previous history of splits use and dividend payout, (2) the increase is primarily related to the price level adjustment and changes in the liquidity measures, (3) a slight change in the demand to hold as measured

by the percentage of the firm traded takes place for firms with an increase in variance (4) the bid-ask spread decreases, but increases relative to the new price. Stock splits with increased returns' variance have significantly different liquidity measures from splits where the variance declined.

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INTRODUCTION

According to accepted financial theory of asset valuation stock splits are neutral events providing no additional value to stockholders. Over seventeen hundred and fifty stock splits occurred among more than twelve hundred NYSE listed companies from 1969 to 1985. Including stock dividends, NYSE companies had more than three thousand stock distributions during this period. Moody's Dividend Record for all stocks and exchanges in the United States for this period reports a total of over seven-thousand four-hundred stock splits and fourteen-thousand seven-hundred stock dividends.

Stock distibutions produce a simple multiplication in the number of shares of common stock. In either case, total firm value should not change except for the relatively negligible cost of the stock distribution process.[1] The capital structure is not altered. Changes do occur in the owners' equity structure, though these changes do not provide the corporation with any new funds or the stockholders with new wealth. Systematic risk should not change and no change in the returns distribution is expected.

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[1] Such costs may include officers' time, handling fractional shares, issuing certificates, revision of the stockholder ledger, mailing costs, increased franchise tax, stock issue tax, and listing fee. Stephen H. Sosnick, "Stock Dividends Are Lemons Not Melons," *California Management Review* 3 (Winter 1961) 63.

Excess returns are evident prior to stock splits' ex-dates,[2] and the rate of returns' variance increases significantly and instantaneously at the split.[3] A cross-sectional mean return does not change with the average increase in variance. Also, Copeland (1976) shows that relative trading volume declines and relative transaction costs increase, indicating decreased liquidity.

Accounting for Stock Distributions:

The accounting changes to owners' equity depends upon the size of the distribution; stock dividends are treated differently than stock splits. The American Institute of Certified Public Accountants Incorporated (AICPA) views stock dividends as having economic value in that stock price is not considered to change materially but stockholders receive "evidence of a part of their respective interests in accumulated corporate earnings..."(1952). The accounting treatment calls for transfer of the fair market value of the stock dividend from retained earnings to other capital accounts.

Stock splits, however, are considered by the AICPA(1952) to have the purpose of reducing market price and obtaining wider stock ownership distribution and improved marketability of shares (i.e. improved liquidty.) Stock spilts do not change the retained earnings account but do reduce the par value per share and, of course, increase the number of shares. No economic value is added.

The distribution size that demarcates stock dividends and splits under the AIPCA(1952) rules is 20 percent, though 20 percent to 25 percent distributions may fall in either catagory. The NYSE manual and SEC rulings (1972) essentially make the same distinction, though all distributions under 25 percent are considered dividends.

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2 Eugene F. Fama, Lawrence Fisher, Michael C. Jensen, & Richard Roll, "The Adjustment of Stock Prices To New Information," *International Economic Review*, 10 (1969) 1-21.

3 James A. Ohlson & Stephen H. Penman, "Volatility Increases Subsequent to Stock Splits: An Empirical Aberration," *Journal of Financial Economics* 14(1985) 251-266.

Corporate Management Rationale for Stock Distibutions:

Stock dividends have been widely used in the United States since the Supreme Court decided that stock dividends were not income and therefore not taxable to stockholders in Towne v. Eisner (245 U.S. 418 (1918)) and Eisner v. Macomber (252 U.S. 189 (1920.) The undistributed profits law of 1936-1937 further encouraged stock dividends use. The 1920's also saw increasing use of the newly introduced (1915) stock split (Dolley, 1933(1).)

In 1933, J. C. Dolley (1933(2)) surveyed managers then using stock splits. The leading motivation stated by the managers was to widen the distribution of corporate shares in order to facilitate trading, reduce trading volume variance, and stablize price. In short, with less instability in price and volume and so reduced transaction costs, the market for the stock is more liquid. Increased stockholder goodwill and decreased liklihood of legislation against high income, which politicians would erroneously infer from high EPS, were also often cited as reasons for using stock splits. Some managers also believed that high earnings per share (EPS) or high cash dividends per share would encourage entry of new competitors into the product market.

Additional reasons for using stock splits were given. First, splits make future sales of new common stock easier by (1) lowering the subscription price to a price considered more popular in the market and (2) increasing the number of stockholders to be solicited in a new offer. Second, an increased number of shares formed part of the strategy in responding to merger proposals. Third, stockholders were believed to receive value in the form of personal satisfaction from holding a larger number of shares despite no market value change. Fourth, increasing an initially small number of shares eased stock exchange listing for some companies. Fifth, the par value changed. Finally, insiders considered a split beneficial to themselves and their holdings.

Recent surveys have shown continued adherence to the rationale first reported by Dolley. Baker and Gallagher (1980) surveyed chief financial officers (CFO's) of firms using stock splits and also of firms that did not. A concensus of opinion exists among CFO's that higher priced stocks have a more restricted market and that an optimal price range exists. Modern portfolio theory states that investments are made in proportions of the portfolio rather than on the basis of the price of individual units of stock. The opinion about optimal price is then curious. Seventy-three percent of CFOs stated that increasing the number of stockholders did not increase product sales volume. Eighty-five percent of CFOs held that labor negotiations and labor legislation were unaffected by EPS reports.

Fifty-four percent of CFO's using stock splits believe that the market ex-date price adjustment is incomplete. Stockholders therefore benefit through overpricing. Woolridge (1983(2)) found support for partial price adjustment on stock dividend ex-dates. Abnormal returns are possible to floor traders and investors who do not receive fractional or odd lot shares. Taxes and transaction costs are responsible for these abnormal returns. Fourteen percent of CFOs believe that cash is conserved, though no evidence exists for any reduction in total dividend payout.

A prime reason for using stock splits has been that trading liquidity improves. The increased ownership base results in an increased number of traders and an increase in trading volume occurs. Increased trading stabilizes price and trading volume. Also, lower transaction costs result from increased trading in round-lots.

In a similar survey of managements' views of stock dividends, Eisemann and Moses (1978) report similar reasons for using smaller distributions. These include: increasing the number of stockholders, making it easier to issue new equity and increasing attractiveness of the stock because of more liquid markets and optimal prices, signalling the true value of the firm, and increasing stockholder return through the tax advantage of capital gains.

Managers not using stock dividends agreed with managers who did employ stock dividends on several points. Cash is conserved and the number of stockholders is increased with stock distributions. Increased round-lot trading provides no significant value to small investors. An optimal stock price exists. Issuing a stock distribution when the price is not above this optimal price will cause a fundamental price devaluation in addition to the distribution price adjustment.

In summary, the prevailing and enduring management view of stock distributions is that a stock's price may be too high or too low to optimally benefit stockholders and the firm. Market valuation is based on factors other than asset value and future earnings. Additional value or return can be achieved using stock distributions through the incomplete adjustment of the stock's price following the distribution. Finally, it is beneficial to the firm to increase the liquidity of the market for its stock and this can be done by using stock dividends and splits. No negative effects are expected.

Statement of the Problem:

There are two unexplained and perhaps related phenomena associated with stock splits: (1) an instantaneous jump in the returns variance occurs at the time of the split and (2) a decrease in liquidity occurs after the split. It is unclear from the extant literature whether these findings are statistical artifacts or whether they are significant statistically, yet theoretically unexplained. In either case, the common use of stock splits is questionable.

Purpose and Justification of the Study:

My dissertation examines the changes in stock return variance behavior and changes in the stock's liquidity around the split ex-date. Rationalizations for splitting stocks have not been empirically justified. No adequate explanation for the variance increase and liquidity decrease exists. Several measurement and control problems in the previous studies are also evident.

Measurement of Price. Problems arise from the prices used in generating returns. Smidt (1979) questioned that closing prices provided unbiased estimates of equilibrium prices. Amihud & Mendelson (1985) found that opening and closing prices are generated differently. Wood, McInish, & Ord (1985) showed that there is significantly abnormal trading behavior and high standard deviations for returns in the opening and closing half hours of trade. Harris (1986) confirmed abnormally high prices in the closing and opening transactions. Because closing prices are typically used to generate daily, weekly, and monthly returns, a bias for high variance may exist and the closing price phenomenon may be generating the variance jump seen at the stock split ex-date.

Significance of Change. Second, while a majority of split stocks exhibit increased variance, not all do. A general cross-sectional pooling of the data across all variance changes may distort the results. The variance change may not be significant but for a few firms.

Control For Price Level. Third, despite Ohlson & Penman's (1985) finding that price level was an insignificant factor, Carey & Sherr (1974) determined it is incorrect to run a cross-sectional analysis of returns without controlling for price level. Futhermore, Harris (1985) found that price level dominated the market value effect associated with the mean price change of end-of-the-day transaction price anomalies.

Control of Firm Size. Fourth, Clark (1973) and McInish & Wood (1985) reported the necessity of controlling for volume size. Also, Cohen, Ness, Okuda, Schwartz, & Whitcomb (1976) and Foster, Olsen, & Shevlin (1984) argued for control of firm size, although Harris (1985) argued that firm size is highly correlated with price level. Volume size and firm size are also highly correlated.

Conflicting Results on Liquidity Changes. Finally, Murray (1985) using Copeland's methodology and a larger, monthly returns dataset, and Dravid (1987) failed to find any liquidity changes around stock splits.

General Hypotheses:

The null hypothesis I am testing are: First, there is no significant jump in the returns' variance following the stock split as a result of the split itself. Second, there is no significant change in the stock's liquidity following the split. (The first two hypotheses examine the legitimacy of the phenomena.) Third, any significant change in returns' variance is uncorrelated to a decrease in the stock's liquidity.

Organization of the Study:

The dissertation is organized into five chapters. Chapter II reviews the empirical research and theoretical work concerning stock returns' variance and liquidity relevant to stock splits. Presentation of the hypotheses tested are formally stated in this chapter.

Chapter III contains a description of the data and the methodology.

Chapter IV presents the results of the empirical tests.

Chapter V summarizes the major findings. Limitations of the study are discussed in this chapter. Extensions concerning liquidity and returns are also made in this chapter.

References and appendices follow.

LITERATURE REVIEW

The relevant research is examined in two main sections. The first section examines developments relating to measurement factors and theory pertinent to a variance shift on the split ex-date. The second section examines developments relating to the liquidity shifts and the theoretical ties between liquidity and variance. After a brief summary, The hypotheses to be tested are stated formally. The statement of the hypotheses completes the chapter.

Returns' Variance Reaction to Stock Splits

Early Excess Returns and Variance Findings

Fama, Fisher, Jensen, & Roll (1969), (FFJR), resolved the seeming incongruity of earlier work that found increased returns accompanied stock splits in a market that is efficient with respect to information. FFJR concluded that the split serves as a signal of improved earnings, but of itself has no value. They found that stock splits tend to occur during strong markets when earnings have improved and are expected to remain strong. Virtually all stock split proposals lead to announcements that are almost always followed by splits. Increased dividend payout follows stock splits in 72 percent of splits.[4] Use of a stock split reinforces the expectation of improved performance. And, while prices rise before the split, price rise after the split is not more rapid, in fact, the returns resume the pre-split relationship to the market.

Rapid price adjustment occurs following both the announcement and the actual split, so the market is semi-strong efficient with respect to information. Unlike FFJR, Chottiner & Young (1971) found price does not fully adjust on the ex-date for stock distributions, except those in the 4 percent to 24 percent range. FFJR did find serial correlation in the monthly returns preceeding the split, though not afterward.

FFJR introduced residual analysis methodology, generating residuals with a double-log "market" capital asset pricing model (CAPM). The systematic risk coefficient, β , used in the return estimation was estimated from a sixty month period on both sides of the split with the fifteen months preceeding the split eliminated and fifteen months subsequent to the split eliminated when dividend decreases occurred.

Mandelbrot (1963) and Fama (1965) examined the distribution of excess returns. They rejected a normal distribution as describing the returns' distribution. A stable Paretian distribution was suggested as a better description of the returns' distribution. Indications of infinite variance made the stable Paretian assumption superior to the normality assumption.

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[4] Barker (1956) found benefits from splits were accrued to stockholders in cases where subsequent dividend increase occurred.

This challenge to the assumption of a normal distribution caused FFJR to measure dispersion of the excess returns with mean absolute deviation (MAD) rather than variance. A scatter diagram of the MAD of the excess returns or residuals indicated an increase just prior to the split that was sustained five years beyond the split. The increase in the MAD was approximately 30 percent and was left unexplained. The FFJR regression methodology led others to examine the systematic risk around splits and challenge some of the FFJR results.

Subsequent stock split-market reaction research has been inconclusive. The Bar-Yosef & Brown (1977) work suggests the FFJR residuals are questionable because of a bias in the systematic risk coefficient and so the dispersion seen around the split. Contrary to FFJR's assumptions, Bar-Yosef & Brown found β to be unstable around the split. β increases during the period fifty to twelve months prior to the split. While β is always less that one, it is larger before the split: "firms which split their shares after experiencing temporarily high earnings reduce investor uncertainty regarding earnings maintenance and future cash dividends." This is expected if firms using splits are entering a period of improved earnings, with returns less correlated to minor fluctuations in the general market. Bar-Yosef & Brown also found that systematic risk is higher in bull markets than in bear markets. Any excess returns seen prior to the split are, then, compensation for stockholders exposure to higher systematic risk.

Expressing beta as $\frac{\rho_{im}\sigma_i}{\sigma_m}$, where ρ_{im} is the coefficient of the linear correlation between the firm returns and market returns, σ_i is the standard deviation of the firm's returns, and σ_m is the standard deviation of the market's returns, it appears that the firm's returns' standard deviation increases one year *prior* to the split then declines and/or the firm's correlation with the market rises then declines through the split. From FFJR, the correlation coefficient is expected to be relatively high. Thus, for β to decline through the split, the firm's returns' variance must plummet (or the market's returns' standard deviation rises, which is unlikely.) But this conclusion is contrary to the MAD findings of FFJR, especially because FFJR note that returns are more in line or more highly correlated with the market return after the split.

Charest (1978) argued that using returns data from both sides of the split to estimate β is not appropriate. A two-step regression, employing an empirical model form of CAPM demonstrated: (1) that residuals are highly sensitive to the risk measure used, (2) residuals are highly sensitive to the time period studied, (3) the systematic risk measure, β , is moving or changing with time, (4) apparently complete price adjustment to split proposals takes place over at least several days if at all, and (5) β increases after splits, contrary to the Bar-Yosef & Brown findings. Charest's support of the FFJR excess return findings came from non-symetrical estimation of β. The results are inconclusive.

Hausman, West, & Largay (1971) used a multifactor model incorporating price-relative and industry-relative earnings, earnings changes, as well as a dummy variable for the split. Increased returns are seen for split stocks four weeks prior to the announcement. The authors suggest, therefore, that price appreciation between the announcement and the distribution date are due to industry and/or specific earnings effects, not the split. The authors argue that increased earnings are already anticipated in returns prior to the split announcement.

Indeed, generating residuals using a single factor model assumes the model's validity. The CAPM validity has been questioned by several, for example, Reinganum (1981) (though Rendleman et al (1982) challenged the results) and Roll (1979). Foster, Olsen, & Shevlen (1984) examined post-earnings announcement returns and determined that a multifactor model was appropriate and that the earnings announcement serves as a proxy for omitted variables in the single factor CAPM. Also, single-factor model parameters are biased. The residuals were generated as the difference between the firm return and the portfolio return, where the firm's size was uniform within the portfolio. Foster, Olsen, & Shevlin found residuals were a linear function of earning forecast error and firm size. FFJR did not control for firm size.

Millar & Fielitz (1973) extended the FFJR model with dividend, earnings, and industry level changes relative to the previous month's level. Stepwise regression was applied. Millar & Fielitz concurred with FFJR in that market trends do not generate excess returns. The split does not produce a price effect. The residuals' distribution is not normal. They also found that the stock distribution size does not contribute to the excess return size.

Woolridge (1983) examined stock dividend returns for signalling. If information asymetry exists between managers and investors then stock dividends may be a low-cost, low-risk signal to the market to adjust price to the true value of the firm. Furthermore, stock dividends are a less ambiguous signal than cash dividends. A comparison return period was used rather than a market form CAPM and all sample firms had no dividend payout. Woolridge concluded that the size of the distribution was a key factor in the return size for dividends. Recall that stock dividends cause a transfer of the market value from retained earnings to equity. In addition, stock dividends serve as a less risky signal to the market than publishing earnings expectations, but stock splits do not.

Grinblatt, Masulis, & Titman (1984), (GMT), examined excess returns around stock distribution announcement dates and ex-dates. Their methodology differs in several ways from FFJR. GMT controlled for degree and type of contaminating news; also categories were included for split factor, exchange listing, post-split dividend policy, and distribution size. Residuals were generated from a benchmark return based on a post-split return average, post-split dividend policy information at the time of the split was controlled for, and a regression analysis was done for the announcement period return upon various firm characteristics.

Various signalling hypotheses were considered. The *retained earnings hypothesis* states that stock dividends cause transfers from retained earnings which may make bond covenants binding if future earnings fall short. Therefore only management that is confident of adequate or improved earnings would risk using a stock dividend. The hypothesis makes no statement about the use of splits because no transfer is made to retained earnings. So the hypothesis does not explain why splits would be used over expected earnings announcements.

The *reputation hypothesis* states that there are indirect costs to false signalling with any stock distribution that affect the firm's reputation and future use of signalling. The indirect costs may not be empirically measurable. This hypothesis concurs with Ross (1977), that only firms that expect higher earnings can afford to use the distribution signal.

The *trading range hypothesis* states, as many managers believe, that an optimal price level exists for a stock. Use of a stock distribution to signal better earnings and improved value, when in fact the signal is fake, would cause the post-split stock price to slip below the optimal price range. This hypothesis also complements the Ross signalling explanation.

Finally, the *attention hypothesis* states that the market is inefficient in that some firms are undervalued and use of an announcement and a split or dividend brings attention of the market, especially the attention of analysts, to the firm and the value estimate is raised and therefore we see excess returns.

GMT found no clustering of splits on any particular day. Knowledge of the post-distribution dividend policy does not affect excess returns. So stock distributions are not solely reinforcing anticipations of dividend increases. (Perhaps, though, stockholders expect a long term increased payout regardless of the short term, known dividend policy.)

The regression results show split announcement returns are a function of post-split β and residual variance, pre-split price increase and market value and any pre-split dividend policy change. Stock dividends announcement period returns are a function of only price changes prior to the announcement. Including post-event levels as explanatory variables is questionable. The market value factor does support the need for a firm size variable or control.

GMT rejected ex-date abnormal returns around stock distributions as the result of coincidental cash dividend ex-dates, nor were abnormal returns caused by a confirmation effect since well over 95 percent of announced distributions occur. GMT also rejected the possibility that actual distributions of stock did not take place, as 95 percent of announcements result in stock distributions.

GMT found excess returns are higher for stock dividends so the retained earnings hypothesis is supported. Dravid (1987) concluded that the retained earnings hypothesis was supported, after finding lower volatility after the the ex-date for stock dividends. It appears signalling is occurring, though increased payout is not a consideration of the market as it generates increased returns. Since the price change prior to the announcement/ex-dates appears significant, the market's attention is apparently is adequate.

While the positive residuals prior to the stock split announcement and ex-date received much attention, the increase in the MAD noted by FFJR was not addressed until Ohlson & Penman. Questioning the residuals' generation of FFJR also questions the validity of the MAD increase. Ohlson & Penman sought to explain the instantaneous and permanent returns' variance increase of about 63 percent that occurred on the ex-date. This increase was seen in over 83 percent of their sample. They examined returns' variance directly without residual generation. Unlike FFJR, Ohlson & Penman reported an instantaneous rather than a gradual increase in the pre-split returns' variance. Daily data was used in a series of pre-split vs. post-split variance level nonparametric comparisons.

Using daily, weekly, and monthly returns, Ohlson & Penman were unable to provide a rational explanation for the volatility increase. Systematic factors included the study time period and market variance level. Firm specific factors included the size of the distribution[5], the post-split price level[6], news content prior to the split, dividend policy and payment around the split, length of time between announcement and ex-date, pre-split variance levels, post-split firm information, changes in the mean return after the split, and changes in the price change structure, particularly the number of zero returns and the effect of the 1/8 discrete price change limit. Even market folklore that investors respond to absolute price change and overreact to information concerning low price stocks fails to explain the sustained returns' volatility increases unless all low-priced stocks show higher variance in return.

The examination of returns and the returns' volatility shift at or around the ex-date can also be examined through option pricing. Reilly & Gustavson (1985) applied a matched-sample methodology to examine option prices around split announcements. They found that in-the-money options for split stocks maintained a relative difference over the non-split stocks from the day before the announcement onward. Out-of-the-money split stock options maintained an advantage after the announcement.

From the Black-Scholes option pricing model, an option's price increases with increases in underlying stock price, volatility in the stock price, time to maturity of the option, and an increase in the risk-free rate, ceteris paribus. The first two factors are applicable to the Reilly & Gustavson work. Unfortunately, it is unclear what is occur-

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[5] Choi & Strong (1983) found premiums are paid for when-issued shares when the distribution is likely to create odd lots, such as a 5-for-3 distribution.

[6] Choi & Strong also found premiums on when-issued shares for lower priced stocks.

ring at the ex-date or if an increase in volatility is great enough to offset the fall in price, considering the adjustment of the option contract across the split.

French & Dubofsky (1986) restricted their study to close-to-the-money options for stocks which split, using a modified Black-Scholes model to generate weighted implied standard deviations (WISD). They found no volatility shift around the announcement date and concluded that the volatility shift at the split carried no information effect. An increase of 10 percent in the WISD at the split was found, which is much smaller than that reported by Ohlson & Penman or the MAD increase of FFJR. The listed option sample, however, may represent a selection bias since firms for which option trading occurs are larger, less volatile than the average of those used in the FFJR and Ohlson & Penman samples. At any rate, confirmation of the increased volatility is reported, though the increase may not be significant.

Dravid applied Ohlson & Penman's methodology and also used an F-test to validate the binomial test results. Controlling for contaminating information and emphasizing the examination of reverse splits, Dravid concurred with Ohlson & Penman's original findings. Reverse splits evidence decreased volatility following the split and negative excess returns. A problem with many zero returns due to the 1/8 discrete price change limit for stocks with very low prices ($1.00-2.00) is noted by Dravid. There is evidence of the sudden and sustained increase in returns' variance at the ex-date of stock splits.

So while a variance shift is found, the significance and timing is uncertain. Price level and the discrete price change limit are expected to affect the shift magnitude to some extent.

Returns' Distribution

Historical Development

Though FFJR generated residuals using a linear regression model, they did not find a normal distribution for returns. The non-normal distribution was their justification for using MAD to measure the dispersion of residuals rather than using the variance mearsure. FFJR also reported that positive serial correlation existed prior to the split. Ohlson & Penman, however, used variance and a variance proxy to examine the increased dispersion phenomenon at and following the split.

The non-normal return distribution was originally suggested by Mandelbrot (1963) and supported by Fama (1965). A stable, Paretian distribution was suggested from the leptokurtosis, high long tails, infinite variance, and serial correlation. The statistically convenient assumption of normality was not supported.

Garbade & Lieber (1972) found that while transactions are independent in time and the side of the market they enter on (bid or ask), there is a tendency for clustering of orders to occur in short time intervals of less than five minutes on a particular side of the market. They also found that since there are discrete price movements in multiples of .125, the equilibrium price will not be statistically independent from the random component of the actual transaction price. Thus, the distribution of price will not be strictly normal. In the case of the split, the price run-up prior to the announcement and split, should exhibit positive serial correlation for even larger periods. Indeed, FFJR report serial correlation in even monthly return data.

Clark (1973) presented an alternative model to the stable Paretian distribution of the price change process. Clark also considered that a price series evolves at different rates for identical periods of time. The inconstant price evolution occurs because new information arrives randomly in the market. The number of price changes during the day, for instance, is therefore variable. With little new information, trading is slow and trading volume low, expectations about future price and return change slowly and the price change process evolves slowly.

Clark used trading volume as a proxy for the speed of evolution. Grouping by trading volume reduced sample kurtosis greatly. Clark suggests that trading volume directs the distribution of price changes which is subordinate to the distribution of individual price changes. That is, several finite variances occur for several respective subgroups of normal distributions. So the distribution of price changes and returns is a collection of normal distributions with individual information and trading volume levels rather than an overall stable Paretian.

Hsu, Miller, & Wichern (1974) empirically tested the stable Paretian behavior of prices. They found that Student-t distributions more accurately describe prices. The Student-t distribution, however, assumes independency in rates-of-return series, which is contrary to the evidence, especially prior to the split. A symetric, stable distribution was not supported; in fact, heavy tails and low leptokurtosis were reported. The dispersion and tailedness parameters are not stable over time. Hsu et al. considered post-World War II monthly rates approximate a normal probability distribution though. Finally, while the entire period of study evidenced infinite variance, subperiods exhibit finite variance.

Carey & Sherr (1974) examined transaction data for market and price level effects in price changes. They held that price changes follow a first order Markov process, i.e. ΔP_t is solely dependent on ΔP_{t-1}, not ΔP_{t-n}. They found that price changes are not independent and that transaction data price changes are dependent upon price levels and so cross-sectional studies should not combine stocks without regard to price level.

Finally, stock price changes behave differently in different markets, though this wasn't found to effect variance change by Ohlson & Penman.

Epps & Epps (1976) produced support for Clark's returns distribution theory of finite variance with a mixture of normal distributions. Variance is conditional and a function of the volume on the transactions. Price changes result from excess demand or supply brought about by new information. Unfortunately, heteroskedasticity and strong reliance on a normality assumption put their results into question.

Oldfield, Rogalski, & Jarrow (1977) and Oldfield & Rogalski (1980) theorized that stock returns were generated by at least two autoregressive jump processes. One process occurred during trading hours and one during non-trading periods such as overnight, weekends, and holidays. They assumed returns were statistically identical and independent for periods longer than one trading day.

Using opening and closing prices, Oldfield & Rogalski showed that returns variance change is dependent on the interval. They reported no significant differences in the distribution of returns by the day of the week on which the returns were generated. Overnight returns are identically distributed. Trading period returns appeared to be largely independent of the previous non-trading period returns. A diffusion variance was not found. The time intervals of transactions follow a gamma distribution. Weekly and monthly returns show basically a normal distribution. Finally, a multiple component jump process is supported for generating returns for an arbitrary time interval.

Fienstone (1979) compared a compound, Poisson-normal (CPM) or jump process[7] to the stochastic Wiener (continuous trading) process. While certain markets (e.g. Deutschemarks) did not appear to have returns generated by the CPM process, generally

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[7] Garman (1976) also assumed the price change process was Poisson-normal.

Fienstone found support for the returns coming from normal distributions from the periods generating them.

The dispersion shift results are reliable, though the normality assumption in the very short term (intraday) is questioned by the presence of strong positive serial correlation before splits and negative correlation in non-event periods.

Serial Correlation

FFJR did not find serial correlation after the split. Ohlson & Penman found only more zero returns after the split. Fama (1965) found slight negative serial correlation in regular, non-event returns. Niederhoffer (1965) found that, generally, the congestion of limit orders, especially at noon and the close and specialists' reluctance to trade on their own accounts bias higher priced issues to trade at intergers. That is, there is stickiness of price at intergers. In non-event trading, reversals are expected because as specialists observe a price run-up to 7/8 with the buy-limit orders being cleaned out leaving only sell-limit orders at 1, they may sell short, driving the price down. Niederhoffer & Osborne (1966) noted also that buy and sell orders show preference for intergers, with diminishing preference for the smaller price-change fractions. However, 85 percent to 95 percent of price changes average less than 1/4 point from the preceeding transaction in non-event returns. They also found that large price changes follow large price changes, reversals outnumber continuations, and there are second-order effects when zero returns occur. Finally, 60 percent of orders are at-market orders.

In addition, the bid-ask effect in closing prices produces negative first-order serial correlation in price changes. The bid-ask effect in closing prices occurs when the final transaction of the day is a market order from one side of the market. It may be matched with a limit order or bought for the specialist's account. The transaction price probably does not equal the price that would have occurred if the market order had crossed with another market order on the floor during more active trading periods.

Osborne (1962) reported that periodic behavior in volume and structure of price might not always show up in Fourier or correlation analysis for a sample stock. Osborne also found that most transactions were in one or two round-lots and that low price stocks show different dispersion than high priced stocks. He predicted that variance should be larger for stocks with larger trading volumes. This is contrary to Cohen, Maier, et al. who showed that thinness of trading, expected with smaller firms, contributed to increased variance.

Simmons (1971) also found little evidence for random walk. Negative serial correlation is expected until market orders exhaust the supply of limit orders at a boundary. Zero price changes means a large supply of limit orders on one side of the market. Simmons found zero price changes and large price changes are persistent. Amihud & Mendelson (1982) point out that positive serial correlation or a series of like signed price changes are expected when the market maker adjusts inventory to the expected optimal level.

Grier & Albin (1973) found price change reversals are three times as frequent as continuations in the general auction market. Working with block trades, they found that the market reacts differently to a block of shares (large volume) than the same volume in several small lots. Block trades may cause negative serial correlation (Epps (1979).) Wood, McInish, & Ord (1985) reported nonstationarity in serial correlation in intraday returns, with significant autocorrelation occuring generally within the first thirty minutes.

Distribution-Summary

While returns may generally be assumed to display normal distributions in certain intervals, slight negative serial correlation is generally found, though in the case of an event like a stock split, there appears to be positive serial correlation preceeding the ex-date. Changes in the distribution of price changes may provide a window to the type of trading that is occurring, such as increased use of limit orders.

Returns' Variance

In 1976, Cohen, Ness, Okuda, Schwartz, & Whitcomb examined the role of thinness-of-trading in explaining cross-sectional differences in returns' variance. They defined thinness as a low number of non-insider outstanding shares (floating supply) or as a relatively low price per share. (This price measure of thinness would suggest a liquidity decline due to a split because the price becomes absolutely and relatively lower.) They argued that if thinness is undesirable then the returns' variance should be high. Other factors include, of course, business and financial risk and fundamental determinants of share price. Cohen, Ness, et al. created the security's turnover ratio, (volume traded divided by floating supply,) as a proxy for new information receipt. They note that demand shifts occur for either informational shifts or from random tenders.

From their model, informational demand shifts will produce variance negatively related to thinness measure, assuming trades don't occur concurrently with informational demand shifts. As will be discussed later, thinness of trading (liquidity) may be declining, at or around the split. The demand prior to the split may be due to information shifts, though a concensus at the announcement date is expected; therefore subsequent demand would tend to be of the random tender nature. At any rate, the thinness measure explained 68 percent of variance in the Cohen, Ness et al. work.

Cohen, Maier, Schwartz, & Whitcomb (1978) went on to show that while aggregate shifts in demand brought about by new information necessitate a new quotation price, only idiosyncratic or individual (random) demand shifts necessarily cause new transaction prices. Through their model development, the authors show that (1) the expected return is independent of the size of the market (which would fall short of explaining the small firm effect), (2) while transaction costs decrease, expected returns and returns' variance increase, and (3) with heterogeneous expectations, variance will be affected by market value.

This suggests that a firm size effect should be seen in the cross-sectional comparisons of variance increases and that more trades, though perhaps smaller in size, would be seen after the split, as holders of heterogeneous expectations form the trading market.

Kon (1984) further tested the validity of a discrete mixture of normal distributions as the process describing stock returns. Two types of parametric shifts occur in the model. The first is time-ordered, caused by capital structure changes, acquisitions, stock splits, or market events. Cyclical shifts arise from day-of-the-week effects, cyclical announcements of earnings and dividends. (As will be shown, a high percentage of splits are surrounded within thirty days of some cyclical announcement.) Kon reports nonstationarity in the variances. And changes in the returns' variance may be due to changes in systematic risk (β), market variance, changes in the residuals, or combinations of the three.

Variables impacting on price change were discussed by Schreiber & Schwartz (1986). They concluded that equilibrium prices were not achieved as quickly for thinner issues. FFJR reported rapid price adjustment for stocks that split. Indeed, many firms represented from the major stock exchanges would be considered in relatively very liquid (not thin) markets. This does not, however, explain any sustained differentials. The variables were: information change, liquidty (idiosyncratic) trading, and market mechanics of the bid-ask spread, a thin limit order book and a sticky limit order book. They suggest that the process of attaining the equilibrium price results in short term serial correlation, short term increased variance and biased betas.

Christie (1982) found evidence for a financial leverage impact on equity volatility, also that the interest rate level positively impacts on equity volatility. Volatility may not be constant, however, because of fixed cost and asset mix. In the context of Christies' model, returns volatility increases with the decrease of debt. In the context of pecking order theory, the split signals improved earnings and an increase in internal cash or slack and the decreased use of debt, which is the next preferred financial source. This counters, though, the managers' claims that splits improved the ability to raise funds through future equity offerings. Christie's work supports the retained earnings hypothesis.

The attention hypothesis would be congruent with increased noise. Goldman & Besa (1979) note that in the short run returns' variance is dominated by noise[8] rather than fluctuations in underlying asset value. (Noise related to the split would be expected to appear at the earlier announcement date.) Conversely, returns' variance is dominated in the long run by fluctuations in the underlying value. FFJR and Ohlson & Penman showed sustained increase, though biases may exist. Indeed, the character of the variance increase may change.

Shiller (1981) reported that, generally, price volatility far exceeded payout volatility. He suggested stock prices respond to changes in the expected real interest rates and the markets are justified in expecting larger variances. Ohlson & Penman found no system-

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[8] Amihud & Mendelson (1986) point out in their working paper that noise is due to transitory liquidity demand change.

atic involvement, however, in the post-split volatility increase. Ohlson & Penman did, however, resort to referring to market overreaction.

DeBondt (1985) and DeBondt & Thaler (1985) found long-term overreaction to unexpected, dramatic new information. The reported overreaction was greater for "loser" portfolios than for "winners." The overreaction was relatively long-termed, lasting two to three years. The reaction period was not as long, however, as the sustained period observed by FFJR. Additionally, stocks that split shoud be considered "winners" and the increase in earnings and dividends may be anticipated.

For shorter periods of time, French & Roll (1985) also found mispricing. Three explanations for returns' variance increase during trading hours were examined. First, more information may arrive during trading hours. Second, private information and the informed investor trading during the day affect the market strongly. Finally, trading in itself induces volatility. They found that 4 percent to 12 percent of the returns' variance is due to mispricing with the bulk of the returns' variance due to information effects. They rejected the first explanation. Negative serial correlation persists so that trading noise may take at least two weeks to disipate, though significant reduction is seen in the long term. This conflicts with the DeBondt and DeBondt & Thaler findings.

French & Roll also did not find firm size a significant variable, though Hillmer & Yu (1979) found that speed of price adjustment to new information does depend on firm size. Patell & Wolfson (1984) examined intraday speed of price adjustment to earnings and dividend announcements. Building upon Hillmer & Yu, they find variance increases that are persistent for several hours, with adjustment activity beginning sixty to ninety minutes before announcements. Large increases in variance are reported up to four hours following the announcement. Serial correlation changes are also reported, with continuations surpassing reversals.

Liquidity

Variance-Liquidity Connection

The relationship between returns' variance and liquidity, specifically volume, has been described in several models. Clark developed a model of the price change in which the daily price change is a series of a random number of intraday price changes. The variance of the daily price change is therefore a random variable. The price change variance mean is proportional to the average number of daily trades. The model indicates that trading volume is positively related to the variability of the price change.

The Epps & Epps model shows intraday price change is the average in all traders' reservation prices. The more traders disagree the larger is the absolute price change. Volume is positively related to the magnitude of trader disagreement when reservation prices are revised.

As Tauchen & Pitts (1983) point out, both models are complementary. The expectation of price change is conditional upon volume. Tauchen & Pitts developed a more general model. While price change and volume are stochastically independent, there is functional dependence through the common impact of individual trader expectations. This is seen in their equations 7a-7d:

$$u_1 = E[\Delta P_i] = 0,$$

$$\sigma_1^2 = Var[\Delta P_i] = \sigma_\theta^2 + \sigma_\varphi^2/J,$$

$$u_2 = E[V_i] = (\frac{\alpha}{2})\sigma_\varphi 2/\pi((J-1)/J)J,$$

$$\sigma_2^2 = Var[V_t] = (\frac{\alpha}{2})^2\sigma_\varphi^2(1 - (\frac{2}{\pi}))J + o(J),$$

where α is a constant greater than zero, θ is a systematic component, φ represents the idiosyncratic component, and J is the number of traders.

As agreement in expectations increases, the price change variance declines, as does the variance of volume. The same effect is seen with the increase in the number of traders, but volume increases. Covariance between variance and volume will exist, however, whenever new information enters the market to cause a change in reservation prices and equilibrium.

The incorporation of the informational effect indicates that average daily volume is proportional to the average daily rate at which new information arrives, the degree of disagreement of traders about the information and finally the number of traders. A decrease in trading volume would be most observable from a decrease in the number of traders, but a decrease would also be seen as expectations were more homogeneous, which might occur in a more liquid, larger market.

Copeland examined trading behavior around stock splits through volume changes rather than returns' variance. He defined liquidity in terms of relative trading volume and relative trading transaction costs, including the spread. Copeland and Epps each developed models for volume which indicated that volume is not a function of only the number of traders but also the rate of message arrival per unit of time, the number of shares that are outstanding, transaction costs, and the percentage of traders who view information optimistically. Copeland found proportional volume declines, while proportional transaction costs, including the spread size, rise. A liquidity-variance inverse relationship is suggested by Copeland's results. He concluded that the liquidity decline is permanent. Murray with an expanded dataset failed to confirm Copeland's results.

Finally, Dravid did not find trading volume a factor in reverse splits and the subsequent variance decreases.

Copeland's liquidity research is pertinent to the examination of the variance increase phenomenon. Since the returns' variance increase corresponds, generally, with proportional volume decreases. Why the split stock should exhibit lower liquidity and how illiquidity impacts upon returns' variance is unclear.

Cohen, Maier, et al. define liquidity in terms of volume and thinness of trading and show the returns' variance can be increased by idiosyncratic orders as the market becomes thinner. Such would be the case if homogeneous expectations were held concerning the stock's value, but individuals required some liquidity or sought to capture capital gains on only a portion of their holdings in adjusting their portfolios following an increase in firm value due to actual and expected increased earnings.

Cohen, Maier et al. show that for given (1) price, (2) latent demand and (3) effective demand for shares, there is an equilibrium level of demand to hold shares. The quantity demanded will change in response to stock issues, stock dividends, and splits, which changes price, of course. The equilibrium quantity and price therefore changes. A proportional change in quantity demanded may not be seen, perhaps, because of the price elasticity of demand for the shares. The price-demand relationship requires examination through examining price changes and relative volume changes.

At any rate, two reasons for shifts in demand are cited. The first is an aggregate shift due to generally available information. The authors assume such a shift leads to changes in the limit prices but need not result in transactions, so quotes (therefore the spread) will change but not transaction price.

On the other hand idiosyncratic shift stems from individuals receiving or needing funds (liquidity), changing risk preferences, or reassessing security value. An idiosyncratic need necessarily requires a transaction and suggests a liquidity premium will be paid.

If the Cohen, Maier et al. model is valid, then return is a function of demand elasticity, the initial quantity held, and the change in the quantity held. (An equivalent function incorporated market value traded, the previous close market value, and the demand elasticity.) Cohen, Maier et al. conclude that the smaller the market value traded, the more volatile the returns, ceteris paribus.

The floating supply (shares that are held for only investment purposes and not for insider control or some other reason that would prevent the shares from being considered a strictly financial asset) along with relatively low price per share have been considered as proxies for market thinness by Cohen, Ness et al.. Also, price volatility is linked to the magnitude of the tender imbalances. As the percentage of traded shares drops, the portion of returns variance due to thinness (illiquidity) will increase. In addition, if fewer traders or fewer trades comprise the market then variance is increased.

Garbade & Silber (1979) defined two attributes of liquidity. A liquid market provdies feasible transactions on short notice at prices near the *contemporaneous* equilibrium value of the asset. Also, in a liquid market, there is a low probability of a substantial change in equilibrium values. A measure of liquidity risk therefore is the variance of the difference between equilibrium value and the transaction price. Liquidity risk is a function of the time between clearings. As the market size increases, the equilibrium price volatility decreases. Finally, liquidity risk is shown to be decreased by the activity of dealers.

Tauchen & Pitts (1983) examined distributional changes in price change and trading volume with respect to changes in the number of traders participating in the market. Concensus on information corresponds to trading volume reduction. They predicted that returns' variance should decrease with an increase in the number of traders, which is expected since greater liquidity occurs. They found that the variance of daily price change and the mean daily trading volume are functions of (1) the average daily rate at which new information flows to the market, (2) the extent of disagreement among traders and (3) the number of active traders. Therefore, as more active participants incorporate new information without concensus, variance increases. After the declaration date, investors should have homogeneous expectations about the direction if not the size of future earnings. Barker found that the number of shareholders increased so an increase in the number of traders might be expected. The increase in the number of traders may cause an increase in volume so an increase in the absolute price change. What has been reported is less trading of the firm's shares, though an increase in the absolute volume.

The Amihud & Mendelson (1986, working paper) model of returns' variance shows that fluctuations between bid-ask prices introduce noise. Thus, the greater the spread, the greater the variance. This stems from the noise component and not the liquidity demands in the short-term. Strict measure of returns' variance, Var(R_i), is a biased estimator of the variance of the value of the firm. The descrepancy between the returns' variance size and the earnings' variance size was noted as well by Shiller. The bias is due to the noise component, which is accentuated for small firms with low price. It would appear, however, that the bias would decrease as the time interval increased and the change in asset value impacted for the major part of price change.

Amihud & Mendelson (1986) used a return-spread model to predict that the expected return increases with increases in the spread. They proposed: (1) assets with larger spread are allocated to portfolios with longer expected holding periods, creating a clientele effect, and (2) observed market return is an increasing and concave piecewise-linear function of the (relative) spread. The longer the holding period, the smaller the compensation required for a given increase in the spread.

They found that firm size is not a significant factor in the expected return but is negatively correlated with the spread. The higher yields required on higher-spread stocks provide an incentive to the firm to increase the stock's liquidity and thereby reduce the firm's opportunity cost of capital. Copeland's findings suggest that the split increases the firm's opportunity cost of capital due to the decrease in liquidity, ceteris paribus. Amihud and Mendelson argue that by increasing liquidity the manager may increase the value of the firm.

Specialists' Role

The secondary market for stocks rely on dealers to insure a market is available. Specialists are expected to reduce daily variance by maintaining relatively stable prices. They buy in a price decline and sell in a price rise as a means to reduce price fluctuations. In the organized exchanges, the specialist is charged with insuring that a market exists for a specific company. In providing the market making service, the specialist is faced by three types of traders (Bagehot (1971).) First, insiders hold an advantageous position over the specialist and other market participants. Second, traders exist who incorrectly believe price adjustment hasn't been completed. Finally, there are traders motivated by liquidity needs. Since offering liquidity is a service, the specialist always profits when liqudiity is supplied.

Losses to traders holding superior information are not the only costs to specialists. Tinic (1972) discussed the cost structure for the specialist. The specialist can affect the ease of sale through the inventory maintained for a particular stock. Carrying costs are incurred. Costs of positioning a single stock are affected by price, trading volume, and institutional trading activity as well as price volatility. The entire cost structure for a specialist will further depend upon the specialist's capitalization, and cost of capital, the size of the specialist's holdings, and the degree of specialization.[9] The profit will depend upon exchange surveillance, indirect and direct competition.

Inactive stocks require larger inventories. Higher priced stocks cause higher variable costs for financing inventories. Demand for liquidity is expected to be great for institutions, though several institutions trading in a given issue may provide each other liquidity by entering orders on opposite sides of the market. Besides carrying inventory, the specialist affects liquidity supply through price, that is, the spread or charge for providing the market services. By adjusting spread and price rather than inventory, price volatility is affected.

Another cost source stems from the systematic risk. The specialist must maintain inventories in one or more issues and is unlikely to carry enough issues to provide good diversification. Tinic found that any diversification effect was overwhelmed by diseconomies of forced inventory maintenance.

Instead of inventory adjustment, the specialist can adjust the bid-ask prices to induce the entry of market participants. The specialist therefore can affect price volatility. The more the specialist uses price adjustment over inventory adjustment to maintain the market, the higher the volatility. Since specialist compensation comes from each stock's bid-ask spread, as costs increase the specialist will increase the spread and thereby increase volatility.

Copeland's results suggest specialists costs and opportunity for liquidity profits have risen. Logically, though, the absolute volume has increased. Inventory variable costs decline significantly with the fall in price. Homogeneous expectations and historical performance records of stocks using splits have reduced the probability of insiders

[9] Garman states inventory requirements on specialists are probably minute, since they are only required to hold 400 shares for each stock.

having superior information. Systematic risk appears to be reduced. The spread and volatility are expected to decline, not increase.

Bid-Ask Spread

Liquidity may be thought of as a service which has a supply and demand. It is assumed that the spread is bounded by commitments to buy and sell. Smidt (1968) suggested that the price of liquidity is the difference between the average of the bid and the ask prices (i.e. 'market price') and the actual transaction price. If no liquidity is required a limit order is placed rather than a market order. When such a limit order is finally executed it may or may not receive payment for liquidity.

If there is little demand for liquidity most orders received will be limit orders and, as Smidt suggested, the spread will be narrow. The spread is expected to narrow due to what may be called professional suppliers of liquidity. If a demand for small quantities of liquidity exists, negative serial correlation is seen in the price changes (Niederhoffer & Osborne.) These orders for immediate execution will take place at the bid or ask price. Demand for large quantities of liquidity should induce larger price moves over a longer period of time, especially since market makers' inventory alone would generally be inadequate to meet large liquidity demands. The spread increases. Normally, negative serial correlation is still expected, though with larger periods. With respect to stock splits, the question is whether a large number of shares come to market after the split but comprise a lower percentage of the firm than traded before.

Transaction costs may be used as one liquidity measure. Tinic broke transaction costs into brokerage commissions and liquidity or prompt-trading costs. Costs to the specialist are discussed above. Tinic's multiple regression model for average spread included an inverse relationship to the log of average daily trading volume ($\beta_2 = -.038307.$) Spread increases as daily average volume declines. Other significant factors included the average price, the number of institutional investors, the number of specialty stocks carried by the specialist, the frequency of trading, and the extent of other exchange competition. Price variance and the specialist's purchasing power were not significant though included. Tinic's model expects a narrower spread for stocks in the same price range with more active markets.

Tinic concluded that the price of liquidity increases with price and the level of trading that is concentrated in the New York Stock Exchange. Liquidity costs comprise one-half of the spread. Finally, price volatility is not related to the magnitude of the spread. Overall, the spread should be narrower for active, lower priced issues in active markets.

Barnea (1974) considered a two-way causation between trading volume and the size of the spread. The simultaneous equation approach was supported and the significant impact of specialists' use of the spread adjustment upon price variability was confirmed. The factors involved in the average spread size did not change.

Schwartz & Whitcomb (1976) questioned, however, Barnea's reliance on the assumption that there was no serial correlation. They claimed that positive autocorrelation existed in the short-term trading, though liquidity-motivated trading generates negative serial correlation in transaction data[10]

Benston & Hagerman (1974) also examined bid-ask spread determinants. They point out that as trading volume increases so do limit orders which decrease the specialist's need for inventory. The result, ceteris paribus, is a reduced spread. The spread is a function, then, of the number of transactions, price per share, the number of dealers,

[10] Barnes, Amir, "Reply: Specialists' Performance and Serial Dependence of the Stock Price Changes," Journal of Financial Quantitative Analysis, Dec. 1976, 909-911.

and the inventory carrying risk. Systematic risk is not included because it is compensated in the return under CAPM. The spread should, however, increase with unsystematic risk increases because of the diseconomies of maintaining inventories for liquidity demand. Benston & Hagerman reject any linear model of the spread. Also, the change in the spread size from an inverse change in the trading volume is not proportional to the changes in the number of transactions.

The split should decrease the spread, not increase it, and thereby serve to reduce the returns' variance. The expected lowered costs to specialists have been made clear. If more zero returns, as found by Ohlson & Penman, indicate more limit orders, then the spread should decrease since demand for liquidity has essentially been supplied at the limit price rather than immediately from specialist's inventory. They may, however, merely reflect the effect of lower price in conjunction with the .125 point price change limit, as noted by Dravid. Higher absolute trading volume has occurred so the increased activity should reduce the need for the specialist's intervention. So with a diminished spread, relative transaction costs should be less not more. Liquidity should be increased, contrary to Copeland's conclusion. In fact, it is surprising that Murray and Dravid found no liquidity increase rather than no change in liquidity. And if the liquidity has increased, then the variance should have decreased.

Elasticity

Cohen, Maier et al. show that for given (1) price, (2) latent demand and (3) effective demand for shares, there is an equilibrium level of demand to hold shares. That quantity demanded will change in response to stock issue, dividends, and splits, which changes price, of course. The equilibrium quantity and price therefore changes. A proportional change in quantity demanded may not be seen, perhaps, because of the price elasticity of demand for the shares. This requires examination if possible, through examining price changes and relative volume changes.

The non-proportional changes suggests that linear relationships are not expected. Benston & Hagerman examined the elasticity of spread with respect to price and reported an elasticity of .594. In other words, doubling the price brings about a 59.4 percent increase in the spread. In addition, the spread elasticity with respect to the number of stockholders was -.165, with respect to the number of dealers was -.0268, and with respect to the unsystematic risk, .137. It appears that the variance change can not be expected to show linear relationships with the liquidity measures. Too, the spread is expected to decrease following a decrease in price, increase in the number of shrareholders, and no expectation of a change in the number of dealers.

Summary

The motivation of managers has been to increase liquidity and thus perhaps firm value by splitting their firm's stock. The increase in liquidity may or may not be occuring However, there is an increase in returns' variance. The increase in the variance is perhaps related to changes in the spread size affected by the demand for liquidity and market participants activity. The activity is noted by changes in the distribution structure, noteably the serial correlation and the number and timing of transaction. The spread size in relation to the price level can induce the variance jump. Elasticities of changes in spread, price, and liquidity demand contribute to the degree of the variance change.

Statement of Hypotheses

I first reexamine the presence of the variance increase and firm-specific, systematic factors, and market microstructure changes that are expected to affect variance levels in non-event trading. Next, and more importantly, the liquidity behavior is examined and relationships predicted by returns/liquidity theory are tested.

HYPOTHESIS 1: Stock splits are not accompanied by a significant change in returns' variance.

Hypothesis 1a: Any significant change in the returns' variance is not associated with the prices used in generating returns.

Hypothesis 1b: Any significant change in the returns' variance is not associated with changes in the return mean or the influence of particular observations.

Hypothesis 1c: Any significant change in the returns' variance rapidly disappears.

Hypothesis 1d: Any significant returns' variance change subsequent to stock splits is not associated with market variance levels.

Hypothesis 1e: Any significant returns' variance change subsequent to stock splits is not associated with firm-specific characteristics.

i: Any significant returns′ variance change subsequent to stock splits is not associated to capital structure changes.

ii: Any significant returns′ variance change subsequent to stock splits is not associated with price or firm size levels.

iii: Any significant returns′ variance change subsequent to stock splits is not associated with the distribution size.

iv: Any significant returns′ variance change subsequent to stock splits is not associated with the frequency of split use by the firm.

v: Any significant returns′ variance change subsequent to stock splits is not associated with the firm′s industry coding.

vi: Any significant returns′ variance change subsequent to stock splits is not associated with the news surrounding the split.

Hypothesis 1f: Any significant returns′ variance change subsequent to stock splits is not associated with changes in behavior of the trade-by-trade price change structure.

i: Any significant returns′ variance change subsequent to stock splits is not associated with the relative effect of the discrete price change limit.

ii: Any significant returns′ variance change subsequent to stock splits is not associated with the change in the average intraday price change.

iii: Any significant returns′ variance change subsequent to stock splits is not associated with the frequency of zero returns subsequent to the split.

iv: Any significant returns′ variance change subsequent to stock splits is not associated with the timing of trades during the day.

HYPOTHESIS 2: There is no significant change is seen in the liquidity of the stock's trading around the split.

Hypothesis 2a: Any significant liquidity change subsequent to stock splits is not associated with a change in the spread.

Hypothesis 2b: Any significant liquidity change subsequent to stock splits is not associated with changes in the timing and number of trades.

Hypothesis 2c: Any significant liquidity change subsequent to stock splits is not associated with the relative trading volume subsequent to the split.

HYPOTHESIS 3: Any significant returns's variance change subsequent to stock splits is not associated with any significant changes in liquidity.

DATA AND METHODOLOGY

The extant research on returns' distribution, liquidity, the market microstructure, and stock distributions specify or suggest several variables that should be examined in an attempt to explain the reported post-split variance increase. This chapter contains a description of variables I will use, the sources for the data, and the methodologies I use to examine and explain the variance increase and test the hypotheses.

Data

Returns' variance increase is examined using three categories of data. First, a market index of returns is used to account for the general level of the economy. Second, various company-specific variables derived from each company's financial data, stock distribution characteristics, and trade-by-trade records are used as explanatory variables. Finally, returns, and trading price data for each firm are provided from daily close-to-close CRSP[11] returns and transaction-data generated daily and intraday returns and respective calculated returns' variances.

Data Description

Sample Size and Traits

Two-thousand nine-hundred and twenty-five stock distributions from the 1969-1985 period on the NYSE made up the dataset from which tests were conducted. One-thousand six-hundred and fifty six splits from the overall period were included, with eight-hundred and one splits from the period 1979 to 1984 forming a subperiod. Likewise, one-thousand two-hundred and sixty-nine stock dividends were included from the longer period, with two-hundred and eighty-one stock dividends from the subperiod. To be included throughout the tests the observation had to have at least 175 CRSP daily returns out of a total of 500 daily returns on each side of the split. To permit examination of the relatively long-term returns' variance changes, stock distributions were eliminated if total asset values were not available on COMPUSTAT or in recent Standard & Poor's Stock Record or Encyclopedia publications. Reverse splits numbered less than twenty and were not included. The size of the remaining distributions had a maximum value of a 9-for-1 split ratio. An apparent distribution-ratio bias existed for certain distribution sizes, particularly distributions of 25 percent, 100 percent, and 200 percent.

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[11] Center for Research in Security Prices

Returns and Returns' Variance Generation

All returns have been generated by adding the current price (p_{it}), adjusted for the current distribution factor (s_{it}) to the current period dividend (d_{it}) then dividing the sum by the previous period price (p_{it-1}) then subtracting one from the quotient.

$$r_{it} = \frac{(p_{it})(s_{it}) + d_{it}}{p_{it-1}} - 1$$

Intraday returns are based upon 11 am and 2 pm prices and the daily returns are based on 11 am prices. Trades may not occur exactly at these times. An accrued expected return is generated that assumes the return increases linearly for the brief period estimated. The accrued expected return is generated for the closest period to the target period. The return is adjusted to provide a 180-minute return or a 24-hour return respectively.

A full description of the dispersion measures follows in the methodology section. Three measures are used. Ohlson & Penman calculated the variance of returns for periods each side of the split with the period equal to the length of the interval between the declaration and the ex-date. This is repeated. A modification is then made with the periods being equal for all firms. Finally, MADs are calculated for the constant periods.

Retrieved Explanatory Variables

Discription and discussion of retrieved variables refer to variables with data collected directly from tapes or the WSJ Index. For additional justification, review of the previous chapter is suggested.

Variables for Variance Change Tests: Since FFJR and others found that earnings and dividends generally increased for the stocks using splits; *dividends* levels are included for the year prior to the split and the post-split period. Christie discussed the role of equity and debt on return variance, so, with *price* and the *number of shares outstanding*, *common equity* and *total debt* are included. In addition, *total assets* serves as a measure of firm size, which Foster, Olsen, & Shevlin and Cohen, Ness, et al. suggest should be controlled for in cross-sectional studies. Total assets was used as a proxy for firm size since total assets reflects more closely market value than common equity taken from the balance sheet. Total assets allows for the inclusion of debt in the capital structure. In order to examine changes and trends in the capital structure, debt and equity values are included for one year before and one year after the split and for five years after the year of the split.

Split factor, *price level* before and after the split are included, though the inclusion of price level is not supported by the Ohlson & Penman findings, but is suggested by Christie and Carey & Sherr, also Harris.

Hausman, West, & Largay reported industry effects in returns between the announcement and ex-date. SIC codes are included. Heavy use of splits by a particular industry might reflect an industry-wide policy of cash conservation such as a high growth industry. A correlation might be seen between split use and capital structure for a given industry. A visual examination of the frequency of each SIC code represented in the dataset shows a contribution range of .04 percent to 3.7 percent, with 90.4 percent of the number of SIC codes represented each contributing .5 percent or less of the dataset.

Some firms had more than one split within the sample. The effect of the frequency that a firm splits its stock upon the variance change has not been published. It may be that the variance increase diminishes for subsequent splits. The historical performance of the firm following previous splits may provide information that reduces uncertainty about future post-split performance and payout. The datasets do not insure that the first split in the dataset is that firm's first stock split. The splits are, however, sequentially numbered within each dataset.

Grinblatt, Masulis, & Titman, among others, controlled for contaminating news impact on returns around the ex-date. Prior work used a two day, three day, one week, or two week news-free period each side of the split. The large dataset provided the possibility of finding observations without news within thirtys of the ex-date.

Eight categories of news items were identified before and after the ex-date: official earnings reports, earnings changes, official cash dividend declaration or distribution announcements, news of changes in sales, court decisions(for or against), labor strikes or settlements, mergers and acquisitions, disbursements and takeover attempts, and "other".

The "other" catagory contains such events as SEC filings for new stock or debt issues, industry news where the firm was mentioned, analysts' reports, company-issued earnings estimates, oil and gas discoveries, etc. Promotion, retirement, and hiring announcements were not included.

The event categories have limitations. First, Grinblatt, Masulis, & Titman found the WSJ Index incorrectly showed no news items 10 percent of the time. Second, it is impossible to judge the impact certain news items actually had on the price and return of the stock. The settlement of a prolonged court case may have been discounted in the price months or years before the date of settlement publication. Obviously, the WSJ is not the only source of information and trade publications may contain events not covered by the WSJ. Also, the coding is qualitative, not quantitative; code values do not reflect the number or importance of news items in a given category. They serve as only crude indicators of new information and sources of trading noise.

Variables For Liquidity Change Tests: *Trading volume* and *time-of-the-trade* are the basis for the liquidity examination. *Number-of-trades per day, price changes between trades,* and *daily average time-between-trades* are implicit in the transaction data and serve as additional measures of liquidity. Time of the final trade is included as is the ratio of the price change limit (.125) to the price. Additional derived variables are discussed below. A pre-split and post-split daily average for each variable is generated using the seventy-five days of data each side of the ex-date. The difference is then calculated.

Barker reported a 30 percent increase in the *number of stockholders* after the split. Managers have considered this increase as motivation for splitting the stock. The level of this variable is included for before and after the split and provides a proxy for the stock's thinness of market.

Generation of Additional Variables

Relative Adjustments

Standardization across firm size is required of some variables. For instance, the absolute change in the number of stockholders for General Dynamics and Augat, Inc. are not comparable, whereas the percentage change is. Percentage changes are produced for the number of stockholders, trading volume changes, debt/equity changes, and trade-by-trade price changes. The average daily trading volume is divided by the number of outstanding shares (in millions) to derive the percentage of the firm traded daily.

Spread Estimation

Crucial to the liquidity change question is the behavior of the spread. The actual bid-ask spread is not available for the trades of the many stocks in the sample. Grinblatt, Masulis, & Titman used 2(*Price*)(*daily return*) as their spread estimator.[12] An alternative measure is used to better reflect price change behavior of all trades. An average is taken of the price changes between reversals throughout the day. For example, suppose the price began at 10, fell to 9.625, then climbed to 9.75 , then 9.875 before falling to 9.75, The first value in the daily average calculation would be |10.0-9.625|, the second value would be |9.875-9.75| and so on. The spread is divided by the average price for the day in order to determine the spread estimator as a percentage of price. This spread-to-price ratio serves to control for price level.

[12] Smidt (1979) used "the smallest absolute price change such that 75 percent of the opposite direction price movements (were) less than or equal to that price change." Roll (1984) developed a spread estimator based on the assumption of informationally efficient markets and the stationary probability distribution of price changes.

$\%spread = 2\sqrt[2]{-(1^{st})\ \textit{order serial Cov}(\Delta P)}$ Intraday and intraday data often evidence strong positive serial correlation and so Roll's estimator is not appropriate here, especially considering the excess returns increase prior to the ex-date.

Amihud & Mendelson (1986) presented a spread estimate with respect to variance: spread = $\frac{(\sigma_i^2) - .000279}{.000986}$.

Liquidity Index

The liquidity index is used to consolidate the various individual liquidity measures. The primary reason for consolidation is the avoidance of expected multicollinearity when examining the variance-liquidity relationship. The components are daily average percentage spread, average number of trades per day, average time between trades per day, and percentage of daily trading volume to number of outstanding shares. Since no liquidity index has appeared in the literature, the formation is subjective.

Liquidity is improved as the spread decreases, the time between trades diminishes, and as the number of trades and percentage of the firm traded increases. The composition of the index is therefore the sum of (1) 1-%spread, (2) the average number of trades in the day, (3) 60/average time between trades, (4) the daily percentage of the firm traded, and (5) the percentage change in the number of shareholders from the previous year. A daily average, based on seventy-five days, is calculated for each side of the split.

Sources

The transaction price and volume data were taken from a master data bank containing over fifty-five million individual trade records for all transactions on the NYSE[13] for the period September 1, 1978 to September 1, 1985. The data have been corrected for errors by the suppliers, Francis Emory & Fitch, Inc. Each trade record contains the transaction price, trading volume, time of the trade, correction code (e.g. sale may be out of sequence), condition code (e.g. sold last, next day delivery, opening sale), and

[13] New York Stock Exchange

Stopped Stock status. Missing returns have been given a missing value (.) but have also been converted to zero in a separate dataset. A missing value will bias the variance extimate from the true variance, but the bias direction is unknown. Substitution of zero for missing returns will also give a bias estimate but will inflate the variance estimate value.

The stock distributions' announcement dates, ex-distribution dates (ex-dates), cash dividends, and price adjustment factors were obtained from the CRSP Daily Stock Master File for the period 1969 through 1985. CRSP Daily Stock Returns File provided the returns generated from closing prices for the period 1969 through 1985. Missing returns were treated as missing (.) and not substituted with zero.

Financial data was taken from the COMPUSTAT II Industrial and Research Tapes. Financial data was also collected from Standard & Poor's Stock Record and Standard & Poor's Stock Market Encyclopedia. The *Wall Street Journal Index* (WSJ Index) was used to confirm or correct certain split announcement and ex-dates. It was also used to screen for various contaminating news items reported within thirty days either side of the split ex-date. Finally, the market return index was obtained from the CRSP Daily Stock Index, NYSE.

Transaction Data Importance

The trade-by-trade or transaction data is important for because the number of trades per day, time between trades, and the trading volume are derived from it. Market microstructure, price change, and spread behavior examinations rely on the individual trade observations. Finally, the CRSP returns rely on daily closing prices. Closing prices may not be representative of general trading prices and distributions. Blume &

Stambaugh (1983) examined the upward bias that closing prices cause in stock returns. They found that the average firm size effect is twice as large when closing prices are used. Returns using prices other than closing or opening prices can be generated with transaction data.

The behavior of opening and closing prices has generally been found to be non-representative of general intraday trading, though Garbade & Sekaran (1981) found opening prices representative of trading prices throughout the day, with opening trades generally are associated with larger trading volumes. Smirlock & Starks disagree. They report a Monday opening effect, a noon-trading effect, and opening price behavior that differs from trading price behavior later in the day. McInish & Wood (1985) also found a Monday opening effect as well as a Monday overnight returns' variance that differ from other weekday overnight returns' variances.

Harris (1985) found negative Monday returns over the weekend and a firm size effect in the timing of the negative returns. The negative Monday effect was only found within the first forty-five minutes of trading, though. He reports abnormal prices at opening and closing of trading and between 12:30 and 1:30 pm also 2:30 and 3:15 pm.

Wood, McInish, & Ord (1985) show that significant abnormal trading behavior with high returns' standard deviations occur in the opening and closing transactions for the first and last half hour, respectively. Harris (1986) confirmed this. Harris also reported the clustering of larger price changes at the end of the day. In conclusion, returns generated from trades bracketed between the opening and closing periods may show a different variance response to splits and so need to be examined.

Methodology

The extant literature makes clear three basic data considerations. The first consideration is the returns' distribution. If the returns' distribution can be assumed normal then variance is the appropriate measure of dispersion. Several points are used to justify this assumption. In addition to the work already cited justifying the assumption that the returns have an approximately the normal distribution, the work of Clark, of Epps & Epps, and of Hsu indicate that the normality assumption becomes more valid with control of the firm size, and the study period length. A dispersion measure not dependent on the assumption is also used, however.

The second issue concerns the question of the nonstationarity of distribution mean, variance, and systematic risk. The methodology for examining mean, variance, and systematic changes will be discussed shortly.

Finally, the previous research suggested that the returns' variance response for stock dividends is different from that of stock splits. The two events may be fundamentally different. Therefore, the variance change around the ex-date for stock dividends and stock splits is measured and examined.
examined separately.

Major Hypothesis 1 Statistical Tests

I initially examine the existence of a variance change. The basic null and alternative hypothese are:

$$Var\left[\dot{R}_2\right] - Var\left[\dot{R}_1\right] = 0\ (Null)$$

$$Var\left[\dot{R}_2\right] - Var\left[\dot{R}_1\right] \neq 0\ (Alternative.)$$

The subscript 2 indicates the post-split period, while subscript 1 indicates the pre-split period. It is assumed that the split ex-date is the valid demarcation of any variance shift. The assumption is examined separately. Implicit in the variance shift examination is the possibility that the returns' distribution is not necessarily stationary. The two periods are of the same length.

Following Ohlson & Penman, an assumption of a stochastic variance leads to a more general hypothesis in terms of an expected (average) difference in the random variances for the two periods. Since the squared mean of daily returns are approximately .1 percent of the expected squared returns, Ohlson & Penman approximated the daily variance by: $E\left[\dot{R}_k^2\right]$, and the null hypothesis then is restated as: $E\left[\dot{R}_2^2\right] - E\left[\dot{R}_1^2\right] = 0$. The second moment is a proxy for variance. As Ohlson & Penman point out, should the mean returns in the periods each side of the split be equal, then the above simplification is no longer an approximation but rather the actual test.

The matching procedure used by Ohlson & Penman compared the daily second moments of each consecutive day following the *declaration* date to the respective, first same day of the week, following the split. For example, if the first day following the declaration date was a Monday, the variance measure for that day would be compared to the variance measure of the first Monday following the split to control for possible day-of-the-week effects in the daily comparisons. The differences in variance for all the comparisons, across all the firms were pooled to obtain the binomial probability statistic. This methodology produces a different comparison period for each firm according to the declaration to the ex-date interval. The exhibition of an instantaneous variance jump at the split is not strictly shown.

Ohlson & Penman also used a binomial probability comparison of $\bar{\sigma}^2_{ik}$ for periods each side of the split. The period length was equal to the time between the declaration date and the ex-date. Their results were the same as the second moment comparisons. The second methodology better indicates the instantaneous jump in variance, but it is limited. The findings are reported for a complete cross-sectional sample, without firm size control. Findings of sustained variance increase are based upon only those firms that had extremely long declaration to ex-date interims. The slight decrease in the variance farther out from the ex-date may simply reflect more information coming to the market during the interim.

The binomial probability test does not rely on a particular distribution. Under the null hypothesis the variance estimator after the split should be larger than the variance estimator before the split in one half of the the observations, i.e. the probability is one half or, $Pr\{\bar{\sigma}^2_2 > \bar{\sigma}^2_1\} = .5$. The alternative hypothesis is that the probability does not equal .5, given the alternative hypothesis of unequal variance.

Finally, there may be an induced bias of counting all the squared daily returns for the interval mentioned. If the interval length is longer for splits with abnormally high variance shifts, then more observations from these firms will bias the probability ratio upward.

To avoid the potential measurement problems in Ohlson & Penman's methodology, the dispersion of returns before and after the ex-date is measured in three ways. First, I repeat Ohlson & Penman's second variance measure using actual variance estimation. A binomial probability comparison is done on the variances for periods of the interim length on each side of the split. I do this to test for replication of Ohlson & Penman's variance increase in the larger sample and to examine any changes in the result when firm size controls are included. Firm size is controlled by dividing the dataset into quintiles based upon total assets.

A modification is then made for the second test of the null hypothesis. Instead of using varying interval periods with observations dropping out in longer periods, constant sample variance measurement periods are used. These periods are 25, 75, 200, and 300 trading days long. Unlike Ohlson & Penman, this methodology includes pre-declaration days exhibiting excess returns, besides the majority of non-event days. This provides a more conservative test of any dispersion change since excess return days will inflate the pre-split variance slightly and also provides longer comparison periods to firms with short interim periods.

The use of the constant sampling period reduces the impact of individual firms exhibiting higher variances for non-systematic reasons, especially within the longer interval periods. Also, the maintenance of the variance increase as a general phenomenon is better tested by maintaining the same sample size.

Finally, a benchmark measure of dispersion is used which did not depend on a normality assumption. First the mean return is generated from the returns for the 200-day periods plus and minus three hundred to five hundred days from the ex-date. The absolute deviation is then generated for each day in the sample period. The mean absolute deviation for each firm for each test period around the split is calculated. Under the null hypothesis $\Pr\{MAD_2 > MAD_1\} = .5$. The test periods include (1) the varying interval lengths and (2) the 25, 75, 200, and 300-day periods from the previous methodologies.

Though GMT found no clustering of splits on any particular day of the week, within the dataset the proportion of split ex-dates falling on Monday is 32 percent with Tuesday accounting for another 25.1 percent. The proportions are similar for the overall dataset including stock dividends and reverse. Despite GMT's finding, there is a decided preference for ex-dates to fall on the first two trading days of the week. The large cross-sectional sample used here should eliminate any day-of-the-week effect. This is especially true as the matches are not made with respect to the announcement date, which Ohlson & Penman did. Also, by calculating a variance over time I further eliminate the day-of-the-week effect and provide a more conservative test as a period daily mean variance is used rather than the daily returns' second moment.

In addition to the binomial probability test, the cross-sectional mean of the variance change across the split is calculated for each test and subsample. The 2-sided T-test is used to test the null hypothesis, $H_0: \overline{\Delta\bar{\sigma}_i^2} = 0$. This is supported because the dataset is sufficiently large so that the central limit theorem is applicable, and while some firms may be represented more than once, the observations are considered independent. Finally, the test is on a mean being equal to zero, not comparing variances directly. The ratio $\bar{\sigma}_2^2/\bar{\sigma}_1^2$ is also calculated.

Minor Hypothesis 1a Tests

Since there is a possible bias in returns generated with closing prices, several return sources were used to run the tests for variance change. The sources are the CRSP daily returns and three-hour intraday returns and daily returns which were generated from non-opening or non-closing prices. Cost considerations were given to the manipulation of the millions of transaction observations available. Seventy-five days is considered long enough to establish a mean return that is not unduly influenced by individual event days, yet provides adequate liquidity variable averages. Therefore, analysis on the transaction data is done for the twenty-five and seventy-five day periods only.

The variance change is expected to be seen for all the returns' sources. Subsequent examination of the general Hypothesis 1 is done with the 1969-1985 CRSP Daily Returns dataset. (Previous examination included those splits with ex-dates in the 1979-1984 period in order to compare CRSP with transaction data returns.)

Minor Hypothesis 1b Tests

Ohlson & Penman reported that the return mean is stationary for the study period. A shift in the mean would affect the variance. A mean shift is therefore examined by calculating the change in the returns' mean each side of the split. The mean change in the return mean should be equal to zero under the null hypothesis. A 2-sided T-test is used to examine cross-sectional change. The testing periods are the same as those used in testing variance changes as are the datasets.

Minor Hypothesis 1c Test

Nonstationarity in certain return distribution parameters is expected and FFJR and Ohlson & Penman found sustained, though diminished, dispersion increases months after the split. Maintenance of the variance shift is specifically examined by comparing the CRSP returns' variance for the 75-day period just prior to the split and the variance for the post-split period from 225 to 300 trading days. The null hypothesis tested is: $Pr\{\bar{\sigma}^2_a > \bar{\sigma}^2_{\hat{n}}\} = .5$. The binomial probability test is used along with the 2-sided T-test.

Minor Hypothesis 1d Tests.

FFJR, GMT, and others found stock splits tend to occur during rising markets. Market variance is higher during rising markets than during declining markets. The systematic component of the firm's returns' variance can increase the variance. Ohlson & Penman did not find a systematic effect in the split variance increase. β has been found to be nonstationary during the split period.

Though not tested directly, a systematic effect would be evident in any significant discrepancies seen between the testing periods (1969-1985 vs. 1979-1984) as well as between the first two variance change measures and the last. The third variance change test uses an excess return measure that should have much of any systematic impact removed when the return mean was subtracted from the daily return. Another specific examination is included to determine systematic impact. The change in the 75-day CRSP daily return variance is regressed upon the market return variance for the quarter in which the split ex-date occurred. The correlation is also measured.

Minor Hypothesis 1e Tests.

I use a linear regression to examine the firm-specific factors uses a linear regression of the percentage change of the returns' variance upon the change in the debt-to-equity ratio, the SIC code, the change in the mean daily return the frequency of the split for the firm within the dataset, the magnitude of the split, and codings for contaminating news items around the split. Firm size is accounted for by rank in total assets. A rank of 1 is the smallest firm in the dataset. Change in dividends is also included. The percentage variance change is based on the 75 day variances each side of the split.

Minor Hypothesis 1f Tests.

The microstructure changes in price close to the split are each plotted against the percentage change in the returns' variance. Since the transaction data is used, the 1979-1984 subset is used to provide the variance change size. Distributions of these changes are examined. Finally, correlations between the variables, binomial probabilities of variable increases, and a regression of the percentage change in variance upon the independent variables are performed. The seventy-five day variance change is used. The variables for which changes are measured are: (1) the ratio of the discrete price change limit to the average daily price, (2) the daily average price change, (3) the daily variance of the price change, (4) the frequency of zero daily returns, and (5) the daily average time of the last trade. Price is initially included in the regression, along with a ranking according to the total asset size.

Major Hypothesis 2 Statistical Tests

Copeland found changes in relative trading volume based on residual analysis. His regression of trading volume upon market trading volume and a one period lag of the market and firm trading volumes produced results that are dependent upon the length of time used to calculate the coefficients. Copeland generated the residuals from a finite adjustment time series model incorporating one lag.

$$V_{jt} = -\alpha_0 + \beta_1 V_{Mt} - \beta_2 V_{Mt-1} + \beta_3 V_{jt-1} + \varepsilon_{jt}.$$

Copeland develops his model based upon information impact in the market. Specification bias exists when there is a non-zero covariance between the change in the impact of information and the independent volume variables. The model presumes only one lag. Copeland's rejection of the seriousness of serial correlation and multicollinearity is questionable. Finally, his dataset is relatively small. Copeland found some empirical support, but his results were not unanimous in supporting the model. Since trade-by-trade data for several measures of liquidity are available, better tests can be made of liquidity change.

The liquidity change around the split is tested chiefly by examining changes in individual measures of liquidity. These measures are the daily average spread size, the number of trades per day, the average time between intraday trades, the percentage of the firm traded, the ratio of the spread to the price, and the liquidity index.

The null hypothesis is that the variable mean before the split is equal to the variable mean following the split. Respective averages are compared for 75 day periods. The null hypothesis $H_0 : Mean_2 - Mean_1 = 0$ is tested with the 2-sided T-test. The continuous transaction data is limited to 75 days each side of the split, as pointed out previously. It is assumed that any transient market reactions have occurred within only a few days, if that long, and that 75 days of data more than adequately reflects normal trading. In addition, since the average represents a cross-sectional mean, individual firm information has a muted impact. The null hypothesis is tested across the split using t-tests. Correlations are also calculated and partial plots done for the absolute changes and percentage changes.

Major Hypothesis 3 Statistical Tests

Changes in liquidity may not show but a small correlation to the variance change. A regression of the change in variance on changes for liquidity measures showing significant changes around the split is performed. A regression of the percentage change in variance on percentage changes for liquidity measures showing significant changes around the split is also performed.

EMPIRICAL RESULTS

Variance Shift Examinations: The tests for Hypothesis 1 serve to reexamine the earlier findings about the returns' variance and mean returns' stability, and the variables which were considered potential factors in the returns' variance shift. This study involved a control variable of total asset size as a proxy for firm size, volume size, and price. The quintile groupings for total asset size have the smallest firms in the first quintile and the largest firms in the fifth quintile. In addition to the firm size control, the dispersion shift was measured in three ways, and tested using binomial probability and t-tests based on returns from three sources.

The results of the variance shift tests for stock splits are presented in Tables 1 and 2 for Test 1 (Tables 3 and 4 for stock dividends). Fixed interval test results for Test 2 are presented in Tables 5 through 8 for stock splits and Tables 9 through 12 for stock dividends. Finally, Test 3 results for mean absolute deviations for fixed measurement intervals are presented in Tables 13 through 16 for stock splits and Tables 17 through 20 for stock dividends.

Table 1. Hypothesis 1 Test For Variance Change in Stock Splits

Declaration-Exdate Interval Variance Measure Period					
Sample	Comparisons	$Pr\{\bar{\sigma}_2^2 > \bar{\sigma}_1^2\}$ (Z)	$\overline{\Delta\bar{\sigma}_i^2}$ (t)	Positive $\overline{\Delta\bar{\sigma}_i^2}$ (t)	$\overline{\bar{\sigma}_2^2/\bar{\sigma}_1^2}$
1969-1985 CRSP Daily Returns Data					
Full Sample	1564	.8095 (24.48)	.0002 (20.11)**	.0004 (30.24)**	2.16
Quintile 1	314	.7611 (9.25)	.0003 (6.98)**	.0005 (12.52)**	2.00
Quintile 2	313	.7796 (9.89)	.0003 (9.61)**	.0004 (23.05)**	2.11
Quintile 3	313	.8211 (11.36)	.0003 (9.65)**	.0004 (12.61)**	2.26
Quintile 4	312	.8333 (11.77)	.0002 (10.70)**	.0003 (13.38)**	2.19
Quintile 5	312	.8526 (12.46)	.0002 (11.87)**	.0002 (18.09)**	2.23
1979-1984 CRSP Daily Returns Data					
Full Sample	764	.8154 (17.44)	.0003 (15.80)**	.0004 (24.08)**	2.27
Quintile 1	154	.7727 (6.77)	.0003 (6.18)**	.0005 (10.18)**	2.21
Quintile 2	153	.7712 (6.71)	.0003 (6.67)**	.0005 (13.40)**	2.15
Quintile 3	153	.8235 (8.00)	.0003 (7.32)**	.0004 (9.33)**	2.54
Quintile 4	152	.8092 (7.62)	.0002 (7.39)**	.0003 (12.21)**	2.12
Quintile 5	152	.9013 (9.90)	.0002 (11.68)**	.0002 (11.12)**	2.34
1979-1984 TRANSACTION Daily Returns Data (Missing Values = (.))					
Full Sample	621	.7101 (10.47)	.0012 (2.57)**	.0034 (6.60)**	18.21
Quintile 1	131	.7328 (5.33)	.0029 (2.81)**	.0042 (3.12)**	24.88
Quintile 2	125	.6640 (3.67)	.0014 (2.08)**	.0026 (2.68)**	22.21
Quintile 3	124	.7581 (5.75)	-.0001 (- .11)	.0026 (2.68)**	8.84
Quintile 4	124	.7097 (4.67)	.0013 (1.66)*	.0026 (2.68)**	11.27
Quintile 5	117	.6838 (3.98)	.0003 (.19)	.0051 (3.63)**	23.73
1979-1984 TRANSACTION Daily Returns Data (Missing Values = 0)					
Full Sample	640	.6750 (8.85)	.0011 (3.02)**	.0030 (8.85)**	55.45
Quintile 1	134	.6750 (4.49)	.0018 (2.78)**	.0030 (3.25)**	25.72
Quintile 2	128	.6406 (3.18)	.0016 (3.18)**	.0024 (2.59)**	156.31
Quintile 3	128	.6875 (4.24)	.0005 (.48)	.0025 (2.57)**	41.27
Quintile 4	127	.7087 (4.70)	.0012 (1.92)*	.0023 (2.79)**	14.93
Quintile 5	123	.6423 (3.16)	.0005 (.43)	.0047 (3.55)**	39.57

* Significant at 95% Level
** Significant at 99% Level

Table 2. Hypothesis 1 Test For Variance Change in Stock Splits Continued

Declaration-Exdate Interval Variance Measure Period					
Sample	Comparisons	$Pr\{\bar{\sigma}_2^2 > \bar{\sigma}_1^2\}$ (Z)	$\overline{\Delta\bar{\sigma}_i^2}$ (t)	Positive $\overline{\Delta\bar{\sigma}_i^2}$ (t)	$\overline{\bar{\sigma}_2^2/\bar{\sigma}_1^2}$
1969-1985 TRANSACTION Intradaily (11am-2pm) Returns Data (Missing Values = (.))					
Full Sample	627	.7464 (12.34)	.0000† (.48)	.0003 (5.08)**	3.39
Quintile 1	132	.7500 (5.74)	-.0000† (- .10)	.0003 (4.85)**	2.82
Quintile 2	126	.7381 (5.35)	.0001 (3.44)**	.0002 (5.76)**	5.76
Quintile 3	126	.7381 (5.35)	.0002 (2.13)**	.0003 (2.39)**	7.12
Quintile 4	125	.7040 (4.56)	.0001 (1.27)	.0003 (1.90)*	4.49
Quintile 5	118	.8051 (6.63)	.0002 (1.46)	.0002 (1.50)	4.38
1979-1984 TRANSACTION Intradaily (11am-2pm) Returns Data (Missing Values = 0)					
Full Sample	642	.7165 (10.97)	.0001 (4.28)**	.0002 (5.48)**	4.73
Quintile 1	135	.7259 (5.25)	.0001 (4.24)**	.0002 (7.78)**	3.11
Quintile 2	128	.7266 (5.13)	.0001 (3.21)**	.0002 (5.52)**	3.94
Quintile 3	128	.7031 (4.60)	.0001 (2.41)**	.0003 (2.78)**	7.88
Quintile 4	127	.6850 (4.17)	.0001 (1.34)	.0003 (1.94)*	4.07
Quintile 5	124	.7419 (5.39)	.0001 (1.47)	.0002 (1.83)*	4.67

* Significant at 95% Level
** Significant at 99% Level
† Absolute Value < .00005

Table 3. Hypothesis 1 Test For Variance Change in Stock Dividends

Declaration-Exdate Interval Variance Measure Period					
Sample	Comparisons	$Pr\{\bar{\sigma}_2^2 > \bar{\sigma}_1^2\}$ (Z)	$\overline{\Delta\bar{\sigma}_i^2}$ (t)	Positive $\overline{\Delta\bar{\sigma}_i^2}$ (t)	$\overline{\bar{\sigma}_2^2/\bar{\sigma}_1^2}$
1969-1985 CRSP Daily Returns Data					
Full Sample	1108	.4865 (- .90)	-.0001 (-2.50)**	.0004 (13.37)**	216.78
Quintile 1	220	.4636 (-1.08)	- .0003 (-1.41)	.0005 (8.04)**	1084.62
Quintile 2	222	.4955 (- .13)	- .0001 (-1.25)	.0005 (6.05)**	1.60
Quintile 3	223	.4709 (- .87)	.0000† (- .15)	.0004 (4.32)**	1.60
Quintile 4	233	.5064 (.20)	- .0001 (-1.64)	.0003 (8.85)**	1.53
Quintile 5	210	.4952 (- .14)	- .0001 (-1.35)	.0003 (6.22)**	1.81
1979-1984 CRSP Daily Returns Data					
Full Sample	243	.5143 (.45)	-.0001 (-0.64)	.0006 (7.12)**	2.36
Quintile 1	48	.5000 (0.00)	- (- .30)	.0006 (4.70)**	2.21
Quintile 2	50	.4800 (- .28)	-.0001 (- .41)	.0007 (2.33)**	1.44
Quintile 3	49	.4286 (-1.00)	.0000† (.53)	.0005 (4.51)**	1.69
Quintile 4	49	.4898 (- .14)	-.0001 (-1.61)	.0005 (4.23)**	3.64
Quintile 5	47	.7021 (2.77)	-.0000† (.79)	.0003 (4.94)**	2.84
1979-1984 TRANSACTION Daily Returns Data (Missing Values = (.)					
Full Sample	185	.5730 (1.98)	.0079 (2.99)**	.0164 (3.76)**	56.93
Quintile 1	32	.2813 (-2.47)	-.0029 (-1.67)	.0016 (2.15)**	2.31
Quintile 2	47	.5745 (2.16)	.0061 (1.16)	.0142 (1.70)*	29.69
Quintile 3	29	.6207 (1.30)	.0222 (2.07)**	.0006 (2.16)**	123.14
Quintile 4	27	.7037 (4.67)	.0101 (1.66)*	.0448 (2.68)**	58.81
Quintile 5	50	.6600 (2.26)	.0070 (1.87)*	.0311 (2.32)**	76.95
1979-1984 TRANSACTION Daily Returns Data (Missing Values = 0)					
Full Sample	191	.5340 (.94)	.0071 (3.02)**	.0166 (3.69)**	2.78
Quintile 1	33	.2727 (-2.61)	-.0021 (-1.68)*	.0010 (2.49)**	1.64
Quintile 2	49	.5102 (.14)	.0054 (1.22)	.0148 (1.65)*	28.79
Quintile 3	30	.5667 (.73)	.0186 (2.02)**	.0376 (2.14)**	123.84
Quintile 4	28	.6429 (1.51)	.0081 (1.35)	.0150 (1.38)	56.54
Quintile 5	51	.6471 (2.10)	.0065 (1.83)*	.0124 (2.29)**	82.88

* Significant at 95% Level
** Significant at 99% Level

Table 4. Hypothesis 1 Test For Variance Change in Stock Dividends Continued

Declaration-Exdate Interval Variance Measure Period					
Sample	Comparisons	$Pr\{\bar{\sigma}_2^2 > \bar{\sigma}_1^2\}$ (Z)	$\overline{\Delta\bar{\sigma}_i^2}$ (t)	Positive $\overline{\Delta\bar{\sigma}_i^2}$ (t)	$\overline{\bar{\sigma}_2^2/\bar{\sigma}_1^2}$
1979-1984 TRANSACTION Intradaily (11am-2pm) Returns Data (Missing Values = (.)					
Full Sample	191	.5288 (.80)	.0000† (0.48)	.0003 (5.08)**	3.39
Quintile 1	32	.4375 (- .70)	-.0001 (- .94)	.0004 (5.31)**	1.60
Quintile 2	49	.5918 (2.69)	.0000† (.09)	.0004 (4.34)**	3.58
Quintile 3	30	.5000 (0.00)	.0000† (- .14)	.0002 (2.52)**	1.80
Quintile 4	28	.5714 (1.81)	.0001 (.88)	.0004 (1.83)*	2.94
Quintile 5	52	.5192 (1.72)	.0001 (.63)	.0002 (1.68)*	5.42
1979-1984 TRANSACTION Intradaily (11am-2pm) Returns Data (Missing Values = 0)					
Full Sample	208	.4567 (-1.25)	-.0001† (- .41)	.0002 (4.69)**	1.45
Quintile 1	32	.3750 (-1.41)	-.0001 (-1.35)	.0003 (5.06)**	1.45
Quintile 2	50	.5600 (.85)	-.0000† (- .41)	.0002 (5.35)**	3.03
Quintile 3	30	.4667 (- .36)	-.0000† (- .23)	.0002 (2.85)**	1.80
Quintile 4	28	.5357 (.38)	.0000† (.62)	.0004 (1.82)*	2.57
Quintile 5	52	.5000 (5.39)	-.0000† (1.47)	.0002 (1.83)*	4.90

* Significant at 95% Level
** Significant at 99% Level
† Absolute Value < .00005

Table 5. Hypothesis 1 Test For Variance Change in Stock Splits Continued

Fixed Interval Variance Measurement Periods

Sample	Comparisons	$Pr\{\bar{\sigma}_2^2 > \bar{\sigma}_1^2\}$ (Z)	$\overline{\Delta\bar{\sigma}_i^2}$ (t)	Positive $\overline{\Delta\bar{\sigma}_i^2}$ (t)	$\overline{\bar{\sigma}_2^2/\bar{\sigma}_1^2}$
1969-1985 Ex-Dates - CRSP Daily Returns Data - T = 25 Days					
Full Sample	1563	.8132 (24.76)	.0002 (22.80)**	.0004 (32.12)**	2.51
Quintile 1	313	.8179 (11.25)	.0004 (9.24)**	.0005 (14.37)**	2.48
Quintile 2	313	.8147 (11.14)	.0003 (11.24)**	-.0005 (17.28)**	2.56
Quintile 3	313	.8115 (11.02)	.0003 (9.92)**	.0006 (12.97)**	2.62
Quintile 4	312	.8109 (11.77)	.0003 (10.70)**	.0004 (13.38)**	2.49
Quintile 5	312	.8109 (10.98)	.0002 (13.68)**	.0003 (18.97)**	2.41
1969-1985 Ex-Dates - CRSP Daily Returns Data - T = 75 Days					
Full Sample	1563	.8042 (24.05)	.0002 (21.67)**	.0003 (21.67)**	1.87
Quintile 1	313	.7348 (8.31)	.0002 (7.53)**	.0004 (13.92)**	1.73
Quintile 2	313	.7380 (8.42)	.0002 (9.00)**	.0003 (17.20)**	1.78
Quintile 3	313	.8339 (11.81)	.0002 (12.17)**	.0003 (18.39)**	1.86
Quintile 4	312	.8654 (12.91)	.0002 (12.90)**	.0002 (18.53)**	2.01
Quintile 5	312	.8494 (12.34)	.0002 (9.42)**	.0002 (11.98)**	1.98
1969-1985 Ex-Dates - CRSP Daily Returns Data - T = 200 Days					
Full Sample	1563	.7780 (21.79)	.0001 (20.32)**	.0002 (34.47)**	1.61
Quintile 1	313	.7125 (7.52)	.0002 (8.34)**	.0003 (13.82)**	1.58
Quintile 2	313	.7157 (7.63)	.0001 (6.70)**	.0002 (15.80)**	1.45
Quintile 3	313	.8051 (10.80)	.0001 (10.44)**	.0002 (19.08)**	1.60
Quintile 4	313	.8115 (11.02)	.0001 (10.44)**	.0002 (17.73)**	1.66
Quintile 5	312	.8429 (12.11)	.0001 (12.05)**	.0002 (15.73)**	1.78
1969-1985 Ex-Dates - CRSP Daily Returns Data - T = 300 Days					
Full Sample	1563	.7441 (19.30)	.0001 (17.93)**	.0002 (32.37)**	1.56
Quintile 1	313	.6773 (6.27)	.0002 (8.04)**	.0003 (15.30)**	1.53
Quintile 2	313	.6997 (7.07)	.0001 (5.81)**	.0002 (15.12)**	1.39
Quintile 3	313	.7700 (9.55)	.0001 (7.78)**	.0002 (12.89)**	1.60
Quintile 4	312	.7981 (10.53)	.0001 (10.10)**	.0002 (18.29)**	1.59
Quintile 5	312	.7756 (9.74)	.0001 (10.24)**	.0002 (14.77)**	1.68

* Significant at 95% Level
** Significant at 99% Level

Table 6. Hypothesis 1 Test For Variance Change in Stock Splits Continued

Fixed Interval Variance Measurement Periods					
Sample	Comparisons	$Pr\{\bar{\sigma}_2^2 > \bar{\sigma}_1^2\}$ (Z)	$\overline{\Delta\bar{\sigma}_i^2}$ (t)	Positive $\overline{\Delta\bar{\sigma}_i^2}$ (t)	$\bar{\sigma}_2^2/\bar{\sigma}_1^2$
1979-1984 Ex-Dates - CRSP Daily Returns Data - T = 25 Days					
Full Sample	764	.8207 (17.73)	.0003 (17.74)**	.0005 (25.44)	2.62
Quintile 1	154	.8312 (8.22)	.0004 (7.65)**	.0006 (12.11)**	2.58
Quintile 2	153	.8235 (8.00)	.0004 (8.12)**	.0005 (12.87)**	2.72
Quintile 3	153	.8170 (7.84)	.0003 (7.35)**	.0005 (9.37)**	2.99
Quintile 4	152	.8026 (7.46)	.0003 (8.49)**	.0004 (13.40)**	2.34
Quintile 5	152	.8289 (8.11)	.0004 (11.15)**	.0004 (14.26)**	2.45
1979-1984 Ex-Dates - CRSP Daily Returns Data - T = 75 Days					
Full Sample	764	.8063 (16.93)	.0002 (16.27)**	.0003 (25.87)**	1.83
Quintile 1	154	.6753 (4.35)	.0002 (6.17)**	.0003 (12.05)**	1.55
Quintile 2	153	.7712 (6.71)	.0002 (7.24)**	.0003 (14.90)**	1.77
Quintile 3	153	.8627 (8.97)	.0002 (6.95)**	.0003 (13.68)**	1.97
Quintile 4	152	.8487 (8.60)	.0002 (7.02)**	.0003 (15.89)**	1.79
Quintile 5	152	.8750 (9.25)	.0002 (7.02)**	.0003 (7.86)**	2.06
1979-1984 Ex-Dates - CRSP Daily Returns Data - T = 200 Days					
Full Sample	764	.7683 (14.83)	.0001 (15.29)**	.0002 (29.59)**	1.46
Quintile 1	154	.6753 (6.83)	.0001 (5.05)**	.0002 (12.71)**	1.27
Quintile 2	154	.7124 (5.25)	.0001 (6.29)**	.0002 (14.42)**	1.39
Quintile 3	153	.8431 (8.49)	.0001 (8.52)**	.0002 (14.26)**	1.56
Quintile 4	153	.7500 (6.16)	.0002 (5.93)**	.0002 (15.53)**	1.48
Quintile 5	152	.8618 (8.91)	.0002 (8.93)**	.0002 (10.98)**	1.65
1979-1984 Ex-Dates - CRSP Daily Returns Data - T = 300 Days					
Full Sample	764	.7199 (12.16)	.0001 (11.28)**	.0002 (21.32)**	1.39
Quintile 1	154	.6039 (2.58)	.0001 (3.17)**	.0002 (11.02)**	1.22
Quintile 2	153	.6797 (4.45)	.0001 (4.88)**	.0002 (11.83)**	1.29
Quintile 3	153	.7712 (6.71)	.0001 (4.95)**	.0002 (7.17)**	1.47
Quintile 4	152	.7829 (6.98)	.0001 (6.76)**	.0002 (14.45)**	1.43
Quintile 5	152	.7632 (6.49)	.0001 (6.55)**	.0002 (9.71)**	1.52
*	Significant at 95% Level				
**	Significant at 99% Level				

Table 7. Hypothesis 1 Test For Variance Change in Stock Splits Continued

Fixed Interval Variance Measurement Periods					
Sample	Comparisons	$Pr\{\bar{\sigma}_2^2 > \bar{\sigma}_1^2\}$ (Z)	$\overline{\Delta\bar{\sigma}_i^2}$ (t)	Positive $\overline{\Delta\bar{\sigma}_i^2}$ (t)	$\overline{\bar{\sigma}_2^2/\bar{\sigma}_1^2}$
1979-1984 Ex-Dates - TRANSACTION Daily Returns Data - T = 25 Days (Missing Values = (.))					
Full Sample	614	.7850 (14.12)	.0016 (3.24)**	.0035 (6.90)**	19.52
Quintile 1	128	.8203 (7.25)	.0031 (2.89)**	.0041 (3.20)**	35.63
Quintile 2	125	.7200 (4.92)	.0015 (2.18)**	-.0024 (2.82)**	8.27
Quintile 3	125	.8000 (6.71)	.0002 (.13)	.0028 (2.91)**	11.24
Quintile 4	123	.8374 (7.48)	.0023 (2.17)**	.0032 (2.78)**	9.68
Quintile 5	113	.7434 (5.17)	.0010 (.69)	.0053 (3.81)**	24.68
1979-1984 Ex-Dates - TRANSACTION Daily Returns Data - T = 75 Days (Missing Values = (.))					
Full Sample	665	.7880 (14.85)	.0020 (6.76)**	.0028 (7.94)**	8864.45
Quintile 1	136	.7647 (6.17)	.0019 (3.39)**	.0026 (3.56)**	4.31
Quintile 2	134	.7090 (4.84)	.0023 (2.60)**	.0035 (2.86)**	18.91
Quintile 3	133	.7970 (6.85)	.0018 (2.62)**	.0027 (5.54)**	44343.63
Quintile 4	133	.8496 (8.06)	.0017 (3.32)**	.0023 (4.04)**	9.68
Quintile 5	106	.8217 (7.31)	.0022 (3.85)**	.0030 (4.78)**	12.40
1979-1984 Ex-Dates - TRANSACTION Daily Returns Data - T = 25 Days (Missing Values = 0)					
Full Sample	636	.7390 (12.05)	..0014 (3.59)**	.0033 (6.85)**	25.63
Quintile 1	134	.7761 (6.39)	.0020 (2.84)**	.0029 (3.32)**	37.66
Quintile 2	128	.6719 (3.89)	.0013 (2.15)**	.0024 (2.67)**	13.70
Quintile 3	128	.7500 (5.66)	.0010 (1.02)	.0028 (2.84)**	25.89
Quintile 4	126	.8016 (6.77)	.0020 (2.34)**	.0031 (2.73)**	17.41
Quintile 5	120	.6917 (4.20)	.0008 (.66)	.0053 (3.77)**	33.23
1979-1984 Ex-Dates - TRANSACTION Daily Returns Data - T = 75 Days (Missing Values = 0)					
Full Sample	665	.7113 (10.90)	.0013 (8.37)**	.0021 (9.46)**	91.86
Quintile 1	136	.6618 (3.77)	.0010 (3.51)**	.0017 (3.90)**	8.14
Quintile 2	134	.6418 (3.75)	.0010 (3.45)**	.0018 (4.01)**	46.95
Quintile 3	133	.7218 (5.10)	.0014 (3.41)**	.0021 (3.88)**	321.16
Quintile 4	133	.7669 (6.16)	.0014 (3.79)**	.0020 (4.34)**	26.42
Quintile 5	129	.7674 (6.07)	.0019 (4.56)**	.0027 (4.99)**	58.06
*	Significant at 95% Level				
**	Significant at 99% Level				

Table 8. Hypothesis 1 Test For Variance Change in Stock Splits Continued

Fixed Interval Variance Measurement Periods					
Sample	Comparisons	$Pr\{\bar{\sigma}_2^2 > \bar{\sigma}_1^2\}$ (Z)	$\overline{\Delta\bar{\sigma}_i^2}$ (t)	Positive $\overline{\Delta\bar{\sigma}_i^2}$ (t)	$\overline{\bar{\sigma}_2^2/\bar{\sigma}_1^2}$
1979-1984 Ex-Dates - TRANSACTION Intradaily (11am-2pm) Returns Data - T = 25 Days (Missing Values = (.))					
Full Sample	649	.7581 (13.15)	.0002 (3.42)**	.0003 (5.43)**	3.42
Quintile 1	129	.8217 (7.31)	-.0001 (.86)	.0004 (5.17)**	3.96
Quintile 2	125	.7840 (6.35)	.0001 (4.24)**	.0002 (8.92)**	3.21
Quintile 3	126	.7778 (6.24)	.0003 (1.87)*	.0004 (2.04)**	7.75
Quintile 4	125	.7520 (5.63)	.0002 (1.92)*	.0003 (2.26)**	4.46
Quintile 5	114	.8421 (10.98)	.0002 (13.68)**	.0002 (18.97)**	4.41
1979-1984 Ex-Dates - TRANSACTION Intradaily (11am-2pm) Returns Data - T = 75 Days (Missing Values = (.))					
Full Sample	664	.7756 (14.20)	.0000† (0.88)	.0002 (8.88)**	2.73
Quintile 1	136	.6838 (4.29)	-.0001 (- .85)	.0002 (5.75)**	1.98
Quintile 2	134	.7727 (6.31)	.0001 (2.65)**	.0002 (11.37)**	2.21
Quintile 3	132	.7727 (6.27)	.0001 (1.86)*	.0002 (3.07)**	4.25
Quintile 4	133	.8195 (7.37)	.0000† (.45)	.0002 (4.22)**	2.34
Quintile 5	129	.8760 (8.54)	.0001 (2.76)**	.0002 (3.27)**	2.89
1969-1985 Ex-Dates - TRANSACTION Intradaily (11am-2pm) Returns Data - T = 25 Days (Missing Values = 0)					
Full Sample	641	.7769 (14.02)	.0002 (4.83)**	.0003 (6.10)**	5.38
Quintile 1	136	.7941 (6.86)	.0002 (3.06)**	.0003 (7.81)**	4.20
Quintile 2	129	.7597 (5.90)	.0001 (3.80)**	.0002 (8.37)**	4.52
Quintile 3	128	.7891 (6.54)	.0002 (2.29)**	.0003 (2.53)**	9.09
Quintile 4	127	.7480 (5.59)	.0001 (1.84)*	.0002 (2.15)**	2.50
Quintile 5	121	.7934 (6.45)	.0001 (1.67)*	.0002 (1.71)*	4.54
1979-1984 Ex-Dates - TRANSACTION Intradaily (11am-2pm) Returns Data - T = 75 Days (Missing Values = 0)					
Full Sample	666	.7192 (11.31)	.0000† (1.93)*	.0001 (9.59)**	4.11
Quintile 1	137	.6423 (3.33)	-.0000† (- .46)	.0002 (9.52)**	2.49
Quintile 2	134	.6493 (3.46)	.0000† (1.32)	.0001 (10.25)**	5.84
Quintile 3	135	.7333 (5.42)	.0001 (2.07)**	.0002 (3.87)**	6.54
Quintile 4	133	.7519 (5.81)	.0000† (.45)	.0001 (3.76)**	2.50
Quintile 5	130	.8077 (7.02)	.0001 (2.48)**	.0001 (3.06)**	3.19

* Significant at 95% Level
** Significant at 99% Level

Table 9. Hypothesis 1 Test For Variance Change in Stock Dividends Continued

Fixed Interval Variance Measurement Periods					
Sample	Comparisons	$Pr\{\bar{\sigma}_2^2 > \bar{\sigma}_1^2\}$ (Z)	$\overline{\Delta\bar{\sigma}_i^2}$ (t)	Positive $\overline{\Delta\bar{\sigma}_i^2}$ (t)	$\overline{\bar{\sigma}_2^2/\bar{\sigma}_1^2}$
1969-1985 Ex-Dates - CRSP Daily Returns Data - T = 25 Days					
Full Sample	1116	.4937 (- .42)	-.0000† (-1.41)	.0004 (16.45)**	1.36
Quintile 1	224	.5134 (.34)	-.0001 (-0.94)	.0004 (8.93)**	1.35
Quintile 2	223	.4574 (-1.27)	-.0000† (-0.83)	.0004 (7.58)**	1.46
Quintile 3	224	.5357 (1.07)	.0001 (1.32)	.0004 (7.06)**	1.46
Quintile 4	233	.4807 (- .59)	-.0001 (-1.53)	.0003 (7.12)**	1.27
Quintile 5	212	.4811 (- .55)	-.0001 (-1.70)*	.0002 (8.31)**	1.24
1969-1985 Ex-Dates - CRSP Daily Returns Data - T = 75 Days					
Full Sample	1116	.4839 (-1.08)	-.0000† (-1.72)*	.0003 (19.60)**	1.15
Quintile 1	224	.5054 (.13)	.0000† (-0.26)	.0003 (9.04)**	1.18
Quintile 2	223	.4933 (- .20)	-.0000† (-0.94)	.0003 (9.71)**	1.17
Quintile 3	224	.4866 (- .40)	-.0000† (-0.33)	.0003 (8.80)**	1.20
Quintile 4	233	.4421 (-1.77)	-.0000† (-1.92)*	.0002 (8.42)**	1.09
Quintile 5	212	.4953 (- .14)	-.0000† (-0.64)	.0002 (8.84)**	1.14
1969-1985 Ex-Dates - CRSP Daily Returns Data - T = 200 Days					
Full Sample	1116	.4722 (-1.86)	-.0000† (-0.57)	.0003 (21.80)**	1.14
Quintile 1	224	.4196 (-2.41)	.0000† (-0.37)	.0003 (9.31)**	1.13
Quintile 2	223	.4619 (-1.16)	-.0000† (-0.33)	.0003 (11.21)**	1.14
Quintile 3	224	.5045 (.13)	-.0000† (-0.11)	.0003 (10.68)**	1.21
Quintile 4	233	.4893 (- .33)	-.0000† (.64)	.0002 (9.74)**	1.12
Quintile 5	212	.4858 (- .41)	-.0000† (- .35)	.0002 (10.18)**	1.11
1969-1985 Ex-Dates - CRSP Daily Returns Data - T = 300 Days					
Full Sample	1116	.4857 (- .96)	-.0000† (-0.98)	.0003 (21.42)**	1.15
Quintile 1	224	.4375 (- .75)	-.0000† (-0.37)	.0004 (8.70)**	1.13
Quintile 2	223	.4798 (- .60)	-.0000† (-0.75)	.0003 (11.19)**	1.15
Quintile 3	224	.5089 (.27)	-.0000† (-0.34)	.0003 (10.72)**	1.20
Quintile 4	233	.4936 (- .20)	-.0000† (-0.89)	.0002 (9.79)**	1.11
Quintile 5	212	.5094 (.27)	.0000† (.18)	.0002 (9.83)**	1.15

* Significant at 95% Level
** Significant at 99% Level

Table 10. Hypothesis 1 Test For Variance Change in Stock Dividends Continued

Fixed Interval Variance Measurement Periods					
Sample	Comparisons	$Pr\{\bar{\sigma}_2^2 > \bar{\sigma}_1^2\}$ (Z)	$\overline{\Delta\bar{\sigma}_i^2}$ (t)	Positive $\overline{\Delta\bar{\sigma}_i^2}$ (t)	$\overline{\bar{\sigma}_2^2/\bar{\sigma}_1^2}$
1979-1984 Ex-Dates - CRSP Daily Returns Data - T = 25 Days					
Full Sample	247	.5263 (.83)	.0000† (0.02)	.0004 (8.12)**	1.43
Quintile 1	50	.5800 (1.13)	.0001 (0.26)	.0006 (4.84)**	1.58
Quintile 2	50	.4000 (-1.41)	- -.0002 (-1.51)	.0004 (3.22)**	1.22
Quintile 3	50	.5800 (1.13)	.0001 (1.62)	.0003 (5.37)**	1.31
Quintile 4	49	.4490 (- .72)	.0000† (0.17)	.0005 (2.85)**	1.63
Quintile 5	48	.6250 (1.73)	.0000† (0.45)	.0002 (4.43)**	1.39
1979-1984 Ex-Dates - CRSP Daily Returns Data - T = 75 Days					
Full Sample	247	.4899 (- .32)	.0000† (-1.06)	.0003 (9.66)**	1.12
Quintile 1	50	.4400 (- .85)	.0001 (-.68)	.0004 (4.22)**	1.13
Quintile 2	50	.4600 (- .57)	-.0001 (-2.02)**	.0003 (4.86)**	.99
Quintile 3	50	.4600 (- .57)	-.0000† (-0.36)	.0002 (5.48)**	1.05
Quintile 4	49	.4898 (- .14)	.0000† (0.15)	.0003 (3.80)**	1.22
Quintile 5	48	.6042 (1.44)	.0000† (1.55)	.0002 (7.95)**	1.23
1979-1984 Ex-Dates - CRSP Daily Returns Data - T = 200 Days					
Full Sample	247	.4372 (-1.97)	.0000† (-1.12)	.0002 (10.11)**	1.09
Quintile 1	50	.3200 (-6.36)	-.0001 (-1.34)	.0002 (3.26)**	1.02
Quintile 2	50	.4000 (-1.41)	-.0001 (-1.63)	.0002 (5.66)**	1.01
Quintile 3	50	.5000 (0.00)	-.0001 (-0.12)	.0002 (6.15)**	1.07
Quintile 4	49	.5510 (.71)	.0001 (1.28)	.0002 (5.74)**	1.21
Quintile 5	48	.4167 (-1.15)	.0000† (0.10)	.0002 (6.95)**	1.13
1979-1984 Ex-Dates - CRSP Daily Returns Data - T = 300 Days					
Full Sample	274	.4372 (-1.97)	.0001 (-2.27)**	.0002 (7.40)**	1.04
Quintile 1	50	.3200 (-2.54)	-.0001 (-1.24)	.0004 (2.30)**	.98
Quintile 2	50	.3600 (-1.98)	-.0002 (-3.07)**	.0002 (5.98)**	.91
Quintile 3	50	.4800 (- .28)	.0000† (-1.19)	.0002 (6.26)**	1.01
Quintile 4	49	.5714 (1.00)	.0000† (1.15)	.0002 (5.50)**	1.20
Quintile 5	48	.4583 (- .58)	.0000† (0.42)	.0002 (5.61)**	1.13

* Significant at 95% Level
** Significant at 99% Level

Table 11. Hypothesis 1 Test For Variance Change in Stock Dividends Continued

Fixed Interval Variance Measurement Periods					
Sample	Comparisons	$Pr\{\bar{\sigma}_2^2 > \bar{\sigma}_1^2\}$ (Z)	$\overline{\Delta\bar{\sigma}_i^2}$ (t)	Positive $\overline{\Delta\bar{\sigma}_i^2}$ (t)	$\overline{\bar{\sigma}_2^2/\bar{\sigma}_1^2}$
1979-1984 Ex-Dates - TRANSACTION Daily Returns Data - T=25 Days (Missing Values = (.))					
Full Sample	191	.5079 (.22)	.0036 (3.08)**	.0090 (4.37)**	17.15
Quintile 1	33	.5152 (.17)	.0002 (-0.11)	.0033 (1.37)	8.243
Quintile 2	48	.3958 (-1.44)	.0026 (1.01)	.0105 (1.87)*	3.88
Quintile 3	30	.5667 (.73)	.0074 (2.38)**	.0134 (2.60)**	20.19
Quintile 4	28	.5357 (.38)	.0054 (1.45)	.0104 (1.53)	26.08
Quintile 5	52	.5577 (.83)	.0038 (1.90)*	.0079 (2.37)**	33.38
1979-1984 Ex-Dates - TRANSACTION Daily Returns Data - T=75 Days (Missing Values = (.))					
Full Sample	209	.5072 (.21)	.0011 (2.35)**	.0034 (5.01)**	5.90
Quintile 1	35	.4857 (-.17)	-.0013 (-0.75)	.0024 (1.84)*	3.81
Quintile 2	61	.4590 (-.64)	.0012 (1.40)	.0035 (2.48)**	5.70
Quintile 3	31	.5806 (.90)	.0033 (2.61)**	.0059 (3.00)**	4.45
Quintile 4	30	.5333 (.36)	.0012 (1.21)	.0025 (1.33)	9.22
Quintile 5	52	.5192 (.28)	.0014 (1.84)*	.0032 (2.35)**	6.39
1969-1985 Ex-Dates - TRANSACTION Daily Returns Data - T=25 Days (Missing Values = 0)					
Full Sample	192	.4635 (-1.01)	.0031 (3.42)**	.0091 (4.40)**	28.27
Quintile 1	33	.3636 (-1.57)	-.0003 (-0.14)	.0044 (1.28)	7.55
Quintile 2	48	.4167 (-1.15)	.0018 (1.03)	.0076 (1.91)*	4.18
Quintile 3	30	.5353 (.36)	.0061 (2.36)**	.0132 (2.65)**	19.49
Quintile 4	29	.5172 (.19)	.0045 (2.34)**	.0103 (1.52)	66.41
Quintile 5	52	.5000 (.00)	.0037 (1.88)*	.0087 (2.38)**	41.79
1979-1984 Ex-Dates - TRANSACTION Daily Returns Data - T=75 Days (Missing Values = 0)					
Full Sample	201	.4975 (-.07)	.0012 (3.78)**	.0030 (5.07)**	25.79
Quintile 1	35	.4857 (-.17)	.0002 (.28)	.0018 (1.91)*	5.51
Quintile 2	53	.4717 (-.41)	.0010 (2.07)**	.0026 (2.78)**	10.21
Quintile 3	31	.5161 (.18)	.0021 (2.53)**	.0048 (3.09)**	6.61
Quintile 4	30	.5667 (.73)	.0011 (1.18)	.0023 (1.32)	61.28
Quintile 5	52	.4808 (-.27)	.0015 (2.13)**	.0035 (2.50)**	44.31
*	Significant at 95% Level				
**	Significant at 99% Level				

Table 12. Hypothesis 1 Test For Variance Change in Stock Dividends Continued

Fixed Interval Variance Measurement Periods

Sample	Comparisons	$Pr\{\bar{\sigma}_2^2 > \bar{\sigma}_1^2\}$ (Z)	$\overline{\Delta\bar{\sigma}_i^2}$ (t)	Positive $\overline{\Delta\bar{\sigma}_i^2}$ (t)	$\bar{\sigma}_2^2/\bar{\sigma}_1^2$
1979-1984 Ex-Dates - TRANSACTION Intradaily (11am-2pm) Returns Data - T = 25 Days (Missing Values = (.))					
Full Sample	192	.5156 (.43)	.0000† (.03)	.0002 (5.82)**	1.58
Quintile 1	33	.5152 (.17)	.0001 (1.21)	.0005 (3.36)**	1.89
Quintile 2	49	.5510 (.71)	-.0000† (-0.49)	.0002 (3.91)**	1.24
Quintile 3	30	.5000 (.00)	-.0000† (-0.20)	.0001 (3.74)**	1.23
Quintile 4	28	.6071 (1.13)	.0000† (.08)	.0001 (3.73)**	1.32
Quintile 5	52	.4423 (- .83)	-.0001 (-0.73)	.0002 (2.16)**	2.06
1979-1984 Ex-Dates - TRANSACTION Intradaily (11am-2pm) Returns Data - T = 75 Days (Missing Values = (.))					
Full Sample	201	.5224 (.64)	-.0000† (-0.85)	.0001 (6.04)**	1.21
Quintile 1	35	.3714 (-1.48)	-.0002 (-1.31)	.0003 (3.38)**	1.26
Quintile 2	53	.5472 (.69)	-.0000† (-1.17)	.0001 (4.78)**	1.01
Quintile 3	31	.4839 (- .18)	-.0001 (.92)	.0002 (2.53)**	1.26
Quintile 4	30	.5667 (.73)	.0000† (.66)	.0001 (2.17)**	1.27
Quintile 5	52	.5962 (1.39)	.0000† (.84)	.0001 (3.35)**	1.28
1979-1984 Ex-Dates - TRANSACTION Intradaily (11am-2pm) Returns Data - T = 25 Days (Missing Values = 0)					
Full Sample	194	.4948 (- .14)	-.0000† (-0.52)	-.0008 (5.20)**	1.57
Quintile 1	33	.5152 (.17)	.0001 (.70)	-.0018 (2.62)**	1.77
Quintile 2	49	.4898 (- .14)	-.0000† (-0.67)	-.0012 (1.69)*	1.23
Quintile 3	30	.5000 (0.00)	-.0000† (-0.19)	-.0009 (3.57)**	1.19
Quintile 4	30	.5667 (.73)	-.0000† (-0.31)	.0002 (3.58)**	1.36
Quintile 5	52	.4423 (- .83)	-.0001 (-0.81)	-.0001 (2.12)*	2.13
1979-1984 Ex-Dates - TRANSACTION Intradaily (11am-2pm) Returns Data - T = 75 Days (Missing Values = 0)					
Full Sample	209	.4833 (- .48)	-.0000† (-0.46)	.0001 (5.84)**	1.52
Quintile 1	35	.4286 (- .84)	-.0001 (- .87)	.0002 (2.99)**	1.46
Quintile 2	53	.5094 (.14)	-.0000† (-1.25)	.0001 (5.02)**	1.33
Quintile 3	31	.4839 (- .17)	.0000† (.67)	.0002 (2.08)**	1.46
Quintile 4	30	.5000 (0.00)	.0000† (.20)	.0001 (2.07)**	1.83
Quintile 5	52	.5577 (.83)	.0000† (.40)	.0001 (3.28)**	1.54

* Significant at 95% Level
** Significant at 99% Level

Table 13. Hypothesis 1 Test For MAD Change in Stock Splits Continued

Fixed Interval MAD Measurement Periods					
Sample	Comparisons	$Pr\{\bar{\sigma}_2^2 > \bar{\sigma}_1^2\}$ (Z)	$\overline{\Delta\bar{\sigma}_i^2}$ (t)	Positive $\overline{\Delta\bar{\sigma}_i^2}$ (t)	$\overline{\bar{\sigma}_2^2/\bar{\sigma}_1^2}$
1969-1985 Ex-Dates - CRSP Daily Returns Data - T = 25 Days					
Full Sample	1564	.8146 (24.88)	.0047 (32.53)**	.0065 (50.49)**	1.46
Quintile 1	314	.8185 (11.29)	.0051 (12.97)**	.0072 (20.97)**	1.45
Quintile 2	313	.8019 (10.68)	.0048 (15.00)**	.0066 (23.40)**	1.45
Quintile 3	313	.8243 (11.47)	.0050 (14.69)**	.0068 (21.92)**	1.48
Quintile 4	312	.8109 (10.90)	.0044 (14.98)**	.0061 (24.44)**	1.45
Quintile 5	312	.8173 (11.21)	.0043 (16.61)**	.0058 (25.03)**	1.46
1969-1985 Ex-Dates - CRSP Daily Returns Data - T = 75 Days					
Full Sample	1564	.8088 (24.42)	.0032 (29.46)**	.0046 (51.83)**	1.30
Quintile 1	314	.7516 (6.23)	.0029 (10.49)**	.0049 (21.01)**	1.25
Quintile 2	313	.7572 (9.10)	.0028 (10.88)**	.0047 (21.44)**	1.26
Quintile 3	313	.8403 (12.02)	.0035 (16.81)**	.0077 (25.09)**	1.32
Quintile 4	312	.8526 (12.46)	.0034 (14.98)**	.0045 (24.42)**	1.33
Quintile 5	312	.8490 (12.12)	.0033 (15.41)**	.0044 (24.59)**	1.33
1969-1985 Ex-Dates - CRSP Daily Returns Data - T = 200 Days					
Full Sample	1564	.7558 (20.23)	.0021 (21.38)**	.0038 (46.84)**	1.19
Quintile 1	314	.7134 (7.56)	.0021 (8.44)**	.0042 (18.02)**	1.18
Quintile 2	313	.6901 (6.73)	.0016 (7.41)**	.0035 (20.58)**	1.24
Quintile 3	313	.7987 (10.57)	.0025 (11.93)**	.0039 (23.19)**	1.23
Quintile 4	313	.7827 (10.10)	.0021 (9.30)**	.0036 (22.29)**	1.20
Quintile 5	312	.7917 (10.30)	.0023 (11.36)**	.0036 (22.50)**	1.23
1969-1985 Ex-Dates - CRSP Daily Returns Data - T = 300 Days					
Full Sample	1564	.6937 (4.96)	.0015 (13.86)**	.0037 (44.20)**	1.15
Quintile 1	314	.6497 (5.31)	.0016 (6.14)**	.0042 (18.34)**	1.15
Quintile 2	313	.6454 (5.14)	.0010 (4.31)**	.0034 (17.98)**	1.10
Quintile 3	313	.7412 (8.53)	.0018 (7.47)**	.0037 (21.22)**	1.18
Quintile 4	312	.7308 (8.15)	.0015 (6.13)**	.0036 (21.29)**	1.15
Quintile 5	312	.7019 (7.10)	.0016 (7.12)**	.0035 (21.01)**	1.16
*	Significant at 95% Level				
**	Significant at 99% Level				

Table 14. Hypothesis 1 Test For MAD Change in Stock Splits Continued

Fixed Interval MAD Measurement Periods					
Sample	Comparisons	$Pr\{\bar{\sigma}_2^2 > \bar{\sigma}_1^2\}$ (Z)	$\overline{\Delta\bar{\sigma}_i^2}$ (t)	Positive $\overline{\Delta\bar{\sigma}_i^2}$ (t)	$\overline{\bar{\sigma}_2^2/\bar{\sigma}_1^2}$
1979-1984 Ex-Dates - CRSP Daily Returns Data - T = 25 Days					
Full Sample	764	.8115 (17.22)	.0053 (24.39)**	.0072 (37.12)**	1.48
Quintile 1	154	.7987 (7.41)	.0056 (9.63)**	.0079 (9.33)**	1.48
Quintile 2	153	.8105 (7.68)	.0053 (11.05)**	.0072 (16.86)**	1.47
Quintile 3	153	.8170 (7.84)	.0057 (10.48)**	.0077 (15.41)**	1.55
Quintile 4	152	.8158 (7.79)	.0049 (13.17)**	.0066 (15.50)**	1.45
Quintile 5	152	.8158 (7.79)	.0048 (13.17)**	.0064 (15.50)**	1.47
1979-1984 Ex-Dates - CRSP Daily Returns Data - T = 75 Days					
Full Sample	764	.8141 (17.36)	.0034 (23.18)**	.0048 (38.82)**	1.30
Quintile 1	154	.7143 (5.32)	.0025 (7.29)**	.0045 (14.59)**	1.19
Quintile 2	153	.7582 (6.39)	.0031 (8.64)**	.0050 (16.48)**	1.27
Quintile 3	153	.8693 (9.14)	.0041 (12.90)**	.0069 (18.50)**	1.36
Quintile 4	152	.8553 (8.76)	.0035 (11.57)**	.0046 (18.44)**	1.30
Quintile 5	152	.8750 (9.25)	.0039 (13.62)**	.0047 (18.93)**	1.36
1979-1984 Ex-Dates - CRSP Daily Returns Data - T = 200 Days					
Full Sample	764	.7788 (15.41)	.0022 (20.08)**	.0035 (38.33)**	1.19
Quintile 1	154	.6818 (4.51)	.0016 (6.27)**	.0032 (14.85)**	1.12
Quintile 2	154	.7273 (5.64)	.0020 (7.05)**	.0035 (15.63)**	1.15
Quintile 3	153	.8366 (8.33)	.0026 (10.85)**	.0036 (18.93)**	1.23
Quintile 4	153	.7908 (7.19)	.0023 (9.38)**	.0034 (16.13)**	1.20
Quintile 5	152	.8487 (8.60)	.0028 (12.62)**	.0036 (20.40)**	1.25
1979-1984 Ex-Dates - CRSP Daily Returns Data - T = 300 Days					
Full Sample	764	.7330 (12.88)	.0017 (14.88)**	.0032 (35.34)**	1.15
Quintile 1	154	.6494 (3.71)	.0010 (3.97)**	.0029 (13.44)**	1.09
Quintile 2	153	.6405 (3.48)	.0013 (4.35)**	.0034 (14.83)**	1.10
Quintile 3	153	.7908 (7.19)	.0019 (7.25)**	.0031 (16.55)**	1.17
Quintile 4	152	.8158 (7.79)	.0023 (9.60)**	.0032 (15.96)**	1.19
Quintile 5	152	.7697 (6.65)	.0022 (9.60)**	.0034 (18.37)**	1.20
*	Significant at 95% Level				
**	Significant at 99% Level				

Table 15. Hypothesis 1 Test For MAD Change in Stock Splits Continued

Fixed Interval MAD Measurement Periods					
Sample	Comparisons	$Pr\{\bar{\sigma}_2^2 > \bar{\sigma}_1^2\}$ (Z)	$\overline{\Delta\bar{\sigma}_i^2}$ (t)	Positive $\overline{\Delta\bar{\sigma}_i^2}$ (t)	$\overline{\bar{\sigma}_2^2/\bar{\sigma}_1^2}$
1979-1984 Ex-Dates - TRANSACTION Daily Returns Data - T = 25 Days (Missing Values = (.))					
Full Sample	619	.7367 (11.78)	.0063 (11.32)**	.0105 (16.59)**	1.97
Quintile 1	129	.7984 (6.78)	.0074 (6.72)**	.0104 (8.75)**	1.99
Quintile 2	126	.6746 (3.92)	.0053 (4.96)**	.0097 (7.44)**	1.99
Quintile 3	126	.7380 (6.29)	.0065 (4.99)**	.0111 (7.73)**	2.49
Quintile 4	124	.7903 (11.14)	.0066 (5.42)**	.0093 (6.56)**	1.67
Quintile 5	115	.6782 (3.82)	.0059 (3.69)**	.0123 (6.88)**	1.74
1979-1984 Ex-Dates - TRANSACTION Daily Returns Data - T = 75 Days (Missing Values = (.))					
Full Sample	667	.7466 (12.24)	.0046 (12.95)**	.0077 (21.30)**	2.37
Quintile 1	136	.6985 (4.63)	.0037 (4.91)**	.0075 (10.06)**	1.85
Quintile 2	134	.6418 (3.28)	.0029 (3.54)**	.0074 (8.29)**	2.28
Quintile 3	134	.7612 (8.37)	.0055 (6.61)**	.0085 (9.65)**	3.66
Quintile 4	133	.8346 (7.72)	.0052 (7.29)**	.0071 (9.71)**	2.00
Quintile 5	130	.8000 (6.84)	.0057 (6.92)**	.0083 (9.94)**	2.05
1979-1984 Ex-Dates - TRANSACTION Daily Returns Data - T = 25 Days (Missing Values = 0)					
Full Sample	684	.6901 (9.94)	.0057 (11.33)**	.0103 (17.38)**	1.59
Quintile 1	139	.7554 (6.02)	.0069 (6.57)**	.0105 (9.08)**	1.70
Quintile 2	137	.6423 (5.67)	.0048 (5.05)**	.0094 (7.96)**	1.60
Quintile 3	135	.7185 (5.08)	.0061 (5.20)**	.0108 (8.38)**	1.68
Quintile 4	138	.7391 (5.62)	.0058 (5.29)**	.0089 (6.68)**	1.51
Quintile 5	135	.5929 (2.16)	.0049 (3.67)**	.0121 (7.14)**	1.46
1979-1984 Ex-Dates - TRANSACTION Daily Returns Data - T = 75 Days (Missing Values = 0)					
Full Sample	684	.7427 (12.69)	.0043 (14.26)**	.0073 (24.11)**	1.57
Quintile 1	139	.7050 (4.83)	.0039 (5.47)**	.0075 (10.70)**	1.49
Quintile 2	137	.6496 (3.50)	.0028 (4.14)**	.0068 (9.63)**	1.38
Quintile 3	135	.7704 (6.29)	.0050 (7.37)**	.0076 (11.33)**	1.51
Quintile 4	138	.8116 (7.32)	.0049 (7.88)**	.0067 (10.81)**	2.07
Quintile 5	135	.7778 (6.46)	.0051 (7.39)**	.0077 (11.27)**	1.41

* Significant at 95% Level
** Significant at 99% Level

Table 16. Hypothesis 1 Test For MAD Change in Stock Splits Continued

Fixed Interval MAD Measurement Periods					
Sample	Comparisons	$Pr\{\bar{\sigma}_2^2 > \bar{\sigma}_1^2\}$ (Z)	$\overline{\Delta\bar{\sigma}_i^2}$ (t)	Positive $\overline{\Delta\bar{\sigma}_i^2}$ (t)	$\overline{\bar{\sigma}_2^2/\bar{\sigma}_1^2}$
1979-1984 Ex-Dates - TRANSACTION Intradaily (11am-2pm) Returns Data - T=25 Days (Missing Values = (.))					
Full Sample	622	.7894 (14.44)	.0029 (17.84)**	.0043 (26.95)**	2.32
Quintile 1	130	.8615 (8.24)	.0038 (10.05)**	.0048 (13.64)**	1.80
Quintile 2	125	.7600 (5.81)	.0030 (8.07)**	.0047 (14.72)**	1.73
Quintile 3	127	.7874 (6.48)	.0029 (7.31)**	.0043 (11.31)**	4.95
Quintile 4	125	.7120 (4.74)	.0025 (7.06)**	.0041 (11.84)**	1.52
Quintile 5	115	.8261 (6.99)	.0024 (7.58)**	.0032 (9.67)**	1.47
1979-1984 Ex-Dates - TRANSACTION Intradaily (11am-2pm) Returns Data - T=75 Days (Missing Values = (.))					
Full Sample	668	.7455 (12.69)	.0018 (12.23)**	.0033 (30.02)**	3.45
Quintile 1	137	.7080 (4.87)	.0017 (4.28)**	.0038 (12.08)**	1.72
Quintile 2	134	.6418 (3.28)	.0013 (3.85)**	.0036 (12.30)**	2.09
Quintile 3	134	.7836 (6.57)	.0021 (6.97)**	.0034 (14.90)**	10.21
Quintile 4	133	.8045 (7.02)	.0019 (6.90)**	.0031 (14.94)**	1.54
Quintile 5	130	.7923 (6.67)	.0018 (6.72)**	.0029 (14.68)**	1.64
1969-1985 Ex-Dates - TRANSACTION Intradaily (11am-2pm) Returns Data - T=25 Days (Missing Values = 0)					
Full Sample	684	.7383 (12.46)	.0026 (16.89)**	.0042 (27.54)**	1.94
Quintile 1	139	.7986 (7.04)	.0033 (8.75)**	.0048 (13.77)**	1.64
Quintile 2	137	.7153 (4.99)	.0027 (7.73)**	.0047 (15.23)**	1.91
Quintile 3	135	.7704 (6.28)	.0028 (7.44)**	.0042 (11.57)**	2.09
Quintile 4	138	.6884 (4.43)	.0022 (6.77)**	.0039 (11.90)**	1.51
Quintile 5	135	.7185 (5.08)	.0021 (7.13)**	.0033 (10.06)**	2.58
1979-1984 Ex-Dates - TRANSACTION Intradaily (11am-2pm) Returns Data - T=75 Days (Missing Values = 0)					
Full Sample	684	.7368 (12.39)	.0018 (13.33)**	.0033 (32.21)**	1.61
Quintile 1	139	.7050 (4.83)	.0016 (4.70)**	.0036 (13.57)**	1.46
Quintile 2	137	.6350 (3.51)	.0014 (4.35)**	.0035 (13.02)**	1.44
Quintile 3	135	.7926 (6.80)	.0021 (7.41)**	.0033 (15.38)**	1.87
Quintile 4	138	.7899 (6.81)	.0019 (7.32)**	.0030 (15.56)**	1.74
Quintile 5	135	.7630 (6.11)	.0018 (7.11)**	.0029 (15.36)**	1.53
*	Significant at 95% Level				
**	Significant at 99% Level				

Table 17. Hypothesis 1 Test For MAD Change in Stock Dividends Continued

Fixed Interval MAD Measurement Periods					
Sample	Comparisons	$Pr\{\bar{\sigma}_2^2 > \bar{\sigma}_1^2\}$ (Z)	$\overline{\Delta\bar{\sigma}_i^2}$ (t)	Positive $\overline{\Delta\bar{\sigma}_i^2}$ (t)	$\overline{\bar{\sigma}_2^2/\bar{\sigma}_1^2}$
1969-1985 Ex-Dates - CRSP Daily Returns Data - T = 25 Days					
Full Sample	1116	.4803 (-1.32)	-.0002 (-0.83)	.0004 (26.16)**	1.06
Quintile 1	224	.4509 (-1.47)	-.0003 (-0.57)	.0049 (13.62)**	1.06
Quintile 2	223	.4709 (- .87)	-.0003 (-0.63)	.0055 (10.02)**	1.07
Quintile 3	224	.5089 (.27)	-.0005 (1.31)	.0051 (12.89)**	1.10
Quintile 4	233	.4592 (-1.25)	-.0004 (-1.17)	.0047 (12.51)**	1.04
Quintile 5	212	.5142 (.41)	-.0003 (- .69)	.0037 (11.54)**	1.05
1969-1985 Ex-Dates - CRSP Daily Returns Data - T = 75 Days					
Full Sample	1116	.4830 (-1.14)	-.0002 (-1.35)	.0035 (26.40)**	1.03
Quintile 1	224	.5089 (.27)	-.0001 (-0.33)	.0037 (12.00)**	1.04
Quintile 2	223	.4664 (-1.00)	-.0004 (-1.20)	.0036 (11.11)**	1.02
Quintile 3	224	.4955 (- .13)	.0013 (0.13)	.0040 (13.09)**	1.04
Quintile 4	233	.4292 (-1.08)	-.0006 (-2.02)**	.0033 (11.09)**	1.00
Quintile 5	212	.5189 (.55)	-.0001 (-0.06)	.0028 (12.35)**	1.03
1969-1985 Ex-Dates - CRSP Daily Returns Data - T = 200 Days					
Full Sample	1116	.4776 (-1.50)	-.0001 (-1.38)	.0034 (27.26)**	1.02
Quintile 1	224	.4777 (- .67)	-.0000+ (-0.02)	.0037 (12.22)**	1.03
Quintile 2	223	.4574 (-1.27)	-.0004 (-1.40)	.0033 (12.34)**	1.00
Quintile 3	224	.4821 (- .54)	.0000 (0.07)	.0043 (12.96)**	1.04
Quintile 4	233	.4721 (- .85)	-.0003 (-1.06)	.0031 (11.60)**	1.01
Quintile 5	212	.5000 (0.00)	-.0002 (- .80)	.0028 (13.34)**	1.02
1969-1985 Ex-Dates - CRSP Daily Returns Data - T = 300 Days					
Full Sample	1116	.4642 (-2.40)	-.0004 (-3.00)**	.0037 (27.13)**	1.01
Quintile 1	224	.4375 (-1.89)	-.0003 (-0.96)	.0042 (12.72)**	1.01
Quintile 2	223	.4215 (-2.69)	-.0007 (-2.18)**	.0037 (12.46)**	.99
Quintile 3	224	.5000 (0.00)	-.0002 (-0.62)	.0041 (12.28)**	1.03
Quintile 4	233	.4678 (- .98)	-.0006 (-2.06)**	.0032 (12.00)**	.99
Quintile 5	212	.4953 (- .14)	-.0003 (-1.01)	.0030 (12.23)**	1.01

* Significant at 95% Level
** Significant at 99% Level

Table 18. Hypothesis 1 Test For MAD Change in Stock Dividends Continued

Fixed Interval MAD Measurement Periods					
Sample	Comparisons	$Pr\{\bar{\sigma}_2^2 > \bar{\sigma}_1^2\}$ (Z)	$\overline{\Delta\bar{\sigma}_i^2}$ (t)	Positive $\overline{\Delta\bar{\sigma}_i^2}$ (t)	$\bar{\sigma}_2^2/\bar{\sigma}_1^2$
1979-1984 Ex-Dates - CRSP Daily Returns Data - T = 25 Days					
Full Sample	247	.5304 (.96)	.0002 (0.41)	.0050 (13.10)**	1.08
Quintile 1	50	.5400 (.57)	.0006 (0.56)	.0062 (7.94)**	1.09
Quintile 2	50	.4200 (.28)	-.0015 (-1.24)	.0057 (4.71)**	1.02
Quintile 3	50	.6200 (1.70)	.0011 (1.72)	.0040 (6.38)**	1.10
Quintile 4	49	.4286 (-1.00)	.0001 (0.09)	.0067 (5.56)**	1.09
Quintile 5	48	.6458 (2.02)	.0006 (0.87)	.0035 (6.28)**	1.10
1979-1984 Ex-Dates - CRSP Daily Returns Data - T = 75 Days					
Full Sample	247	.5101 (.32)	-.0003 (-1.05)	.0029 (12.14)**	1.01
Quintile 1	50	.4800 (- .28)	-.0004 (-.54)	.0032 (4.15)**	1.01
Quintile 2	50	.4400 (- .85)	-.0003 (-2.30)**	.0022 (5.01)**	.96
Quintile 3	50	.4800 (- .28)	-.0005 (-0.82)	.0029 (6.29)**	.99
Quintile 4	49	.5102 (.14)	.0002 (0.25)	.0035 (5.73)**	1.03
Quintile 5	48	.6458 (1.98)	.0007 (1.53)	.0025 (8.12)**	1.07
1979-1984 Ex-Dates - CRSP Daily Returns Data - T = 200 Days					
Full Sample	247	.4656 (-1.08)	-.0004 (-1.66)	.0028 (13.64)**	1.00
Quintile 1	50	.4000 (-1.41)	-.0008 (-1.45)	.0026 (4.04)**	.96
Quintile 2	50	.4400 (- .85)	-.0001 (-2.22)**	.0027 (6.41)**	.98
Quintile 3	50	.5200 (0.28)	-.0003 (-1.45)	.0027 (6.59)**	1.01
Quintile 4	49	.5306 (.43)	-.0003 (-0.49)	.0030 (7.01)**	1.04
Quintile 5	48	.4376 (- .86)	-.0001 (-0.22)	.0032 (6.69)**	1.02
1979-1984 Ex-Dates - CRSP Daily Returns Data - T = 300 Days					
Full Sample	274	.3577 (-4.71)	-.0009 (-3.65)**	.0029 (12.65)**	1.04
Quintile 1	50	.2800 (-3.11)	-.0018 (-2.89)**	.0035 (3.98)**	.98
Quintile 2	50	.3400 (-2.26)	-.0018 (-3.09)**	.0027 (6.74)**	.91
Quintile 3	50	.4400 (- .85)	-.0007 (-1.29)	.0025 (5.70)**	1.01
Quintile 4	49	.4898 (- .14)	-.0000† (-0.04)	.0029 (6.70)**	1.20
Quintile 5	48	.4375 (- .87)	-.0003 (-0.55)	.0030 (5.97)**	1.13
*	Significant at 95% Level				
**	Significant at 99% Level				

Table 19. Hypothesis 1 Test For MAD Change in Stock Dividends Continued

Fixed Interval MAD Measurement Periods					
Sample	Comparisons	$Pr\{\bar{\sigma}_2^2 > \bar{\sigma}_1^2\}$ (Z)	$\overline{\Delta\bar{\sigma}_i^2}$ (t)	Positive $\overline{\Delta\bar{\sigma}_i^2}$ (t)	$\overline{\bar{\sigma}_2^2/\bar{\sigma}_1^2}$
1979-1984 Ex-Dates - TRANSACTION Daily Returns Data - T = 25 Days (Missing Values = (.))					
Full Sample	190	.4526 (-1.31)	.0022 (1.68)*	.0139 (6.32)**	1.42
Quintile 1	41	.3902 (-1.41)	-.0002 (-0.08)	.0114 (3.48)**	1.09
Quintile 2	36	.3889 (-1.42)	-.0046 (-1.91)*	.0211 (2.731.87)*	1.08
Quintile 3	33	.4545 (- .53)	.0068 (2.05)**	.0141 (3.99)**	1.37
Quintile 4	36	.5278 (.33)	.0045 (1.23)	.0104 (2.24)**	2.02
Quintile 5	44	.5000 (1.73)	.0045 (1.73)*	.0143 (3.42)**	1.55
1979-1984 Ex-Dates - TRANSACTION Daily Returns Data - T = 75 Days (Missing Values = (.))					
Full Sample	200	.5200 (.57)	.0022 (3.44)**	.0077 (9.18)**	1.72
Quintile 1	43	.5349 (.46)	.0021 (1.85)*	.0076 (6.47)**	1.35
Quintile 2	41	.4146 (-1.09)	.0006 (.47)	.0084 (4.46)**	1.59
Quintile 3	34	.6176 (1.37)	.0028 (1.94)*	.0073 (4.45)**	1.31
Quintile 4	38	.6053 (1.30)	.0029 (1.73)*	.0072 (3.04)**	2.37
Quintile 5	44	.4545 (- .80)	.0024 (1.73)*	.0085 (3.72)**	1.94
1969-1985 Ex-Dates - TRANSACTION Daily Returns Data - T = 25 Days (Missing Values = 0)					
Full Sample	208	.4279 (-2.08)	.0021 (1.82)*	.0134 (6.76)**	1.26
Quintile 1	43	.3721 (-1.68)	.0002 (0.08)	.0114 (3.44)**	1.09
Quintile 2	42	.3810 (-1.54)	-.0033 (-1.59)	.0082 (3.25)**	1.33
Quintile 3	36	.4167 (-1.00)	.0003 (2.05)**	.0211 (3.89)**	1.34
Quintile 4	43	.4651 (- .64)	.0035 (1.23)	.0128 (2.34)**	1.27
Quintile 5	44	.5000 (.00)	.0042 (1.71)*	.0138 (3.43)**	1.30
1979-1984 Ex-Dates - TRANSACTION Daily Returns Data - T = 75 Days (Missing Values = 0)					
Full Sample	208	.5240 (.69)	.0018 (3.41)**	.0067 (10.15)**	1.22
Quintile 1	43	.5581 (.76)	.0017 (1.62)	.0065 (5.97)*	1.25
Quintile 2	42	.4286 (- .18)	.0004 (.30)	.0070 (4.46)**	1.27
Quintile 3	36	.6111 (1.33)	.0028 (2.15)**	.0072 (4.89)**	1.21
Quintile 4	43	.5349 (.31)	.0011 (1.77)*	.0061 (3.62)	1.17
Quintile 5	44	.5000 (0.00)	.0021 (1.81)*	.0071 (4.13)**	1.19

* Significant at 95% Level
** Significant at 99% Level

Table 20. Hypothesis 1 Test For MAD Change in Stock Dividends Continued

Fixed Interval MAD Measurement Periods

Sample	Comparisons	$Pr\{\bar{\sigma}_2^2 > \bar{\sigma}_1^2\}$ (Z)	$\overline{\Delta\bar{\sigma}_i^2}$ (t)	Positive $\overline{\Delta\bar{\sigma}_i^2}$ (t)	$\overline{\bar{\sigma}_2^2/\bar{\sigma}_1^2}$
1979-1984 Ex-Dates - TRANSACTION Intradaily (11am-2pm) Returns Data - T = 25 Days (Missing Values = (.))					
Full Sample	191	.4660 (- .94)	-.0005 (-1.73)*	.0029 (9.96)**	1.07
Quintile 1	41	.5366 (.47)	-.0006 (-0.79)	.0033 (6.00)**	1.06
Quintile 2	37	.3784 (-1.48)	-.0011 (-1.32)	.0033 (3.53)**	.99
Quintile 3	33	.4242 (- .87)	-.0004 (-0.67)	.0030 (4.82)**	1.03
Quintile 4	36	.5000 (0.00)	.0001 (.15)	.0027 (5.13)**	1.16
Quintile 5	44	.4545 (- .80)	-.0006 (-0.94)	.0022 (3.38)**	1.11
1979-1984 Ex-Dates - TRANSACTION Intradaily (11am-2pm) Returns Data - T = 75 Days (Missing Values = (.))					
Full Sample	200	.5250 (.71)	.0003 (1.14)	.0026 (9.79)**	1.31
Quintile 1	43	.5814 (1.07)	-.0007 (1.21)	.0029 (4.45)**	1.23
Quintile 2	41	.4390 (- .78)	-.0001 (-0.18)	.0033 (5.24)**	1.38
Quintile 3	34	.5294 (.34)	.0004 (.64)	.0032 (3.51)**	1.18
Quintile 4	38	.5000 (0.00)	.0001 (.29)	.0023 (5.28)**	1.42
Quintile 5	44	.5682 (.90)	.0002 (.71)	.0017 (5.41)**	1.32
1979-1984 Ex-Dates - TRANSACTION Intradaily (11am-2pm) Returns Data - T = 25 Days (Missing Values = 0)					
Full Sample	208	.4471 (-1.53)	-.0004 (-1.62)	.0028 (10.05)**	1.11
Quintile 1	43	.5581 (.68)	-.0006 (- .75)	.0031 (5.68)**	1.07
Quintile 2	42	.4048 (-1.23)	-.0007 (-0.99)	.0034 (4.08)**	1.26
Quintile 3	36	.4167 (-1.00)	-.0005 (-0.81)	.0025 (4.41)**	1.03
Quintile 4	43	.4186 (-1.10)	.0000† (0.61)	.0027 (5.30)**	1.07
Quintile 5	44	.4318 (- .90)	-.0005 (-0.93)	.0023 (3.40)**	1.10
1979-1984 Ex-Dates - TRANSACTION Intradaily (11am-2pm) Returns Data - T = 75 Days (Missing Values = 0)					
Full Sample	208	.5144 (.42)	.0003 (1.24)	.0025 (10.91)**	1.20
Quintile 1	43	.5814 (1.07)	.0007 (1.25)	.0028 (4.52)**	1.20
Quintile 2	42	.4286 (- .93)	-.0001 (- .20)	.0032 (5.41)**	1.23
Quintile 3	36	.5000 (0.00)	.0003 (.61)	.0029 (5.08)**	1.09
Quintile 4	43	.4651 (-0.46)	.0002 (.42)	.0022 (5.57)**	1.27
Quintile 5	44	.5909 (1.21)	.0003 (.92)	.0016 (5.97)**	1.18

* Significant at 95% Level
** Significant at 99% Level

The binomial tests confirm Ohlson & Penman's variance shift results. Regardless of the dataset, dispersion measure, the time period from which splits were taken-all but one of the Z statistics are highly significant (> 3) for stock splits. The probabilities of the variance increases for the CRSP return datasets are approximately the levels of Ohlson & Penman. Transaction datasets generally show lower probabilities, but the Z statistic is significant nonetheless. There is strong evidence that a shift has occurred.

The cross-sectional average of the variance change is presented for the all observations, also for those observations showing an increase in variance . T-statistics accompany these mean changes in dispersion. Tests 1 and 2, (those measuring actual variance) show significant shifts in the returns' variance for the entire sample as well as the subsamples of observations showing increases. The exception occurs in the larger firm sizes for the tests relying upon the transaction datasets. The exceptions are consistent across the treatment of missing values as well.

The size of average variance changes for the transaction data sets and the extraordinarily high ratios of post-split to pre-split variance (hereafter referred to as simply ratios) suggests that outliers are effecting the average change in variance. In fact, the average ratios generated in Test 1 and Test 2 are all higher than 2, some much higher. Ohlson & Penman showed average increases less than 100%. This questions the significance of the variance change. The 75-day average percentage change in the returns' variance change was an increase of 82.60%, which is similar to the percentage reported by Ohlson & Penman.

An examination was made using datasets truncated in order to reduce outlier impact. The fifty largest and smallest variance change ratios were removed. The stock dividend tests for the period 1979-1984 were truncated by a total of fifty observations since the data set was smaller. The ratios in the truncated tests are slightly smaller, yet still larger than Ohlson & Penman found. The average variance changes are still significant. In fact, the T statistics for the average variance change tend to be higher, indicating that, with the outliers removed, the significance of the shift is valid.[14]

The results of Test 3 also shows a significant mean absolute deviation increase for the majority of splits. The increase in the mean absolute deviation ranges from 50% to 80% and is more in line with Olson & Penman's increases.

The phenomenon is confirmed. Firm size does not appear to be a factor. Larger firms often exhibited a slightly larger probability across the measures and datasets, though occassionally the change was not significant for the higher priced firms when non-closing prices were used to generate the returns. A firm size effect was evident in the returns generated from the intraday prices. Figure 1 provides a plot of the 75-day variance change for the various firm sizes.

Indeed, intraday prices always exhibited significant Z statistics, though smaller probabilities. It is interesting that the average change of variance for the intraday observations is often of the magnitude of the average variance changes for the CRSP returns-generated average variance shift. This may stem from the outlier effect. There is an alternative explanation. Variances for returns derived from intraday prices are smaller than variances based upon closing prices. Changes in the price level and behavior of the price changes would have a greater impact on the intraday variance. This does not explain the reduced Z statistics, however.

Also, the intraday data was restricted to the seventy-five days of data each side of the split while the CRSP data afforded larger data sets. Examining Tables 5 and 6, there is evidence in the CRSP data alone, that the average variance changes are larger the shorter the interval in which they are calculated. The period of study is not a factor

[14] The results for the examination using the truncated datasets are available upon request.

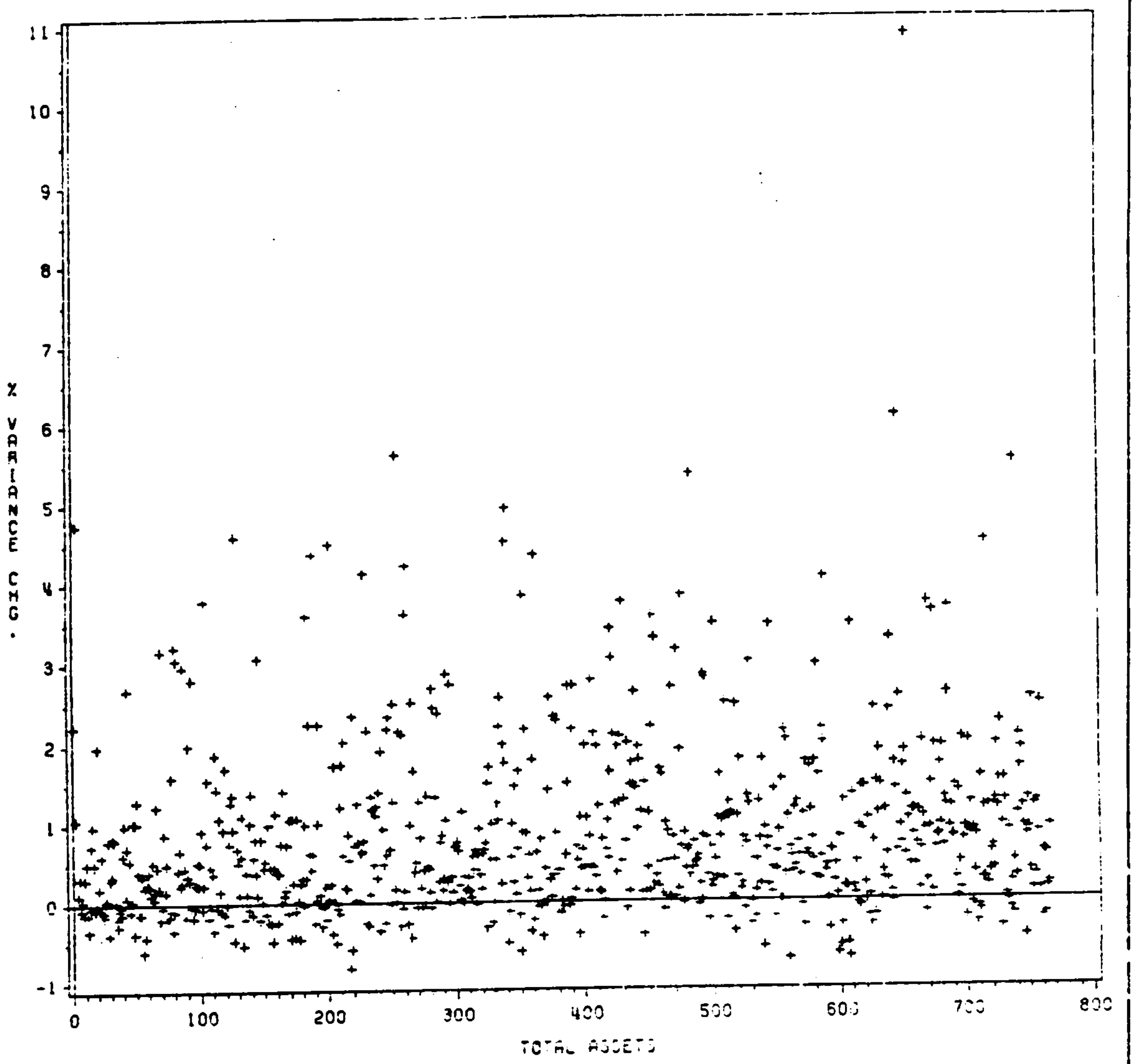

Figure 1. Variance Change vs. Total Assets

since the CRSP results for the period also covering the transaction data are not different from the CRSP results of the entire 1969-1985 study period.

Test 1 used the interim period length as used by Ohlson & Penman. The introduction of the various fixed measurements periods, as noted earlier, was done to incorporate both event days and the averaging effect of introducing more non-event days as the test period lengthened. Test 2 and Test 3 used this approach.

Tables 5 through 8 and Tables 13 through 16 present similar findings for variance measures and mean absolute deviation measures, respectively. Some general statements can be made for both tests, regardless of the test period or returns dataset.

The first observation is that, as the measurement time period increases there appears to be a reduction in the probability of the percentage of firms exhibiting a dispersion increase. The proportion is always highly significant, however. This drop is approximately .05 from the 25-day measurement period to the 300-day measurement period. While the drop is consistent, it may not be significant. I infer it reflects the averaging of more non-event days. There is also the possibility of more missing values occurring and thus reducing the variance beyond the 175 day requirement for CRSP returns data. The significance of the shift for the longer period also supports the permanence of the shift.

So, the majority of firms show increased dispersion in the returns and that dispersion increase is significant. This appears to be regardless of the firm's size, how the dispersion was measured, the length of time used in the measurement period, or the time of day used to select prices used to generate the returns. The increased variance phenomenon is confirmed to take place to some extent in most firms.

Ohlson & Penman found that the return mean did not shift. They used the binomial probability test to determine the finding. The change in the means used to determine the variance dispersion measure were calculated and the averages of the mean changes for the CRSP data tests are presented in Tables 21 through 24. Mean returns generated from intraday prices had mixed results. Consistent mean increases were found for some datasets, decreases or insignificant changes for others. The correlation between the variance change and the mean change, however, is low. Correlations were run for the respective changes for each disperson change test using CRSP data. Correlations were always less than .20, with correlations for Test 1 and Test 3 generally having an absolute value less than .01. The sign was not consistent.[15] A cross-sectional mean of the change of the price relative mean return for the 75-day period was 9.46%, but the increase is insignificant. Figure 2 presents a plot the the 75-day variance change and the 75-day return mean change. No relationship can be detected from the graph.

Any outlier effect is pervasive for quintiles and measurement periods. For the CRSP returns the average difference is generally nonsignificant for the interim period and the 25-day measurement period. One explanation for this finding is that the first measurement period would have no returns from the pre-declaration period and the second measure would have relatively few as the average interim period is approximately forty-eight days.

It appears that the anticipation of improved earnings is seen in a higher daily or intradaily return mean up to the announcement date. This supports FFJR's finding of excess returns prior to the announcement and split, though not after. Since the average difference is still seen for the 300-day measurement period, the increase in beta reported several months before the split and the decline in beta across the split is supported with the decline in the mean. Rapid price adjustment was reported by FFJR. It appears that the market corrected the price prior to the split to account for the future (expected) earnings increases and this correction is reflected in the differences in the longer-term

[15] The mean changes for the various datasets are available upon request.

Table 21. Hypothesis 1 Test For Mean Change in Stock Splits Continued

Sample	$\Delta\overline{RETURN}$	(t)	$\Delta\overline{RETURN}$	(t) for $\bar{\sigma}_2^2 > \bar{\sigma}_1^2$
1969-1985 Ex-dates-CRSP Daily Ret. Data-Var. Change Test 1.				
Full Sample	.0001	(.74)	.0002	(1.28)
Quintile 1	.0005	(1.38)	.0007	(1.67)*
Quintile 2	-.0006	(-1.75)*	-.0005	(-1.23)
Quintile 3	.0002	(.53)	.0003	(.79)
Quintile 4	.0001	(.27)	.0001	(1.42)
Quintile 5	.0004	(1.63)	.0003	(1.42)
1969-1985 Ex-dates-CRSP Daily Ret. Data-Var. Change Test 2 (75-day)				
Full Sample	-.0006	(-6.47)**	-.0006	(-6.02)**
Quintile 1	-.0010	(-4.19)**	-.0012	(-4.27)**
Quintile 2	-.0013	(-6.35)**	-.0013	(-5.43)**
Quintile 3	-.0006	(-5.43)**	-.0005	(-2.41)**
Quintile 4	-.0001	(-0.77)	-.0002	(-1.28)
Quintile 5	.0001	(0.46)	.0001	(0.50)
1969-1985 Ex-dates-CRSP Daily Ret. Data-Var. Change Test 3 (75-day)				
Full Sample	-.0005	(-8.96)**	-.0005	(-8.28)**
Quintile 1	-.0009	(-5.92)**	-.0011	(-6.19)**
Quintile 2	-.0005	(-3.52)**	-.0005	(-2.81)**
Quintile 3	-.0004	(-3.28)**	-.0004	(-2.56)**
Quintile 4	-.0004	(-3.42)**	-.0004	(-3.06)**
Quintile 5	-.0004	(-3.80)**	-.0004	(-4.02)**

* Significant at 95% Level

** Significant at 99% Level

Table 22. Hypothesis 1 Test For Mean Change in Stock Splits Continued

Sample	$\Delta\overline{RETURN}$	(t)	$\Delta\overline{RETURN}$	(t) for $\bar{\sigma}_2^2 > \bar{\sigma}_1^2$
1979-1984 Ex-dates-CRSP Daily Ret. Data-Var. Change Test 1.				
Full Sample	.0001	(0.29)	.0002	(0.74)
Quintile 1	.0005	(0.87)	.0006	(1.08)
Quintile 2	-.0004	(-0.83)	-.0004	(-0.66)
Quintile 3	-.0004	(- .79)	-.0003	(-0.63)
Quintile 4	.0001	(.26)	.0003	(0.64)
Quintile 5	.0005	(1.49)	.0005	(1.39)
1979-1984 Ex-dates-CRSP Daily Ret. Data-Var. Change Test 2 (75-day)				
Full Sample	-.0008	(-6.17)**	-.0008	(-5.45)**
Quintile 1	-.0016	(-4.71)**	-.0016	(-3.78)**
Quintile 2	-.0015	(-4.72)**	-.0016	(-4.59)**
Quintile 3	-.0007	(-2.39)**	-.0008	(-2.21)**
Quintile 4	-.0005	(-1.68)	-.0004	(-1.43)
Quintile 5	.0001	(0.42)	.0000	(0.13)
1979-1984 Ex-dates-CRSP Daily Ret. Data-Var. Change Test 3 (75-day)				
Full Sample	-.0005	(-5.32)**	-.0004	(-4.55)**
Quintile 1	-.0006	(-2.78)**	-.0006	(-2.48)**
Quintile 2	-.0005	(-2.46)**	-.0004	(-1.75)*
Quintile 3	-.0004	(-1.97)**	-.0003	(-1.48)
Quintile 4	-.0003	(-1.69)*	-.0004	(-1.93)*
Quintile 5	-.0005	(-3.22)**	-.0004	(-2.88)**

* Significant at 95% Level
** Significant at 99% Level

Table 23. Hypothesis 1 Test For Mean Change in Stock Dividends Continued

1969-1985 Ex-dates-CRSP Daily Ret. Data-Var. Change Test 1.				
Sample	$\Delta\overline{RETURN}$	(t)	$\Delta\overline{RETURN}$	(t) for $\bar{\sigma}_2^2 > \bar{\sigma}_1^2$
Full Sample	-.0019	(-5.28)**	.0001	(0.18)
Quintile 1	-.0030	(-3.31)**	.0005	(0.53)
Quintile 2	-.0023	(-2.78)**	-.0005	(-0.46)
Quintile 3	-.0011	(-1.49)	.0007	(0.76)
Quintile 4	-.0025	(-2.98)**	-.0011	(-1.36)
Quintile 5	-.0007	(-1.15)	.0009	(0.95)
1969-1985 Ex-dates-CRSP Daily Ret. Data-Var. Change Test 2 (75-day)				
Full Sample	-.0005	(-4.43)**	-.0001	(-.48)**
Quintile 1	-.0008	(-3.07)**	.0002	(0.53)**
Quintile 2	-.0006	(-2.13)**	-.0006	(-1.51)**
Quintile 3	-.0004	(-1.69)*	.0000	(0.05)**
Quintile 4	-.0005	(-1.89)*	.0002	(0.74)
Quintile 5	-.0002	(-0.99)	-.0003	(-0.74)
1969-1985 Ex-dates-CRSP Daily Ret. Data-Var. Change Test 3 (75-day)				
Full Sample	-.0000	(-0.38)	-.0004	(-3.27)**
Quintile 1	-.0000	(-0.03)	-.0004	(-1.59)
Quintile 2	.0000	(0.04)	-.0003	(-1.35)
Quintile 3	-.0002	(-0.97)	-.0006	(-2.44)**
Quintile 4	-.0000	(-0.11)	-.0006	(-1.50)
Quintile 5	.0001	(0.32)	-.0001	(-0.29)

* Significant at 95% Level
** Significant at 99% Level

Table 24. Hypothesis 1 Test For Mean Change in Stock Dividends Continued

1969-1985 Ex-dates-CRSP Daily Ret. Data-Var. Change Test 1.				
Sample	$\Delta\overline{RETURN}$	(t)	$\Delta\overline{RETURN}$	(t) for $\bar{\sigma}_2^2 > \bar{\sigma}_1^2$
Full Sample	-.0005	(-0.70)	.0001	(0.07)
Quintile 1	-.0006	(-0.34)	.0039	(1.56)
Quintile 2	-.0010	(-0.62)*	.0006	(0.24)
Quintile 3	.0008	(.53)	-.0011	(-0.48)
Quintile 4	-.0029	(-1.57)	-.0044	(-1.85)*
Quintile 5	.0011	(0.79)	.0010	(0.81)
1969-1985 Ex-dates-CRSP Daily Ret. Data-Var. Change Test 2 (75-day)				
Full Sample	-.0002	(-0.91)	.0001	(0.31)
Quintile 1	-.0005	(-0.67)	.0005	(0.52)
Quintile 2	-.0009	(-1.57)	-.0017	(-1.97)*
Quintile 3	-.0004	(-0.82)	.0001	(0.11)
Quintile 4	.0004	(0.76)	.0007	(0.88)
Quintile 5	.0002	(0.54)	.0008	(1.33)
1969-1985 Ex-dates-CRSP Daily Ret. Data-Var. Change Test 3 (75-day)				
Full Sample	-.0003	(-1.98)*	-.0005	(-2.73)**
Quintile 1	-.0000	(-0.07)	-.0006	(-1.64)
Quintile 2	-.0000	(-0.06)	.0004	(0.74)
Quintile 3	-.0005	(-1.46)	-.0011	(-2.04)**
Quintile 4	-.0007	(-1.92)*	-.0010	(-2.20)**
Quintile 5	-.0003	(-0.90)	-.0005	(-1.28)

* Significant at 95% Level

** Significant at 99% Level

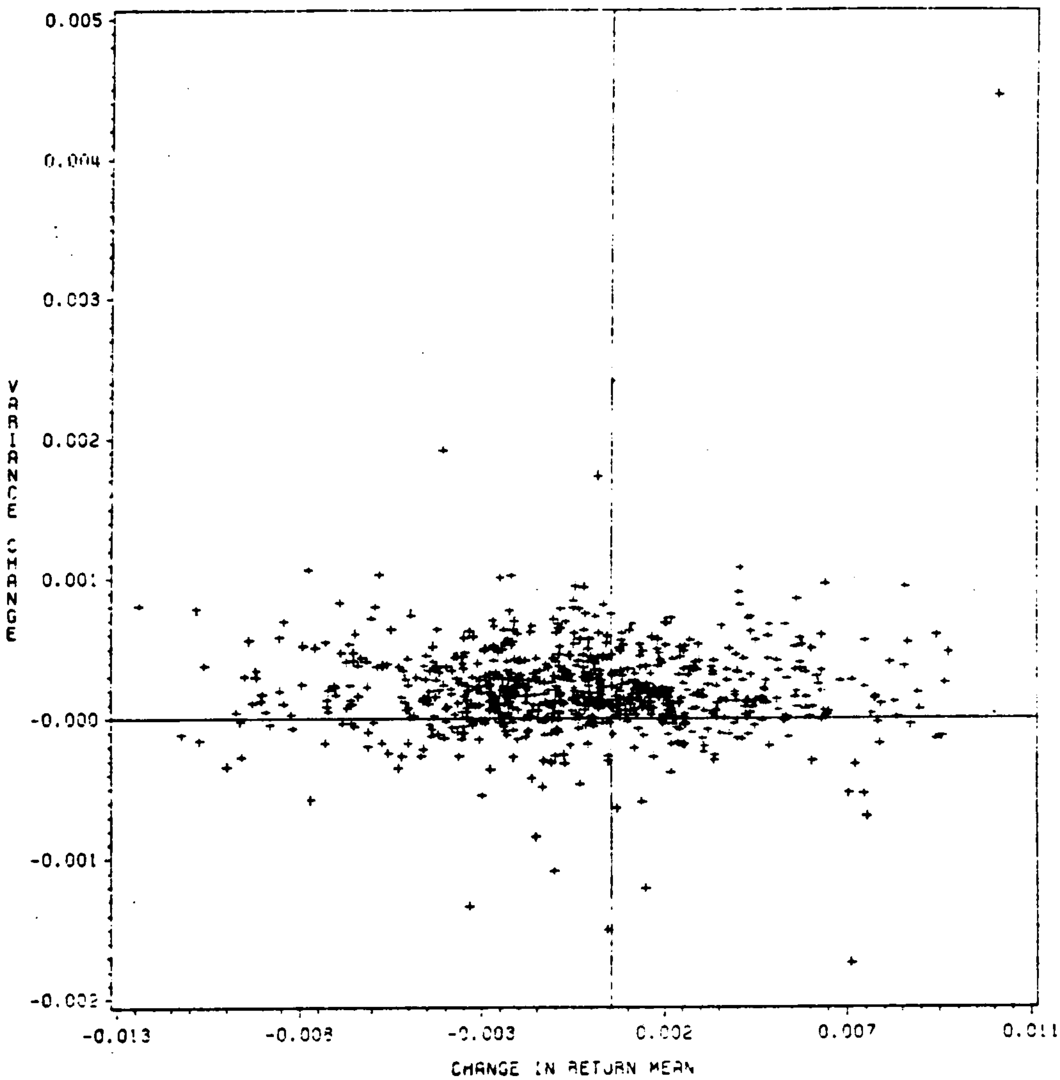

Figure 2. Variance Change vs. Mean Change (75 Day Period)

return means each side of the split. The returns' mean decline, while perhaps becoming a factor of the variance shift for the longer periods, does not contribute to the explantion of the findings in Test 1 of the variance shifts seen in the shorter dispersion measurement periods. In fact, the correlation between the mean change and variance change for the 75-day period is -.00411 for 1969-1985 period and .01463 for the 1979-1984 period. The mixed results and low correlation suggest the mean change is not significant and not contributing to the variance shift.

Stock Dividend Variance Shift Examination: Before further examining the duration and factors effecting variance shift, the results of the previous tests for stock dividends are presented. The Z statistics for three dispersion tests, with very few exceptions, are not significant. The negative sign on the T statistics and the probabilities less than .5000 indicates a tendency for the variance to decline, as reported in extant literature. The average variance change also indicates variance decline. Generally, the average decline is not significant however. Again, the ratios indicate the presence of a few outliers, though the outlier effect appears dampened in the intraday returns' results.

The findings here support the earlier research cited. Stock dividends do not evidence variance increase around the ex-date, in fact, there is a slight decline. A firm size effect appears to exist for the means, with smaller firms exhibiting a decline in their daily mean return, since smaller firms have been shown to generally be contributing to the significance of the mean daily return change. This may not be significant as discussed earlier. The effect of the price change limit is examined shortly. If price change microstructure and price level-related components of the price change are important in the variance shift, then price shift associated with a stock dividend may be too small for changes in the spread and relationships of the price change limit and average price change to take place. The accounting treatment differences between splits and dividends should not make any difference in the market unless trading behavior is different.

Returning to the results for splits, the previous series of tests confirmed the positive variance shift for stock splits and a slight negative shift for dividends. Table 25 presents the comparisons of 75-day variances for periods immediately before and after the ex-date with a 75-day period about one trading year after the split. The evidence from the longer measurement periods suggests the duration is relatively permanent, certainly within the confines of the data. The results of an alternative duration test for stock dividends is presented in Table 25.

The dispersion increase remains significant over one trading year after the split. This confirms cited empirical results. It also suggests the change is not directly due to changes in value. When tested on the same side of the ex-date, however, there is evidence that a significant long term decline in variance is occurring. This decline is not large relative to the increase due to the split. The low probabilities seen in the longer measurement periods offer support.

The dispersion appears to increase prior to the split, because improved earnings that have occurred and expectations about future earnings causing steady price rises. The dispersion also increases dramatically at the split. Since the excess returns cease at the split, presumably the subsequent decline (which through averaging brings down the percentage of increased variances) is more likely connected with changes in either firm value or liquidity.

Systematic Examinations: The connection between the market return and variance and that of the firm return and variance is expressed in the beta of CAPM as discussed before. It is less clear if the magnitude of the market variance would influence the size and significance of the variance change around splits. The correlation between the market

Table 25. Hypothesis 1 Test For Variance Change in Stock Splits Continued

Duration of 75-Day Variance Examination					
Sample	Comparisons	$Pr\{\bar{\sigma}_2^2 > \bar{\sigma}_1^2\}$ (Z)	$\overline{\Delta\bar{\sigma}_i^2}$ (t)	Positive $\overline{\Delta\bar{\sigma}_i^2}$ (t)	$\overline{\bar{\sigma}_2^2/\bar{\sigma}_1^2}$
1969-1985 Ex-Dates - CRSP Daily Returns Data - Variance Comparison for Days -76 to -1 vs. Days 225 to 300.					
Full Sample	1394	.6808 (13.50)	.0001 (10.53)**	.0003 (27.22)**	1.72
Quintile 1	282	.6241 (4.07)	.0001 (3.21)**	.0004 (13.42)**	1.71
Quintile 2	287	.6272 (4.31)	.0001 (4.21)**	-.0003 (12.07)**	1.62
Quintile 3	282	.6950 (6.54)	.0001 (5.32)**	.0003 (13.21)**	1.80
Quintile 4	272	.7390 (7.88)	.0001 (7.09)**	.0003 (13.21)**	1.81
Quintile 5	271	.7232 (4.06)	.0001 (6.12)**	.0002 (10.41)**	1.69
1969-1985 Ex-Dates - CRSP Daily Returns Data - Variance Comparison for Days Ex-date to 75 vs. Days 225 to 300.					
Full Sample	1394	.3694 (-9.75)	-.0001 (-6.60)**	.0003 (18.70)**	1.02
Quintile 1	282	.3901 (-3.69)	-.0001 (-2.58)**	.0004 (10.40)**	1.08
Quintile 2	287	.3659 (-4.54)	-.0001 (-2.92)**	.0003 (9.81)**	1.04
Quintile 3	282	.3688 (-4.41)	-.0001 (-3.64)**	.0003 (8.05)**	1.03
Quintile 4	272	.3603 (-4.61)	-.0001 (-2.94)**	.0002 (8.41)**	1.01
Quintile 5	271	.3616 (-4.56)	-.0001 (-3.75)**	.0002 (5.67)**	.96
1969-1985 Ex-Dates - CRSP Daily Returns Data - MAD Comparison for Days -76 to -1 vs. Days 225 to 300.					
Full Sample	1394	.6966 (14.68)	.0023 (16.20)**	.0047 (37.81)**	1.24
Quintile 1	282	.6631 (5.48)	.0023 (5.77)**	.0036 (16.41)**	1.24
Quintile 2	281	.6307 (4.42)	.0019 (5.58)**	.0050 (15.29)**	1.20
Quintile 3	282	.7128 (7.15)	.0022 (7.37)**	.0046 (20.39)**	1.24
Quintile 4	272	.7500 (8.25)	.0029 (10.30)**	.0047 (18.17)**	1.29
Quintile 5	271	.7306 (7.59)	.0022 (9.20)**	.0038 (16.72)**	1.23
1969-1985 Ex-Dates - CRSP Daily Returns Data - MAD Comparison for Days Ex-date to 75 vs. Days 225 to 300.					
Full Sample	1394	.3802 (-8.95)	-.0013 (-9.64)**	.0035 (25.95)**	.96
Quintile 1	282	.4397 (-2.03)	-.0011 (-2.90)**	.0041 (12.26)**	.99
Quintile 2	287	.3902 (-3.72)	-.0014 (-4.09)**	.0041 (12.35)**	.96
Quintile 3	282	.3723 (-4.29)	-.0016 (-5.87)**	.0036 (11.31)**	.94
Quintile 4	272	.3382 (-5.34)	-.0010 (-3.81)**	.0027 (11.05)**	.97
Quintile 5	271	.3579 (-4.68)	.0000† (0.26)	-.0017 (-11.38)**	.93

* Significant at 95% Level.
** Significant at 99% Level

Table 26. Hypothesis 1 Test For Variance Change in Stock Dividends Continued

Duration of 75-Day Variance Examination					
Sample	Comparisons	$Pr\{\bar{\sigma}_2^2 > \bar{\sigma}_1^2\}$ (Z)	$\overline{\Delta\bar{\sigma}_i^2}$ (t)	Positive $\overline{\Delta\bar{\sigma}_i^2}$ (t)	$\overline{\bar{\sigma}_2^2/\bar{\sigma}_1^2}$
1969-1985 Ex-Dates - CRSP Daily Returns Data - Variance Comparison for Days -76 to -1 vs. Days 225 to 300.					
Full Sample	1054	.4810 (-1.23)	-.0000† (-0.42)	.0004 (18.67)**	1.35
Quintile 1	213	.5023 (.07)	.0000† (.38)	.0005 (9.34)**	1.41
Quintile 2	208	.4760 (- .69)	-.0000† (- .21)	.0004 (8.73)**	1.31
Quintile 3	213	.4601 (-1.16)	-.0000† (- .21)	.0005 (8.10)**	1.43
Quintile 4	218	.4817 (- .54)	-.0000† (- .84)	.0003 (8.82)**	1.28
Quintile 5	202	.4851 (- .42)	- .0000† (- .30)	.0003 (7.66)**	1.39
1969-1985 Ex-Dates - CRSP Daily Returns Data - Variance Comparison for Days Ex-date to 75 vs. Days 225 to 300.					
Full Sample	1054	.5038 (.25)	.0000† (1.24)	.0003 (11.06)**	1.27
Quintile 1	213	.5352 (1.03)	.0000† (0.49)	.0004 (9.98)**	1.25
Quintile 2	208	.5000 (0.00)	.0000† (0.80)	.0004 (8.33)**	1.28
Quintile 3	213	.4789 (- .62)	-.0000† (-0.13)	.0004 (8.18)**	1.28
Quintile 4	218	.5046 (.14)	.0000† (1.58)	.0003 (8.83)**	1.28
Quintile 5	202	.5000 (0.00)	-.0000† (-1.07)	.0003 (7.81)**	1.28
1969-1985 Ex-Dates - CRSP Daily Returns Data - MAD Comparison for Days -76 to -1 vs. Days 225 to 300.					
Full Sample	1054	.4886 (- .74)	.0001 (0.35)	.0051 (24.56)**	1.08
Quintile 1	213	.4977 (- .07)	.0004 (0.79)	.0059 (12.71)**	1.10
Quintile 2	208	.4094 (- .28)	-.0001 (-0.12)	.0053 (11.17)**	1.07
Quintile 3	213	.4695 (- .89)	.0003 (0.56)	.0060 (10.24)**	1.11
Quintile 4	218	.5000 (0.00)	-.0003 (-0.56)	.0042 (10.97)**	1.04
Quintile 5	202	.4851 (- .42)	-.0000† (-0.03)	.0044 (10.88)**	1.07
1969-1985 Ex-Dates - CRSP Daily Returns Data - MAD Comparison for Days Ex-date to 75 vs. Days 225 to 300.					
Full Sample	1054	.4962 (-0.25)	.0000† (0.06)	.0044 (25.09)**	1.05
Quintile 1	213	.5070 (.20)	-.0001 (-0.17)	.0047 (12.63)**	1.05
Quintile 2	208	.5288 (.83)	.0000† (0.10)	.0043 (11.15)**	1.05
Quintile 3	213	.4648 (-1.03)	-.0001 (-0.31)	.0050 (10.18)**	1.05
Quintile 4	218	.4954 (- .14)	.0003 (0.85)	.0041 (11.59)**	1.06
Quintile 5	202	.4851 (- .43)	-.0001 (-0.24)	-.0040 (11.19)**	1.04

* Significant at 95% Level
** Significant at 99% Level

variance level and the returns variance change was -.0214. The regression coefficient for the market variance level was -570.673, but it was not significant, with a t-value of -.451. The model's F-value was only .203 and the adjusted R^2 was negative. The regression results confirm Ohlson & Penman's results. The change in the variance associated with stock splits does not appear to contain a systematic component. This is supported by the MAD increases, which may be considered as excess returns.

The correlation of the market variance level and the percentage variance change for stock dividends was .10874. The regression coefficient was positive (1345.94) and significant ($t = 3.495$) at the $\alpha < .0005$ level. The F-value was 12.217 and also significant. The adjusted R^2 was only .0109.

Firm-Specific Variable Examiniation: The change in the debt-to-equity ratio across the year containing the split showed a cross-sectional mean increase of .1844 ($t = 29.05$.) This represents a sizeable increase in debt. In fact, the cross-sectional mean increase in debt across the year was 224.14 millions dollars, which obviously includes some large debt increases for a few firms. Figure 3 presents a plot of the 75-day daily variance change against the one year change in debt.

Means for the debt change and other firm-specific variables are presented in Table 27. While most firms did not change their debt load significantly, there is a slight preference for taking on more debt. The five year average change in debt was 648.39 millions dollars ($t = 3.01$.) The amount of new equity issued after the split is not examined here, but is left for future research. It would appear that the pecking order theory of capitalization is more appropriate here than the reported split justification that the split makes equity issue easier.

The increase in debt (which was negatively correlated with the variance change with correlations of -.03882 and -.10835, respectively for the one-year and the five-year

Table 27. Distributions of Firm-Specific Variables

Variable Description	Mean	Std. Dev.	T
Price Adjustment Factor on Ex-date	.8035	.5288	42.00
Change in the Debt/Equity Ratio	.1835	.1697	29.05
1-Year Mean Debt Change	$224.144mm	1768.256	3.34
5-Year mean Debt Change	$648.393mm	2568.894	3.01
% Chg. in Total Divdends	.2282	.5082	9.70
Mean Number of Splits for Firm	1.96	1.08	n.a.
% of Firm Traded Daily Before Split	.00134	.0018	18.54
% of Firm Traded Daily After Split	.00122	.0013	23.70
% Chg. in Avg. Daily Price Chg. Var.	-.0979	3.3652	-0.78

changes) accompanied by the known improved earnings concurs with the retained earnings hypothesis in that the signal is strong that improved earnings are sufficient to maintain or improve absolute payout and are sufficient to encourage managers to engage in taking on more debt and any bond covenants that are attached. The examination of retained earnings use is not done here to examine the pecking order theory's application.

Several comments are derived but not tested here. The first comment is that 83 observations (out of 765 observations) had contaminating news prior to the split concerning mergers and acqusitions. The debt findings may be influenced by subsequent acquisitions by the firms that have split their stock. The acquisition would change the capital structure considerably. A choice of debt financing for such acquisitions might explain the findings here.

The second comment is that the general increase in debt would indeed make the firm more risky, ceteris paribus. In that sense, the mean and variance of returns would be expected to increase unless the use of the debt financing is providing a diversification effect. New plant and equipment might be expected to increase profit and thereby counter the added risk to debt. Finally, the correlations presented above are negative. With both returns' variance and debt increasing, the correlations would indicate that the larger debt increases occurred at firms with the smaller variance increases. There is slight support of this in Figure 3. This would support the suggestion that the use of debt in combination with the improved retained earnings potential reduces risk. In other words, the use of debt reduces the variance increase. This is not seen in Figure 3, however. Future research should examine changes in the cost of the debt due to the split.

The other variable measured as a cross-sectional mean change is the change in dividends. A significant mean increase is seen of about 23 percent (t = 11.02.) This is fully expected from the cited literature. Figure 4 presents the change in the 75-day var-

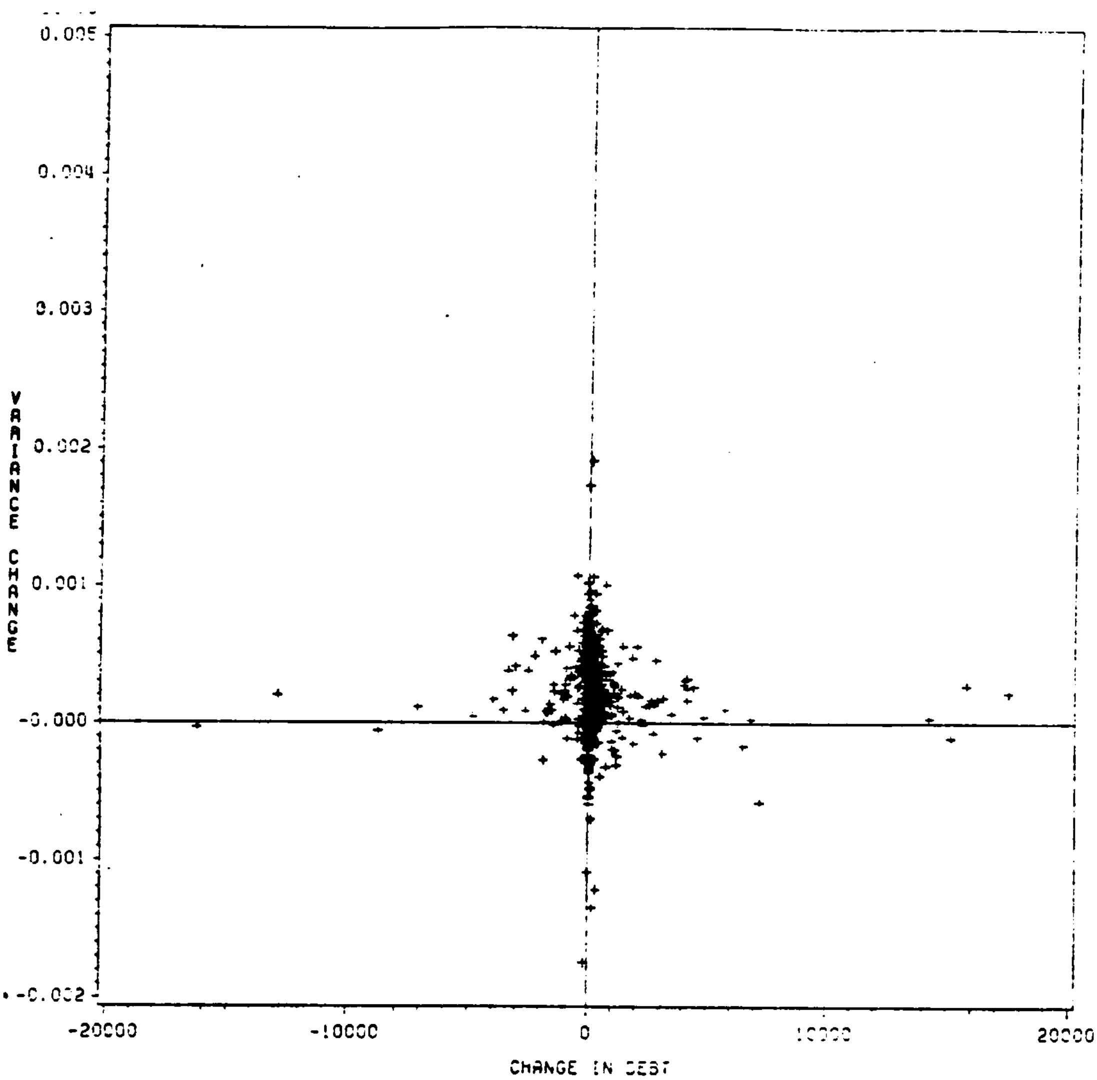

Figure 3. Variance Change vs. 1 Year Debt Change

iance plotted against the ratio of the new dividend payout to the old dividend payout. Figure 5 presents the percentage change in the 75-day variance plotted against the ratio of the new dividend payout to the old dividend payout. Dividends are the total dividends in millions of dollars paid out for the year, either the year ending prior to the split or for the year of the split. This probably biases the ratio change downward if dividend increases are generally seen after the split. The plot shows that a number of firms decreased their dividends. FFJR reported that the large majority of firms kept payout the same or increased it. The correlation between the change in dividend payout and the change in the 75-day variance shift is negative (-.07673.) There is a weak correlation. This suggests that firms with the largest change in dividend payout (which may be announced or anticipated prior to the ex-date) may have slightly smaller increases in variance.

The SIC code was included because financial firms had been removed from one study in the literature because stock distributions were so frequent for that industry. As noted above, no particular code number contributed in a significant way through its frequency. Associated codes were not grouped. The SIC code correlation to the variance change was negative and not large (-.09421.)

The frequency of split use by a firm was included as a factor and showed a negative correlation of -.11812 with the variance shift. This suggests that the variance surrounding the split is reduced in subsequent splits for that firm. This may be because the market perceives less risk. An alternative explanation could be made that subsequent splits were not of the original price magnitude and exhibited different characteristics relative to price. The correlation is not large and the regression results will be discussed shortly, but if the relationship is valid the finding may be based upon market perception or, alternatively, simply related to price magnitude and changes. This question is not answered here, but remains for future research to answer.

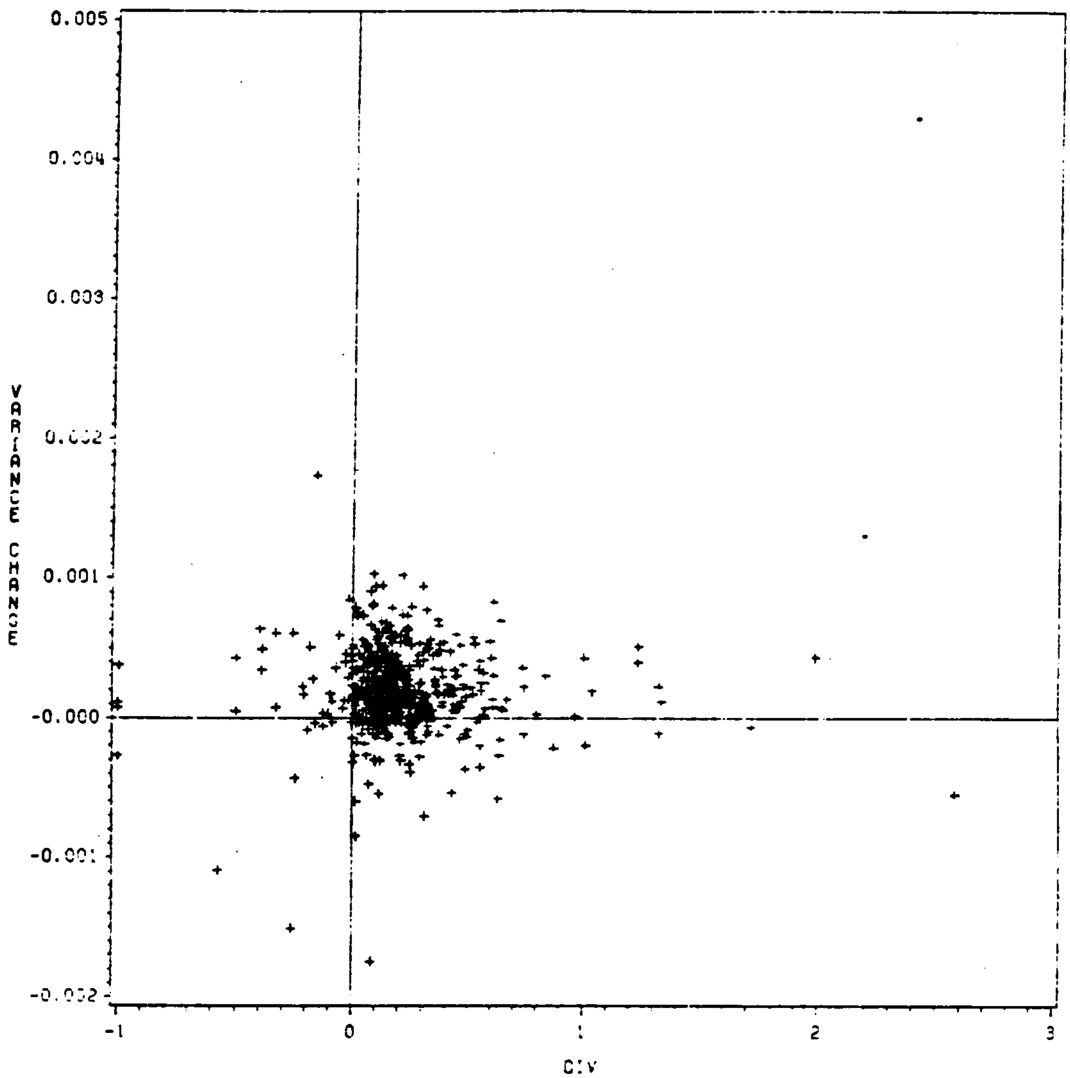

Figure 4. Variance Change vs. % Change in Dividends

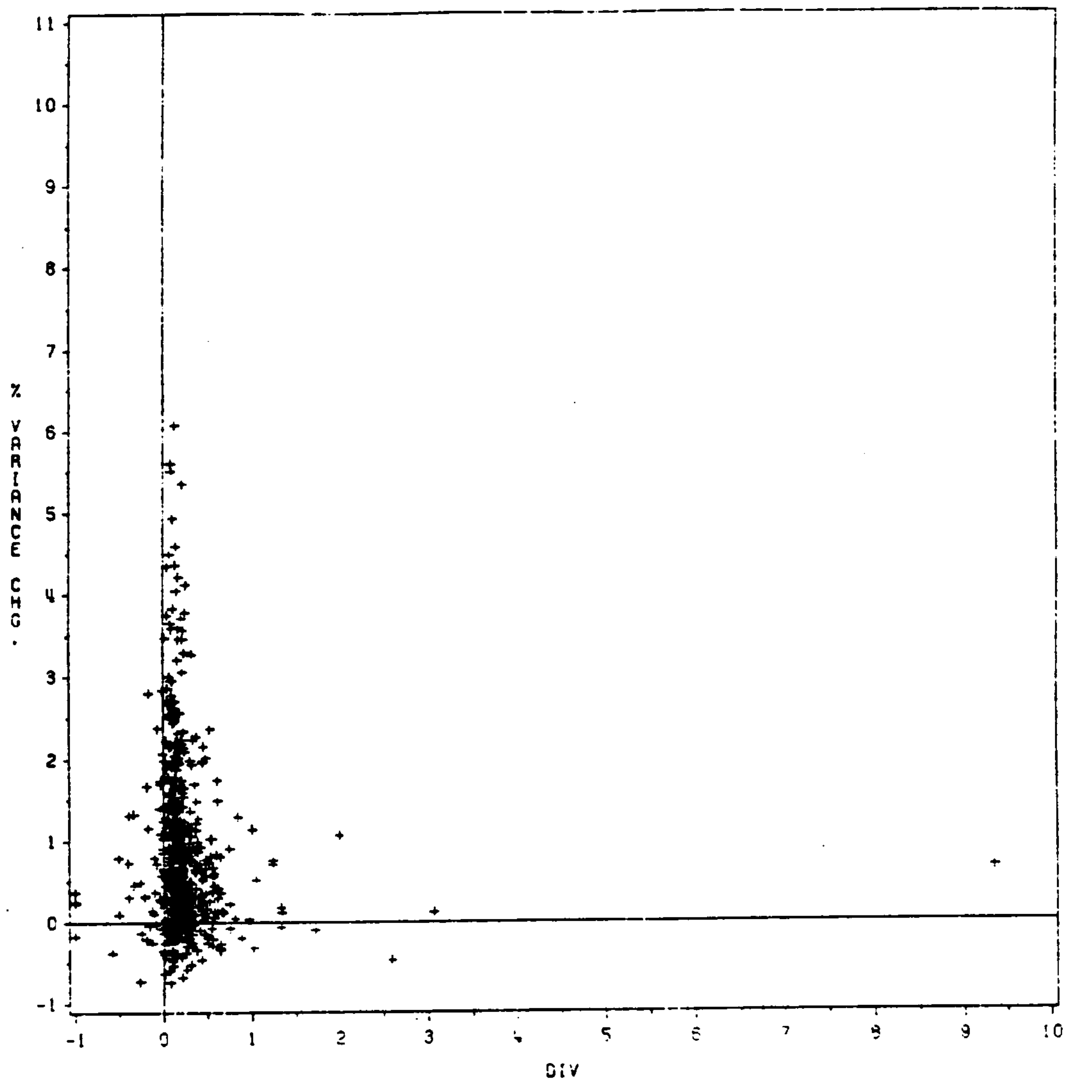

Figure 5. % Variance Change vs. % Change in Dividends

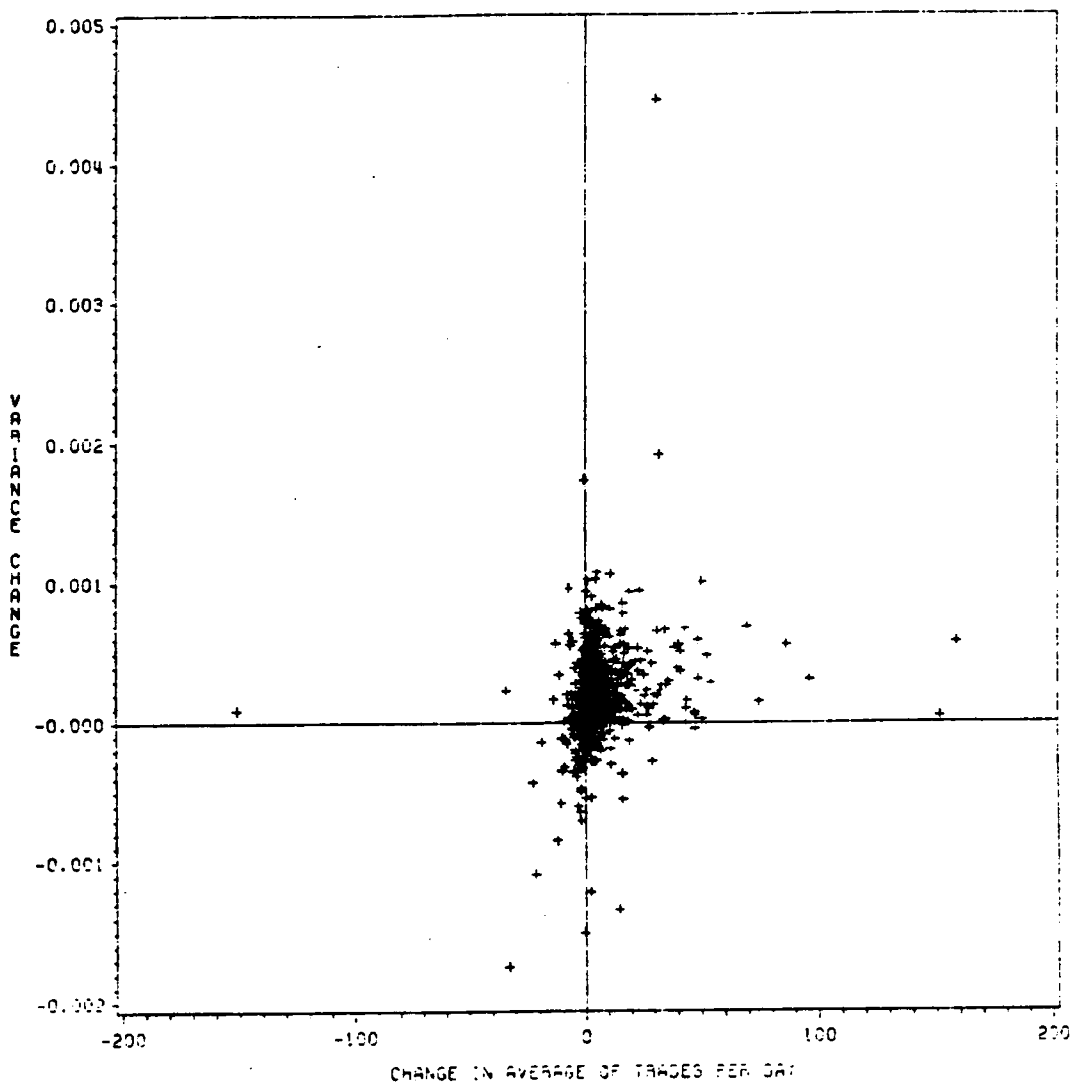

Figure 6. Variance Change vs. Change in Mean Trades-Per-Day

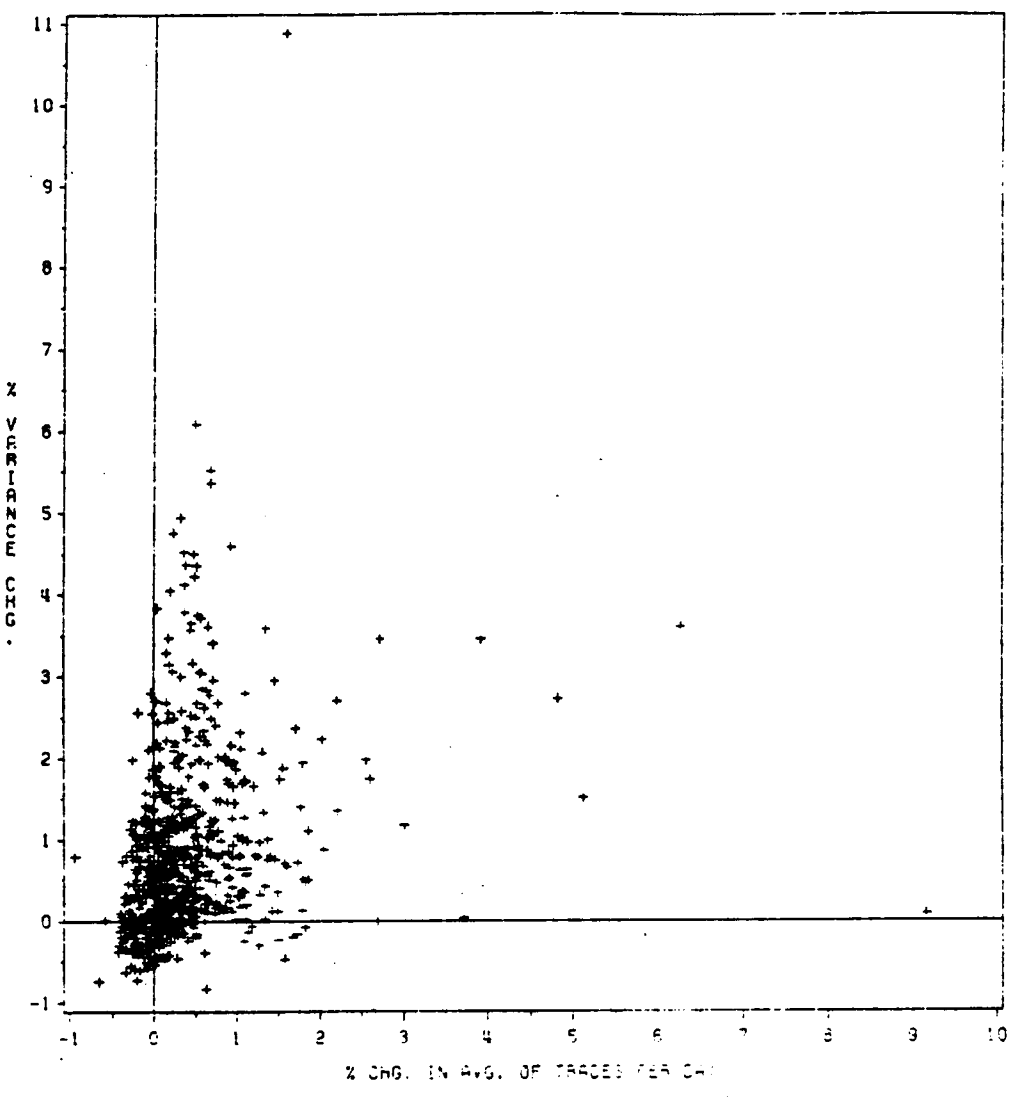

Figure 7. % Variance Change vs. % Change in Mean Trades-Per-Day

Ohlson & Penman did not find the distribution size to be a factor in the variance increase, but here a positive correlation with the variance change indicates otherwise. The size of the split is highly correlated with most of the liquidity measures and price. The correlation with the change in the averge price-change is slight and negative (-.0014.) The correlation with the variance of the price change is slightly more negative. As the distribution becomes larger the limit ratio increases; the correlation is .88403. A positive cross-sectional correlation of .213 is seen with the increase in the trades per day. Figure 6 presents a plot of the 75-day variance change and the change in the average number of trades per day, while Figure 7 examines the percentage changes.

A larger, negative linear correlation exists with the change in the daily average spread estimate (-.48056.) Finally, a positive correlation exists between the stock distribution size and the average daily volume. The distribution size is expected to be significant because of it effect on the price changes and spread changes. Figures 8 and 9 present the 75-day variance change and the plotted against the mean spread change, first as absolute changes then as percentage changes, respectively.

The 'news' variables showed very small, linear correlations with the change in returns' variance. The range was -.086 for "other" news prior to the ex-date to .04449 for dividend news prior to the ex-date. Only dividend information and earnings information before the split showed a positive correlation to the variance change. This is unexpected if there is any news impact and the information is of value to the market place. One comment is that earnings and dividends are anticipated, though with varying accuracy. Also certain caveats were made above about the news categories which may effect the results here. A negative correlation with news after the split is expected if the news generally confirms expectations.

Equation 1 presents the regression of the firm-specific factors. The return mean change is included.

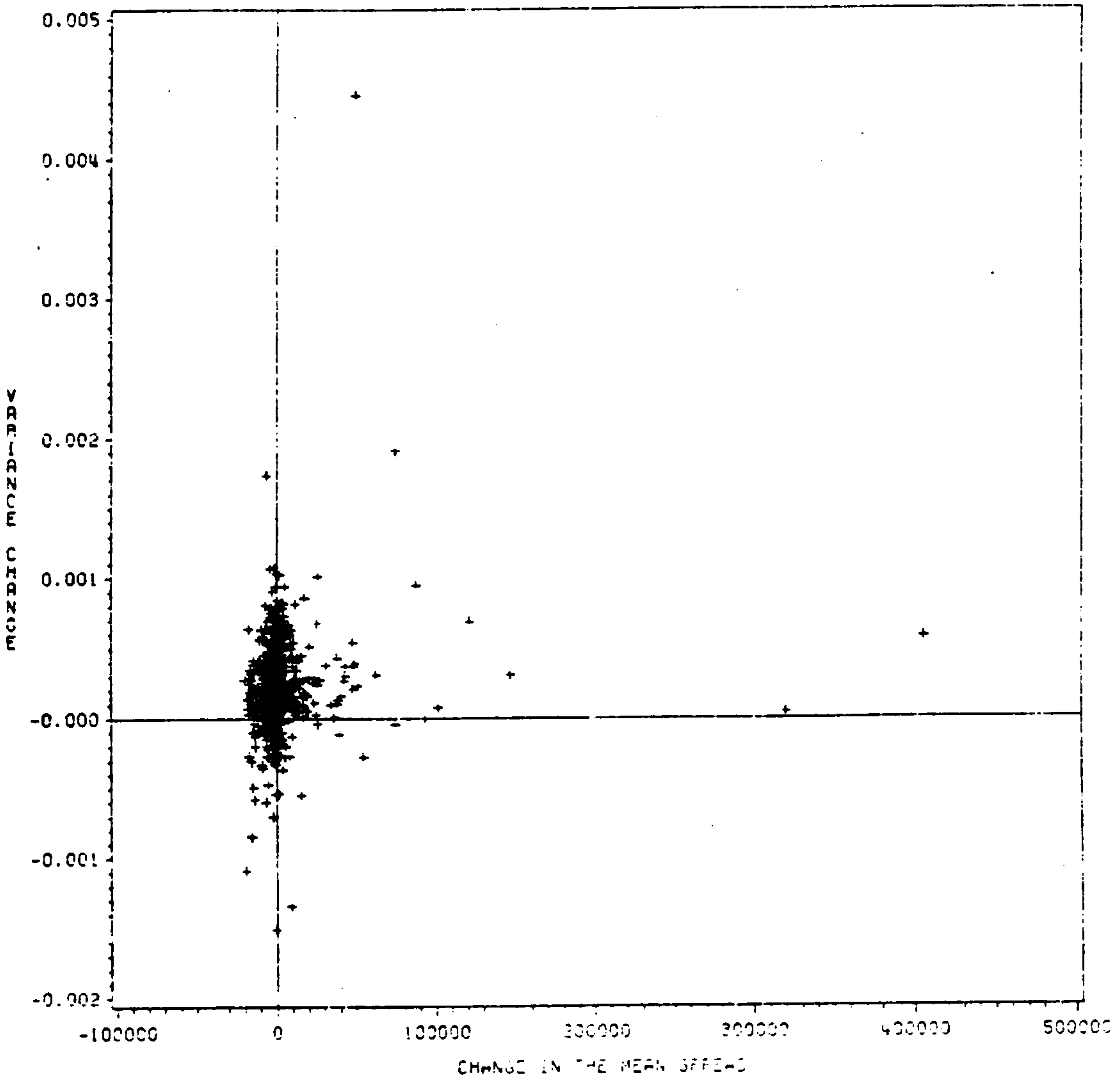

Figure 8. Variance Change vs. Change in the Mean Spread

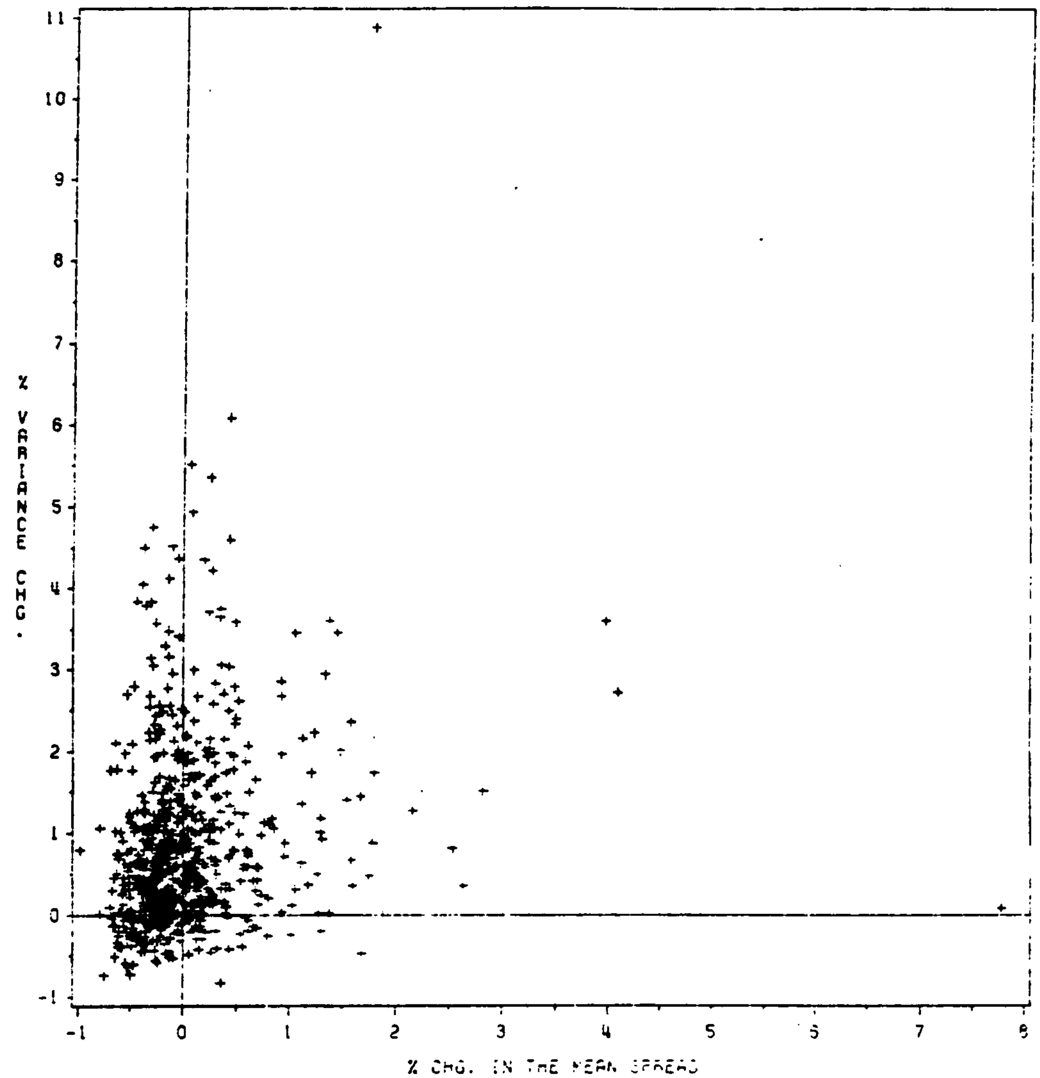

Figure 9. % Variance Change vs. % Change in the Mean Spread

$$\Delta\bar{\sigma}_i^2 = .6070 - .1265\Delta D/E + 6.1536^{-07}SIC + .0003FIRMSIZE - .1854\Delta DIV$$
$$(2.723) \quad (-.474) \quad (.025) \quad (1.441) \quad (-2.071)$$

$$-.0003\Delta\overline{RET} + .6439DISTSIZE - .0716SPLITFREQ \quad Eq.(1)$$
$$(-.08) \quad (5.367) \quad (-1.728)$$

The intercept, the dividend change (ΔDIV_t) and the distribution size (DISTSIZE) are significant at $\alpha < .05$. The frequency of the split is significant at $\alpha < .10$. The regression results discounts the involvement of non-price factors such as the firm's industry group (SIC) or the firm's capital structure changes ($\Delta D/E_t$) and confirms Ohlson & Penman's findings. [16] The change in the mean of returns ($\Delta\overline{RET}$) is not significant. The correlation between the returns' variance change and the returns' mean change is only .0271. There is evidence that the frequency of split use may reduce the change in variance, but a price level effect may exist in this finding.

The change in dividend payout reduces the change in variance. Two hundred and ninety-six firms had dividend announcements prior to the split, though this news never proved significant in earlier regressions. Ohlson & Penman did not find the dividend policy affected the proportion of firms experiencing variance increases. It appears, therefore, that there is a non-price level effect. By that I mean that there is a market reaction in the returns to the dividend payment or the fimr's split use history and not simply a change in the returns' distribution due to the price decline from the split.

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[16] A number of regressions were examined. Multicollinearity often was severe. The coefficients for the news variables were never significant, with the exception of "other" news prior to the split. This has no theoretical support to suggest why "other" news should decrease the variance change while news about earnings, dividends, sales, mergers, or acquisitions did not. Certainly the latter variables impact more on firm value generally. The variables representing the presence of contaminating news were subsequently removed. Debt change variables were also removed after models in which they were included were found to have severe multicollinearity and negative adjusted R^2 values. The debt change variables were always negatively signed, as expected. The removal of these variables does not represent total removal of the capital structure change as the change in the debt-to-equity ratio remained in the regression.

The regression used in Equation 1 was selected for several reasons. The F-value (7.442) is significant (Prob > F is .0001.) The adjusted R^2 value is .0748. No severe multicollinearity is present. Serial correlation is not severe. Finally, heteroskedasticity is present, as evidenced by the significance of the distribution size in the regression of the absolute values of the regression residuals upon the variables. Weighted-least squares and data transformations were considered and rejected. Coefficients are unbiased and consistent, though not efficient.

Microstructure Examinations

Mean changes in the microstructure are reported in Table 28. The series of Figures 10 through 18 provide plots of the absolute and percentage changes in the 75-day returns' variance plotted against the absolute and percentage changes for the daily average price change, the variance of the daily average price change, the limit ratio, mean time between trades, and the daily average number of price reversals.

The daily average price change declines, though the mean change is not significant. This is expected with a price decline, though the mean change is rather small considering the price change limit is .125. The proportion of observations showing decline, while significant, is not as large as was expected for a general, dramatic price decrease. Considering that the ratio of the price change limit of .125/price increased as expected, the average price change was expected to fall more, though the mean may be affected by increases for some firms. Figure 4 presents the 75-day daily returns' variance change plotted against the average price change. Figure 5 presents the same variables, but in percentage change terms.

The variance of the price change has declined significantly, however. This appears to be the results of the combination of several factors. First, Ohlson & Penman's finding of increased zero returns is confirmed. While Dravid reported many zero returns due to prices in the one to two dollar range, the smallest average daily price in the study was $5.51. Also there is a significant increase in price reversals within the day. The cross-sectional mean increase is 3.42 (t = 11.21.) This particular change is expected for two reasons. First, the average number of trades per day has increased slightly by .56 (t = 7.18.) Second, positive serial correlation was reported prior to the split, but not after. The excess returns and the positive serial correlation suggest that price tended to move up to capture the increased earnings. Once this was done, normal trading resumed, showing slight negative serial correlation. Figure 6 presents the change in vari-

Table 28. Distributions of Liquidity & Microstructure Variables

Variable Description	Mean	Std. Dev.	T
Price Before Ex-date	$48.59	$33.71	n.a.
Price After Ex-date	$28.79	$13.33	n.a.
Change in Price	-$19.80	$26.76	n.a.
% Chg. in Price	-0.3556	-52.04	n.a.
Change in Avg. Daily Price Chg. Mean	-.0039	.0849	11.25
% Chg. in Avg. Daily Price Chg. Mean	-.9468	3.71	-6.47
Change in Avg. Daily Price Chg. Var.	-.1565	.1.57	-2.67
% Chg. in Avg. Daily Price Chg. Var.	-.0979	3.3652	-0.78
Change in Avg. Daily Price Reversals	3.4230	8.1990	11.21
% Chg. in Avg. Daily Price Reversals	.3868	.6957	14.95
% Chg. in Zero Returns	.0631	.4331	4.03
Change in the Limit/Price Ratio	.0019	.0013	38.15
% Chg. in the Limit/Price Ratio	.6988	.7195	26.08
Change in Avg. No. of Trades/Day	.3757	.7176	14.06
% Chg. in Avg. No. of Trades/Day	.578	.1527	10.17
Change in Mean Time Bet. Trades†	.2776	.3705	10.19
% Chg. in Mean Time Bet. Trades†	3.0761	4.8715	8.59
Change in Time of Last Trade	11.0334	26.3499	11.24
Change in Spread	-0.0677	.2169	-8.39
% Chg. in Spread	-.2123	.1924	-29.63
Change in Spread/Price	.0007	.0028	7.15
% Chg. in Spread/Price	.2679	.3411	21.09
Mean Daily Trading Vol. Pre-Dist.	18517	34170	14.55
Mean Rel. Daily Trading Vol. Pre-Dist.	34188	65610	13.99
Mean Daily Trading Vol. Post-Dist.	32663	60022	14.61
Change in Relative Trading Vol.	-1525.8576k	40870.3028	-1.00
% Chg. in Relative Trading Vol.	-.0239	.6039	-1.07
% Chg. in Non-Relative Trading Vol.	.8554	1.2813	17.93
% Chg. in % of Firm Traded Daily	.0245	.5268	1.13
% Chg. in the No. of Shareholders	.1418	.3419	10.24
Change in Liquidity Index†	-44.0151	709.8506	-1.45
% Chg. in Liquidity Index†	.7834	5.5164	18.07

† Severe outliers removed.

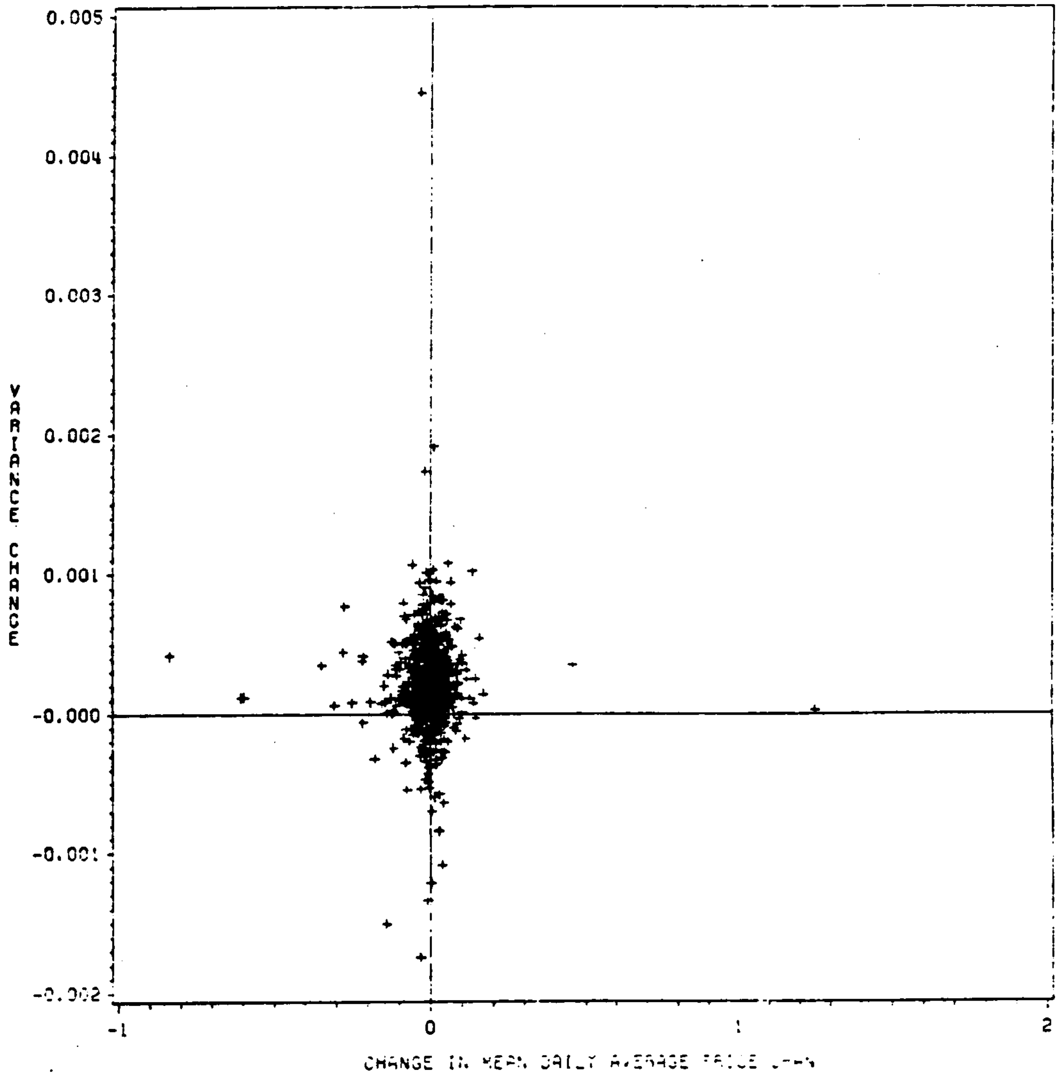

Figure 10. Variance Change vs. Change in Mean Daily Price Change

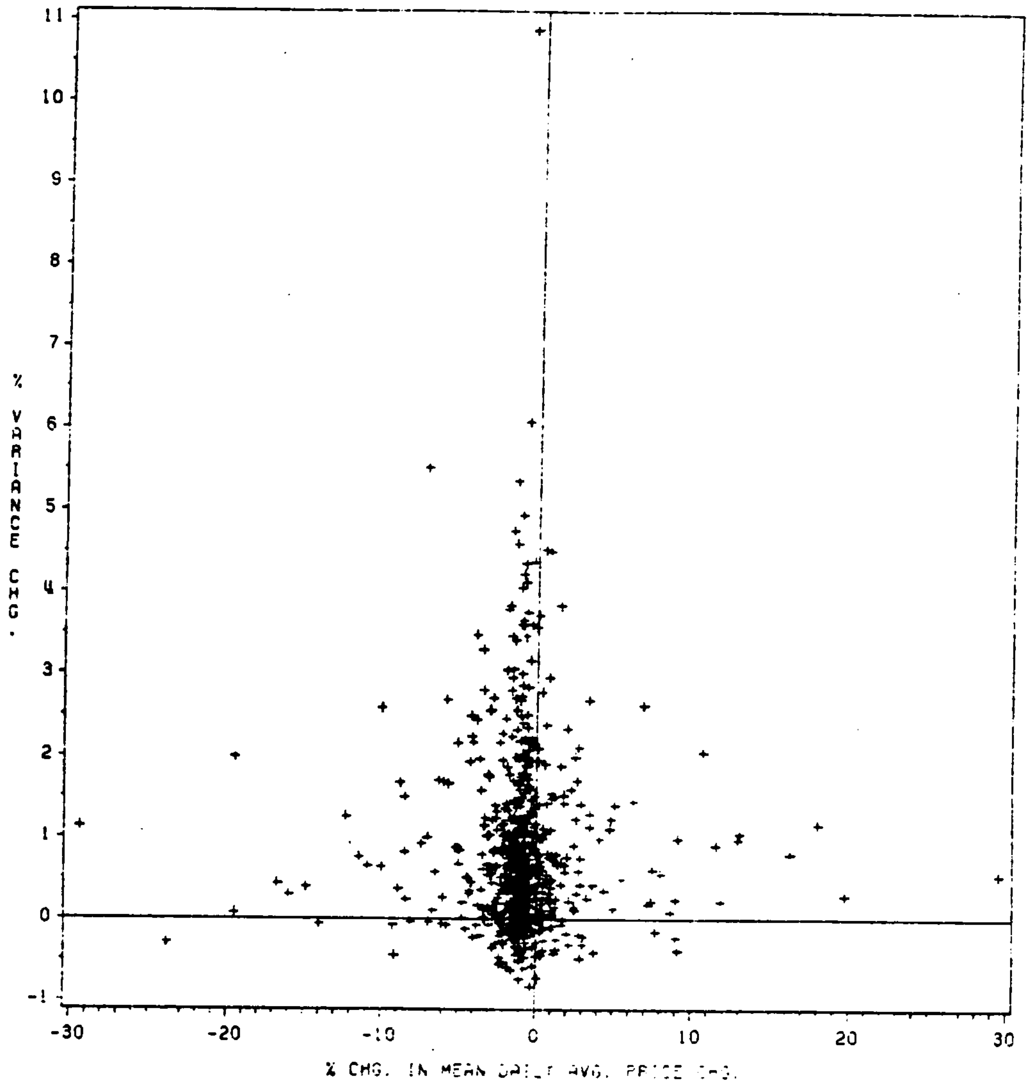

Figure 11. % Variance Change vs. % Change in Mean Daily Price Change

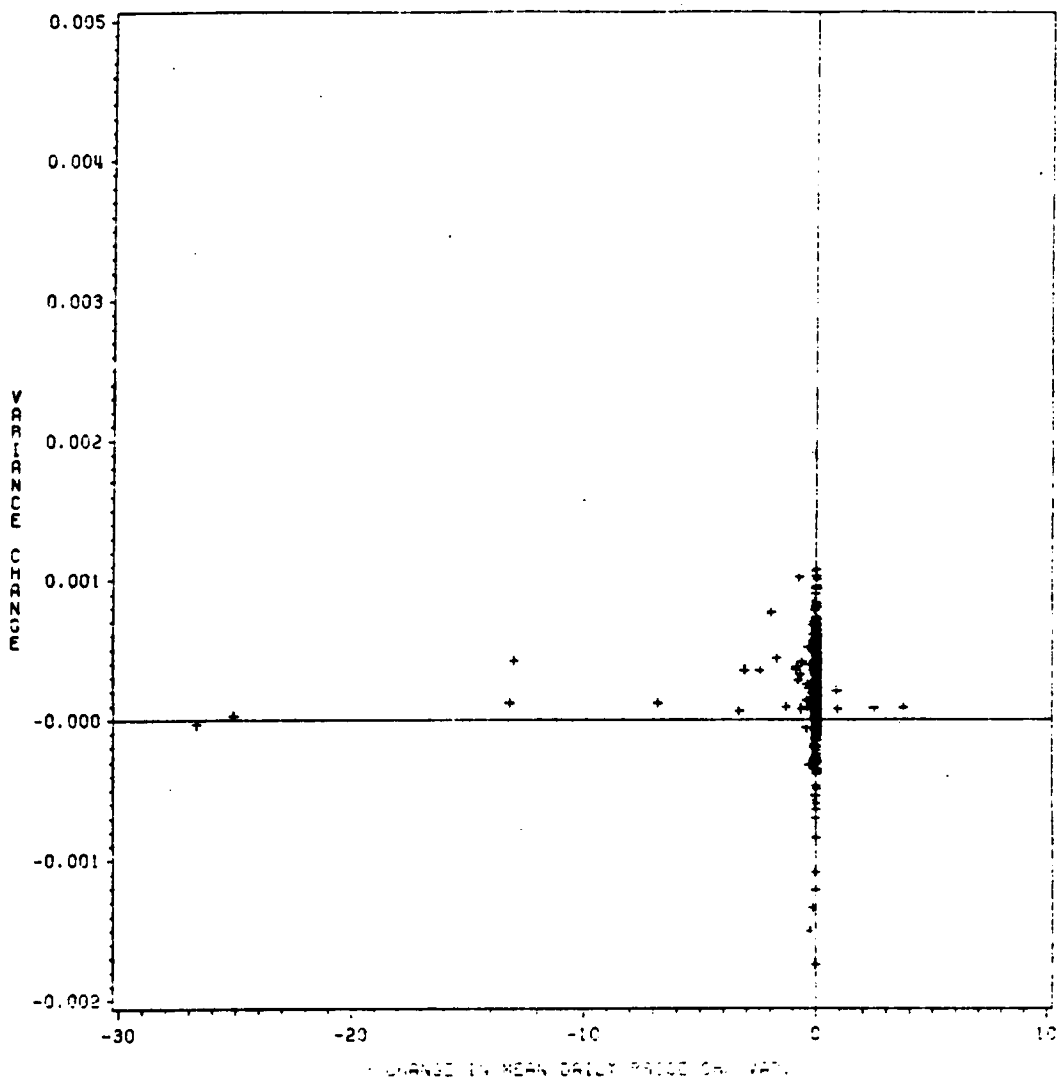

Figure 12. Variance Change vs. Change in Daily Variance of Price Change

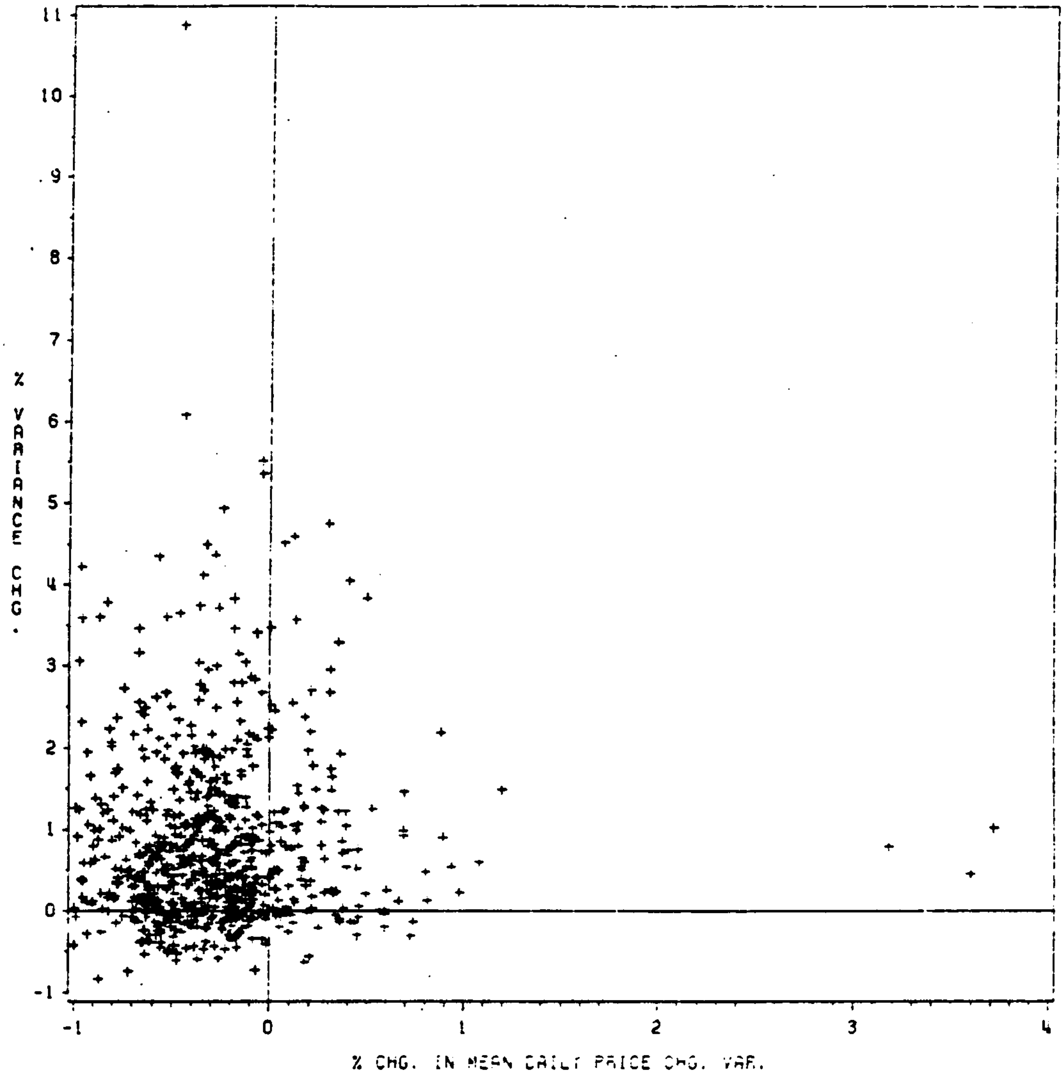

Figure 13. % Variance Change vs. % Change in Daily Var. of Price Change

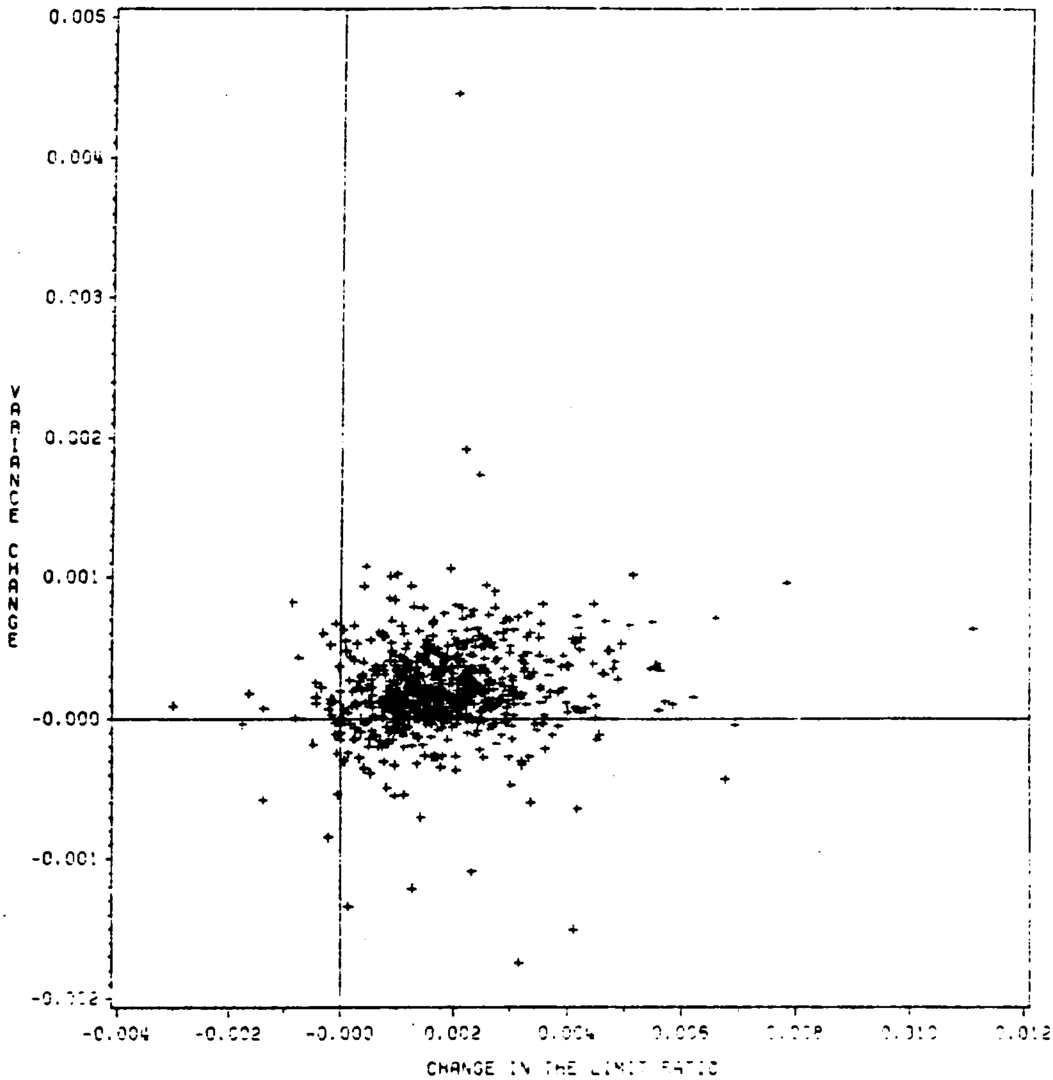

Figure 14. Variance Change vs. Change of Limit Ratio

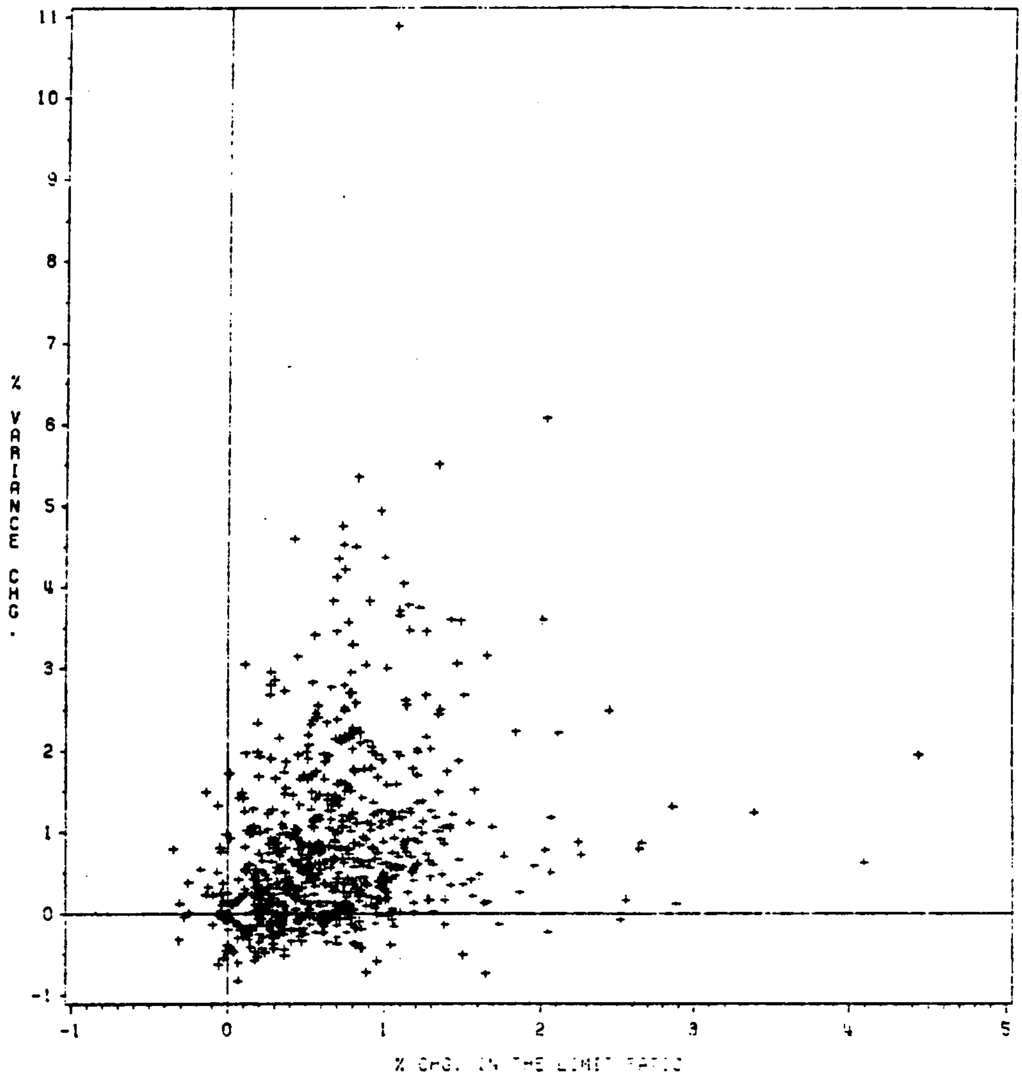

Figure 15. % Variance Change vs. % Change of Limit Ratio

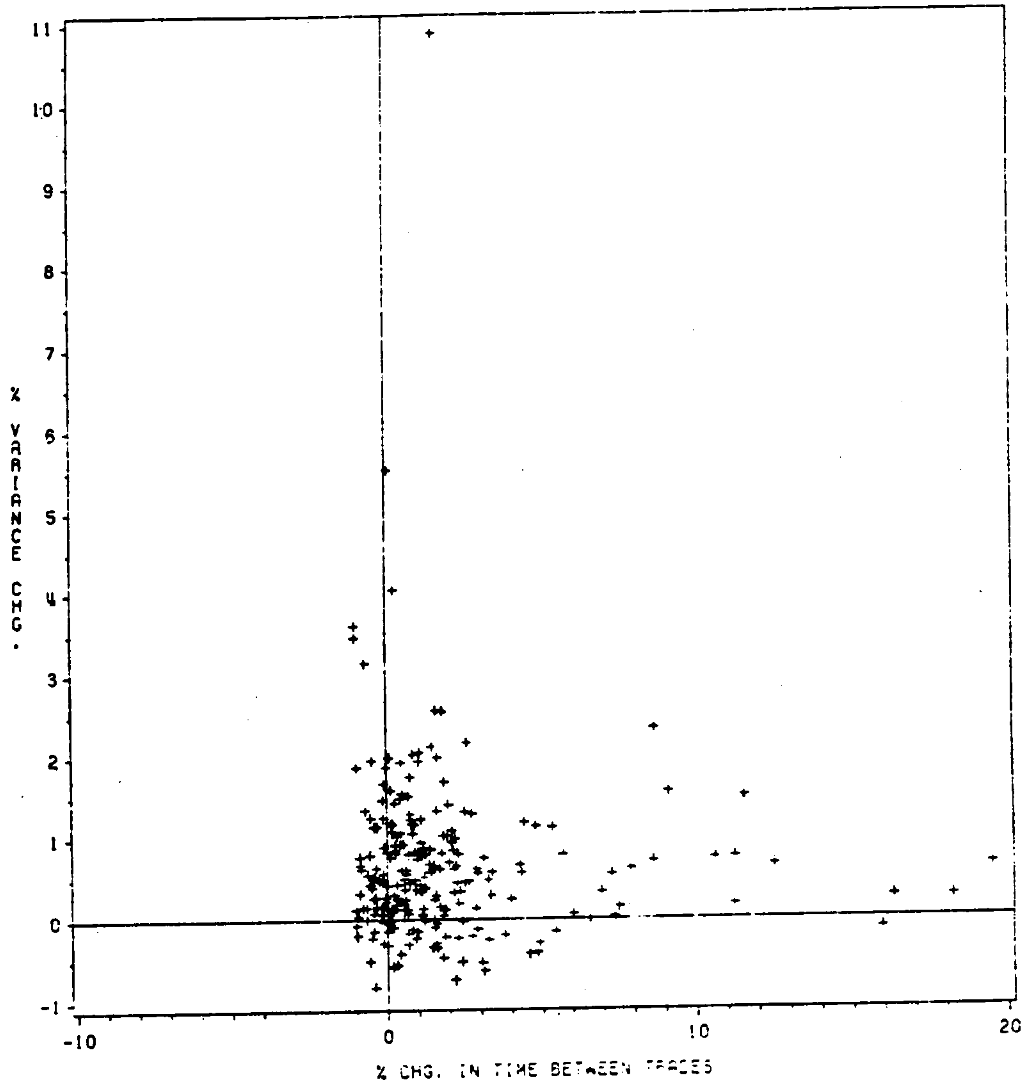

Figure 16. % Variance Change vs. % Change in Mean Time Between Trades

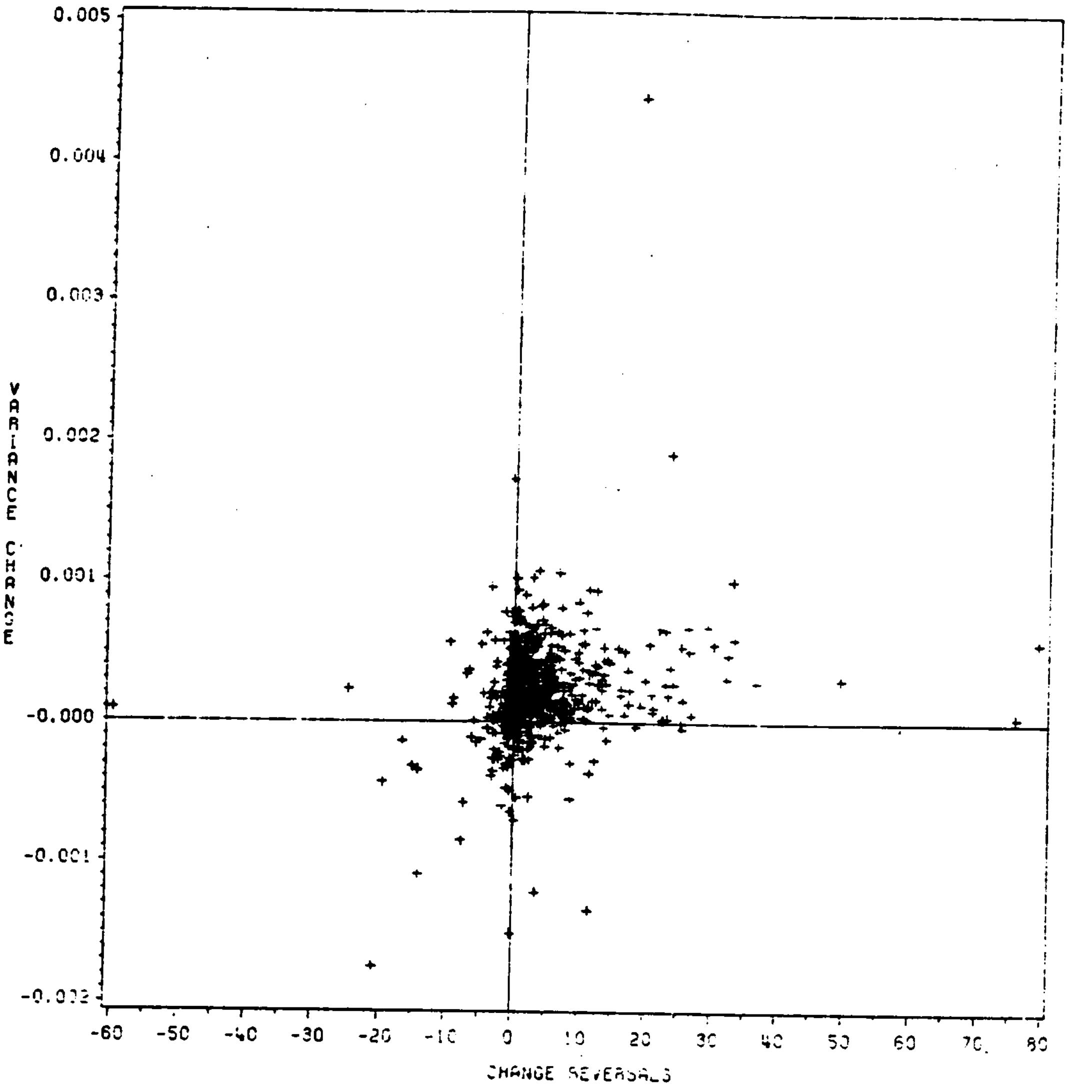

Figure 17. Variance Change vs. Change in Daily Price Reservals

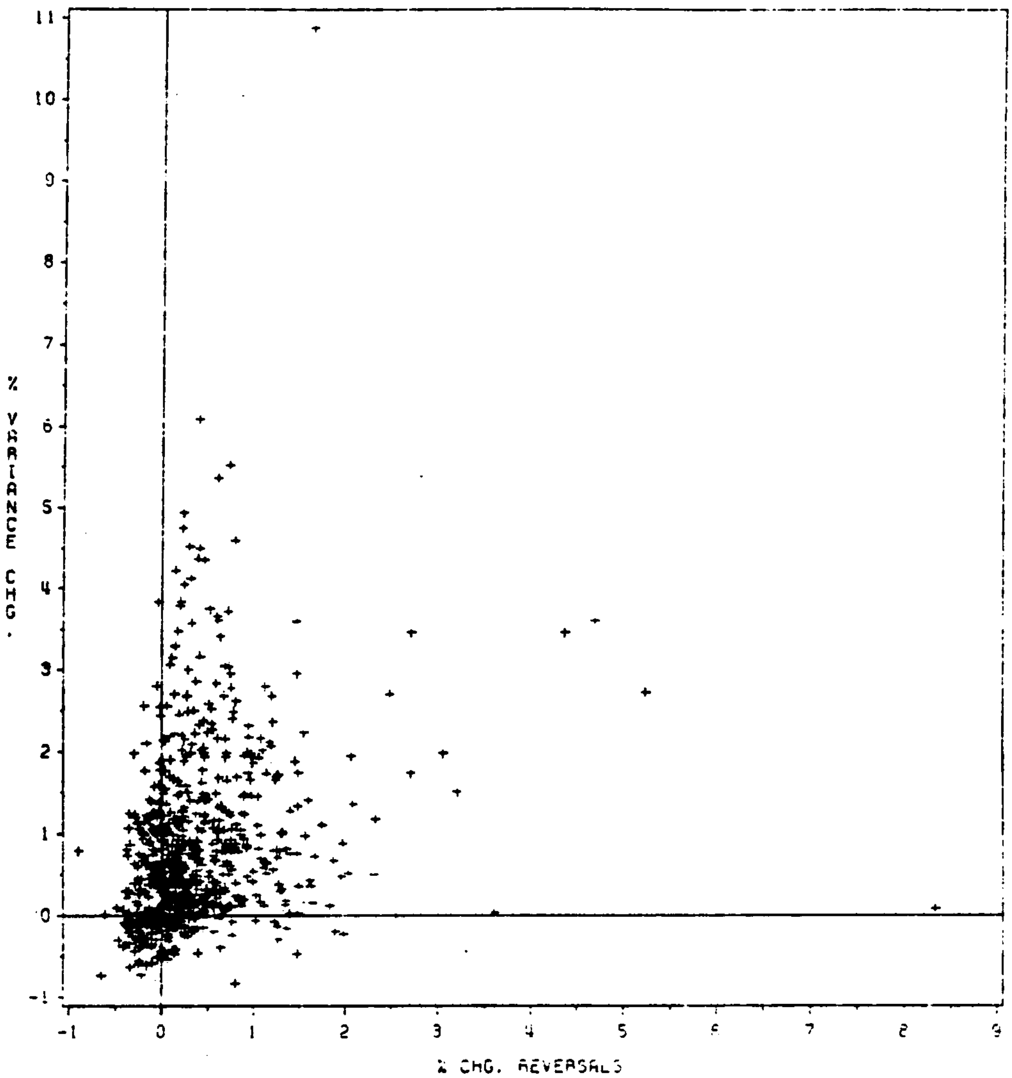

Figure 18. % Variance Change vs. % Change in Daily Price Reversals

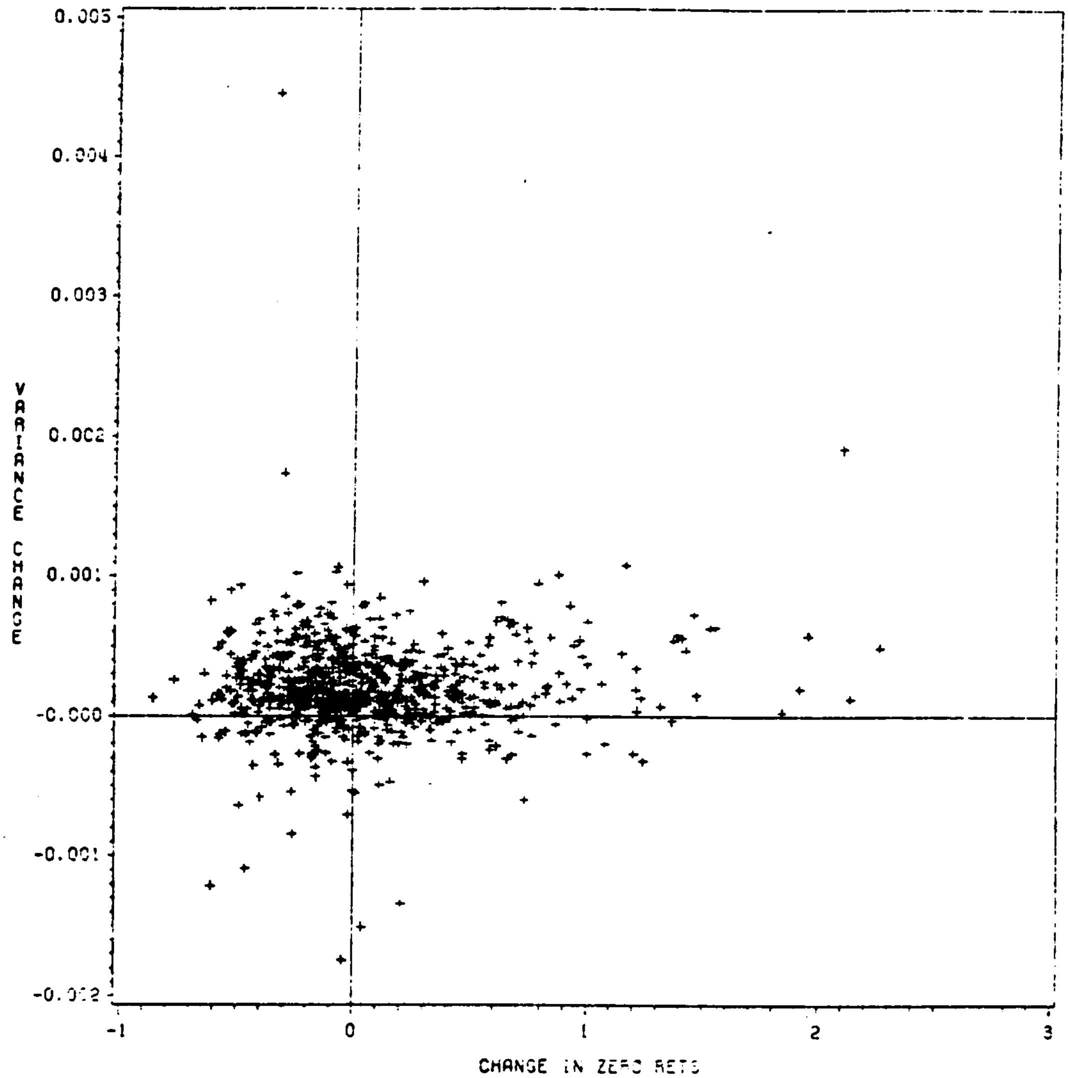

Figure 19. Variance Change vs. Change in No. Zero Returns

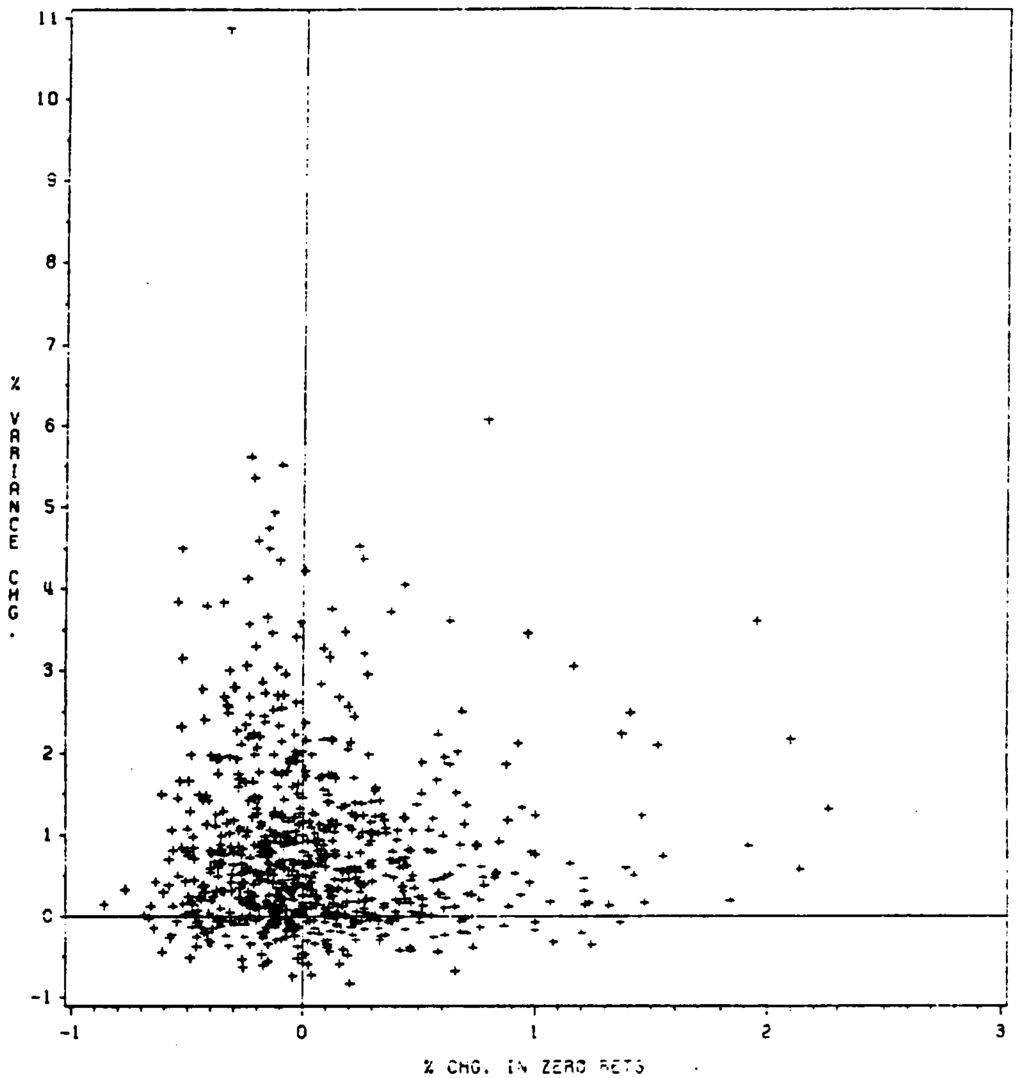

Figure 20. % Variance Change vs. % Change in No. Zero Returns

ance plotted against the change in the daily price change variance. Figure 7 presents the same variables, but in percentage change terms.

The variance of the price change declines with the split as compared to the period immediately prior to the ex-date because price adjustment for improved earnings and dividends had taken place. It appears that prior to the split the limit orders at the boundary are being exhausted since positive serial correlation occurs. Market makers are adjusting inventory more. By the ex-date , the value-change driven price adjustment is complete. The number of limit orders increases and there is an increased percentage of market trades with unfilled limit orders.

The meaning of the significant mean increase in the time of the last trade by 11.03 minutes (t = 11.24) is unsure. Its correlation is relatively high (.24876) with the magnitude of the variance change. This is expected since the beginning and end of the trading day exhibits increased variance in non-event trading. This effect was not seen clearly in the earlier returns' variance shift comparisons between the datasets.

With a greater number of trades per day it would be logical to expect the last trade to occur later in the day. The 'closing' effect along with an increase in zero price changes and reversals would explain the price change variance declining while the return variance rose.

The regression of the percentage change of the variance on the percentage changes of the average price change, the variance of the daily average price change, the limit ratio, and the number of zero returns, along with the actual change in the average time of the last trade and finally, the firm size ranking is shown in equation 2.[17] Other models were examined including an intercept and average price but the alternative models did

[17] Collinearity diagnostics revealed no severe multicollinearity neither was there any significant serial correlation. Heteroskedasticity was found and was apparently introduced through the percentage change in the limit ratio and the change in the average time of the last trade. Weighted least squares and variable transformation was considered but rejected. Coefficients should be considered unbiased and consistent but not efficient.

not approach the R^2 of the model selected or were the multicollinearity diagnostics as acceptable.[18] Alternative models are available upon request.

$$\Delta\bar{\sigma}_t^2 = -.00859\overline{\Delta PR} + .00056\sigma^2_{\Delta PR} + .18943 LIMRATIO + .01092 TIMELT$$
$$(-7.84) \quad (.047) \quad (3.206) \quad (7.016)$$

$$+.148434\, \Delta 0RET + .000918 FIRMSIZE \quad Eq.(2)$$
$$(2.202) \quad (5.473)$$

In the variance shift comparisons the mean change in variance was often higher in the smaller firms (quintiles 1 and 2.) There is a strong association between smaller firm size and lower price. Smaller firms generally show greater returns' variance so the percentage change in variance should be greater for them since the change was not greatly different from the largest firm. Also, average price change should be larger for larger firms. So, I expect the change in the average price change to be negatively signed. FIRMSIZE should be negatively signed also. The firm size is positively signed and significant. Several explanations are possible. First, the firm size proxy of total assets may not be the most appropriate for firm size and the ranking may allow some firms to be misrepresented. Second, the model is misspecified. The other variables are signed as expected, however.

From the regression and the earlier discussion, the changes in trading across the split are defined. There is a price effect on the price changes and there is a trading behavior change as well. The lower price is responsible for the reduced average price change and the decline in the variance of the price change. The increase in zero returns may be produced by the lower price and accompanying changes in the price change distribution. The distribution for price after the split shows a lower mean but also a smaller variance and the lower bound is over five dollars. The correlation between the change in the number of zero returns and the change in price is -.11146.

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[18] The adjusted R^2 for the model was .3986. The F-value was 78.34, with a Prob > F of .0001.

The zero returns more likely represents changes in trading behavior, in particular the increased activity at-market and the increase in a supply of limit orders. Reversals of price are more common so limit orders tend not to be exhausted at one boundary. Figure 19 indicates that the majority of firms have a decline in zero returns after the split, despite the mean. For those firms there would appear to be more limit-order trades. Also, in trading behavior changes, there are more trades, spaced farther apart and the last trade occurs later in the day. Absolute trading volume is increasing so there are more shares traded. The liquidity changes are discussed below.

Liquidity Examination: The investigation of liquidity around the split produced mixed results. The cross-sectional averages of the change in liquidity measures supports Copeland on the one hand since the spread relative to price increases with a mean percentage change of .2679 (t = 21.09.) So relative to price the spread has increased, though in an absolute sense the mean spread declined by .0677 (t = -7.18.) Also, liquidity decreases when trades are farther apart. The mean time between trades increased by .2776 minutes (t = 10.19.) The significance of this change on liquidity is not determined here. Some observations were large and the range for this variable was restricted to percentage changes not over 20 when the means presented above was calculated.

When the average daily volumes were adjusted for the split the mean percentage change in the average daily trading volume was .0240 (t = .60) which indicates that the relative trading volume does not decline, contrary to Copeland's residual analysis findings. Also, the mean percentage change in the average percentage of the firm traded daily was slightly increased by .0245 (t = .53), though this too was an insignificant change.

The reasoning that the split improves liquidity is supported by the increase in the average number of trades per day and the reduction in the spread. The insignificant increase in the volume and percentage of the firm traded would add to the justification for using splits. The series of Figures 19 through 28 are plots of the absolute and percentage changes in the 75-day variance change plotted against various absolute and percentage changes in the liquidity measures, including the liquidity index.[19]

When the liquidity index is examined the liquidity change is dependent upon the control of outliers, though with or without the outliers, the change is insignificant. The proportion of observations with increased liquidity indices across the split is .4411, however. When the entire sample is used, the mean decline in the index is -75932.52 (t = 1.10.) When the dataset is restricted to exclude outliers of changes less than -5000 or greater than 5000 the average change is a more modest -44.015 (t = 1.45) but the mean percentage change rises to .0186 (t = .05) from a value far below zero yet insignificant. (The liquidity index was examined for the quintiles based on firm size. No firm size group showed significant changes in the index. The largest firm size group did show a mean increase in the liquidity index but the t-statistic was only .05.)

Two comments must be made about the results just presented. First, outliers, occassionally extreme, exist for some of the vairables and contribute to the means, though in some cases they are offset by outliers at the opposite end of the range and the basic results have generally been supported even with truncated datasets.

The second comment is that the liquidity index is a creation that may not have proper weights on the components. The index may generate a biased value relative to the true liquidity in the market place.

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19 Certain outliers were removed to provide a better scale for the plots. They were removed as follows: 3 observations greater than 9 for the percentage change in the price change variance, 1 observation greater than 13 for the percentage change of the limit ration, and 1 observation less than -200 and 1 observation larger than 400 for the percentage change in time between trades, finally, 3 observations greater than 8 for the percentage change in the averge daily volume.

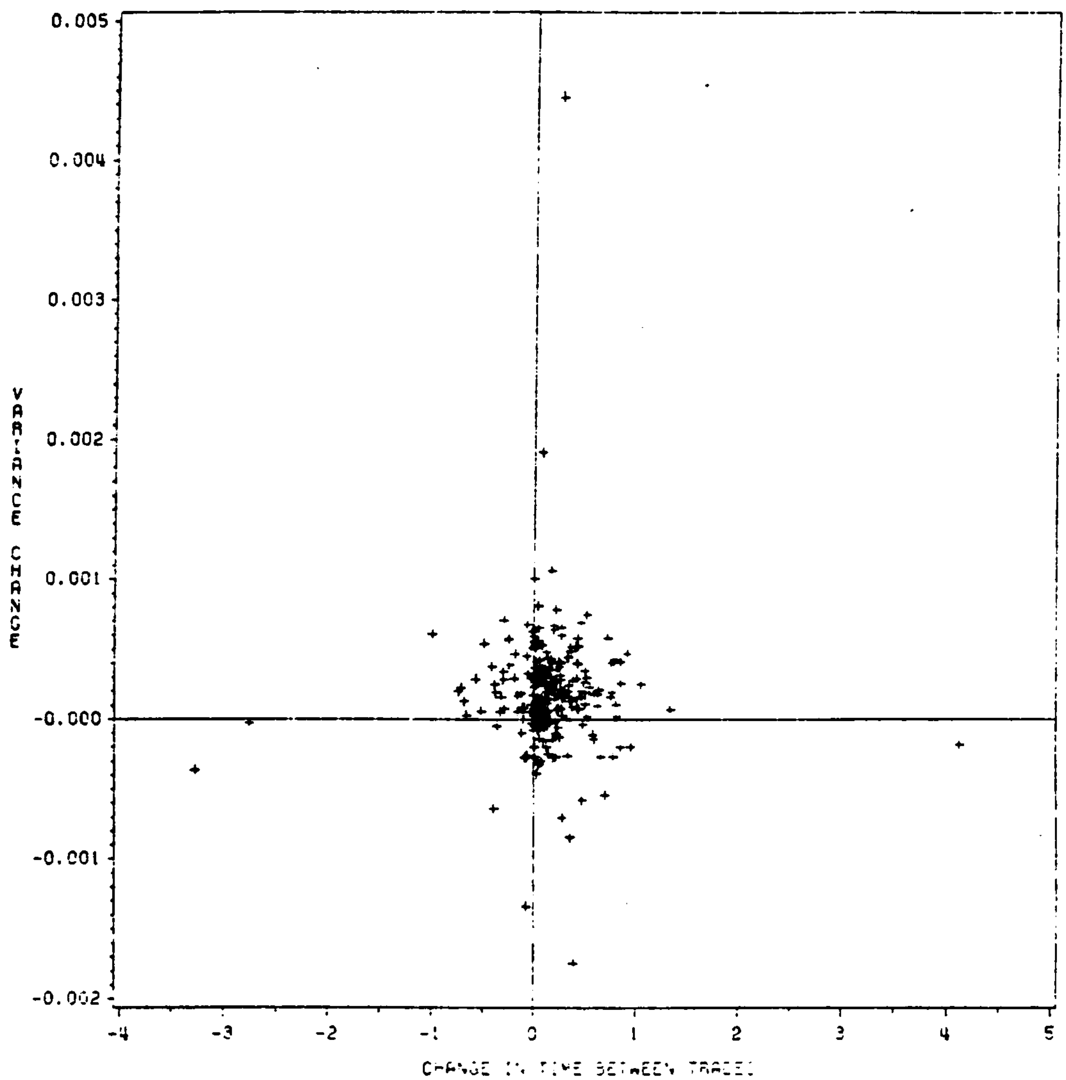

Figure 21. Variance Change vs. Change in Mean Time Between Trades

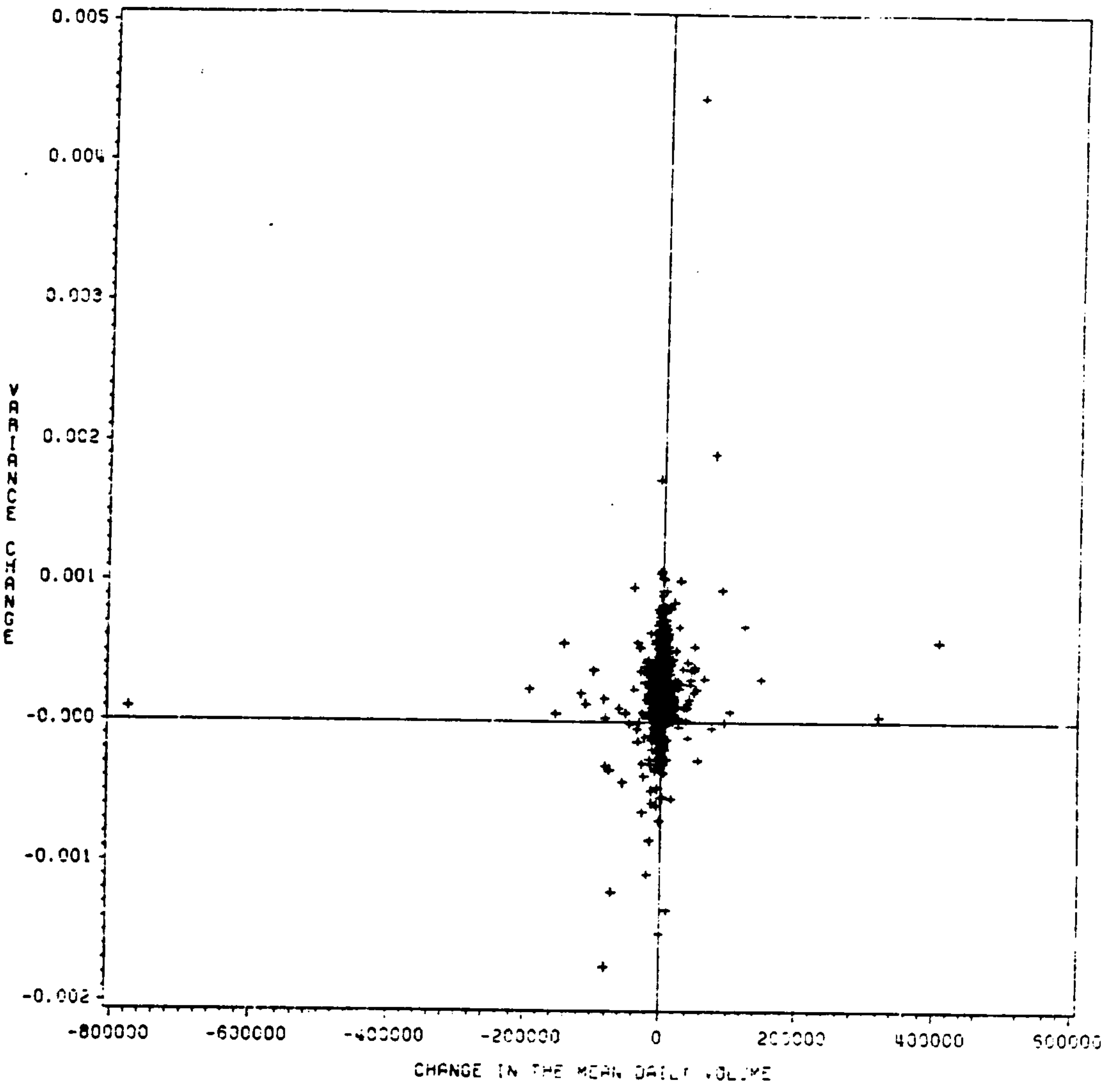

Figure 22. Variance Change vs. Change in Mean Daily Relative Vol.

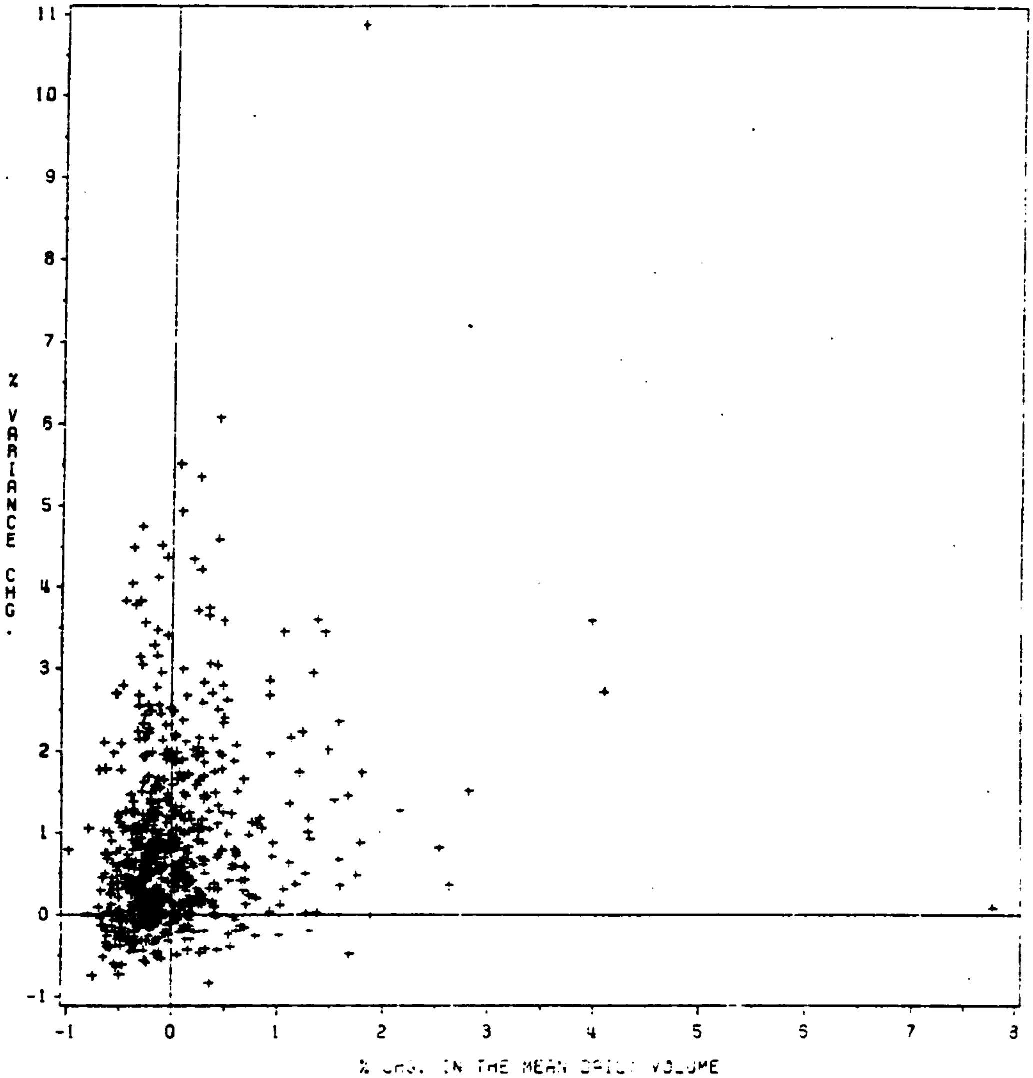

Figure 23. % Variance Change vs. % Change in Mean Daily Relative Vol.

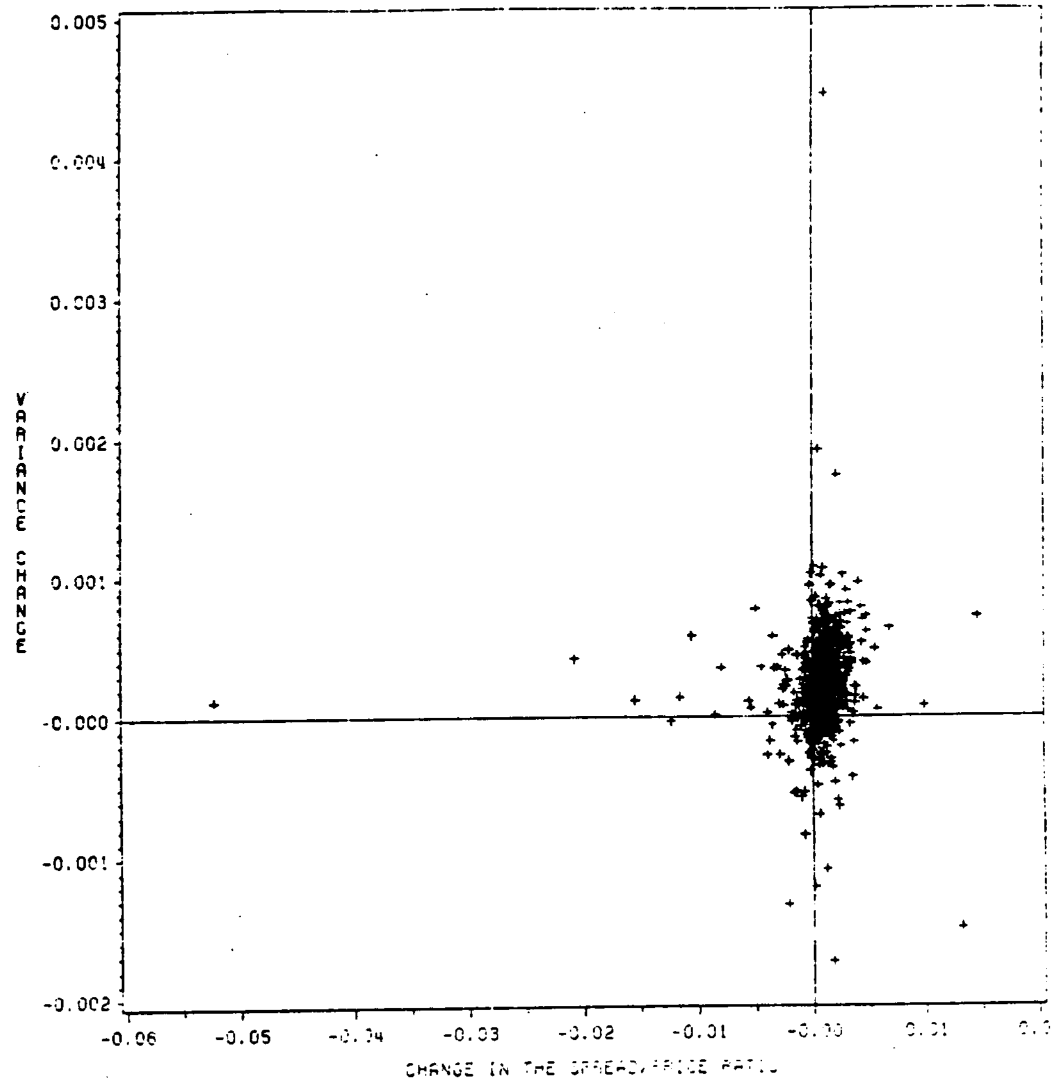

Figure 24. Variance Change vs. Change in Spread/Price Ratio

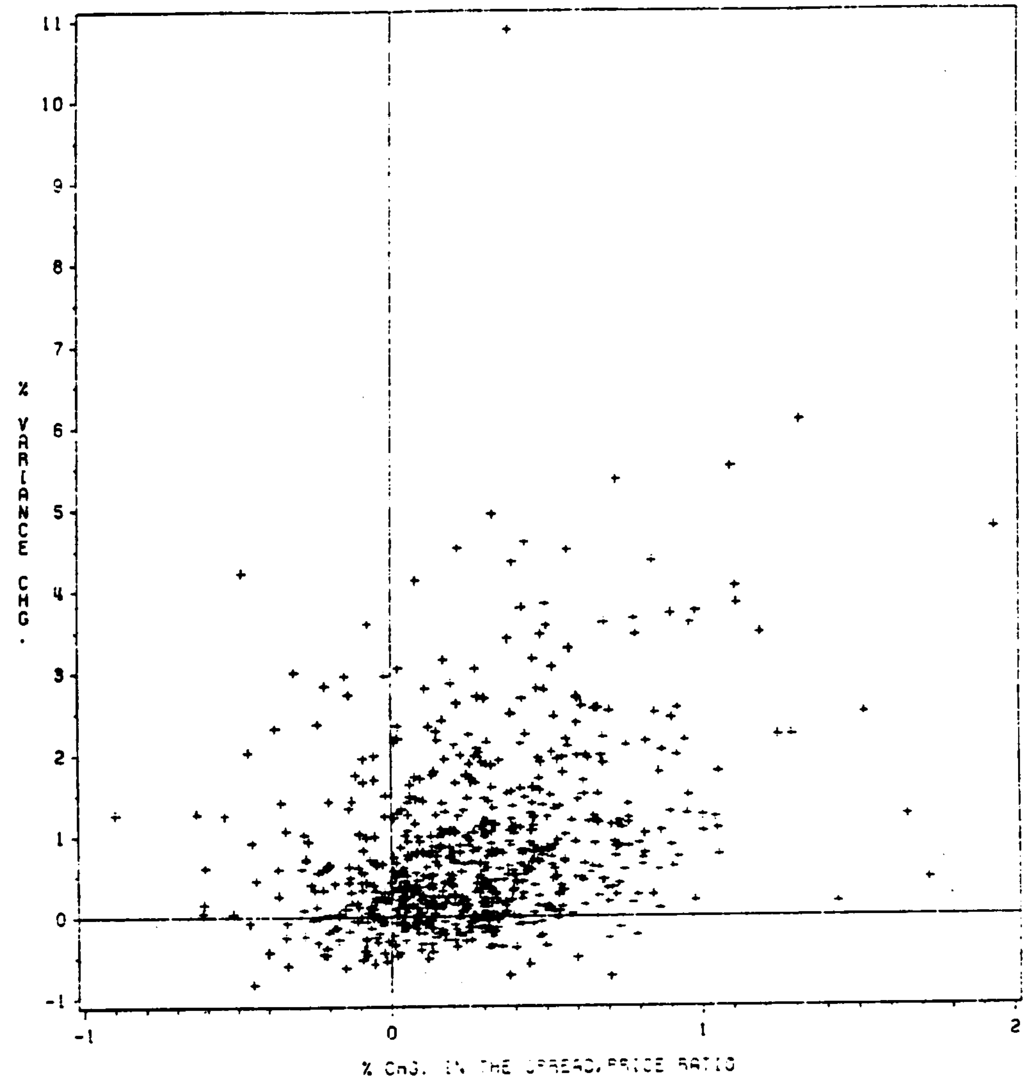

Figure 25 % Variance Change vs. % Change in Spread/Price Ratio

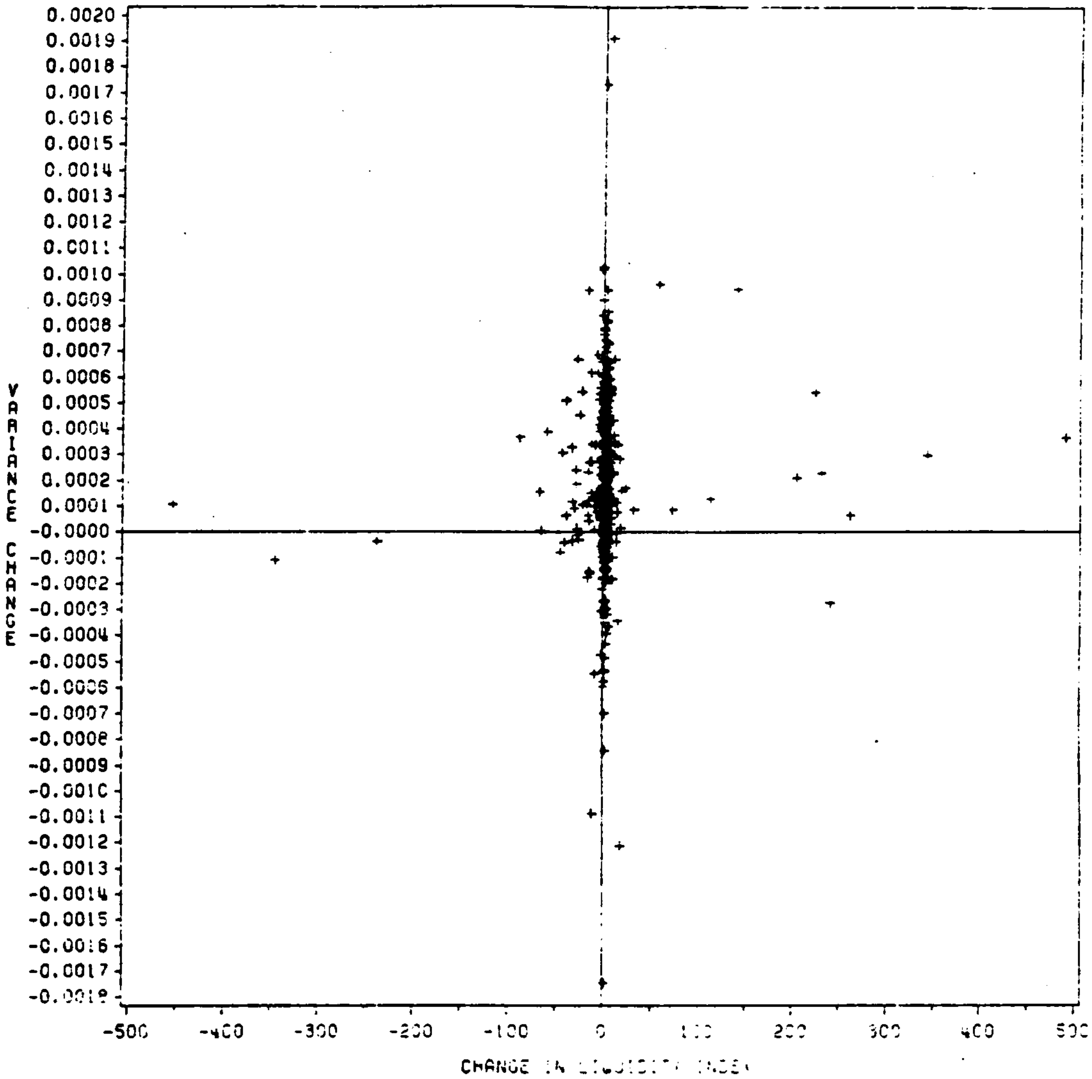

Figure 26. Variance Change vs. Change in the Liquidity Index

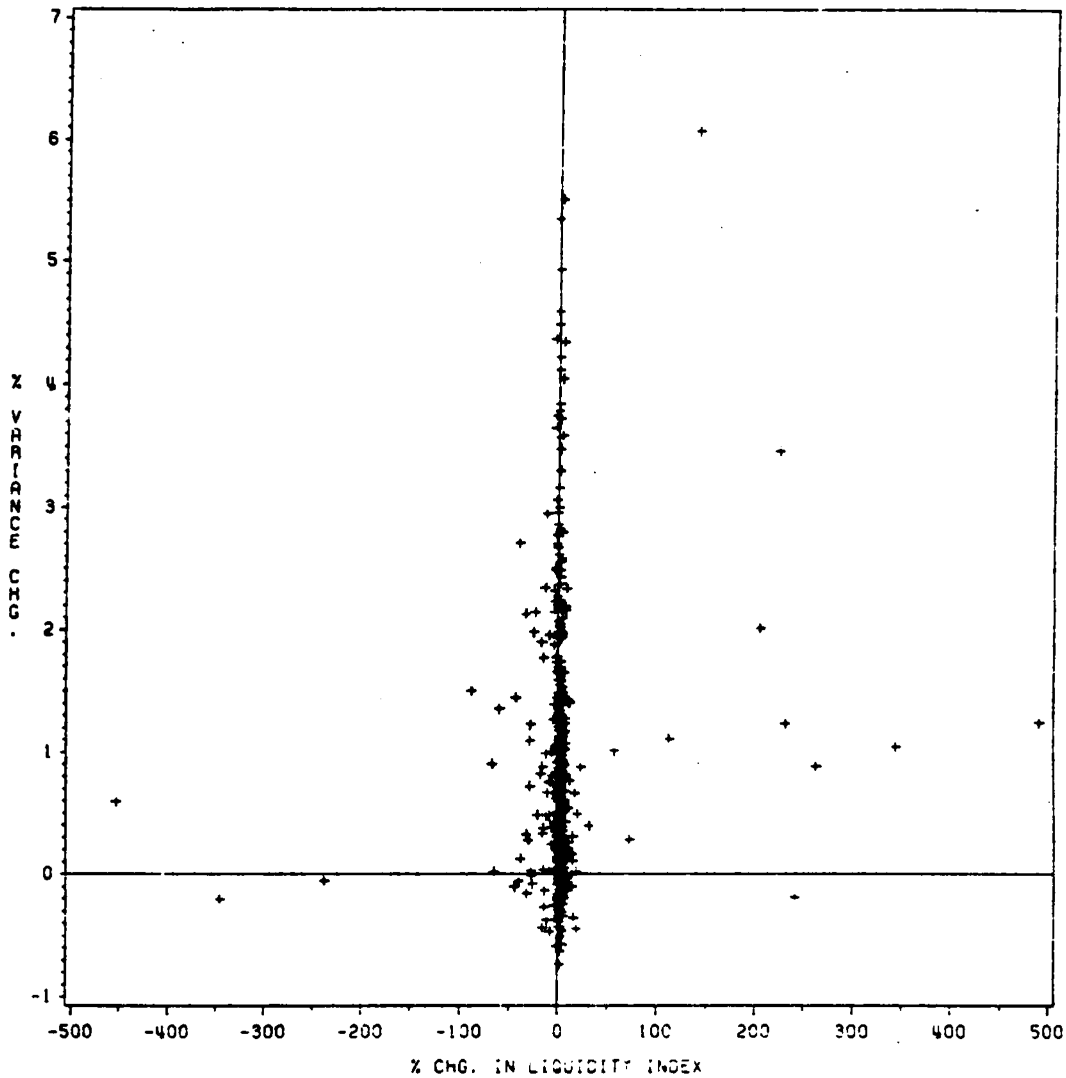

Figure 27. % Variance Change vs. % Change in the Liquidity Index

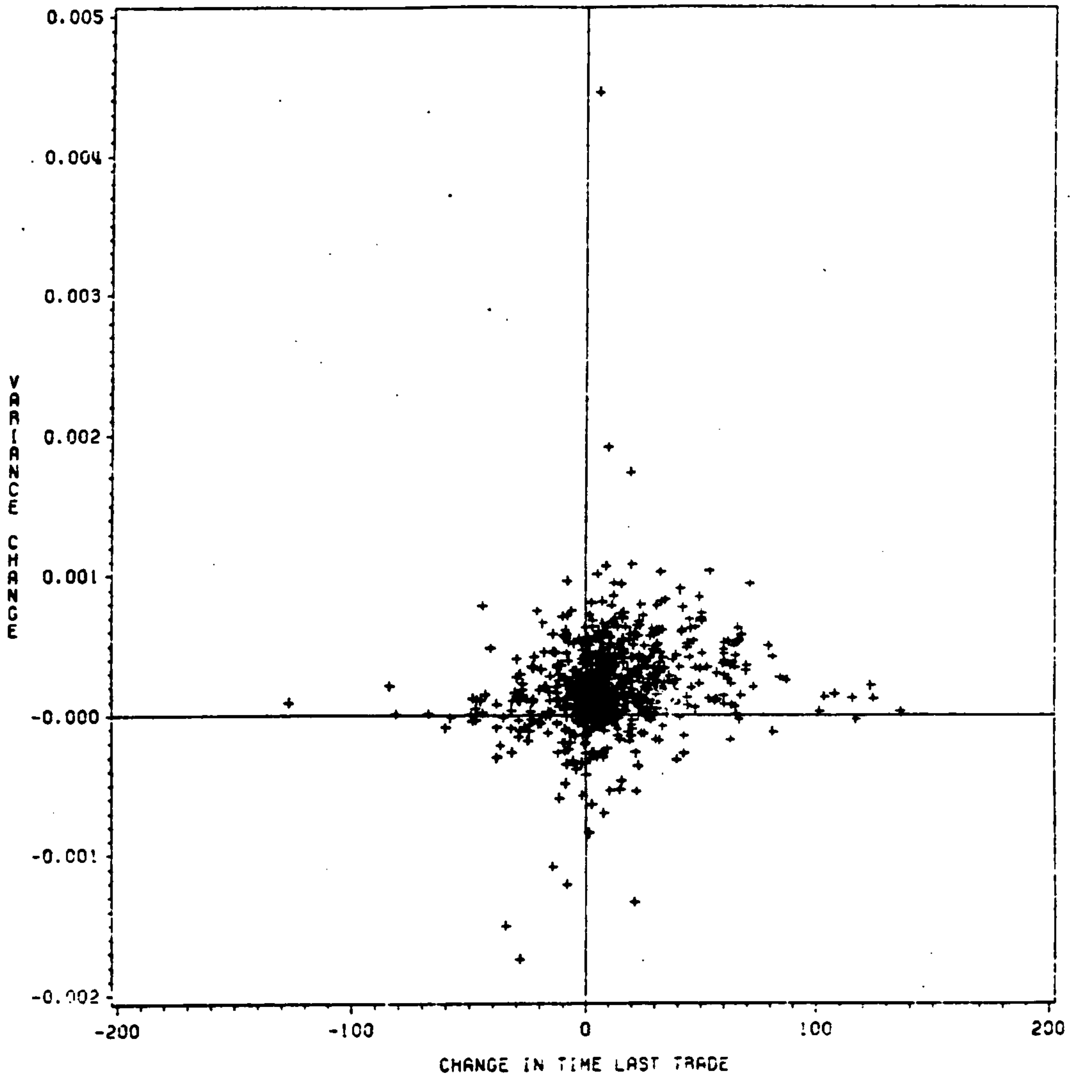

Figure 28. Variance Change vs. Change in Time of Last Trade

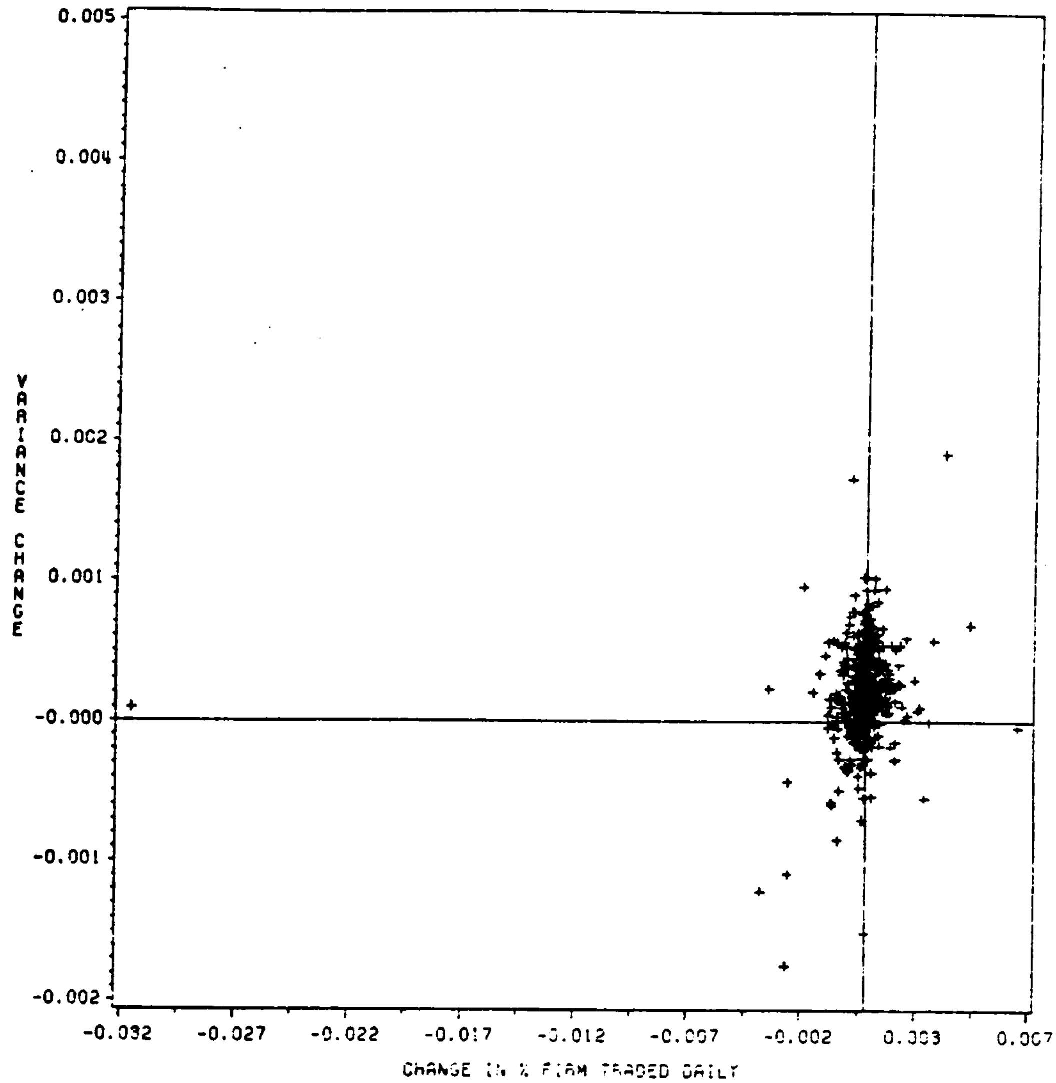

Figure 29. Variance Change vs. Change in % of Firm Traded

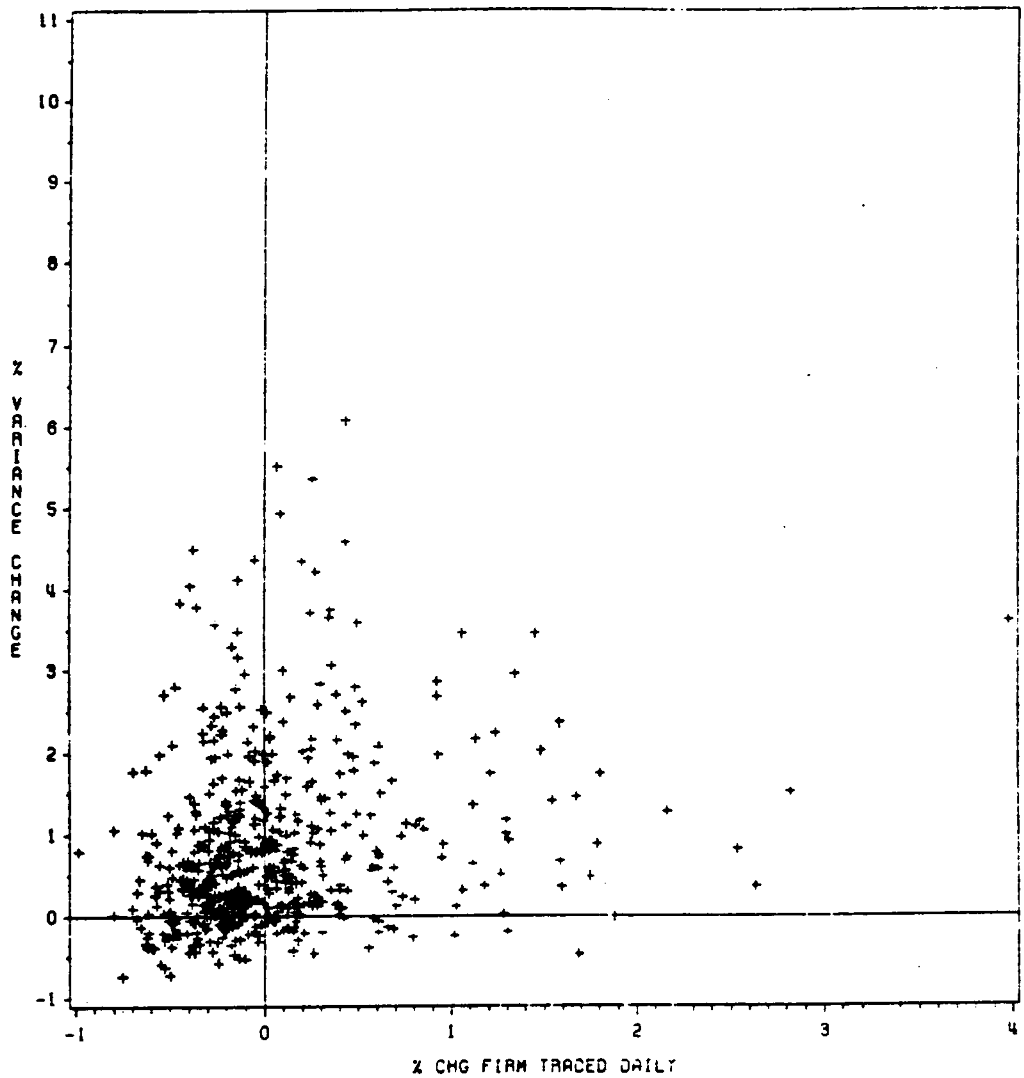

Figure 30. % Variance Change vs. % Change in % of Firm Traded

Regression Results. Two regressions are reported. [20] The first regression examines actual changes in the dependent and independent variables. Equation 3 presents the regression coeffcients.[21]

$$\Delta\sigma_i^2 = -.00007\Delta AVGPRCHGVAR + .01647LIMITRAT + .000005TRADESPD$$
$$(-2.91) \qquad (1.62) \qquad (5.360)$$

$$-.000006TIMEBT - .00051SPREAD - 8.44^{-10}DAILYVOL + .05574SPR/PRI$$
$$(-1.087) \qquad (-3.007) \qquad (-1.48) \qquad (5.576)$$

$$+ .0000034TIMELT - .0061\%FIRMTR + 1.45^{-11}LIQINDEX \quad Eq.(3)$$
$$(6.467) \qquad (-.395) \qquad (1.765)$$

The change in variance of the daily average price change is included in the regression because one measure of liquidity is narrowness of price movement. Normally, the relationship should be positive but the change in variance here reflects the price decline and the smaller mean price change. The variables' absolute decline reduces the change in the returns' variance. The coefficient is significant

The change in the limit ratio and spread-to-price ratio are positive. The limit ratio coefficient is not significant at $\alpha < .10$, although the PROB > |T| = .1058. The spread-to-price ratio coefficient is significant at $\alpha < .001$. Both variables reflect relative increases to price change and transaction costs due to the price change limit and the lower price.

There appears to be decreased costs to market makers. Inventory costs are reduced in two ways. First, the price per share declined. Second, if the market maker maintains a constant volume, then new shares from the distribution will be sold and cash added to the portfolio. The plot of the mean daily volume change does indicate reduced

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[20] As before, models were tested and rejected on the basis of severe multicollinearity, low adjusted R^2 and low F-values. Alternative models can be obtained from the author.

[21] The F-value for the equation is 38.372, with a PROB > F of .0001. The adjusted R^2 is 39.31. No severe multicollinearity was detected.

trading for the majority of firms but with more trades and more at-market trades occurring, therefore there is some offsetting. It appears then that the relative spread increase is purely from the bounds of the price change limit. A lowering of the bounds would add liquidity to the market.

The increase in relative spread may be considered a constraint or factor in determining the distribution size. This question is not addressed here, but a large split would produce a large (relative) transaction cost increase. (It is interesting that an "optimal" price may have some basis then. Within the full sample, mean daily price before the split was 48.59, with a standard deviation of 33.71. After the split, the mean price was 28.79 with a standard deviation of 13.33. The lower bound of the price distribution come into consideration, but the dispersion appears relatively reduced. The trade-off between spread reduction and relative spread increase may have a functional impact in the decsion of the target, post-split price. That question is left for further research.)

The trades-per-day coefficient is positive and small and significant at $\alpha < .05$. The time between trades is negative and not significant. More trades per day should, if it is a good proxy for more traders, provide improved liquidity. The change in trades per day has a correlation of .83479 with the change in daily volume. There is only a slight positive correlation (.002) with the price change variance change. The positive effect on the returns' variance could occur through by producing more trades when the price change limit has decreased liquidity.

The spread decline produces a significant decrease in the variance change. An examination of the trade-off between the absolute spread decline and the relative spread increase is left for future investigation. Some models of the spread include consideration of the returns' variance. These are models for general or "normal" trading. The phenomenon here, however, does not appear to involve price dispersion due to asset value changes. The change is, for themost poart, immediate and caused by the price-level change. It is the change in price and the limit of .125 serving as a lower boundary that appears to produce the variance change.

The variance change takes place only after trading has begun at new prices with new spreads. So in this case the spread change preceeds the returns' variance increase. The variance change is considered immediate because (1) Ohlson & Penman showed their proxy of $\bar{R}_i^2$ jumped instantaneously at the price change on the ex-date and (2) the effect is found in increasingly smaller periods around the ex-date in this present study. The minimal impact of firm-specific variables not related to price level also supports the primary importance of the price level change.

The spread/price change coefficient supports this as well. The coefficient of .0557 is relatively large, positive, and significant. The relative increase in the spread has a strong increasing effect on the variance . Recalling that the returns means decreased across the split (the relative decrease or increase from the firm's "normal" trading is not known) the increased variance does not appear to be compensated in the return.

The argument could be made that a decrease in the correlation with the market return occurred while the firm variance increased, with one offsetting the effect of the other. Therefore, managers would not be concerned with raising the variance of returns in this case since the normal trading return, post-split, would be unaffected. The increase in the relative spread may not be considered in light of the absolute drop in the spread or an unknown compensation may occur elsewhere.

The time-of-the-last-trade change is significant in this equation . and has been discussed above. As a liquidity measure, it reflects the increased number of trades per day. The "close-of-the-day" trading may have a systematic factor that becomes more prominent for split stocks. This can not be answered here.

The change in the percentage of the firm traded is not significant. Its negative sign suggests that the improved liquidity of more of the firm trading each day, more of the firm available to trade, and so a more liquid market, reduces the variance. This does not appear to be supported by the increased mean relative volume increase associated with increased variance in Table 29.

Finally, the change in the liqudity index is positive and significant at the $\alpha < .10$ level. The coefficient is small, however. A caveat about the index has been noted above.

In general, the absolute changes in liquidity serve to reduce the variance but in relative terms the liquidity changes brought about by the split in the price level drop have served to increase the variance.

Equation 4 examines this in terms of percentage change.[22]

$$\%\Delta\bar{\sigma}_t^2 = \underset{(10.149)}{.8373\%\Delta TRDSPD} - \underset{(-1.31)}{.00035\%\Delta TIMEBT} + \underset{(13.85)}{1.3863\%\Delta SPREAD/PR}$$

$$- \underset{(-2.116)}{.2347\%\Delta RELTRDVOL} + \underset{(1.174)}{.000004\%\Delta LIQINDEX} \quad Eq. (4)$$

The signs and significance of the coefficients have not changed from the previous regression, except that this model shows a change in the decline in the change of the relative trading volume. It is now significant.

This regression deals with percentage changes so it is in relative terms. Of particular interest is the coefficients for the percentage change in the spread-to-price ratio and for the percentage change in the spread-to-price ratio and for the percentage change in the relative trading volume. We know that the relative spread is increasing so the greater the increase, the greater the variance change will increase. In fact, given the regression, a 1 % increase in the change of the ratio will create a .72% increase in the percentage

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22 The percentage change models, with the exception of the model presented, showed severe multicollinearity, not unexpectedly. Variable combination, in the form of the liquidity idex was applied. Ridge regression was considered but rejected. A model containing only the liquidity index percentage change showed the coefficient to be insignificant.

Equation 4 had an F-value of 108.937, with a PROB > F of .0001. The adjusted R^2 of .4829 was virtually the same as the R^2 of .4873. The t-statistics of -1.31 and 1.174 were not significant at $\alpha < .10$. No severe multicollinearity was found in this model.

change of the variance increase. Conversely, we know that as trading volume, actual or relative, increases, the returns' variance increases declines. From equation 4, it appears that as the volume change increases, the increase in the returns' variance is decreasing.

Finally, the liquidity index again is not significant. Its value in reducing the multicollinearity is questioned, though equation 4 did not have severe multicollinearity. As a measure of over all liquidity, it has lacked power. In all cases it showed a positive relationship to the variance increase. Since the change was negative generally, if not significant, it suggests that the decrease in liquidity is associated with an increase in returns' variance, but this is seen from other variables.

Table 29 presents the means of the various variables examined above for the groups of firms that showed a decline in variance and the means for the firms that showed and increase in variance. The comparison is interesting. A number of large differences are seen. The mean of the average intraday price change is twice as low for firms with increased variance as for firms with decreased variance, but the variance of the intraday price changes is much smaller. The mean change in the number of trades per day is six times greater for firms that have increased post-split variance. The average change in the number of intraday price reversals is seven times greater for the firms with increased variance. The mean spread/price ration is twice as large for firms with variance increases than for those firms with variance decreases. Finally, the mean percentage of the firm traded increases after the split ($t=2.27$), while the mean percentage of the firm traded drop ($t=-2.60$) after the split for firms exhibiting variance decline.

Several factors are relatively equal, the mean spread and number of reversals after the split. Also, some mean changes are not significant. It appears, however, that the firms that had larger distributions and so the larger price adjustments, also experienced the higher liquidity values.

Table 29. Mean Comparisons for Variance Increases & Decreases

Variable Description	Mean	T	Mean	T	T†
Condition	$\Delta\bar{\sigma}_i^2 > 0$		$\Delta\bar{\sigma}_i^2 < 0$		$M1 \neq M2$
Chg. in Ret. Var.	.0003	25.87	-.0002	-8.68	-19.52
% Change in Var.	1.08	24.31	-.2165	-14.72	-27.71
Chg. Avg. Daily Pr. Chg.	-.0043	-1.12	-.0027	-0.67	- .84
Chg. Avg. " Pr. Chg. Var	-.1423	-2.53	-.0027	-1.12	- .37
Chg. .125/Price	.0019	36.15	.0016	13.54	- 2.75
Chg. No. Trades/Day	6.8193	10.17	1.4045	1.75	- 5.17
Chg. Price Reversals/Day	4.0967	11.66	.5767	1.11	- 5.61
Chg. in Spread	-.0705	-7.78	-0.0557	-3.14	.74
% Chg. Spread/Pr.	.3025	20.77	.1217	5.85	- 7.12
% Chg. in Tot. Dividends	.2282	9.70	.2370	6.06	.19
% Chg. in 0 Returns	.0671	3.77	.0466	1.42	- .55
% Chg. in No. S/Hs	.1313	8.92	.1870	5.05	1.40
% of Firm Traded/Day	.0559	2.27	-0.1096	-2.60	- 3.38
% Chg. Rel. Trd. Vol.	.0601	2.27	-.1286	-3.50	- 4.18

† T-statistic: H_o:*Means are equal.*

CONCLUSION

I sought to determine (1) if a firm's rate of return variance increases when the common stock is split, (2) if a firm's trading liquidity decreases when the common shares are split, and (3) do liquidity changes influence the variance change. I also investigated certain factors that might explain the increase in the returns' variance. I confirmed some findings of the extant literature and rejected others. I made extensions to the understanding of the variance and liquidity changes surrounding stock splits.

Confirmations and Extensions

Variance Shift Conclusions: My research confirms many of Ohlson & Penman's findings, i.e., for the majority of firms the returns' variance increases significantly on the ex-date. The difference is sizeable and dramatic. It appears to be relatively permanent, with only a slight decline over time. The decay could be due to the price increasing over time or to changes in the basic asset value, but this is conjecture. The reason for the decay is not determined here. The variance change is nonsystematic. Contaminating news around the split does not impact significantly upon variance change. The methodology used by Ohlson & Penman was adequate for determining these results.

The variable change distribution examinations, plots, and the regressions provide several new findings and extensions, some of which conflict with the extant empirical work. Unlike Ohlson & Penman, I conclude that firm size or trading volume(highly and positively correlated with firm size) is an important determinant in the direction and size of the variance change. The size of the stock distribution appears to interact with the firm's size and trading activity in affecting the returns' variance.

Ohlson & Penman rejected a number of other firm-specific factors. I found that dividend payout change appears to have a statistically significant role in the variance change. The number of firms that decreased dividends was larger than expected from the post-split dividend policies reported by FFJR. Another source of investor uncertainty could be the frequency of split use. The mean number of the split for a firm within the 1979-1984 dataset was higher for firms exhibiting variance decline. Debt generally increased, but the increase was insignificant in explaining the variance increase. I did not find the change in capital structure to be a significant variable in the phenomenon.

For the first time intraday prices were used to examine the variance change accompanying splits. I conclude that the variance change does not depend upon the close-of-trading effect. I did find that the last trade of the day occurs later in the day following the split so the variance level may be inflated by the close-of-the-day effect but the variance change is not significantly affected.

Microstructure Changes. The most important findings relate to the changes in the trading microstructure and the liquidity changes. Several findings are not surprising and are expected because of the price decrease. Essentially, normal or non-event trading is resumed after the split; the exact timing of these changes is not determined. The study made a demarcation at the ex-date. Price-related changes are expected at the split, but trading behavior changes may begin before the ex-date. The 75-day based daily means usually showed significant changes.

I find that the mean and variance of the intraday price changes fell after the ex-date price adjustment change. The change in the mean price change is insignificant. Furthermore, I observe that the means and variances of the intraday price changes are much smaller for firm's that had a variance increase than for firms that had a variance decreases. In fact, the mean price change variance increases for firms with increased returns' variance. Price reversals increase significantly, and the mean number of zero returns increase, although the mean is influenced by many relatively large increases. There are more trades during the day. Trades are spaced slightly farther apart.

Liquidity Changes: Liquidity change is dependent on how liquidity is defined. The average spread decreases significantly, but the average spread relative to price increases significantly. I observe a much larger relative spread increase for those firms showing the increases in the returns' variance than for firms where the variance actually declined. The cross-sectional mean of the number of shareholders increases, as does the mean of the average number of trades per day.

The relative trading volume shows a general decline for the full dataset, agreeing with Copeland's findings, but the relative decline is not universal. I found that firms with variance increases had a mean increase in relative trading volume. I submit that the results of Copeland, Murray, and Dravid are due to a cross-sectional dampening effect, i.e., the interaction of several factors determine whether or not relative trading volume increases, and the interaction confounds simple cross-sectional investigations.

The percentage change in relative trading volume fell. The entire dataset had an insignificant mean increase in the percentage of the firm traded daily. What is most interesting is that both relative trading volume and the percentage of the firm traded increased significantly for firms exhibiting variance increases but declined for those exhibiting variance decreases.

Variance-Liquidity Relationship: I believe that an important contribution of this work is the connection the results show between the liquidity change and returns' variance change. I submit that the variance increase is the result of the interaction of firm specific factors that determine whether liquidity will increase or decrease. Not all firms will experience improved liquidity and the change in liquidity will vary. When liquidity increases, the increased trading causes the increased relative spread to have a greater impact the returns' distribution as more trades introduce more price changes. The price change limit and the price level accentuate the effect. Price movement is driven by firm-specific factors, such as uncertainty about dividend policy, merger activity, past history of split use. The insignificant changes in the returns' variance reported for stock dividends may be due to these liquidity change not taking place, or the change is being too small or negative. I believe that managers can improve liquidity, but not by simply splitting the stock.

Justifications For Splits: Several of the reasons for using stock splits appear to be have a basis in fact. Merely employing a stock split will not guarantee a more liquid market, however. The price variance declines, but it is unclear if trading volume stabilizes. While more shareholders may be seen after the split, the extent of trading, as measured by the percentage of the firm traded each day changes only when there is increased relative trading. Given the uncertainty in predicting the size and direction of the liquidity and returns' variance changes, it is unlikely that a stock split can be reliable signal. In addition, it is unclear that stock dividends provide a reliable signal, as was suggested in the extant literature. Excess returns are generated for stockholders before the ex-date but no predictable general advantage is seen afterward.

Limitations

This research has some limitations. The regression model forms were assumed to be linear. Variables were assumed to have a distribution that approached normality. Also, it now appears that interactions between variables should be incorporated in future examinations. The binomial probability test and the t-test do not always provide powerful, consistent results.

No single model of returns' variance return was employed. The results suggest that future examinations should develop a model based upon one of the trading volume models in order to provide better direction for the research.

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