

Stock Splits, Bid-Ask Spreads, and Return Variances: An Empirical Investigation of NASDAQ Stocks

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This paper examines the bid-ask spread effect on the increase in return variances following the ex-date of splits for a sample of NASDAQ stocks. Comparing two measures of return variance (one based on closing-transaction-price returns and the other based on average-of-bid-ask-price returns), we find that the split-induced increase in stock return variance persists even after controlling for the movements of stock prices between the bid and ask prices. This result suggests that the increase in post-split variance is not due entirely to the bid-ask spread effect. Our findings for a sample of NASDAQ stocks are consistent with those of Conroy, Harris, and Benet (1990) for a sample of NYSE stocks, but do not support the conclusion of Dubofsky (1991) that exchange trading location is a significant factor in explaining split-induced increase in volatility.

INTRODUCTION

Ohlson and Penman (1985) document that the variance of stock returns increases permanently approximately 30 percent following the ex-split date. They explore several explanations for this anomalous finding, but are unable to provide a convincing answer. Some of their explanations, however, have been examined extensively in subsequent research.

Amihud and Mendelson (1987) develop a theoretical model that suggests a positive cross-sectional relationship between measured return variances and relative bid-ask spreads. If the relative bid-ask spread increases when the stock price decreases, according to their model, the increase in the measured variance of stock returns following the ex-split date may be explained as the result of the change in the relative bid-ask spread. Conroy, Harris, and Benet (1990) provide empirical evidence of a cross-sectional relationship between the split-induced increase in the measured variance and the relative spread shifts subsequent to splits using the model proposed by Amihud and Mendelson (1987). They find that for a sample of NYSE stocks the increase in relative bid-ask spreads explains part, but not all, of the increase in variance following a stock split. Dubofsky (1991) compares variance changes associated with stock splits of firms listed on the NYSE with those of AMEX. He seeks to reduce measurement problems caused by price discreteness and bid-ask spread by measuring variance using weekly returns. Dubofsky (1991) reports that adjusting for

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the effects of price discreteness and bid-ask spread significantly reduces the split-induced increase in variance for AMEX stocks but not for NYSE stocks. He concludes that the exchange trading location is a significant factor in explaining volatility shifts subsequent to stock splits.

This paper examines volatility and bid-ask spread changes associated with stock splits of OTC-NASDAQ firms. Prior studies have focused on stock splits of exchange-listed firms.¹ The trading mechanism is different between exchanges (e.g., NYSE and AMEX) and OTC markets.² The OTC market is a competitive, multiple dealership market, and the exchange is a single agency, auction market. OTC stocks, on average, are small firm and large spread stocks. Furthermore, individual investors own a greater proportion of OTC stocks, on average, than do institutional investors. Therefore, it would be interesting to investigate split-induced volatility and spread changes for a sample of OTC stocks and compare the results with those of Dubofsky (1991), who argues that the trading location is a significant factor in explaining the volatility shifts subsequent to stock splits.

In contrast with works by Dubofsky (1991) and Conroy, Harris, and Benet (1990), this paper provides a more direct test to determine if split-induced changes in variance persist after controlling for the bid-ask spread effect on return variances. To control for the spread effect on measuring return variances, this paper uses a measure of variance based on average-of-bid-ask-price returns instead of closing-transaction-price returns that are used in prior studies.³

SAMPLE SELECTION AND TEST DESIGN

Data for this study are drawn from the CRSP NASDAQ tape. The master file provides information about stock splits (split factor, declaration date, and ex-split date). Daily bid and ask prices, returns, and trading volume are derived from the returns file. Our sample contains 873 stock splits which are selected using the following criteria:

- The split factor must be at least 1.25 (5 for 4). We want to avoid stock dividends and focus exclusively on stock splits;
- The split announcement occurs after April 1, 1983, and the ex-split date is before June 30, 1987. Our choice of beginning sample period is limited by the availability of trading volume data in the CRSP NASDAQ file. We exclude stock splits whose ex-dates occurred after June 30, 1987 in order to eliminate the impact of the market crash of October 19, 1987;
- Data on the stock must be available for the period beginning 70 trading days before the announcement date ($AD - 70$) and ending 60 days after the ex-split date ($EX + 60$). This reduces any bias caused by stocks that are newly listed or delisted during the test period;

¹ Copeland (1979) and Murray (1985) are exceptions and provide evidence on the liquidity effects of stock splits of OTC stocks.

² See Schwartz (1988, pp. 59-63) for detailed differences between exchanges and OTC markets

³ We do not claim that the variances of average-of-bid-ask-price returns are an exact measure of true variance. This measure of variance, however, is free from measurement errors associated with the movements of closing transaction prices between the bid and ask prices.

- The stock must be listed on the NASDAQ national market system (NMS) during the test period.⁴ For stocks that are not traded on the NMS, the end-of-day price reported in the NASDAQ file is the average of the closing bid and ask prices.

Summary statistics for the sample used in this paper are shown in Table 1. The average price and dollar spread of the sample on the trading day before ex-split day (EX - 1) are \$31.11 and \$0.84, respectively. As compared to the sample from NYSE firms used by Conroy, Harris, and Benet (1990), the average price of our sample from NASDAQ firms is approximately \$10 lower while the average dollar spread is more than double. In addition, only in 24 of the 873 cases in our sample is the pre-split dollar spread equal to \$0.125, the minimum possible spread. For these cases, the dollar spreads cannot decrease after the ex-split date; thus, the percentage spreads would increase. The results of this paper are less apt to be driven by the stocks with minimum spread than are those of Conroy, Harris, and Benet (1990).

Table 1—Description of the Sample

Size of Split	Average Price ^a	Average Spread ^b	Sample Size
1.25 ≤ F < 1.50	\$18.38	\$0.66	133
1.50 ≤ F < 2.00	\$28.76	\$0.74	356
2.00 ≤ F < 3.00	\$37.05	\$0.93	351
3.00 ≤ F	\$44.71	\$1.81	33
Total	\$31.11	\$0.84	873

^aThe average price is the mean closing transaction price of the stocks in the sample on the trading day before ex-split day (EX - 1)

^bThe average spread is the mean of the difference between closing ask and bid prices of the stocks in the sample on the trading day before ex-split day (EX - 1). The number of cases in which the dollar spread is at the minimum of \$1/8 on the trading day before ex-split day is 24 of the total 873

This paper examines split-induced changes in volatility and spread between pre-announcement (pre-AD) and post-ex-split (post-EX) periods. The pre-AD period consists of 50 trading days starting from 70 days before the announcement of stock splits (AD - 70) through 21 days before the announcement (AD - 21). The post-EX period contains 50 trading days starting from 11 days after the ex-date (EX + 11) through 60 days after the ex-date (EX + 60). To reduce the information effects and systematic trading patterns around the announcement and ex-date of stock splits, the pre-AD period ends 21 days before the announcement and the post-EX period starts 11 days after the ex-date.⁵

⁴ If there are no trades during a day, CRSP uses the average of the bid and ask prices as the quoted transaction price. We find, however, that the sample in this study includes on average less than 5 percent of nontraded stocks during the test period.

⁵ We choose the pre-AD period starting 21 days before the announcement and the post-EX period starting 11 days after the ex-date with arbitrary approximation because the split announcement effect lingers longer than the ex-split effect. See Grinblatt, Masulis, and Titman (1984) and Maloney and Mulherin (1992) for

Table 2—Changes in Return Variance, Relative Spreads, and Trading Volume Around Stock Splits^a

		Pre-Announcement Period (AD-70 to AD-21)	Post-Split Period (EX+11 to EX+60)	Changes Between Periods	Matched Pair t-test (p-value) ^b	Wilcoxon Signed Rank Test (p-value) ^c
Daily Return Variance (percent)	Mean	0.0639	0.0921	0.0281	t=9.22	z=9.17
	Median	0.0471	0.0690	0.0152	(0.000)	(0.000)
Average Relative Spreads ^d (percent)	Mean	2.54	3.00	0.46	t=9.23	z=4.87
	Median	1.84	2.16	0.30	(0.000)	(0.000)
Average Daily Trading Volume ^e	Mean	29,559	29,601	42	t=0.03	z=-0.71
	Median	12,770	11,771	-326	(0.978)	(0.480)

^aEntries in this table are mean and median values for the stocks in the sample during the period from 70 trading days to 21 trading days before the split announcement day (AD - 70 to AD - 21) and the period from 11 trading days to 60 trading days after the ex-split day (EX + 11 to EX + 60), and mean and median values of their changes between the periods

^bThe t-statistic tests whether mean of the paired difference of each variable between pre-announcement and post-split periods equals zero

^cThe z-statistic tests whether median of the paired difference of each variable between pre-announcement and post-split periods equals zero

^dThe relative bid-ask spread is computed as: $(\text{Ask Price} - \text{Bid Price}) / ((\text{Bid} + \text{Ask})/2)$

^eThe trading volume for the post-EX period is adjusted for the split factor

EMPIRICAL RESULTS

This paper first examines the changes in daily return variance, average relative bid-ask spreads, and average daily trading volume between the pre-AD and post-EX periods for the sample of NASDAQ firms. The results are shown in Table 2. The average daily return variance in the post-EX period is more than 40 percent larger than that in the pre-AD period. The difference is statistically significant, as indicated by the matched pair t-test and the Wilcoxon signed rank test. In Table 2, we also observe that the relative bid-ask spread, which is computed as

$$\frac{\text{Ask} - \text{Bid}}{(\text{Bid} + \text{Ask})/2}$$

empirical evidence of the impact of split on stock values and trading patterns around the announcement and ex-split date.

increases after stock splits.⁶ The changes in mean and median of relative spreads between the pre-announcement and post-split periods are 46 percent and 30 percent, respectively. The matched pair t-test and the Wilcoxon signed rank test show that the mean and median of the difference are statistically significant. The increase in relative spread is consistent with the results of Conroy, Harris, and Benet (1990) for NYSE firms and with the results of Copeland (1979) for OTC firms.⁷

For our sample of NASDAQ firms, however, we find that the average daily trading volume in the pre-AD period is not significantly different from the split-adjusted trading volume in the post-EX period. This result is neither consistent with that of Copeland (1979), who reports a decrease in dollar trading volume after splits for a sample of 162 OTC stocks, nor with that of Lamoureux and Poon (1987), who report an increase in split-adjusted trading volume after splits for a sample of 213 NYSE/AMEX stocks.

The empirical results reported in Table 2 of the split-induced increase in the measured variance and the relative spread shifts subsequent to splits are consistent with the findings of prior studies for samples of exchange-listed stocks.⁸ Dubofsky (1991) argues, however, that adjusting for the effects of price discreteness and bid-ask spread eliminates the split-induced increase in variance for AMEX stocks but not for NYSE stocks. This paper examines the impact of the bid-ask spread on the increase in return variance following stock splits by using a measure of variance based on average-of-bid-ask-price returns instead of closing-transaction-price returns that are used in prior studies.

Table 3 shows results using two different measures of daily return variances (one based on closing-transaction prices and the other based on average-of-bid-ask prices) between pre-AD and post-EX periods. The mean and median of daily return variances computed with average-of-bid-ask prices are significantly lower than those computed with closing-transaction prices for both pre-AD and post-EX periods. This result indicates that a large proportion (approximately 40 percent for our sample of NASDAQ stocks) of daily return variances measured with closing transaction prices is driven by the movements of stock price between bid and ask prices. Even after controlling for the stock price movements between the bid and ask prices, however, we observe persistence of the increase in variance subsequent to stock splits. Both mean and median of variances of average-of-bid-ask-price returns in post-EX period are still higher than those in pre-AD period. The difference is statistically significant at the 0.01 level, as indicated by the matched pair t-test and the Wilcoxon signed rank test. This result suggests that the increase in variance of

⁶ We also compute the frequencies of dollar spread changes between the trading day before and after ex-split date. For approximately 40 percent of our sample, the dollar spreads either increase or do not change. In 32 percent of the total sample, dollar spreads decrease less than proportionately when compared to the price level changes by splits. Only in 27 percent of the total sample do the dollar spreads decrease either proportionately or more than proportionately.

⁷ Copeland (1979) shows that the bid-ask spread increases from 4.85 percent of the bid price one day before the split to 7.03 percent one day afterward for his sample of 162 OTC stocks. Conroy, Harris, and Benet (1990) report that average relative spread, which is defined as percent of average closing price, increases from 0.95 percent for two months before the split announcement to 1.46 percent for two months after the ex-split date for their sample of 147 stock splits of NYSE firms.

⁸ For our sample of NASDAQ firms, we replicate the regression analysis used by Conroy, Harris, and Benet (1990). Consistent with the results of Conroy, Harris, and Benet (1990), we find that the changes in variance of closing-transaction-price returns have a positive relationship with the changes in relative spreads between pre-AD and post-EX periods.

Table 3—Daily Return Variance (percent) for Closing-Transaction Price and Average-of-Bid-Ask Price

		Pre-Announcement Period (AD-70 to AD-21)	Post-Split Period (EX+11 to EX+60)	Changes Between Periods	Matched Pair t-test (p-value) ^b	Wilcoxon Signed Rank Test (p-value) ^c
Closing Transaction Price	Mean	0.0639	0.0921	0.0281	t=9.22 (0.000)	z=9.17 (0.000)
	Median	0.0471	0.0690	0.0152		
Average of Bid-Ask Price	Mean	0.0382	0.0548	0.0165	t=6.97 (0.000)	z=8.07 (0.000)
	Median	0.0256	0.0372	0.0108		
Changes Between Return Methods	Mean	-0.0260	-0.0370			
	Median	-0.0120	-0.0150			
Matched Pair t-test (p-value) ^c		t=-16.62 (0.000)	t=-15.86 (0.000)			
Wilcoxon Signed Rank Test (p-value) ^d		z=-12.84 (0.000)	z=-12.83 (0.000)			

^aThe t-statistic tests whether mean of the paired difference of each variable between pre-announcement and post-split periods equals zero

^bThe z-statistic tests whether median of the paired difference of each variable between pre-announcement and post-split periods equals zero

^cThe t-statistic tests whether mean of the paired difference of each variable between closing-transaction-price return and average-of-bid-ask-price return methods equals zero

^dThe t-statistic tests whether mean of the paired difference of each variable between closing-transaction-price return and average-of-bid-ask-price return methods equals zero

stock returns following stock splits is not due solely to an increase in the relative bid-ask spread. Our findings for a sample of NASDAQ stocks are consistent with those of Conroy, Harris, and Benet (1990) for a sample of NYSE stocks, but do not support the conclusion of Dubofsky (1991) that exchange trading location is a significant factor in explaining split-induced increase in volatility.

SUMMARY AND CONCLUSION

This paper documents a significant increase in return variances and relative spreads in the post-split period for a sample of NASDAQ stocks. Although there is a positive relationship between the increases in measured return variances and relative spreads following stock splits, a direct investigation using average-of-bid-ask prices shows that only a small portion of the split-induced increase in variances is due to the bid-ask spread effect. The split-induced increase in return variances persists even after controlling for the movement of stock prices between the bid and ask prices.

Consistent with the finding of Conroy, Harris, and Benet (1990) for a sample of NYSE stocks, our findings for a sample of NASDAQ stocks indicate that the increase in post-split variance is not due entirely to the bid-ask spread effect. Our findings add a puzzle to Dubofsky's conclusion that exchange trading location is a significant factor in explaining the split-induced volatility shifts. Dubofsky (1991) states that the increase in AMEX post-split volatility disappears after controlling for the spread effect by measuring variance using weekly returns, but not for NYSE stocks. Our results for a sample of NASDAQ stocks are similar to those for NYSE stocks.

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