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Volatility Increases Subsequent to NYSE and AMEX Stock Splits

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ABSTRACT

The post-split increase in daily returns volatility is less for AMEX stocks than for NYSE stocks. The exchange trading location is a significant factor in explaining the volatility shift even after stock price and firm size are considered. Furthermore, when measured on a weekly basis, there is no increase in AMEX stocks' returns volatility. These results suggest that measurement errors created by bid-ask spreads and the 1/8 effect, and also one or more of the elements that make the NYSE different from the AMEX, explain why the estimated volatility of daily stock returns increases after the ex split date.

OHLSON AND PENMAN (1985) provide evidence that NYSE stock returns variances increase subsequent to ex stock distribution days for splits of 100% or greater. The increase in volatility is independent of the size of the split and the post split price. Seven potential problems that might affect their results are analyzed and rejected.[1]

Ohlson and Penman (1985) suggest that the greater post-split volatility may be due to the activity of relatively ignorant noisy traders who prefer trading low-priced stocks (this "clientele factor" is attributed to Black (1986, pg. 534)) and "institutional factors" (a rather broad category that incorporates measurement problems created by the "1/8 effect" and bid-ask spreads) as possible hypotheses for the post split volatility increase.

This paper extends Ohlson and Penman's (1985) analysis to AMEX stocks. Exchange listing can serve as a proxy for several real factors that may cause the increase in post-split variance, many of which are related to the clientele factor and institutional factors cited above. If the increase in volatility differs between NYSE and AMEX stocks, it will suggest that one (or more) of the following contributes to the phenomenon:

a) Attributes of the stock and/or company. AMEX stocks are smaller and lower priced than NYSE stocks. Shares of low priced and small sized firms are characterized by wider bid-ask spreads (see Roll (1984) and

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[1]Ohlson and Penman's (1985) paper has also spurred subsequent work on smaller sized distributions and reverse splits (Dravid (1987)), and on split-related beta shifts (Brennan and Copeland (1988)). However, the source of the volatility-stock split relationship still remains a mystery.

Amihud and Mendelson (1986), for example), and wider spreads can create more "noise-induced variance" (Amihud and Mendelson (1987)).

b) Specialist behavior. Results from the microstructure literature suggest that specialists' pricing processes (the size of the bid-ask spread and its midpoint) could differentially influence pre-and post-split volatility on the two exchanges. For example, Hasbrouck (1988) finds that specialists are more likely to participate in trades of low volume stocks than high volume stocks; the purpose of these actions is to maintain price continuity (stability). Also, rules that dictate specialists' actions differ on the two exchanges. For example, the handling of open limit orders to sell on stocks' ex split days differ; AMEX Rule 132 holds the specialist responsible for reducing such orders by the size of the split, while NYSE Rule 118 requires open orders to sell NYSE stocks not be reduced on the ex-distribution day.

c) Ownership clientele factors. Institutions dominate ownership and trading of NYSE stocks but not of AMEX stocks. Trading volume, order flow and order types (limit orders vs. market orders, day orders vs. good 'til cancelled orders) potentially differ, with large block orders occurring more frequently on the NYSE.[2,3] Individuals face higher per share transaction costs than do institutions (compare Blum, Kracaw, and Lewellen (1986) to Berkowitz, Logue, and Noser (1988)), and this may affect their trading decisions at different stock price levels.[4] Small investors may prefer the lower price created by a split as it facilitates trading round lots; institutions may prefer higher priced shares so as to minimize their transaction costs.[5]

[2]Karpoff (1987) reviews the (generally positive) relationship between volume and price volatility. Copeland (1979) finds that relative volume declines after a stock split, however, this result is not found by Lakonishok and Lev (1987). Neither partitions the sample by exchange, and this may explain the different conclusions.

[3]The following three measures illustrate the degree to which block trading, defined as one involving 10,000 or more shares, is greater on the NYSE than on the AMEX:

Statistic	Years	AMEX	NYSE
Avg. share value in blocks / Total share volume	1975-1987	0.193	0.352
Avg. share volume in blocks / Total shares listed	1975-1987	0.071	0.153
Avg. number of block trades / Total number of trades (000)	1980-1987	0.0115	0.0266

The data are from the 1988 NYSE and AMEX *Fact Books*. Large block trades can be defined in other ways (see Holthausen, Leftwich, and Mayers (1987)).

[4]Investors' order placement strategies can affect stocks' returns distributions (Ho, Schwartz, and Whitcomb (1985)) and bid-ask spreads (O'Hara and Oldfield (1986)). Amihud and Mendelson (1986) predict a clientele effect for stocks: investors with longer planned holding periods will tend to invest in stocks with wider bid-ask spreads.

[5]Lakonishok and Lev (1987) acknowledge that splits may affect the composition of a firm's stockholders, and they also succinctly present the "optimal price argument"—the often cited rationale that a split lowers a stock's price to an optimal level preferred by investors.

Given these differences between NYSE and AMEX stocks, market making mechanisms, and owner characteristics, it is of interest to compare the variance-split relationship on the two exchanges. The empirical results confirm that there are post-split increases in the variance of both NYSE and AMEX daily returns. However, the increase in post-split daily volatility is less for AMEX stocks than for NYSE stocks after controlling for price and split size. Furthermore, when returns are measured on a weekly interval, NYSE stocks still exhibit a post-split increase in volatility (though a smaller one), but there is no increase in the volatility of weekly returns subsequent to AMEX stock splits. Thus measurement errors caused by bid-ask spreads, the 1/8 effect, and also specialist actions and/or ownership clientele factors, may be the sources of the greater post-split daily returns variance.

In Section I, the method and results of investigation are presented. Section II contains conclusions of the study.

I. Method and Results

The CRSP Daily Master File is used to obtain all data. The period from July 2, 1962 to December 31, 1987 is analyzed. There are 1856 NYSE and 696 AMEX splits of 100% or greater for 1082 NYSE and 558 AMEX companies.

Ohlson and Penman's (1985) method is replicated. In this procedure, the squared return on the first trading day following the date the split was declared is matched with the squared return on the first same day of the week following the ex-distribution date. Then, each subsequent day's squared return in the post announcement, pre-ex date period is matched with the next post-ex date squared return that falls on the same day of the week. Ohlson and Penman argue that the squared expected daily return can be ignored since it is inconsequential relative to the expected squared daily return. Thus, their primary test statistic is p, the proportion of cases in which post-split squared returns strictly exceeds the matched pre-split squared returns.

For the 76818 NYSE daily return comparison, $p = 0.582$, while $p = 0.558$ for the 23299 AMEX return comparisons. The z-statistic that tests for the difference between these two proportions is 6.48. The null hypothesis of equal proportions on the two exchanges is rejected. The average ratios of post-split squared returns (pooled over all events) to pre-split squared returns are 1.762 on the NYSE and 1.471 on the AMEX. The z-statistic that tests for the difference between these two ratios is 6.10, which is significant.[6] This represents additional evidence that the increase in variance is more pronounced on the NYSE than the AMEX.

Figures 1 and 2 depict the difference in the split-variance relationship for the two exchanges. These figures plot the mean squared daily returns for 300 days around the ex-distribution date (day 0). Following Ohlson and Penman's (1985) procedure, these data are not matched by the day of the week.

[6]Cochran's (1977) method is used to estimate the ratios, the variance of the difference between the two ratios, and the z-statistic.

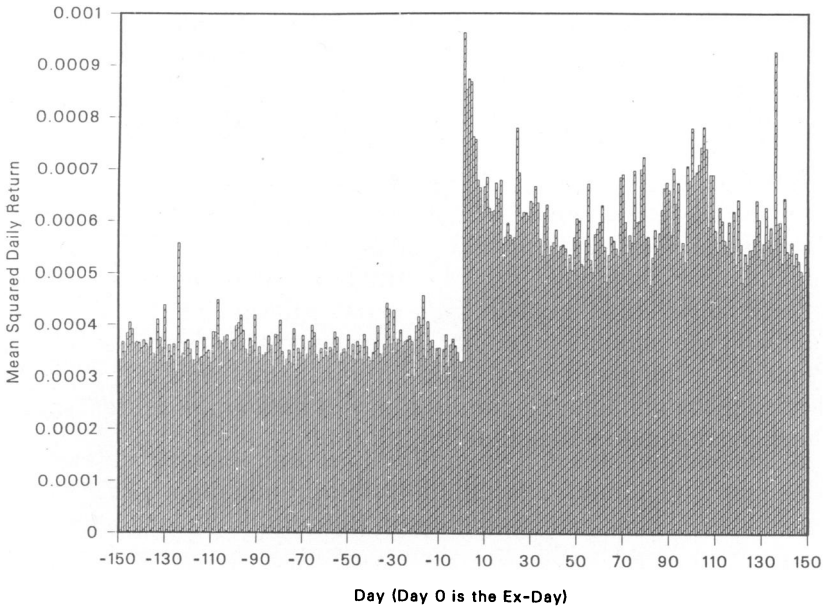

Figure 1. Mean squared daily returns around 1856 NYSE Ex-distribution days for splits of 100% or greater. The diagram averages the squared daily return on each of 301 days in event time. Day 0 is the ex split day. The sample consists of 1856 NYSE stock splits, 2 for 1 or greater, between July 2, 1962 and December 31, 1987.

However, unlike Ohlson and Penman's figure, these figures incorporate pre-announcement data, excluding the 3 trading days around the announcement date itself.[7] A visual examination of Figure 1 for the NYSE shows a permanent increase in volatility that persists for 150 days beyond the ex day. However, Figure 2 which shows mean squared daily returns for AMEX splits indicates that the greater post-split volatility is not as pronounced.

The values on the y-axes of Figures 1 and 2 also reveal that overall volatility is higher for the sample of AMEX stocks than for the sample of NYSE stocks. The average mean squared return in the pre-split period (days -150 to -1) is 0.000364 on the NYSE and 0.000760 on the AMEX. For the post-split period (days 1 to 150) the corresponding figures are 0.000606 and 0.000946, respectively.

[7]Because Ohlson and Penman (1985) exclude pre-announcement data, the number of firms' data used in preparing their figure declines as the distance from the ex date increases. In order to graph mean squared daily returns for a longer interval of time (301 days, vs. Ohlson and Penman's 151 days), pre-announcement data had to be included in preparing my Figures 1 and 2. Incorporating pre-announcement returns into these data should not create any biases, as I confirmed Ohlson and Penman's finding that pre-announcement volatility is insignificantly different from post-announcement/ pre-ex date volatility, for both NYSE stocks ($p = 0.503$) and AMEX stocks ($p = 0.498$). The z-statistic for the difference in proportions test is 1.317.

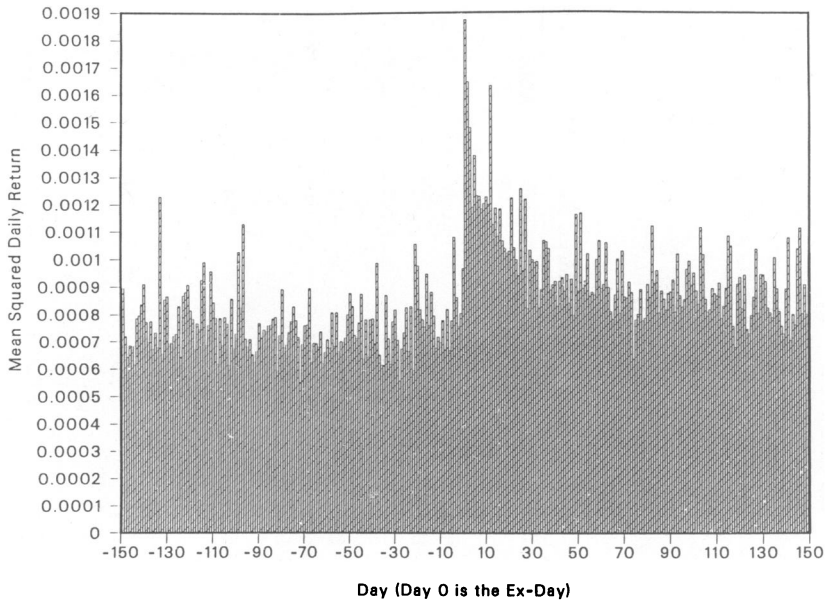

Figure 2. Mean squared daily returns around 695 AMEX ex-distribution days for splits of 100% or greater. The diagram averages the squared daily return on each of 301 days in event time. Day 0 is the ex split day. The sample consists of 695 AMEX stock splits, 2 for 1 or greater, between July 2, 1962 and December 31, 1987.

The possibility that differences in stock prices and/or split sizes on the two exchanges are causing the different results is examined next. This is motivated by the fact that the average first ex day stock price for NYSE splits is \$31.31, while for AMEX splits it is \$22.82. In addition, 85.2% of the AMEX events are 100% splits, compared to 89.3% of the NYSE splits.

Table I partitions the data by four split sizes and the nine price levels used by Ohlson and Penman (1985). For example, Panel 1 presents the data for the 100% splits. The two columns under p show the proportions of all comparisons for which the squared return is greater after the split than the matched squared return before the split. The column labelled z is the z-statistic that tests whether the proportions differ for the two exchanges. Thus, after controlling for stock price level, the returns volatilities of 100% NYSE splits increase significantly a greater proportion of time than those of 100% AMEX splits in four of the nine price levels (price levels 1, 3, 4, and 6). The same is observed in three of the four price levels for 150% splits, two of the seven price levels for 200% splits, and two of the six price levels for the largest splits of Panel 4. Only in the large splits (greater than 200%) is there a single case where the opposite is true; in price level 2 of Panel 4, a significantly greater proportion of AMEX splits experiences a volatility increase. These statistics indicate that the increase in post-split volatility is less for AMEX splits after controlling for price level and split size.

Table I

Squared Daily Return Comparisons and Estimated Standard Deviation Comparisons In Pre- and Post-Split Periods By Size of Split and Post-Split Price

This table presents the proportion of cases in which the post ex-distribution day squared daily return exceeds the matched post announcement, pre ex-date, squared daily return. The proportion is denoted p, and it is presented for NYSE and AMEX stock splits. The z-statistic tests whether the proportions differ for the two exchanges. The columns under "mean SD(R2)/mean SD(R1)" are the NYSE and AMEX ratios of the mean estimated standard deviation after an ex date to the mean estimated standard deviation before an ex date.

The four panels contain the results for different stock split sizes. Within each panel, the results are further partitioned into nine ex-distribution day price levels. Price level 1 are those splits which resulted in a price less than or equal to \$10/share; i.e., P1 ≤ \$10. The other price levels are \$10.125 < $P2$ ≤ 20, \$20.125 < $P3$ ≤ 30, \$30.125 < $P4$ ≤ 40, \$40.125 < $P5$ ≤ 50, \$50.125 < $P6$ ≤ 60, \$60.125 < $P7$ ≤ 70, \$70.125 < $P8$ ≤ 100, and P9 > \$100.

Price level	# Splits		# Comparisons		p		z	Mean SD(R2)/Mean SD(R1)	
	NYSE	AMEX	NYSE	AMEX	NYSE	AMEX		NYSE	AMEX
Panel 1. Two for One Splits									
1	18	45	722	1294	0.587	0.502	3.663***	1.180	1.212
2	264	247	9242	8027	0.565	0.571	−0.783	1.282	1.281
3	631	198	24255	6815	0.583	0.568	2.078**	1.382	1.320
4	442	64	19287	2265	0.593	0.566	2.463**	1.440	1.206
5	194	19	8726	661	0.588	0.557	1.550	1.195	1.198
6	50	8	2277	304	0.569	0.500	2.265**	1.049	0.994
7	28	2	1313	49	0.549	0.510	0.532	1.166	0.913
8	23	4	1396	137	0.569	0.511	1.314	1.109	0.932
9	6	1	353	28	0.567	0.571	−0.049	1.294	1.491
Panel 2. Three for Two Splits									
1		1		22		0.318			0.293
2	4	3	183	122	0.585	0.484	1.730*	1.288	1.129
3	7	4	316	174	0.604	0.517	1.863*	1.287	1.077
4	11	3	592	134	0.617	0.493	2.631***	1.264	1.228
5	1	2	124	72	0.669	0.611	0.818	1.797	1.369
6	2		127		0.528			1.129	
8	2		49		0.673			1.461	
9	1		47		0.574			1.195	

Table 1—*Continued*

Price level	# Splits		# Comparisons		p		z	Mean SD(R2)/Mean SD(R1)	
	NYSE	AMEX	NYSE	AMEX	NYSE	AMEX		NYSE	AMEX
				Panel 3. Three for One Splits					
1	3	2	169	35	0.509	0.514	−0.058	1.056	1.463
2	24	28	830	848	0.588	0.534	2.217**	1.525	1.058
3	42	14	2006	505	0.592	0.521	2.902***	1.273	1.057
4	49	10	2251	361	0.570	0.562	0.272	1.302	1.246
5	20	5	1053	126	0.593	0.532	1.306	1.447	0.914
6	5	1	240	36	0.554	0.611	−0.634	1.248	1.100
7		2		75		0.587			1.383
8	3	2	238	74	0.576	0.622	−0.698	1.276	1.298
				Panel 4. Greater than Three for One Splits					
1	1	7	86	333	0.500	0.523	−0.371	1.733	1.249
2	6	6	377	170	0.525	0.635	−2.395**	1.322	1.289
3	5	7	128	294	0.594	0.497	1.831*	2.074	1.284
4	5	5	178	141	0.584	0.546	0.681	1.587	0.743
5	4	1	142	113	0.606	0.460	2.306**	1.156	0.927
6	1	2	34	63	0.588	0.603	−0.141	1.099	0.571
8	1		31		0.516			1.000	
9	1		46		0.630			2.241	

*Significance at the 10% Level.
**Significance at the 5% Level.
***Significance at the 1% Level.

The last two columns of Table I present the ratio of the mean estimated standard deviation after an ex date (mean SD(R2)) to the mean estimated standard deviation before an ex date (mean SD(R1)). The individual observations are used in ANCOVA model to evaluate whether there is a difference in the split-variance relationship on the two exchanges. The model is

$$Y_{ijk} = \mu + \alpha_i + \beta_j + \gamma\left(P_{ijk} - \bar{P}_{...}\right) + \delta\left(MV_{ijk} - \overline{MV_{...}}\right) + \varepsilon_{ijk}$$

where

Y_{ijk}	=	the natural log of the ratio of post-split estimated variance to pre-split estimated variance for a firm listed on exchange $i = 1, 2$ (1 = NYSE, 2 = AMEX), with a split size $j = 1, \ldots, 4$ and k = the number of observations for factor level combination ij.
μ	=	overall grand mean, a constant.
α_i	=	the effect of the exchange.
β_j	=	the effect of the split size.
$P_{ijk} - \bar{P}_{...}$	=	the deviation of the natural log of the firm's ex day price from its overall mean.
$MV_{ijk} - \overline{MV}_{...}$	=	the deviation of the natural log of the firm size from its overall mean. Firm size is defined as the market value of the firm's equity on the ex date.
ε_{ijk}	=	normally distributed random error, with mean equal to zero, and variance equal for all i, j, and k.

The null hypothesis is that $\alpha_i = 0$. The results are presented in Table II.

Table II

Results for the ANCOVA model

$$Y_{ijk} = \mu + \alpha_i + \beta_j + \gamma\left(P_{ijk} - \bar{P}_{...}\right) + \delta\left(MV_{ijk} - \overline{MV}_{...}\right) + \varepsilon_{ijk},$$

Where Y_{ijk} is the natural log of the ratio of post-split variance to pre-split variance, μ is the overall grand mean, α_i is the exchange effect, β_j is the split size effect, $P_{ijk} - \bar{P}$ is the deviation of the natural log of price from its overall mean, and $MV_{ijk} - \overline{MV}_{...}$ is the deviation of the natural log of market value from its overall mean.[a]

Source of Variation	Sum of Squares	Degrees of Freedom	F Ratio	Signif. of F
Model	19.09	6	9.92	< 0.0001
Error	814.31	2539		
Corrected Total	833.39	2545		
Exchange	14.03	1	43.74	< 0.0001
Split Size	0.16	3	0.16	0.9211
Price	1.34	1	4.19	0.0407
Market Value	3.56	1	11.09	0.0009

[a]Model $R^2 = 0.0229$.

They show that the post-split increase in volatility depends most highly on the exchange factor ($F = 43.74$). The market value factor ($F = 11.09$) and price factor ($F = 4.19$) are also statistically significant; they likely capture the effects that split-induced changes in bid-asked spreads and perhaps volume have on the ratio of stock volatility around ex split dates. However, the highly significant exchange factor indicates that other differences related to exchange procedures, specialist actions, and/or ownership clienteles are also relevant.

In all of the above tests, data were gathered only for the period between the split announcement date and the ex date and for an equal number of days subsequent to the ex date. This procedure could affect the computed proportions p and the mean estimated standard deviations if there are systematic differences between the types of firms that announce splits just a few days before the ex date and those that make split announcements well in advance of the ex date.

To test this possibility, the number of squared returns comparisons was equalized for each split event. Returns were obtained for a period from 99 days before the ex split date to 100 days after, thereby incorporating pre-announcement returns in the data before the exdate. The same conclusion is reached that the increase in post-split volatility is less for AMEX stocks than for NYSE stocks. For the 171,874 NYSE comparisons, $p = 0.568$, and the average ratio of post-split squared returns to pre-split squared returns is 1.661. For the 62,407 AMEX comparisons, $p = 0.544$, and the average ratio of post-split to pre-split squared returns is 1.325. The z-statistics that test the null hypotheses of equal proportions on the two exchanges and equal ratios of post-split to pre-split squared returns are 10.37 and 10.48, respectively. Thus, the result that the split related volatility shift differs on the two exchanges is confirmed.

Finally, the "1/8 effect" is analyzed as a possible explanation for the differential exchange effect on split-related returns variances. Because trades almost always occur at 1/8 variations, there is a resulting bias in the estimator of daily returns variances (Ball (1988), Gottlieb and Kalay (1985)), particularly for low priced stocks. Following Ohlson and Penman's (1985) approach to testing this hypothesis (see their section 4.7), squared weekly returns are compared over the period beginning 99 days before the ex split date and ending 100 days after that date. On the NYSE, $p = 0.549$ for 30,232 weekly returns comparisons; on the AMEX, $p = 0.520$ for 11,024 weekly returns comparisons. The z-statistic for the difference in proportions test is 5.08. Interestingly, the average ratios of post-split to pre-split squared weekly returns are 1.393 on the NYSE and 1.000 on the AMEX (the difference is significant ($z = 7.67$)). These ratios indicate that the increase in AMEX post-split volatility disappears when returns are measured weekly. Thus, measurement problems caused by the 1/8 effect and bid-ask spreads more fully explain the AMEX results, but the elements that make the AMEX and NYSE different from each other prevent this conclusion from being drawn for NYSE stocks.

II. Conclusions

Ohlson and Penman's (1985) finding that NYSE stocks experience an increase in the variance of their daily returns after an ex stock split date is confirmed to exist for AMEX-listed stocks also. However, the post-split increase in daily volatility is greater for stocks on the NYSE than for stocks on the AMEX. The listing location proxies for several real variables that may play a role in explaining this phenomenon. These variables include security related factors, specialist behavior and market making activities, and stock owner characteristics. The results of the ANCOVA model show that even after controlling for the effects of stock price and firm size, the exchange location remains the most significant factor in explaining the increase in daily volatility.

When returns are measured on a weekly interval, the average ratio of post-split to pre-split squared returns declines to 1.000 for AMEX stocks. This implies that the measured increase in volatility is due to measurement problems (the 1/8 effect and bid-ask spreads) for the market environment of the AMEX. But the factors that make the two exchanges different prevent the same conclusion from being drawn for NYSE stocks.

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