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A Note on the Behavior of Stock Returns around Ex-Dates of Stock Distributions

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A RECENT PAPER BY Ohlson and Penman [7] (henceforth OP) documents that, for stock splits larger than two-for-one (one hundred percent), the volatility of stock returns after the ex-split date is significantly higher than the presplit volatility. The increase in the standard deviation of daily returns is of the order of twenty-eight to thirty-five percent and persists for as long as a full year after the ex-date.[1] Even more interesting is their finding that there is no (permanent) change in the variance of returns at the *announcement* date. They investigate several potential explanations for this "aberration" but are unable to find a satisfactory answer. Grinblatt, Masulis, and Titman [6] (henceforth GMT) examine the behavior of expected returns around announcement dates and ex-dates for stock distributions exceeding ten percent. Classifying stock distributions as either stock dividends (split factors of twenty-five percent or less) or stock splits, they conclude that return behavior differs across these two types of distributions, with stock dividends exhibiting larger abnormal returns than splits. This is interpreted by them as evidence in favor of the "retained earnings hypothesis": the dissimilar accounting treatment of these two types of stock distributions affects retained earnings in different ways, and hence splits are not simply large stock dividends.

This paper extends the work of OP to all types of stock distributions. In Section I, postsplit variance is shown to be different from the presplit variance for small stock splits and stock dividends. While small splits display an increase in volatility like large splits, stock dividends are associated with a decrease in the volatility of returns. This evidence also supports GMT's conclusions that stock splits and stock dividends are "different" types of events. Section II investigates the volatility of returns for reverse splits and demonstrates that postsplit volatility *decreases* for these events. This evidence is complementary to Woolridge and Chambers' [9] findings that reverse splits are also associated with negative abnormal returns at their announcement and ex-dates. Section III concludes the paper.

I. Small Splits and Stock Dividends

OP present convincing evidence (in particular, see OP Figure 1, page 257) that the variance of returns after the ex-date for *large* stock splits (greater than or

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[1] This is in contrast to the temporary increases (related to trading activity) documented by Beaver [1] and others for events such as earnings announcements.

equal to one hundred percent) is significantly higher than the variance prior to the ex-date. This section extends their results to stock dividends (less than twenty-five percent) as well as small stock splits (between twenty-five percent and one hundred percent).

The analysis is based on a sample of 639 stock splits and stock dividends during the period July 2, 1962 to December 31, 1981. Initially, approximately 8000 events were obtained from the CRSP daily master file. For each event, the immediately preceding and succeeding distributions (stock or cash) were also recorded. Splits and stock dividends that met the following criteria are included in the final sample:

1. The number of days N between the announcement of the distribution and its ex-date is greater than 20, and
2. There are no cash dividend announcements or ex-dates in the N-day period before and after the ex-date for the stock distribution.

This procedure ensures that the final sample does not include stock distributions with contaminating events during the twenty-day (or longer) period on either side of the ex-date.[2] For cash dividends, the existence of abnormal returns has been documented not only on the actual announcement and ex-dates, but also during the few days prior and subsequent to these days (see, for example, Eades, Hess, and Kim [2]). By ensuring that the sample under consideration is not "contaminated" by cash dividend announcements or ex-dates, the possibility that cash dividends may be a cause of anomalous return behavior is ruled out.[3] Returns data are obtained from the CRSP daily returns file.

OP argue that, in view of the large quantity of data available and the *a priori* plausibility of the null hypothesis of equal variances pre- and postsplit, a conservative statistical test is called for, which does not rely on specific assumptions about the distribution of returns. They test for an increase in postsplit variance by computing the proportion of "successes":

$$p \equiv \Pr(\tilde{R}_2^2 > \tilde{R}_1^2) \begin{cases} = 0.5, & \text{under the null hypothesis,} \\ > 0.5, & \text{under the alternate hypothesis,} \end{cases}$$

where $\tilde{R}_1$ and $\tilde{R}_2$ denote pre- and postsplit returns. Assuming independence across N observations, the related simple binomial statistic $(p - \pi)/\sqrt{N\pi(1 - \pi)}$ is asymptotically distributed $N(0,1)$, where $\pi = 0.5$. The test statistic is computed by matching post- and presplit returns for each split and tallying the proportion of cases, pooled across splits and dates, in which R_2^2 exceeds R_1^2. The matching procedure they elect to use is designed to control for possible day-of-the-week effects. The squared return for the first day after the announcement is compared with the return for the first corresponding day of the week after the split. This

[2] There is also the possibility of events other than split announcements or cash dividends (such as the announcement of a merger or new product line, or even an earnings report) occurring during this period. This was tested by reference to the *Wall Street Journal Index* for the forty-five largest and smallest returns, as well as one hundred other randomly selected stocks. Only two stocks out of the 190 examined were found to have significant coincidental events. Deleting these had no effect on the results obtained.

[3] OP do not control for cash dividends in their sample.

is repeated until all the trading days between the announcement and the split dates are exhausted. OP find that, out of 1257 splits examined, 1054, or 83.9 percent, exhibit an increase in the postsplit variance.

Results obtained using OP's return-matching procedure and binomial test are shown in Table 1. As expected, an increase in variance is very much in evidence for large splits, with a binomial z-statistic of 5.59. This is simply a replication of the OP result. Small splits also exhibit a similar (significant) increase in variance ($z = 2.48$). In contrast, stock dividends show a significant *decrease* in variance, with a z-statistic of -5.61. For all stock distributions, the combined z-statistic is -1.23, implying that the estimated probability is 0.496, which is not statistically different from 0.500. Hence, all stock distributions as a class of events are *not* associated with a variance change. However, when we examine different types of stock distributions, we see that OP's findings regarding large splits do extend to small splits, while stock dividends exhibit the opposite effect.[4] This can be interpreted as evidence in support of GMT's findings that stock splits do not behave like large stock dividends; the events appear to be fundamentally different.

II. Reverse Splits

Reverse splits have not generally received the attention that splits and stock dividends have. Woolridge and Chambers [9] document the existence of *negative* abnormal returns around the proposal date, date of approval by shareholders, and ex-date for reverse splits. This behavior is opposite of that of splits and stock dividends and raises obvious questions about the possibility of a change in the volatility of returns around ex-dates for reverse splits. There is no theoretical reason to predict the existence (or direction) of any change in the volatility. However, if found, it could be viewed as evidence complementary to that of OP and Woolridge and Chambers [9].

The analysis is based on reverse splits announced during the period July 2, 1962 to December 31, 1981. Initially, sixty-nine events were obtained from the CRSP daily master file. They were checked for the occurrence of coincidental events (such as cash dividend announcements or ex-dates, earnings announce-

[4] In order to validate these results, three other tests were performed. The first test is a binomial test of the variance ratio, computed as postsplit variance divided by presplit variance. The number of cases for which this ratio is greater or less than 1.00 is counted. Under the null hypothesis, there should be an (approximately) equal number of instances. The results obtained are very similar to the binomial test findings. Next is the conventional F-test, which tests whether this ratio of variances is significantly different from 1.00, under the assumption that returns for the pre- and postsplit periods are drawn independently from a normal distribution. To aggregate the individual F-statistics across events, the procedure outlined by Fisher [5, p. 99] is used. Assuming independence across events, the p-values calculated for individual events are distributed uniformly $U(0,1)$. The natural logarithms of these probabilities multiplied by -2 are distributed $\chi^2(2)$. Hence, they can be summed and inverted using the additivity property of the χ^2 distribution. The procedure used by Shanken [8] is essentially a minor variation, using a standard normal distribution instead of a χ^2. This test also confirms the earlier results. Finally, the sensitivity of the results to the matching procedure is examined by using the following alternative method: returns are matched, not by day of the week, but *symmetrically* around the ex-date. The squared return for day -2 is matched with that for day $+2$, and so on. Results obtained are virtually identical to those shown in Table I.

Table I

Squared Daily Return Comparisons in Pre- and Postsplit Periods by Type of Stock Distribution for 639 Events between July 2, 1962 and December 31, 1981

Size of Stock Distribution	Number of Daily Return Comparisons		
	$\tilde{R}_2^2 > \tilde{R}_1^2$	$\tilde{R}_2^2 \leq \tilde{R}_1^2$	$\hat{\Pr}(\tilde{R}_2^2 > \tilde{R}_1^2)$[a]
Stock dividends (≤ 0.250)	7772	8487	0.478 (−5.61)
Small splits (> 0.250 and < 1.000)	1658	1518	0.522 (2.48)
Large splits (≥ 1.000)	2293	1929	0.543 (5.59)
All splits (> 0.250)	3951	3447	0.534 (5.85)
All stock distributions	11723	11934	0.496 (−1.23)

[a] $\hat{\Pr}(\tilde{R}_2^2 > \tilde{R}_1^2)$ is the estimated probability that squared daily returns in the postsplit period ($\tilde{R}_2^2$) exceed squared daily returns in the presplit period ($\tilde{R}_1^2$). It is calculated by computing the proportion of the total number of cases in which this occurs for returns matched by day of the week. The binomial z-statistic reported (in parentheses) is distributed $N(0,1)$ conditional on the null hypothesis that $\Pr(\tilde{R}_2^2 > \tilde{R}_1^2) = 0.500$.

ments, mergers, etc.) around their ex-date using the *Wall Street Journal Index*. Reverse splits that were accompanied by any other major event were deleted. The final sample of fifty-seven events is therefore a "pure" sample in the sense of GMT.

In performing the binomial test for reverse splits,[5] a major problem (that does not arise for splits and stock dividends) is encountered: for almost every event, there are a very large number of instances where the presplit squared return is *equal* to the matched postsplit squared return. Most of these are zero returns that occur because these stocks typically trade in the range of \$1 to \$2 presplit and only slightly higher postsplit. At these prices, the restriction that stock prices must be multiples of \$0.125 results in a large number of zero returns on *both* sides of the ex-date.[6] Choice of the treatment of matched equal squared returns becomes a crucial factor in determining the outcome of the test. In an effort not to favor either hypothesis, the treatment adopted is to split the number of equal squared returns between the null and alternate hypotheses. The z-statistic obtained for the test is −3.51, which indicates that there is a significant *decrease* in the variance of returns after the ex-date. Figure 1 illustrates mean squared daily returns around ex-dates. The effect of the reverse split does not appear to

[5] For reverse splits, the alternate hypothesis is $p < 0.5$.

[6] There is a possibility that the binomial test methodology employed will not be able to distinguish between a real decrease in variance and an apparent decrease attributable to price discreteness. For example, a low-priced AMEX stock that trades in 1/16ths before the reverse split and in 1/8ths after the split may have a relatively larger number of zero returns postsplit, coupled with occasional large returns. By examining the trading prices of every stock in the sample in the pre- and postsplit periods, it was verified that the results are not being driven by differences in units of trading.

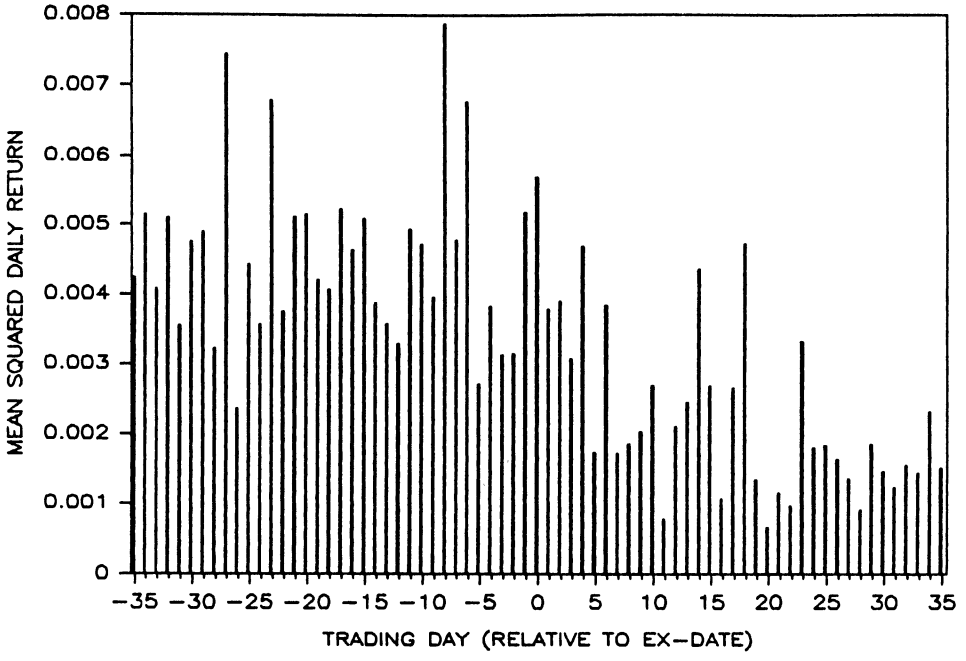

Figure 1. Plot of Mean Squared Daily Returns around the Ex-Date (Day 0) for 57 Reverse Splits.

be as pronounced as that of OP (Figure 1, page 257), which reflects their much larger sample size. Once again, the behavior of returns associated with reverse splits is seen to be in the opposite direction of that for splits, reinforcing the possibility that these are related anomalies.[7]

[7] OP adopt an alternative treatment: they count matched equal squared returns in favor of the null. The z-statistic obtained using their procedure is 1.74, which is not significant at the 0.05 level, but signifies a possible *increase* in the variance of returns for reverse splits, in contrast to the results presented. In order to resolve this inconsistency, the variance-ratio tests discussed earlier for splits and stock dividends were performed for reverse splits. Postsplit variance was found to be lower for forty-three of the fifty-seven events. The estimated probability $\hat{\Pr}(\tilde{R}_2^2 > \tilde{R}_1^2)$ is 0.246, with a binomial z-value of −3.84. The F-test also confirmed this result: the aggregate z-value (computed as described in the previous section) is −11.23. Finally, the bootstrap procedure of Efron [3, 4], which avoids the problem of treating matched equal squared returns, was used. Bootstrap estimates of the presplit variance are obtained using the procedure described by Efron. A random sample of size N is drawn with replacement from the time series of N presplit returns, where N is equal to the number of days between the announcement and ex-dates. The sample variance is computed, and 1000 replications are carried out. From these 1000 variances, 500 variance ratios are calculated, and a bootstrap histogram is obtained. The "percentile method" described in Efron [4] is used as follows: under the null hypothesis that pre- and postsplit variances are drawn from the same population, the empirical bootstrap histogram of variance ratios is used to compute the p-value for the sample variance ratio. The p-values obtained for individual events are aggregated using the procedure described earlier to obtain an $N(0,1)$ statistic, from which an overall p-value is determined. The aggregate z-value obtained is −10.80, which is strongly supportive of a decrease in the postsplit variance. The bootstrap procedure confirms the findings obtained by using the variance ratio tests and binomial test using the selected matching treatment. Hence, the result obtained for reverse splits using the OP treatment is not correct and should be ignored. In their application, OP do obtain significant results using this alternative, which is a result of both their larger sample size and the much smaller number of matched equal squared returns associated with splits relative to reverse splits.

OP investigate a number of potential explanations for their empirical findings but are unable to find a convincing answer. Of these, trading volume has been investigated here and does not appear to be of much use in explaining the variance decrease for reverse splits either.[8] None of the other (unsuccessful) tests carried out by OP have been replicated here, as they do not appear *a priori* to be potentially any more useful in explaining the observed anomalous behavior for reverse splits than for splits.

III. Conclusion

The results obtained support prior evidence that the ex-date for stock distributions is not a "nonevent" as theory would lead us to believe. The results from three previous papers are extended and related to each other. Woolridge and Chambers [9] find that reverse splits are associated with abnormal negative returns, and this behavior is opposite to that of stock splits and stock dividends, as documented by GMT. OP document that stock splits are associated with an increase in the variance of postsplit returns. It has been shown here that reverse splits once again exhibit a variance effect in the opposite direction. Finally, the change in the volatility for stock dividends is also found to be opposite to that for splits. In conjunction with GMT's findings that their mean returns are also of different magnitudes, this supports the "retained earnings hypothesis" that stock dividends and splits are not similar events of different sizes.

[8] This was tested by collecting data on trading volume for all reverse splits in the sample from Standard and Poor's *Daily Stock Price Record.* The average daily pre- and postsplit trading volumes are computed as a percentage of the total volume of shares outstanding for the identical periods used earlier for comparison of the variances. The difference between the pre- and postsplit daily trading volumes averaged across events is statistically insignificant. Neither the product-moment correlation nor the rank-order correlation between trading-volume ratio and variance ratio is found to be statistically different from zero.

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