Return Performance Surrounding Reverse Stock Splits: Can Investors Profit?

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Abstract

We examine long-run return performances of over 1,600 firms with reverse stock splits over a 40-year period. These stocks record statistically significant negative abnormal returns over the three-year period following the ex-split month. They also experience poor operating performances over the same time period, suggesting informational inefficiencies. However, due to their unique financial characteristics, these stocks were difficult to sell short, thus restricting arbitrageurs from earning abnormal profits, even if they correctly anticipated the price declines. These results are consistent with Fama's (1970) and Jensen's (1978) definitions of market efficiency, which requires zero economic profits from trading on the basis of available information.

Return Performances Surrounding Reverse Stock Splits: Can Investors Profit?

I. Introduction

This study begins by examining the long-term stock and financial performances of firms following reverse stock splits. We find a significant downward price drift over the three years following the ex-split date, as well as significantly lower earnings and operating cash flows (OCF) over the same time period following the ex-split date, when compared to firms with similar characteristics. These results suggest that the market underestimates the future poor performances of reverse stock splits, and that investors should be able to exploit this market inefficiency by short-selling these stocks. However, institutional restrictions on short-selling and other transaction costs related to the unique characteristics of these stocks significantly curb investors' ability to earn abnormal profits from these stock movements. We thus conclude that while reverse splits are informationally inefficient, investors' opportunities to reap abnormal returns from this information are limited. Following Fama (1970) and Jensen (1978), we view this scenario as being consistent with market efficiency.[1]

Our study contributes to the finance literature in several ways that are unique to this event. First, we investigate whether there are long-term benefits to firms undergoing reverse splits. Previous studies document short-run advantages to reverse split firms such as an increase in trading liquidity as reflected by a reduction in the bid-ask spread around the ex-split date (Han (1995)) and an increase in trading volume (Lamoureux and Poon (1987)). Conversely, Han (1995) and Kim et al. (2005) find significantly negative abnormal returns on the ex-split day, a finding that we also report, suggesting that the market anticipates negative information about the firm following this date.[2] We examine this conjecture by

[1] "A market is efficient with respect to information set θ_t if it is impossible to make economic profits by trading on the basis of information set θ_t." (Jensen 1978, p. 96). Fama (1970) discusses this within a "fair game" context.

[2] Earlier papers on reverse stock splits focus on the announcement-day effect and report significantly negative abnormal returns over the announcement period (e.g., Woolridge and Chambers (1983) and Peterson and Peterson (1992)).

calculating the subsequent three-year stock returns and operating performances for a sample of 1,612 reverse splits from 1962-2001. Our results show that, both in terms of market and operating performances, firms perform poorly after undertaking a reverse stock split. The market results corroborate those reported by Desai and Jain (1997), who document marginally significant negative abnormal stock returns for a limited sample of 76 firms from 1976 through 1991.[3] The operating results are also new to this study. Thus, we present a more comprehensive long-run performance study of reverse stock splits than previously examined.

Our next two contributions are driven by the nature of our sample. Specifically, reverse-split firms are non-random in that they primarily hail from the extreme left-tails of the distributions for stock price and firm size. We demonstrate that these firms have liquidity and financial distress characteristics that 1) prevent investors from reaping abnormal profits despite expectations of a poor market performance and 2) make it difficult for standard asset pricing models to accurately measure long-run abnormal returns.

Regarding the inability to earn abnormal returns, we find that on the month and for three years following the month of the ex-split date, sample issues have significantly lower monthly short interest compared to firms without reverse splits. Further, the inability to short-sell is greater for sample stocks with an ex-split price less than $5, a finding consistent with D'Avolio (2002) and Desai, Ramesh, Thiagarajan, and Balachandran (2002), who show that stocks without short interest are small, illiquid securities, and priced predominantly below $5 per share. We also find that when we divide our sample into stocks above and below an ex-split price of $5 per share, only the smaller-priced subsample earns significantly negative abnormal returns. Taken together, the underperformance and short-selling findings suggest that investors are restricted in their abilities to earn economic profits after the ex-split

[3] As we show in the next section, their sample selection criteria captures only a small percentage of the firms with reverse splits over this 16-year period.

date. Thus, despite the systematic underperformance after the ex-split date, we conclude that these results are consistent with an economically efficient market (Fama (1970) and Jensen (1978)).

In a similar vein, we document that the sharp decline in stock price on the day of the reverse split can be explained by a reduction in transaction costs on the ex-split date. This phenomenon can be traced to the nature of our sample, which is that most reverse splits are priced under $1/share prior to the ex-split date. Specifically, we find that the magnitude of the ex-split date stock decline is directly related to the size of the stock split, which, in turn, is directly related to the reduction in the stock's relative bid-ask spread. Accordingly, investors selling prior to the ex-split date to avoid the negative return on that date will have to incur higher transaction costs to liquidate their positions. Once again, we conclude that despite the significant negative abnormal return recorded on the ex-split date, the market acts in an economically efficient manner.

In addition, this paper contributes to the debate on how to measure long-run stock return performances. Due to the unique nature of our sample, commonly-used expected returns models may not adequately capture the risk characteristics of stocks undergoing reverse stock splits. Since market efficiency must be tested jointly with a model of expected returns, using an incorrect model might result in a rejection of market efficiency, when it is actually the incorrect model that is producing the abnormally negative returns. Fama (1998) calls this the "bad-model problem" and shows that this issue is more serious when calculating long-run returns.

To address the bad-model problem, we match each sample firm to a single matched-control firm, where we pair by stock price, firm size and industry. Using this technique, we find that reverse split firms record significantly negative abnormal returns over a one-year, two-year and three-year period following the ex-split date. However, when we compare these risk-adjusted returns to those generated by a number of other commonly-used models, we find that the single matched-control abnormal returns generally are smaller than those generated by the standard returns models. These results suggest that standard models do not control for the unique risk factors inherent in extremely small, low-priced firms.

Our findings and interpretations have implications on other long-run performance studies. First, they suggest that researchers may need to go beyond the standard expected returns models when calculating long-run abnormal returns. This is particularly true for samples that come from the extreme tails of a distribution, such as stock price and firm size. Second, informational inefficiencies (e.g., systematic underperformance) may not always result in exploitable trading rules leading to arbitrage profits. Shleifer and Vishny (1997) describe conditions in which pricing anomalies in financial markets are likely to appear but are not eliminated due to limits on arbitrage. Fama (1970), Jensen (1978) and Rubinstein (2001) describe these situations as being economically market efficient or minimally rational.

The remainder of the paper is structured as follows. Section II describes the sample selection process. Section III describes the research methodology and the various benchmarks for computing abnormal returns. Sections IV and V present the empirical results for the returns and operating performance tests. Sections VI and VII provide empirical evidence consistent with investors being unable to profit from the negative stock performances. Summary and conclusions are presented in the final section.

II. Sample Selection and Description

The initial sample includes 1,737 common-stock reverse splits from January 1, 1962 through December 31, 2002, as identified on the CRSP database. We eliminate 32 observations with split factors less than 1:2.[4] Since we require each sample stock to trade for at least one year after the reverse split, we eliminate the 93 reverse splits that took place in year 2002. This reduces the sample of reverse splits to 1,612.

Table 1 presents descriptive statistics for reverse splits. Panel A shows the distribution of reverse splits by year. Only 100 (6.2 percent) of our sample occurs between 1962 and 1980. The heaviest activity is between 1990 and 2001, with 1,169 reverse splits (72.5 percent). While Desai and Jain (1997) find only 76 reverse splits from 1976 through 1991, our sample contains 554 reverse splits over the same period. The difference is due to methodology: Desai and Jain (1997) identify their sample indirectly through announcements in the Wall Street Journal, whereas we use the CRSP tape to find reverse stock splits.[5]

Panel B shows that when grouped by trading venue, 1,254 reverse splits (77.8 percent) take place on the NASDAQ, while the NYSE and AMEX account for 178 (11.0 percent) and 180 (11.2 percent), respectively. These results are in marked contrast to forward splits, in which the NASDAQ and the NYSE/AMEX comprise an almost equal number of forward splits (Byun and Rozeff (2003)). Since CRSP's coverage of NASDAQ firms begins in 1968, the percentages for the reverse splits are tilted towards the NYSE/AMEX, although we note that our sample contains only 26 reverse splits before 1968.

Panel B also presents the mean pre-split and post-split prices for the sample stocks, where mean prices are calculated from 60 to 120 calendar days prior to and 30 to 90 calendar days after the ex-split date. As Panel B shows, mean pre-split and post-split prices differ by exchange. The mean pre-split

[4] We eliminate these splits for two reasons. First, consistent with Byun and Rozeff (2003), who examine forward splits, extremely small reverse splits result in negligible stock market reactions. Second, to confirm that the CRSP's reverse stock split identifier is accurate, we randomly selected 100 reverse stock splits and used Moody's Dividend Record to confirm whether a reverse split took place in that particular year as well as the split factor. For this subsample, all 95 reverse splits greater than or equal to 1:2 were accurate. However, the five firms with split factors less than 1:2 did not check out.

[5] CRSP identifies announcements dates for just 138 of the 1,612 firms with reverse splits.

price is $7.24 for NYSE firms, compared to $1.21 for NASDAQ stocks. The mean, post-split price level for NYSE stocks is $12.73 versus $3.94 for NASDAQ stocks. The differential in pre-split price between the NYSE/AMEX and NASDAQ is consistent to that reported by Han (1995).[6]

Panels C through E break our sample down by split size, pre-split price and market capitalization. The most frequent split factors are between 1:2 and 1:10 with 917 events (56.9 percent). Panel D shows that 63.2 percent of the sample firms have pre-split prices of $1 or less while only 6.1 percent have pre-split prices greater than $5. Since one of the principal motivations for having a reverse split is to avoid exchange delisting due to a low stock price, the high percentage of under-$1 stocks is not surprising. In terms of market capitalization, Panel E shows that virtually all of the sample firms are in the smallest market equity size quintile of all stocks listed on the NYSE, with, 92.1 percent falling into quintile 1 and the remaining 7.9 percent being in quintile 2.

In summary, reverse stock splits are done primarily by small, NASDAQ companies trading at extremely low prices. As we later show, these firms are different from larger firms in terms of transaction costs, trading liquidity, institutional ownership and short-selling constraints. Because our sample of firms have unique characteristics, we take these factors into consideration when calculating our long-run performance metrics and, more importantly, when assessing market efficiency.

III. Long-run Abnormal Returns: Methodology

Since market efficiency is a joint test of efficiency and the expected returns model, using an incorrect model may result in a rejection of market efficiency, when in fact it is the model that is producing the abnormally negative returns. Fama (1998) calls this the "bad-model problem" and shows that it is most serious when calculating long-run returns. Most long-run stock performance papers use

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[6] Han (1995) reports an average price of $4.66 and $1.97 for NYSE/AMEX and NASDAQ stocks respectively, as of 30 trading days before the announcement date. His sample consists of 61 NYSE/AMEX and 75 NASDAQ firms from 1963-1990.

standard risk-adjustment models, adjusting by market returns, firm size, book-to-market ratios, and/or price momentum. Each factor controls for inherent risks common to all firms, and allows researchers to extract the abnormal price performance above and beyond these risks. However, since reverse splits predominantly hail from the left tails of the distributions of firm size and trading price, we propose that these standard models may not capture the liquidity and financial risks of our sample issues.

To address these concerns, we utilize a matched-firm technique, where we match each sample firm by industry, market price and firm size.[7] Specifically, for each sample firm, we find a control firm on Compustat that is in the same industry using the Fama and French (1997) classification system. We then select those firms whose pre-event price levels are within the same price range as the sample firm (see Table 1, Panel D). From these potential control firms, we select a firm whose total assets at the beginning of the sample firm's fiscal year most closely match the sample firms' total assets. The average price is $1.80 for the reverse split sample is and $1.93 for the control sample. The t-statistic for differences between prices is 0.63, insignificant at standard significance levels. The mean total assets are $188.14 million for the sample firms and $103.20 for the control sample. Although the t-statistic is 2.00, significant at the 0.05 level, both groups basically are pulled from very small firm-size samples.

Alternatively, we use three standard benchmark portfolios to adjust the raw returns of the sample firms: (1) size-adjusted abnormal returns, (2) size-and-book-to-market-adjusted abnormal returns, and (3) size-and-book-to-market-and-momentum-adjusted abnormal returns. Size-adjusted abnormal returns are calculated by subtracting the buy and hold returns for the portfolio for firms in the same CRSP (NYSE/AMEX/NASDAQ) market capitalization decile as the sample firm. Size-and-book-to-market-adjusted abnormal returns are based on Fama and French's (1993) methodology. Each month, all NYSE

[7] There is a debate over whether to match each sample firm by a single control firm or by a benchmark portfolio. Barber and Lyon (1997) show that a single control firm based on size and book-to-market performs well, while Lyon, Barber, and Tsai (1999) advocate the use of a portfolio of firms matched on the same two attributes. We use both methods, but present the results for only one for brevity sake.

firms are sorted into size quintiles based on market value of equity, with each size quintile sorted further into quintiles based on their book-to-market ratios. Accordingly, for each month in our sample period, all NYSE firms are sorted into one of 25 portfolios. These determine our breakpoints for our portfolio assignments. Each sample firm is then matched to one of 25 CRSP (NYSE/AMEX/NASDAQ) portfolios formed in month t-1, the month before the ex-split date. Size-and-book-to-market ratio-and return momentum abnormal returns are based on Jegadeesh and Titman (1993), Carhart, (1997) and Desai and Jain (1997).[8] In the month prior to the ex-split date, 75 portfolios are created based on these three factors. Five size quintiles are formed on market value of equity, each quintile is sorted into five book-to-market quintiles, and then further sorted into three momentum groups based on the firms' cumulative raw returns for the six months prior to the event month (the top 30%, the middle 40%, and the bottom 30%.). Each sample firm is then matched with one of the 75 portfolios at the beginning of each month.

We principally use the BHAR approach to calculate long-run abnormal returns. Abnormal returns are calculated for the ex-split month, for the one-, two-, and three-year periods following (but not including) the ex-split month, and for one year prior to the ex-split month. The overall methodology for computing BHARs is shown in Appendix A.

For all models, we calculate equally-weighted returns in lieu of value-weighted returns, because equal weighting is less likely to obscure the mispricing found in smaller firms (Loughran and Ritter (2000)). To avoid a survivorship bias (Loughran and Ritter (1996)), we do not impose the requirement that each sample firm trade for three full years after the stock split. Instead, following Mitchell and Stafford (2000), if a sample firm does not survive the three-year post-event period, the benchmark portfolio's returns are used for this firm's returns for the remainder of the period.

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[8] Byun and Rozeff (2003) find that momentum is a positive factor influencing the one-year post-event abnormal returns for forward stock splits. In the next section, we show adding momentum to size and book-to-market adds little to the standard expected return models for reverse stock splits.

We also perform several robustness tests, including calculating calendar-time abnormal returns (CTARs), using standard regression models to calibrate expected returns, bootstrapping, and examining the effects of delisting returns on the abnormal returns.

IV. Long-run Abnormal Returns: Empirical Results

A. Post-Split Performance Tests

Table 2 presents the one-, two- and three-year BHARs for the post-split period. As Panel A shows, using the matched-firm approach yields a mean three-year BHAR of -22.7 percent (t-statistic = -5.59) and a median three-year BHAR of -13.8 percent (p-value <0.001). In contrast, the remaining models (size, size/book-to-market and size/ book-to-market/momentum) record mean (median) BHARs of -43.6 (-63.9) percent, -32.1 (-56.6) percent and -29.8 (-51.6) percent, respectively, all t-statistics and p-values statistically significant at the 0.001 level. Thus, when compared to the three standard expected return models, the matched-firm approach produces smaller three-year mean BHARs and dramatically smaller medians. We believe these differences are due to the unique risk characteristics of the sample issues (e.g., small size and low stock price). Still, regardless of the method used to generate abnormal returns, firms with reverse splits are significant underperformers three years after the reverse split date. Examination of the one- and two-year BHARS yields a similar conclusion.

B. Pre-*Event (12-Month) Performance Tests*

Table 2 presents BHARs for the 12-month period preceding the ex-split date. We find strong differences in BHARs between using the matched firm approach (Panel A) and matched portfolio benchmarks based on standard returns models (Panels B-D). In Panel A, the mean BHAR is 1.0 percent (t-statistic = 0.55). In Panels B-D, the mean and median pre-event, one-year BHARs range between -31.7 percent and -46.3 percent, with t-statistics around -20.00 and p-values less than 0.001. The differences in the pre-event BHARs between the standard methodologies and the matched firm approach suggest that the pre-event price and/or industry classification might be omitted risk factors for our sample of firms.

C. Ex-Split Month (Month 0) Abnormal Returns

Month 0 begins on the reverse split distribution date and extends through the last trading day of that calendar month. Table 2 shows that all four models yield very similar results, with means of minus 10 to 12 percent and medians of minus 8.5 to 12 percent. Given the relatively short interval examined (roughly 11 trading days), the similarity of returns is not surprising. What is interesting, however, is that the ex-split month produces such overwhelmingly negative results, since the ex-split date itself should be fully anticipated by the market. On the surface, these results run counter to what one would expect in an efficient market. In Section VII, we explore possible factors that could be driving these results and whether or not the explanations are consistent with efficient market theory.

D. Robustness Tests

1. Calendar-time abnormal returns (CTARs)

Whereas Barber and Lyon (1997) and Lyon, Barber and Tsai (1999) provide evidence that BHARs are well-specified in simulation studies, Barber and Lyon (1997) also demonstrate that BHARs are positively skewed. Fama (1998), Mitchell and Stafford (2000), and Barber and Lyon (1997) show that BHARs have a cross-sectional dependence problem that biases standard errors downward, thereby producing negatively-biased test statistics and leading to an incorrect rejection of the efficient market theory. To address these issues, we use a calendar-time abnormal return approach (CTARs) as an alternative method to calculate abnormal returns (see Fama (1998) and Mitchell and Stafford (2000)).

We note that Lyon, Barber and Tsai (1999) show that CTARs are generally misspecified in non-random samples, and Loughran and Ritter (2000) argue that the CTAR approach has low statistical power.

At calendar month t, $CTAR_t$ is the average abnormal return using the matched firm approach for all sample firms that had a reverse split within one, two or three years prior to month t. To reduce heteroscedasticity caused by an uneven number of firms in each month, we ignore a month if there are less than ten sample firms. The mean abnormal return is then scaled by the portfolio's standard deviation of returns during the past 60 months - including the calendar month in question. The student's t-test and sign test are applied to the time series of standardized calendar month portfolio returns. The one-year, two-year and three-year CTARs (not tabulated) are -16.2 percent (t-stat = -2.10), -20.0 percent (t-stat =-3.14) and -20.2 percent (t-stat =-3.34), respectively, significant at the 0.05, 0.01 and 0.01 levels.[9] These findings reinforce our earlier conclusions that firms with reverse splits tend to be long-term underperformers.

2. Different Time Periods

Fama (1998) argues that long-run performance tests might be influenced by temporal biases. Byun and Rozeff (2003) find this to be the case for BHARs surrounding forward stock splits and Ritter and Welch (2002) report similar results for initial public offerings. To determine if our results are sensitive to the time period examined, we replicate our performance tests over the intervals 1976-1991 (Desai and Jain's (1997) period) and 1992-2001 using the size, book-to-market and momentum adjustment method.[10] We do not include the 1962-1975 period because only 31 events have available data. The results are shown in Table 3. For both sample periods, the ex-split month and post-split BHARs are similar in terms of magnitude and significance levels. Thus, unlike Byun and Rozeff (2003), who find

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[9] We also use market capitalization as a proxy for firm size and the results as virtually identical to those we report.
[10] To compare our findings with Desai and Jain (1997), we present the size/book-to-market/momentum BHARs only.

differences in stock-split, post-period BHARs by time period, we find little evidence that the event month or post-split period is time dependent.

A different story emerges when examining the 12-month pre-event period. From 1976-1991, the mean BHAR is -4.6 percent and not statistically significant (t-statistic = -1.47). These results are similar to Desai and Jain's (1997) pre-event results. In contrast, from 1992-2001 the 12-month BHAR is -44.6 percent (t-statistic = -24.70). These results clearly show that for the standard expected return models, the pre-event BHARs are quite sensitive to the time period examined and support Fama's (1998) contention that the sample period investigated can often produce "spurious anomalies."

3. Bootstrapping

To check the robustness of the standard models' use of benchmark portfolios (Barber and Lyon (1997) and Kothari and Warner (1997)), we use a bootstrapping procedure (see, for example, Ikenberry, Lakonishok and Vermaelen (1995)). For the size-book-to-market-momentum BHARSs method, we randomly select a single control firm from the sample firm's benchmark portfolio and calculate the difference between the buy-and-hold return of the sample firm and the control firm. This represents one observation of the bootstrapping BHAR. We repeat this process 200 times. The final BHAR is the equal-weighted bootstrapped BHAR over one-year, two-year and three-year intervals. We use the distributions across the 200 replications as the standard deviations in place of the standard deviations for our reverse split stock sample. Similar methodologies are used for the size-adjusted and size-and-book-to-market BHARS.

The results are robust to using bootstrapped BHARs. The mean one- two- and three-year bootstrapped BHARs for the size, book-to-market and momentum benchmark portfolios (not tabulated) are -16.7 percent (t-statistic = -6.31), -25.3 percent (t-statistic = -7.28) and -34.8 percent (t-statistic =

-8.58), respectively.[11] For this benchmark, all 200 of the replications are negative. Thus, the bootstrapping method increases the discrepancies between the matched firm BHARs and the standard model BHARs.

4. Regression Approach

Fama (1998) argues that matching by firm characteristics may produce different results than using residuals from expected returns models. Accordingly, we calculate abnormal returns using both the Fama and French (1993) three-factor regression model and the Carhart (1997) four-factor regression model. Since the results are similar for both models, we report the four-factor regression abnormal returns only.

The Carhart (1997) four-factor model is:

$$R_{it} - R_{ft} = \alpha_i + b_i(R_{mt} - R_{ft}) + s_i SMB_t + h_i HML_t + m_i UMD_t + \varepsilon_{it}, \quad (2)$$

where R_{it} is the raw return for the reverse split firm i in month t, R_{ft} is the 1-month Treasury-bill return, R_{mt} is the CRSP value-weighted market index return, SMB_t is the return on a portfolio of small stocks minus the return on a portfolio of large stocks, and HML_t is the return on a portfolio of stocks with high book-to-market ratios minus the return on a portfolio of stocks with low book-to-market ratios, and UMD_t is the return on a portfolio of high momentum stocks minus the return on low momentum stocks.[12] We estimate α_i, b_i, s_i, h_i, and m_i for each sample firm using a time-series of 24 monthly returns prior to the event month. Firms with less than six monthly returns are deleted. We then use these

[11] The one-year, two-year and three-year bootstrap BHARs for the size and book-to-market benchmark portfolios are –17.9 percent (t-statistic = -6.81), -26.3 percent (t-statistic = -7.64) and –36.2 percent (t-statistic = -9.04), respectively. The median bootstrap BHARs are -21.5 percent, -25.6 percent, and -29.2 percent. Further, each of the 200 replications for each year produces negative BHARS. The corresponding bootstrapped performance measures using the size portfolio are similar in magnitude and significance.
[12] The data for SMB, HML and UMD can be found on Kenneth French's web site, http://mba.tuck.dartmouth.edu/pages/faculty/ken.french. We thank Ken French for making this data available.

estimates and calculate the abnormal returns for each period as the average residuals from the actual risk-adjusted return minus the return (see Womack (1996)).

Our results (not tabulated) are consistent with the BHARs reported in Table 2. The month 0 median abnormal return is -9.8 percent (p-value<0.001) and the one-, two-, three-year median abnormal returns are -22.0 percent, -35.9 percent, and -45.5 percent, all significant at the 0.001 level. Thus, the negative stock performances reported in Table 2 are invariant to whether we use a portfolio benchmark approach or a regression approach.

5. Delisting Returns

The results in Table 2 do not take delisting returns into account. Shumway (1997) and Shumway and Warther (1999) point out that ignoring delisting returns may lead to erroneous conclusions in long-run returns tests. Accordingly, we re-calculate the long-run performances for the four methods presented in Table 2 using delisting returns of -30 percent for NYSE/AMEX firms and -55 percent for NASDAQ firms (Shumway (1997) and Shumway and Warther (1999)). We find no qualitative differences in long-run performances when we use the delisting returns, suggesting that the results reported in Table 2 are robust to this adjustment.

V. Operating Performances and Negative Post-Split Abnormal Stock Returns

We next examine the operating performances of the sample firms over a four-year interval including and following the year of the reverse split to determine if they are associated with the negative post-split stock-return performance. We focus on annual earnings per share (EPS) and annual operating cash flows deflated by total assets (OCFA) at the beginning of the ex-split month. All data are from the Compustat database. For operating cash flows, we use the SFAS 95 definition for all firms from 1989-

2001. Prior to 1988, when firms were not required to disclose their OCF, we define OCF as net income plus depreciation expense minus the increase in noncash current assets plus the increase in current liabilities (the current portion of long-term debt is excluded from current liabilities).

The reverse-split group is compared to the control group of firms matched by industry, pre-split price and total assets, defined as before. We present both means and medians for the sample and control group portfolios, and then present t-statistics for differences between means and Wilcoxon statistics for differences between medians.

The results are presented in Table 4. Both the sample and control firms experience negative EPS and OCF in every year over the four-year interval. However, with the exception of year 3 OCF, the sample firms' performance measures are significantly lower then those of the control firms. In year 0, the sample group's mean EPS is $-0.925 versus -$0.309 for the control group (a difference of means t-statistic = -9.69), while the sample's OCFA is -0.090, compared to -0.055 for the control firms (t-statistic = -3.35). The medians produce similar results. Thus, regardless of whether we examine means or medians, firms with reverse stock splits are weaker performers than comparable firms over the split year.

The poor operating performances of firms with reverse stock splits continue over the following three years. For year +1, the sample firms' mean EPS is $-0.392 versus $-0.197 for the control firms (t-statistic = -4.55), while the sample mean OCFA is $-0.076 compared to the control firms' $-0.046 (t-statistic = -2.89). The median EPSs are $-0.180 and $-0.050 for the sample and control firms; the corresponding median OCFAs are $-0.014 and $0.002. During the next two fiscal years, the reverse split firms' performance remains significantly more negative compared to the control firms, excepting year 3's OCFA results.

Overall, these results are consistent with the reverse-split samples' significantly negative post-reverse split BHARs shown in Table 2. As Panel A showed, when matched by industry, pre-split price and total assets, reverse stock-split companies significantly underperform over the one-, two- and three-year periods immediately following the ex-split date. Thus, the market does not adequately impound future firm operating performance into the sample issues' stock prices.

VI. Is There an Arbitrage Profit to be Had? Short-Selling Constraints and Market Efficiency

According to Jensen (1978):

"A market is efficient with respect to information set θ_t if it is impossible to make economic profits by trading on the basis of information set θ_t. By economic profits, we mean the risk adjusted returns net of all costs." (page 96)[13]

We test Jensen's (1978) definition of market efficiency for reverse stock splits by determining the extent that investors can realize an arbitrage profit by immediately selling stocks short after they have a reverse split. If investors are limited in their ability to short-sell, then they will be unable to take advantage of the underperformance that we document in Sections IV and V.

A. Short-Selling Characteristics of Sample Firms

To short a stock, an investor must first be able to borrow the security from another lender. D'Avolio (2002) uses a sample from a "large institutional lending intermediary" that contains data on loan supply, loan fees and loan recalls from April 2000 to September 2001 to assess the characteristics of firms that are short-sold. He finds that 32.2 percent of the stocks in the lowest NYSE market equity decile and 33.5 percent of the stocks priced below $5 per share are "unshortable."[14] For our sample (see

[13] Alternatively, Rubinstein (2001) refers to this type of market as a "minimally rational market." According to Rubinstein (2001, p.16), "Even if we decide markets are not rational, they may still fail to supply opportunities for abnormal profits….If you tell me such-and-such stock is overpriced but there are significant obstacles to short selling or significant costs to trading the stock, again, I may not be able to do much about the opportunity."

[14] Desai, Ramesh, Thiagarajan, and Balachandran (2002) find that heavily shorted NASDAQ stocks are in the 7.29 (8.00) mean (median) size decile for all NASDAQ stocks ranked by market equity capitalization.

Table 1), 92.1 percent of the reverse stock split firms are in the lowest size quintile, 91.9 percent of the stocks trade under $5 per share prior to the split, and the average post-split price for the 1,254 NASDAQ reverse splits is under $4 per share. Thus, reverse stock splits have similar financial characteristics to D'Avolio's (2002) sample of unshortable stocks.

D'Avolio (2002) also demonstrates a positive relation between institutional ownership and the ability to short a stock. This is because stocks cannot be sold short unless the short-seller is able to borrow the shares from an outside lender, and these lenders are almost always institutional investors (D'Avolio (2002)). The mean institutional ownership for D'Avolio's (2002) sample of stocks that were not shorted and did not appear in his loan database is 7.3 percent versus 41.0 percent for stocks that were shorted and also appeared in his loan database. For our sample, the mean (median) percent ownership by institutional investors is 7.5 percent (2.1 percent) following the reverse split (see Table 5). Thus, our sample is consistent with D'Avolio's group of stocks that were not shorted. Like D'Avolio, we use shares held by 13F filing institutional investors as reported on the Thomson/Spectrum/CDA quarterly tapes, reporting the average percentage of shares over the four quarters following the split, but not including the split quarter. As further evidence, we find that the mean (median) number of institutions holding stock in our sample of firms following the reverse stock split is 5.71 (2.75) institutions. While D'Avolio does not report this metric, we believe it is further proof that our companies have little presence among the institutions.

B. Short Sales

In this section, we evaluate the ability of investors to short-sell stocks on and following the reverse split month by examining their monthly short interest. We define each firm's monthly short interest as the number of shares sold short divided by the firm's outstanding shares. The short-selling data are from a NASDAQ database, which contains monthly short sales for all stocks traded on the NASDAQ from June 1988 through December 2003. Thus, our sample is limited to reverse splits listed on the NASDAQ and inferences from our analyses should be confined to these firms only.

We present short interest data over two time periods. First, we examine short-selling on the ex-split month. If investors can profit from the negative price drift on and following the split, then we expect to see relatively high levels of short-selling on that month. Second, we analyze the short interest over the three-year period following but not including the ex-split month. Again, we propose that if investors are able to take advantage of the three-year underperformance, we should see relatively large short interests over this time period.

Table 6, Panel A compares the short interest on the month of the reverse split for a sample of 1,019 firms against control groups of all of the remaining NASDAQ firms on the NASDAQ database. Each sample firm is compared to the average short interest of all other NASDAQ firms that did not have a reverse split on that month. Thus, each of the 1,019 firms with reverse splits has its unique control group.

The mean (median) monthly short interest for the sample firms is 0.30 (0.00) percent versus 1.13 (0.97) percent for all other NASDAQ firms, a difference of 0.83 (0.97) percent (t-statistic = 18.85; p-value <0.001). These results show that, overall, reverse-split firms had a lower short-selling interest than the typical NASDAQ firm on the month of the reverse split. Examination of the overall distribution of short interest for the reverse split sample reveals that 64.6% of the firms had a 0.00 percent short interest on the ex-split month. Thus, it appears that investors were unable to short sell the majority of these firms on the ex-split month.

Panel B presents the results when we separate the sample firms into two groups - those with an immediate ex-post split price at or below $5 per share and those priced above $5. The rationale behind this categorization comes from D'Avolio (2002), who shows that it is more difficult to short sell stocks priced below $5 per share. Consistent with D'Avolio, the 747 sample stocks priced at or under $5 have a mean (median) monthly short interest of 0.25 (0.00) percent, compared to 0.54 (0.00) percent for the 272 stocks priced above $5. The t-statistic testing for difference in means is 3.53, significant at the 0.01 level. The p-value testing for differences in medians is 1.00 – reflecting the fact that the median short interest for each group is 0.00. However, we also find that 69.2% of the at-or-under $5 group has a monthly short interest of zero, while 53.7% of the over $5 subsample has a zero monthly short interest. Thus, consistent with D'Avolio (2002), it was more difficult to short sample firms priced under $5.00.

In Panel C we compare the short interest between sample and control firms segmented by price. For firms trading at $5-or-under, the sample firms record a mean (median) short interest of 0.25 (0.00) percent versus 0.78 (0.62) percent for the control firms. Test statistics for the differences in means (t-statistic = 10.67) and medians are both significant at <0.001 levels. Comparing the short interest of the over-$5 sample firms with over-$5 control firms yields mean (median) monthly short interest of 0.54 (0.00) percent, compared to 1.31 (1.23) percent (differences have a t-statistic = 8.92 and a p-value <0.001). These findings show that, on the ex-split month, the sample firms possessed special characteristics that made them more difficult to sell short, regardless of whether or not they were priced below or above $5.

In Panels D-F, we examine the average monthly short interest for the reverse-split firms over the 36 month period following the reverse-split month.[15] The inferences drawn from this time period are similar to those drawn from the monthly data – there were few opportunities to short sell firms following reverse stock splits. In Panel D, the mean (median) monthly short interest for all sample firms is 0.51 (0.15) percent compared to 1.34 (1.12) percent for the remaining NASDAQ firms, a difference of 0.83 (0.97) percent (t-statistic = 28.04; p-value < 0.001). Thus, over the three-year period, there is

[15] Due to missing data, the number of observations for the monthly and three-year periods are slightly different.

significantly less short-selling for the sample of reverse stock splits than for other NASDAQ firms. In Panel E, we find that sample firms trading at or under $5 per share have significantly less short interest than sample firms trading over $5 per share.[16] In Panel F, we find that when also stratified by price, reverse stock split firms still experience less short selling than our samples of control firms.

Overall, these findings are consistent with investors having limited opportunities to short-sell stocks undergoing reverse stock splits. The market implication of this restriction is that investors, by and large, are unable to take advantage of the reverse split firms' long-run underperformance. This result is consistent with Jensen's (1978) definition of market efficiency, which allows for information inefficiencies, but an inability to earn economic (i.e., abnormal) profits from that information.

C. Long-run Performance for Reverse Splits Trading Over and Under $5 Per Share

To understand further the market implications that low-priced stocks are difficult to short after reverse stock splits, we present and compare the one-, two- and three-year post-split BHARS for those firms with an immediate ex-split price less than or equal to $5 per share against those firms with an immediate ex-split price over $5 per share.

Table 7 shows the BHARS using the matched firm approach. We find that the $5-or-under firms record a three-year BHAR of -23.8 percent (t-statistic = -4.87), while the over-$5 firms have a non-significant BHAR of –8.3 percent (t-statistic = -1.37). Similarly, the one- and two-year BHARs for the $5-or-under group are significantly negative, whereas they are lower and insignificantly different from zero for the over-$5 group. Thus, the $5-or-under stocks essentially are driving our long-run

[16] Although not shown in Table 6, we also perform the same tests on the NASDAQ firms without reverse splits over the 36-month period following the ex-split month. The mean monthly short interest for those firms priced at or below $5 is 0.65 percent. In contrast, firms trading above $5 have a mean monthly short interest of 1.41 percent. Testing for differences in means produces a t-statistic of 19.94, significant at the 0.001 level. Median short interest of 0.43 percent for stocks trading at or under $5, compared to 1.24 percent for those trading above $5, yields a p-value less than 0.001. Thus, differences in short interest between NASDAQ stocks priced under/over $5 remain statistically significant regardless of whether or not they experience a reverse stock split.

performance results. These results, in conjunction with the short-selling findings that few stocks priced at or under $5 were sold short, support the view that the sample's negative, post-event performance is consistent with an efficient market. That is, trading frictions, in this case short-selling constraints, limit investors from earning an arbitrage profit from immediately selling short firms that have reverse stock splits.

VII. Explaining the Ex-Split Date Negative Return: Transaction Costs

As we noted in Section IV.C, there is a significant negative abnormal return of at least -10.0 percent on the month of the ex-split date. Additional tests using the matched firm approach show that the mean abnormal return on the day of the reverse split is -6.66 percent (t-statistic of -17.11). The puzzle behind this finding is that the ex-split date is usually known in advance; hence, can investors develop a strategy that enables them to benefit from the expected decline in share value, such as selling their stock before the reverse split?

We investigate whether a change in transaction costs can explain these ex-split day results. Han (1995) reports that firms with reverse splits experience a significant decline in transaction costs, measured by a reduction in bid-ask spreads, on and after the ex-split date. He conjectures, but does not document, that the drop in share price on the ex-split date might be attributed to this reduction in transaction costs. The premise is that low-priced stocks have wider relative bid-ask spreads than higher priced stocks. Since reverse splits are designed to raise share prices, *ceteris paribus*, stocks will experience a decline in bid-ask spreads on the ex-split date. For existing shareholders to be indifferent between selling his/her shares on the ex-split date vis-a-vis the previous trading day, the stock price must drop on the ex-split day in proportion to the decline in the relative bid-ask spread on that date.

That is, the negative abnormal return recorded on the ex-split day is mitigated by a commensurate reduction in the bid/ask spread.

We propose and demonstrate the following three relationships. First, we document a negative relation between the levels of stock prices and bid-ask spreads. Second, we show that the drop in the relative bid-ask spread is directly related to the magnitude of the reverse split. This follows from the argument that the larger the reverse split, the larger the discrepancy in before-and after-split date prices. Finally, we demonstrate that the negative abnormal return on the ex-split date is directly related to the size of the reverse split.

The relative bid-ask spread for time t (BAS_{it}) is:

$$BAS_{it} = \frac{AP_{it} - BP_{it}}{(½) \bullet (AP_{it} + BP_{it})} \qquad (3)$$

where AP_{it} = ask price of stock i at day t, and BP_{it} = bid price of stock i at time t. CRSP provides reliable data on the closing bid and ask prices for NASDAQ stocks only. Accordingly, we conduct our analyses across the 1,254 NASDAQ firms that have sufficient bid-ask data. To minimize noise, we use mean BASs computed over the 30 trading days before and 30 trading days after the ex-split date, respectively. We refer to these means as the pre-split and post-split relative bid-ask spreads.

McInish and Wood (1992) find a negative relation between relative bid-ask spreads and stock prices for NYSE-traded firms during the first six month of 1989. To see if this relation holds for our sample of NASDAQ stocks, we divide the sample firms into three groups based on the pre-split price and compare the BASs between groups. Using 30 trading days to calculate a mean pre-split price, the sample is divided into firms with mean prices under \$1.00, those with mean prices between \$1.00 and \$5.00, and those with mean prices above \$5.00. We find that the under-\$1.00 group (n = 911) has a mean relative BAS of 22.6 percent, compared to 9.6 percent for stocks between \$1.00 and \$5.00 (n = 252), and 5.0 percent for stocks over \$5.00 (n = 58). T-tests show that the differences between groups are statistically significant at the 0.01 level. Thus, there is an inverse relation between stock price and the bid-ask spread for our sample firms.[17]

We next examine the relation between the magnitude of the reverse split and the change in bid-ask spreads on the ex-split date. We divide the reverse split sample into four groups based on relative split size: group 1 consists of those firms with a 1:2 reverse split; group 2 consists of firms with reverse splits over 1:2 but less than 1:10; group 3 are firms with reverse splits of 1:10 but less than 1:20; and group 4 are firms with reverse splits of 1:20 and higher. We propose a direct relationship between the split size group and the reduction in the relative bid-ask spread.

Table 8, Panel A shows the mean (median) pre-split, post-split, and change in BAS for each of the four reverse split groups. The mean and median changes in BAS decrease monotonically over the four split groups. Group 1 yields a mean change in BAS of 0.63 percent, compared to -1.90 percent for group 2, -6.66 percent for group 3 and -20.97 percent for group 4. The medians produce a similar pattern of changes in BASs. The t-statistics and Wilcoxon-Z statistics, testing whether temporal changes are different from zero, are statistically significant for groups 2 through 4, but not for group 1 (1:2 splits). Further, as Panel B shows, regardless of which two groups we compare, there is an increase in the negative change in BAS as the split size increases as illustrated by the t and z statistics between groups. Thus, there is a direct relationship between the split size and the reduction in the relative bid-ask spread.

Having established this link, we propose that the ex-split day negative abnormal return is directly related to the split size. This follows from Appendix B, where we show that the percentage decline in

[17] To demonstrate that these results are not restricted to reverse split firms only, we replicate these tests on a matched sample of 1,254 NASDAQ firms that do not have a reverse split, where we match by industry (3-digit SIC code) and pre-split price. The mean relative BASs for the three control groups are very similar to those recorded by the reverse-split firms. For the under-$1, between $1 and $5, and over-$5 groups, the mean relative BASs are 23.7 percent, 10.6 percent and 4.1 percent, respectively. Again, the differences between the three groups are statistically significant at the 0.01 level.

share price on the ex-split date should be determined by the changes in transaction costs (i.e., relative BASs) that occur on this day. Formally,

$$\text{expected percentage } \Delta \text{ in } P_o \leq 1 - \left(\frac{1 - tc_b}{1 - tc_o}\right) \tag{4}$$

where tc_b = transaction costs before the ex-split date and tc_o = transaction costs on the ex-split date. If there is no change in transaction costs (i.e., $tc_b = tc_o$), the expected decline in share price on the ex-split date is zero. However, if $tc_0 < tc_b$, that is, a drop in transaction costs on the ex-split day, then equation (4) predicts a decline in share price on the ex-split day.

Given the results reported in Panel A, we predict a significant drop in share price on the ex-split day for groups 2 through 4, but an insignificant change in share price for group 1. As Table 8, Panel C shows, both the mean and median abnormal returns become increasingly negative as we move from group 1 to group 4. The mean abnormal return for group 1 is -2.0 percent, -5.8 percent for group 2, -11.3 percent for group 3, and -12.9 percent for group 4. The medians decrease steadily from -2.0 percent for group 1 to -14.7 percent for group 4. Consistent with our prediction that the magnitude and significance of the ex-split day abnormal returns mirrors the size and statistical significance of the change in BASs, only groups 2 through 4 have statistically significant means and medians.

Panel D shows that the differences in abnormal returns between most groups are statistically significant at the 0.01 level. In particular, there are significant differences in both the mean and median abnormal returns between groups 1 and 4.[18] Taken together, the results from Table 8 strongly suggest that changes in transaction costs are at least partially responsible for the negative ex-split day abnormal returns, which, in turn, would be consistent with Jensen's (1978) definition of an efficient market.

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[18] By performing our analyses on groups, we side-step the issue as to whether the proposed associations are linear. Nevertheless, as an alternative test, we regress the abnormal ex-split day return on the change in the relative bid-ask spread. The coefficient on the change in BAS is -0.27, with a t-statistic of -4.40, providing further evidence of a negative relation between the ex-split date abnormal return and the change in BAS.

VIII. Summary and Conclusions

We examine 1,612 reverse splits from 1962 through 2001 and find a long-run return underperformance for firms beginning in the ex-split month and extending out three years after the split. These findings are robust to whether we use BHARs or CTARs, different time periods, bootstrapping, delisting returns, portfolio benchmarks, single-firm controls, and different proxies for size. To provide a justification for this underperformance, we compare operating performances for the sample firms vis-à-vis a control group for the four year period after and including the year of the reverse split. Both the sample and control firms record negative EPS and OCFA in almost every year. However, with one exception, the sample firms' mean and median EPSs and OCFAs are significantly more negative than those of the control firms. On balance, these results are consistent with the return underperformance results and suggest informational inefficiencies.

We next address the issue of whether the market is economically efficient by determining whether investors can earn abnormal returns by short-selling these firms. According to Jensen (1978) and Rubinstein (2001), markets are efficient only if investors can profit from information available at the time of the ex-split date. Prior research shows that stocks without short interest are generally small, illiquid, have limited institutional ownership, and are priced under $5/share. These characteristics match our sample of firms with reverse splits. More importantly, the mean monthly short interests for NASDAQ firms for the ex-split month and the 36-month period following the reverse split are significantly less than for the remaining NASDAQ firms. Further, when we compare sample firms priced at or below $5/share to the sample firms priced above $5/share, the former group's monthly short interest is significantly lower than the over-$5/share group. This result, coupled with the finding that stocks priced at/below $5/share are essentially driving the long-run, negative BHARs, suggests that arbitrageurs, hoping to profit from the expected decline in the share prices of the sample firms, apparently had a difficult short-selling these stocks. We conclude that despite the price and operating underperformances following the reverse split, markets are economically efficient.

Our final tests examine the ex-split day anomaly, where the sample firms experience a significantly negative abnormal return. Because the reverse split date is typically known in advance, it is unclear why investors do not sell their holdings prior to this date. We offer a transaction costs explanation to account for this phenomenon. We find that the magnitude of the ex-split day stock decline is directly related to the size of the stock split which, in turn, is directly related to the reduction in the stock's relative bid-ask spread. Thus, investors selling prior to the ex-split date to avoid the negative return on the stock split date will pay higher transaction costs to liquidate their positions. These findings, again, are consistent with an economically efficient market.

Our study has implications for future, long-run return performance tests. As we show, even in cases in which markets are not informationally efficient, investors may still be unable to profit from that prior knowledge. We thereby recommend that researchers look for trading frictions (e.g., the inability to sell short) that might prevent investors from earning positive abnormal returns from the expected increase/decrease in share prices. The appearance of these investing obstacles, in turn, depends on the nature of the event under investigation.

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Table 1

Descriptive Statistics for Reverse Splits

Panel A: Yearly Distribution Showing Number of Reverse Splits, Pre-Split Price, and Post-Split Price

Year	No.	Pre-Split Price	Post-Split Price	Year	No.	Pre-Split Price	Post-Split Price
1962	2	2.27	7.29	1982	23	1.87	6.23
1963	5	2.44	9.58	1983	28	2.05	5.24
1964	9	1.59	6.03	1984	28	0.66	3.48
1965	5	2.70	9.66	1985	38	2.05	6.94
1966	4	3.00	9.95	1986	27	1.93	5.32
1967	1	17.00	19.24	1987	62	1.08	4.29
1968	3	6.25	17.82	1988	55	3.34	6.55
1969	3	5.10	11.30	1989	67	6.38	9.26
1970	0	0.00	0.00	1990	92	0.79	3.09
1971	4	4.10	10.89	1991	84	1.36	5.54
1972	6	5.02	15.04	1992	140	0.96	3.87
1973	11	4.65	7.10	1993	103	1.43	6.02
1974	5	8.80	5.96	1994	87	4.73	6.31
1975	7	1.70	8.46	1995	87	1.58	6.32
1976	9	2.16	7.30	1996	82	1.89	5.52
1977	6	1.59	9.15	1997	86	1.85	5.05
1978	9	1.22	4.25	1998	156	1.30	3.54
1979	6	1.95	5.69	1999	103	1.21	3.43
1980	5	2.22	8.85	2000	51	3.54	6.58
1981	15	4.75	4.68	2001	98	0.89	3.66

Panel B: Distribution by Stock Market Showing Number of Reverse Splits, Mean Pre-Split Price and Post-Split Price

Stock Market	No.	% of Total	Pre-Split Price	Post-Split Price
NYSE	178	11.1 %	$ 7.24	$ 12.73
AMEX	180	11.1	2.31	6.75
NASDAQ	1,254	77.8	1.21	3.94
Total	1,612	100.0 %		

Panel C: Distribution by Split Size Showing Number of Reverse Splits, Pre-Split Price, and Post-Split Price

Split-Size	No.	% of Total	Pre-Split Price	Post-Split Price
1:2	136	8.4 %	$6.72	$ 8.52
(1:2 to 1:10)	917	56.9	2.06	5.19
[1:10 to 1:20)	385	23.9	0.97	4.83
≥ 1:20	174	10.8	0.44	4.02
Total	1,612	100.0 %		

Panel D: Distribution by Pre-Split Price Showing Number of Reverse Splits, Pre-Split Price, and Post-Split Price

Pre-Split Price Range	No.	% of Total	Pre-Split Price	Post-Split Price
0<P<=$1	1,018	63.2 %	$0.47	$2.71
$1<P<=$2	257	15.9	1.40	6.08
$2<P<=$5	207	12.8	3.12	10.02
$5<P<=$10	57	3.5	6.45	11.55
$10< P	42	2.6	31.56	30.12
No pre-price data	31	1.9	NA	4.19
Total	1,612	99.9 % (rounding error)		

Panel E: Distribution of Sample Firms Based on Market Capitalization of all Stocks listed on the NYSE

Size Quintile	No.	% of Total
1 (lowest)	1,485	92.1 %
2	127	7.9
3-5	0	0
Total	1,612	100.0 %

The sample consists of 1,612 reverse stock splits. Year is the year of the split. Stock Market is the stock market that the firm was trading on at the time of the split. Split-Size is the magnitude of the split. No. is the number of splits. Pre-Split Price is the mean pre-split price level, measured over -120 to -60 days prior to the ex-split day. Post-Split Price is the mean post-split price level, measured over 30 to 90 days following the ex-split day.

Table 2

Reverse Stock Split Buy and Hold Abnormal Stock Returns (BHARs)
Surrounding the Ex-Distribution Date for Reverse Splits Using Different Expected Returns Generating Models

Panel A: Matched Firm Approach on Industry, Pre-Split Price and Total Assets (N=1,318)

	Pre-12month		Ex-Split Month		1-Year		2-Year		3-Year	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
BHAR (%)	1.0	-1.6	-10.5	-8.5	-12.7	-9.9	-14.5	-11.4	-22.7	-13.8
t-stat	0.55		-11.01[a]		-4.37[a]		-4.08[a]		-5.59[a]	
p-val.		<0.001		<0.001		<0.001		<0.001		<0.001

Standard Models

Panel B: Size-Adjusted Abnormal Returns (N=1,528)

	Pre-12month		Ex-Split Month		1-Year		2-Year		3-Year	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
BHAR (%)	-36.1	-46.3	-12.1	-11.9	-15.1	-29.4	-29.7	-50.2	-43.6	-63.9
t-stat	-24.49[a]		-18.96[a]		-8.19[a]		-13.21[a]		-17.58[a]	
p-val.		<0.001		<0.001		<0.001		<0.001		<0.001

Panel C: Size and Book-to-Market Adjusted Abnormal Returns (N=1,136)

	Pre-12month		Ex-Split Month		1-Year		2-Year		3-Year	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
BHAR (%)	-32.7	-42.0	-11.1	-11.2	-9.3	-26.8	-20.6	-41.6	-32.1	-56.2
t-stat	-19.72[a]		-14.83[a]		-4.08[a]		-8.20[a]		-11.86[a]	
p-val.		<0.001		<0.001		<0.001		< 0.001		<0.001

Panel D: Size, Book-to-Market and Momentum-Adjusted Abnormal Returns (N=1,136)

	Pre-12month		Ex-Split Month		1-Year		2-Year		3-Year	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
BHAR (%)	-31.7	-39.3	-11.1	-11.1	-8.5	-26.1	-19.0	-39.6	-29.8	-51.6
t-stat	-19.72[a]		-14.84[a]		-3.77[a]		-7.48[a]		-10.77[a]	
p-val.		<0.001		<0.001		<0.001		< 0.001		<0.001

Monthly abnormal returns are calculated around the reverse ex-split date using different expected returns generating models. The ex-split month is from the ex-split date to end of the month. The 1-Year, 2-Year, and 3-Year BHARs are for the time periods following (and excluding) the ex-split month. The Pre-12month BHARs are the 12 months prior to (and excluding) the ex-split month. In Panel A, we adjust each firm's raw returns by subtracting a single security matched by firm size (assets), industry, and pre-split stock price. In Panel B, we adjust raw returns by subtracting the return of a portfolio of NYSE/AMEX/NASDAQ stocks in the same size-decile (market capitalization) as the sample firm. In Panel C, we adjust raw returns by subtracting the return of a portfolio of stocks in the same size-quintile and same book-to-market quintile as the sample firm. In Panel D, we adjust raw returns by subtracting the return of a portfolio of stocks in the same size-quintile, same book-to-market quintile, and same price momentum group (one of three groups). All matchings are done on the beginning of the ex-split month. All returns are from the monthly CRSP database. The top and bottom 2 percent are deleted before all tests. If a sample stock is delisted, its BHAR is computed using the last available stock price, and this return is used for all subsequent intervals up to 36 months. The p-value tests whether the median is statistically different from zero. The t-stat tests whether the mean is statistically different from zero. N is the number of observations in the reverse split sample. [a] is significant at the 0.01 level and [b] is significant at the 0.05 level.

Table 3

Long-run BHARs for Reverse Splits by Time Periods

Panel A: BHARs for Reverse Splits for Subperiod 1976-1991 (N=348)

	Pre-12 month		Ex-Split Month		1-Year		2-Year		3-Year	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
BHAR (%)	-4.6	-12.8	-8.2	-8.0	-13.4	-24.4	-20.4	-36.5	-31.4	-51.7
t-stat	-1.47		-6.73[a]		-4.10[a]		-4.69[a]		-6.50[a]	
p-value		<0.001		<0.001		<0.001		<0.001		<0.001

Panel B: BHARs for Reverse Splits for Subperiod 1992-2001 (N=758)

	Pre-12 month		Ex-Split Month		1-Year		2-Year		3-Year	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
BHAR (%)	-44.6	-52.8	-12.3	-12.6	-6.2	-27.9	-19.6	-42.3	-31.1	-52.7
t-stat	-24.70[a]		-12.61[a]		-2.03[b]		-6.16[a]		-9.21[a]	
p-value		<0.001		<0.001		<0.001		<0.001		<0.001

This table reports BHARs around the ex-split date for reverse splits. Panel A reports BHARs for 348 splits from 1976 through 1991 that have portfolio assignments. Panel B reports BHARs for 758 splits from 1992 through 2001 that have portfolio assignments. BHARs are measured as the difference between the raw returns of the sample company minus the return on a portfolio of stocks matched by market capitalization, book-to-market ratio, and pricing momentum. The p-value tests whether the median is statistically different from zero. The t-stat tests whether the mean is statistically different from zero. [a] significant at the 0.01 level; [b] significant at the 0.05 level.

Table 4

Annual Earnings Per Share and Annual Operating Cash Flows for Reverse Stock Split Firms and Control Firms Three Years Prior to, Including, and Three Years Following a Reverse Stock Split

Year	Sample	EPS		OCFA	
	Sample	Sample	Control	Sample	Control
0	Mean	-0.925	-0.309	-0.090	-0.055
	t-stat	-9.69[a]		-3.35[a]	
	Median	-0.290	-0.080	-0.024	-0.000
	Wilcoxon	-5.25[a]		-2.63[a]	
	N	1,140	1,138	1,150	1,138
1	Mean	-0.392	-0.197	-0.076	-0.046
	t-stat	-4.55[a]		-2.89[a]	
	Median	-0.180	-0.050	-0.014	0.002
	Wilcoxon	-3.35[a]		-2.91[a]	
	N	1,022	1,026	1,027	1,026
2	Mean	-0.243	-0.107	-0.070	-0.037
	t-stat	-3.55[a]		-3.04[a]	
	Median	-0.100	-0.030	-0.006	-0.036
	Wilcoxon	-2.89[a]		-2.48[a]	
	N	908	930	913	931
3	Mean	-0.155	-0.074	-0.063	-0.0638
	t-stat	-2.06[b]		-2.24[b]	
	Median	-0.060	-0.020	0.004	0.008
	Wilcoxon	-2.28[b]		-1.16	
	N	772	781	777	782

This table presents mean annual earnings-per-share (EPS) and operating cash flows deflated by beginning of year total assets (OCFA) for our sample of reverse splits and our control sample. Firms are matched by industry, pre-split price, and total assets. Industry is defined using the Fama and French (1997) classifications. Pre-split price is the mean pre-split price level, measured over -120 to -60 days prior to the ex-distribution day. Total assets are the total assets at the beginning of the ex-split month. Since 1988, firms have been required by SFAS 95 to disclose operating cash flows. We use this measure of operating cash flows for all firms from 1988 through 2001. Before 1988, we use the following formula to derive operating cash flows: net income plus depreciation expense minus the increase in noncash current assets plus the increase in current liabilities (the current portion of long-term debt is excluded from current liabilities). The t-stat tests for differences in means between the sample and control group. The Wilcoxon (z) statistic tests for differences in medians between the sample and control group. N is the number of observations in each group. [a] significant at the 0.01 level; [b] significant at the 0.05 level.

Table 5

Institutional Investment Holdings and Number of Financial Institutions Holding Stock Before and After the Reverse Stock Split

	Pre-Split		Post Split	
	Mean	Median	Mean	Median
Percent Institutional Ownership	5.7	1.1	7.5	2.1
Number of Institutions Holding Stock	6.37	2.75	5.71	2.75

This table shows the institutional ownership and number of financial institutions holding stock before and after the split for the full sample of reverse stock splits. Percent Institutional Ownership is the average percent of the total stock owned by institutional investors. Number of Institutions Holding Stock is the average number of financial institutions holding stock for the four quarters preceding and following the split date. The quarter including the split date is excluded. The data are from 13F for filings with the SEC from the Thomson/Spectrum/CDA quarterly tapes.

Table 6

Monthly Short Interest For Sample Firms Versus Control Firms

<u>Short Interest on Ex-Split Month of the Reverse Split</u>

Panel A: Full Sample of Reverse Splits vs. Control Firms (N=1,019)

	Mean (%)	t-stat.	Median (%)	p-value
Full Sample	0.30	18.85[a]	0.00	<0.001
Control Firms	1.13		0.97	

Panel B: Sample Firms with Ex-Split Price ≤$5 (N=747) vs. Sample Firms with Ex-Split Price >$5 (N=272)

	Mean (%)	t-stat.	Median (%)	p-value
Sample ≤$5	0.25	3.53[a]	0.00	1.000
Sample >$5	0.54		0.00	

Panel C: Sample Firms vs. Control Firms Stratified by Whether Firm's Ex-Split Price is ≤$5 (N=747) or >$5 (N=272)

	Mean (%)	t-stat.	Median (%)	p-value
Sample ≤$5	0.25	10.67[a]	0.00	<0.001
Control Firms ≤$5	0.78		0.62	

	Mean (%)	t-stat.	Median (%)	p-value
Sample (> $5)	0.54	8.92[a]	0.00	<0.001
Control Firms (>	1.31		1.23	

<u>Short Interest Over 36 Month Period Following the Ex-Split Month</u>

Panel D: Full Sample vs. Control Firms (N=1,004)

	Mean (%)	t-stat.	Median (%)	p-value
Full Sample	0.51	28.04[a]	0.15	<0.001
Control Firms	1.34		1.12	

Panel E: Sample Firms with Ex-Split Price ≤$5 (N=752) vs. Sample Firms with Ex-Split Price >$5 (N=252)

	Mean (%)	t-stat.	Median (%)	p-value
Sample (≤$5)	0.36	5.82[a]	0.13	<0.01
Sample (>$5)	0.67		0.36	

Panel F: Sample vs. Control Firms Stratified by Whether Firm's Ex-Split Price Is ≤$5 (N=752) or >$5 (N=252)

	t-stat.	Median (%)	p-value
Sample (≤$5)	9.43[a]	0.13	<0.001
Control Firms (≤$5)		0.44	

	t-stat.	Median (%)	p-value
Sample (>$5)	10.88[a]	0.36	<0.001
Control Firms (>$5)		1.24	

The sample consists of the reverse stock splits appearing on the NASDAQ short-selling database with trading months from June 1988 through December 2003. The control is the remaining NASDAQ firms that also appear on the NASDAQ database. For each sample firm, we calculate the number of shares sold short each month as a percentage of the firm's total shares outstanding. We do this each month over the 37 (maximum) month period including and following the month of the reverse split and compute an overall average for each firm. We use the same dates and calculate the same average monthly short interest for the control firms. Sample Firms ≤$5 are firms that have an ex-split price of $5.00 or less immediately after the split. Sample Firms >$5 are firms that have an ex-split price greater than $5.00 per share immediately after the split.

Table 7

Post-Split BHARs by Ex-Split Price

	Ex-Split Price ≤ $ 5.00	Ex-Split Price > $ 5.00
1 Year (%)	-8.5 (-2.31)[b]	-3.6 (-0.98)
2 Years (%)	-14.0 (-3.00)[a]	-7.8 (-1.50)
3 Years (%)	-23.8 (-4.87)[a]	-8.3 (-1.37)
Obs.	828	499

This table presents post-split BHARs using the matched-firm technique for one, two, and three years after the ex-distribution date of the reverse split. The sample is split into two categories based on the price of the security at the close of the ex-split date. The categories are (1) ex-split price is less than or equal to $ 5 per share and (2) ex-split price is greater than $ 5 per share. The t-statistic testing for whether the BHAR is significantly different from zero is presented in parentheses below the BHAR. [a] = significant at the 0.01 level; [b] = significant at the 0.05 level.

Table 8

Changes in the Relative Bid-Ask Spreads and Ex-Split Day Abnormal Returns for Reverse Splits Segmented by Magnitude of Split for NASDAQ Stocks

Panel A: Relative Bid-Ask Spreads (BAS) for Pre-Split Period and Post-Split Period

Group	Split Size	Pre-Split Period BAS (%)			Post-Split Period BAS (%)		Change in BAS (%)		T-Stat	Wilcoxon-Z
		Obs	Mean	Median	Mean	Median	Mean	Median		
1	1:2	66	9.56	6.34	10.19	6.93	0.63	0.59	0.36	0.07
2	(1:2,1:10)	535	13.66	10.33	11.75	8.20	-1.90	-2.13	-2.66[a]	-4.60[a]
3	[1:10,1:20)	182	17.41	13.91	10.75	7.70	-6.66	-9.71	-5.17[a]	-7.55[a]
4	≥ 1:20	66	35.37	33.31	14.40	10.82	-20.97	-22.49	-7.80[a]	-6.84[a]

Panel B: Testing for Differences in Changes in Relative Bid-Ask Spreads Between Groups

Split Groups	Difference in Means Between Groups (%)	Difference in Medians Between Groups (%)	T-Statistic	Wilcoxon Z
1 – 2	2.53	2.72	2.66[a]	3.38[a]
2 – 3	5.76	7.58	6.35[a]	8.19[a]
3 – 4	14.31	12.78	6.70[a]	6.92[a]
1 – 4	21.60	23.08	9.75[a]	8.71[a]

Panel C: Event-day Abnormal Return for Reverse Splits by Size of the Split

Split Groups	Split Size	Observations	Mean AR (%)	Median AR (%)
1	1:2	66	-2.0 (-1.47)	-2.0 (0.16)
2	(1:2,1:10)	484	-5.8 (-7.83)[a]	-4.8 (<0.001)
3	[1:10,1:20)	167	-11.3 (-8.63)[a]	-9.8 (<0.001)
4	≥ 1:20	56	-12.9 (-4.76)[a]	-14.7 (<0.001)

Panel D: Testing for Differences in Abnormal Returns Between Groups

Split Groups	Difference in Means Between Groups (%)	Difference in Median Between Groups (%)	T-Statistic	Wilcoxon-Z
1 – 2	3.8	2.8	2.44[a]	1.73[c]
2 – 3	5.5	5.0	3.66[a]	3.76[a]
3 – 4	1.6	4.9	0.53	0.54
1 – 4	10.9	12.7	3.59[a]	2.88[a]

This table presents changes in the relative bid-ask spreads and the ex-split day abnormal return for 1,254 NASDAQ reverse splits, where the reverse splits are divided into four categories based on the magnitude of the split. The relative bid-ask spread (BAS) is defined as the closing ask price minus the closing bid price divided by the average of the two (closing price). The pre-split BAS is averaged over the thirty calendar days prior to the ex-split date. The post-event BAS is averaged over the thirty calendar days following the ex-split date. The abnormal return for the reverse split firm is the raw return on the ex-split date minus the return on a matched firm, where the matching is done by size, industry and pre-split price. Panel A presents pre- and post-split BAS and the change in BAS from pre- to post period. Panel B compares and tests for significant differences in changes in relative bid-ask spreads from the pre-event period to post-event period between groups The difference in means (medians) between any two groups is calculated by subtracting the change in the mean (median) bid-ask spread for one group from the change in the mean (median) bid-ask spread from the other group. Panel C presents the mean and median ex-split day abnormal return using the matched control firm approach for the sample of NASDAQ firms that have both bid-ask data and returns data. Panel D tests for differences in abnormal returns between groups. The t-stat(istic) tests for the difference in means. The Wilcoxon-Z tests for the difference in medians.

[a] significant at the 0.01 level. [c] significant at the 0.10 level.

Appendix A

To compute daily abnormal returns for each sample firm using the buy-hold method, we use the following formula:

$$BHAR_{it} = \prod_{t=1}^{N}(1 + R_{it}) - \prod_{t=1}^{N}(1 + E(R_{it}) \qquad \text{(A1)}$$

where: $BHAR_{it}$ = Buy and hold abnormal return for firm i in month t

R_{it} = firm i's raw return in month t

$E(R_{it})$ = expected return for firm i in month t

N = # of months

Next, we calculate the average buy-hold abnormal return for all firms in month t as follows:

$$\overline{BHAR_{it}} = \frac{\sum \prod_{t=1}^{N}(1 + R_{it}) - \prod_{t=1}^{N}(1 + E(R_{it})}{n} \qquad \text{(A2)}$$

where: $\overline{BHAR_{it}}$ = Average buy-hold abnormal return for all firms in month t

n = # of firms

We calculate t statistics for the $\overline{BHAR}$ values as follows:

$$t_{BHAR} = \frac{\overline{BHAR_{i,t}}}{\sigma(BHAR_{i,t})/\sqrt{n}} \qquad \text{(A3)}$$

where: $\sigma(BHAR_{i,t})$ = Cross-sectional sample standard deviation of abnormal returns for the sample of n firms

Appendix B

Determining level of pre-event and post-event transaction costs where investor is indifferent between selling shares either before or after the reverse split.

Sell stock before reverse split date (rsd)

(B1) $R_b = \frac{P_b\,(1 - tc_b) - P_P}{P_p}$

where: R_b = percent return before rsd

P_b = Stock price before rsd

tc_b = transaction costs before rsd

P_p = Purchase price

Sell stock on reverse split date (rsd)

(B2) $R_o = \frac{P_o\,(1 - tc_o) - P_P}{P_p}$

where: R_o = percent return on rsd

P_o = Stock price on rsd

tc_o = transaction costs on rsd

P_p = Purchase price

Indifferent if

(B3) $R_b = R_o$ or $\frac{P_o\,(1 - tc_o) - P_P}{P_p} = \frac{P_b\,(1 - tc_b) - P_P}{P_p}$

(B4) $P_o\,(1 - tc_o) = P_b\,(1 - tc_b)$

(B5) Therefore, if $P_o = P_b \left(\frac{1 - tc_b}{1 - tc_o}\right)$, I am indifferent.

(B6) Accordingly, if $tc_0 < tc_b$, then $(1 - tc_b) < (1 - tc_o)$ and $P_o < P_b$.

Expected price decline on reverse split date

(B7) Expected percentage decline in P_o should be $\leq 1 - \left(\frac{1 - tc_b}{1 - tc_o}\right)$