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Stock Splits, Tick Size, and Sponsorship

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ABSTRACT

A traditional explanation for stock splits is that they increase the number of small shareholders who own the stock. A possible reason for the increase is that the minimum bid-ask spread is wider after a split and brokers have more incentive to promote a stock. I document a large number of small buy orders following Nasdaq and NYSE/AMEX splits during 1993 to 1994. I also find strong evidence that trading costs increase, and weak evidence that costs of market making decline following splits. This is consistent with splits acting as an incentive to brokers to promote stocks.

STOCK SPLITS SEEM TO BE PURELY COSMETIC CHANGES with no real economic consequences. After a two-for-one split, each shareholder has twice as many shares, but each represents a claim on only half as much of the corporation's assets and earnings. However, one real consequence of a stock split is that the tick size increases as a proportion of the stock's price. Except for a small number of very low-priced issues, U.S. stocks listed on an exchange or on Nasdaq have a tick or minimum price variation of $0.125 during the sample period.[1] Thus, a decrease in the stock price and an increase in the relative tick size are indistinguishable consequences of a split. Some authors, notably Angel (1997), argue that splits are intended to move relative ticks to desired levels. Several empirical studies provide indirect evidence that is consistent with an increase in relative tick size as a motivation for splits. Desai and Jain (1997), Fama et al. (1969), Lakonishok and Lev (1987), and others document that splits occur after stocks have experienced significant price increases or, equivalently, after relative tick sizes have decreased significantly. Angel shows that there is far less dispersion internationally in relative tick sizes than in stock prices.

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[1] The tick was halved to $0.0625 (one-sixteenth of a dollar) in July 1997 for listed and Nasdaq stocks. The New York Stock Exchange has announced plans to move to decimal pricing, but they have not yet decided if stocks will be traded in increments of $0.01, $0.05, or $0.10.

Tick size may matter because a larger tick size may result in more profitable market making, providing brokers with additional incentives to promote or "sponsor" the newly split stock. Practitioners have long claimed that splits broaden a firm's shareholder base by increasing the number of small investors, an increase that is supported by the findings of Lamoureux and Poon (1987) and Maloney and Mulherin (1992).

In this paper, I provide evidence that is consistent with stocks being promoted or sponsored following splits. I examine intraday trades and quotes for a sample of 235 stocks that split in the period from April 1993 through March 1994. A strikingly clear result that is obtained for the great majority of splits is that there are a very large number of small trades immediately following the split and an overwhelming majority of the small trades are buy orders. However, small traders are not buying after splits because costs of trading have fallen, for I find equally strong evidence of an increase in trading costs following splits. This is consistent with splits providing a motive for brokers to promote or sponsor a stock. I also find some evidence that splits lower costs of market making, but this evidence is much weaker.

The remainder of the paper is organized as follows. Explanations of why firms split their shares are discussed in Section I. Section II describes the sample and data used in the paper. In Section III, evidence that splits make stocks more popular with small investors is provided. Section IV presents evidence on incentives to promote stocks following splits. Section V discusses whether incentives to promote stocks completely explain the dramatic increase in small buys following splits. Section VI offers a summary and conclusions.

I. Splits and Incentives to Promote Stocks

A. Splits Increase the Relative Tick Size and Increase the Percentage Spread

Stock splits can make market making more profitable both by increasing dealers' revenues and by lowering the costs of market making. The increased profitability of market making following a split provides incentives to brokers to promote the stock.[2] Market makers for stocks listed on the Nasdaq often have retail brokerage businesses and the brokers can capture the additional revenues directly. NYSE stocks are often traded on regional exchanges or over-the-counter where brokerage firms can realize the increase in trading profits through their market making or specialist operations. Other brokers may receive payment for order flow for promoting NYSE/AMEX stocks. Payment for order flow is usually a fixed amount (typically 1¢ to 2¢) per share.[3] After a split a given dollar trade generates more shares and more payment to the broker for the order flow.

[2] Evidence of the active role of brokers in promoting securities is given in a study of closed-end fund IPOs by Hanley, Lee, and Seguin (1996). They find predictable aftermarket declines in fund prices and post-issue purchases by small investors before the price declines.

[3] NASD (1991).

One way in which market making becomes more profitable following splits is that an increase in the relative tick size following a split implies a wider minimum spread. Gray, Smith, and Whaley (1996), Maloney and Mulherin (1992), and Conroy, Harris, and Benet (1990) all show that average quoted bid-ask spreads as a percentage of price increase following splits. Angel (1997) provides a model in which a greater cost of trading depresses the stock price while the increased spread leads brokerage firms to promote the stock, resulting in an increase in the number of investors who "know about" a stock. This second effect tends to increase stock prices. An optimal tick size is achieved by balancing these effects to maximize the stock price.

Other authors suggest that market making may be more profitable following splits because a larger tick may lower the costs of market making. Harris (1997) proposes several ways in which a larger tick may reduce costs. First, with a larger tick, there may be fewer trading errors and fewer misunderstandings about agreed-upon transactions prices. Errors are costly and time-consuming to correct, and the desire to avoid errors may slow trading. With a coarse price increment there is less room for misunderstandings.

A large tick may also minimize costly negotiation. If a stock is quoted at 40 bid, 40½ ask, a potential buyer during our sample period could offer to buy at 40⅛, 40¼, or 40⅜ to obtain price priority over the 40 bid price. The three possible prices may lead to offers and counteroffers between traders. If instead the stock splits two-for-one, and the stock is quoted at 20 bid, 20¼ ask, there is only one possible price inside the spread, 20⅛, and negotiations will be concluded more quickly. In general, a larger tick eliminates some negotiation. Each trader will be worse off on some trades and better off on others as a result. For most traders, these gains and losses will even out in the long run, so a net gain is achieved by avoiding the costs of negotiation.

Harris (1997) argues that a particularly important problem with a small tick is that it decreases the incentive to expose orders. Market makers, specialists, and limit order traders post quotes at which they will buy or sell. These quotes provide liquidity to market orders that demand immediacy. If the tick size is very small, it is cheap for someone else to obtain priority over the existing quote by entering a quote one tick above (or below) the current price. Quote matching like this can be an innocent attempt to obtain priority or it can be an attempt to exploit the option provided by the exposed order. To see how this option is exploited, consider a quote matcher who enters an order to purchase at one tick above the existing bid quote. This new quote is executed first. If the stock price rises, the purchaser makes money. If it falls, the purchaser is at little risk because she can always sell out at a small loss to the trader who had provided the previous inside quote. Harris asserts that in either case, quote matching arising from a small tick reduces the incentives of market participants to provide inside quotes.

Even if the increase in tick size following splits reduces costs, it is possible that the increase in volatility observed subsequent to splits may result in a net increase in costs of market making. Numerous studies show that market makers and specialists require greater compensation for trading more vol-

atile stocks and Ohlson and Penman (1985), Dubofsky (1991), Koski (1998), and Angel, Brooks, and Mathew (1998) document that volatilities typically increase following splits. Ohlson and Penman find an average increase in volatility of 30 percent.

B. Evidence on the Importance of Tick Size as a Split Determinant

There is a substantial body of support for the traditional explanation that splits return stocks to their normal price range. Several researchers, including Fama et al. (1969), Lakonishok and Lev (1987), Lamoureux and Poon (1987), and Maloney and Mulherin (1992) demonstrate that stock prices typically increase significantly in the months prior to a split. Lakonishok and Lev show that four and five years before the split, stock prices of the splitting firms are similar to prices of stocks in a control sample with similar asset values and the same four-digit SIC code. However, at the split announcement month the mean stock price of splitting firms is $54.12 and the mean price of control firms is $32.37. After the split, prices of the sample and control group stocks are very similar again. A cross-sectional examination of the sample firms indicates that the larger the deviation from industry and market-wide mean stock prices, the greater the size of the split. Lakonishok and Lev conclude that the motivation for stock splits appears to be to return the price to a level that is consistent with other firms in the industry and with market averages. Given the fixed tick size in the U.S. markets, a normal price range is synonymous with a normal relative tick size. Attempts to return a stock to a price that is similar to that of other firms in the industry are indistinguishable from attempts to return to a relative tick size that is similar to other firms in the industry.

II. Sample and Data

The sample is all splits of two-for-one or greater that occurred in the 12 months from April 1993 through March 1994 and that were recorded on the CRSP Nasdaq or NYSE/AMEX tape. Split announcement dates are the declaration dates obtained from CRSP. *The Wall Street Journal* was searched for announcement dates that preceded the declaration date for each split, but none were found. The source of intraday data for this paper is the New York Stock Exchange's Trade and Quote (TAQ) database. Splits were eliminated from the sample if I was unable to find data on TAQ both before and after the split. If a stock split twice during the sample period (this happened for two stocks), it was deleted. The remaining sample consists of 146 Nasdaq and 89 NYSE/AMEX splits for a total sample of 235 splits.

For each stock in the sample, I obtain all trade and quote data for the split month, the three calendar months before the split, and the three calendar months following the split from TAQ. These time series are of sufficient length to allow me to examine trading for each stock in four separate periods. The first period is before the split announcement, the second is between

Table I

Sample Characteristics

The sample consists of all stock splits of two-for-one or greater that occurred from April 1993 through March 1994 that were included in the splits described in the CRSP tapes and had quote and trade information on TAQ. Share prices before and after splits are defined as the last bid-ask midpoint prior to the split ex-date, and the first bid-ask midpoint of the ex-date.

Panel A: Timing of Splits

Month	4/93	5/93	6/93	7/93	8/93	9/93	10/93	11/93	12/93	1/94	2/94	3/94
Splits	13	16	34	16	14	25	26	22	21	17	12	19

Panel B: Distribution of Split Factors

Split Factor	2 − 1	5 − 2	3 − 1	4 − 1	5 − 1
Splits	214	1	17	1	2

Panel C: Distribution of Share Prices ($) Immediately before and after Splits

	All Splits		NYSE/AMEX Splits		Nasdaq Splits	
	Before	After	Before	After	Before	After
Minimum	4.250	2.250	13.125	6.688	4.250	2.250
5 percent	19.500	9.750	26.313	13.250	14.063	7.250
25 percent	33.375	16.500	45.313	20.750	29.125	14.750
Median	46.125	22.375	55.750	27.125	39.375	19.125
75 percent	60.313	29.000	73.688	36.125	53.000	25.000
95 percent	89.063	39.750	95.063	45.125	75.250	35.500
Maximum	149.125	59.125	117.250	49.875	149.125	59.125
Mean	48.92	23.41	58.95	28.375	42.80	20.38

the announcement and the split execution date, the third is the first month following the ex-date, and the fourth is from 22 days (about one month) following the ex-date to the end of the third calendar month following the split month.

TAQ's trade records contain the time, price, and number of shares in each transaction. Codes are included for trades that are canceled or corrected and for trades that are reported out of sequence. Odd-lot trades are not included. The quote records contain all updates to inside bid and ask quotes and are time-stamped to the second. Quote sizes are also included, but are only meaningful for NYSE/AMEX stocks. Quotes of regional exchanges are ignored (except later to determine if they are less likely to conflict with NYSE quotes following splits) as they are almost always outside of NYSE/AMEX quotes and are usually good for much smaller sizes.[4]

Table I provides a description of the sample. Panel A describes the timing of the splits. All of the 12 sample months contain at least 12 splits, with the largest number, 34, in June 1993. Panel B reports the distribution of split

[4] Blume and Goldstein (1997) find that NYSE quotes equal one or both sides of the best prices an average (across stocks) of 99.9 percent of the time.

factors. Of the 235 sample splits, 214 were two-for-one. Most of the remaining splits were three-for-one. This is comparable to the distribution of split factors reported in Gray et al. (1996), who report about 300 two-for-one splits and about 25 three-for-one splits in their 1993 to 1994 sample.

For each stock, I calculate the mean of the last inside bid and ask quotes prior to the split and the average of the first inside bid and ask quotes following the split. Panel C describes the distribution across stocks of share prices before and after splits. When all stocks are considered, the median presplit price is \$46.125, and the range is from \$4.25 to \$149.125.[5] Nasdaq stocks tend to have slightly lower presplit prices than listed stocks. For Nasdaq stocks, the median presplit price is \$39.375 and the mean is \$42.80; NYSE/AMEX stocks have a median price of \$55.75 and a mean of \$58.95. The range of prices in Panel C following splits suggests that if there is an optimal price range, or, equivalently, if there is an optimal relative tick size, it differs greatly across stocks as the Angel (1997) model predicts.

III. Evidence that a Split Makes the Stock Attractive to Small Investors

Figure 1 provides the distribution, across sample stocks, of the percentage of postsplit trades that are smaller than the presplit round lot. For stocks that split two-for-one this is the percentage that is 100 share trades. Both 100 and 200 share trades are included for stocks that split three-for-one. The figure indicates that there is a strong demand following splits to make smaller trades than the presplit round lots. For the median Nasdaq stock, between 10 percent and 15 percent of postsplit trades are smaller than a presplit round lot. For 25 of the 146 sample Nasdaq stocks, between 20 percent and 25 percent of postsplit trades are smaller than presplit round lots. For NYSE/AMEX stocks, the percentage of small trades is even higher. I do not have data on odd-lot trades so I cannot test whether the proportions of postsplit trades shown in Figure 1 differ significantly from the proportions of equivalent odd-lot trades prior to the split. However, the number of odd-lot trades is small. In 1993, odd-lot trades accounted for 0.8 percent of NYSE volume.

Figure 2 shows the aggregate number of small buys and sells in the 66 days (approximately three months) following the split. A trade is defined as a buy (sell) order if the trade price is greater (less) than the average of the contemporaneous bid and ask quotes. Following Lee and Ready (1991) I define the contemporaneous quotes as the most recent quotes that were time-stamped at least five seconds before the trade. Figure 2 reveals that buy orders dominate small trades on every one of the 66 days following the splits. In each of the first two days, there are approximately 7,800 small buy orders and 1,400 small sell orders. This surfeit of buy orders is consistent across

[5] The stock that split at a price of \$4.25 is Arch Petroleum, a Nasdaq company. I was unable to find any articles announcing the split in *The Wall Street Journal*.

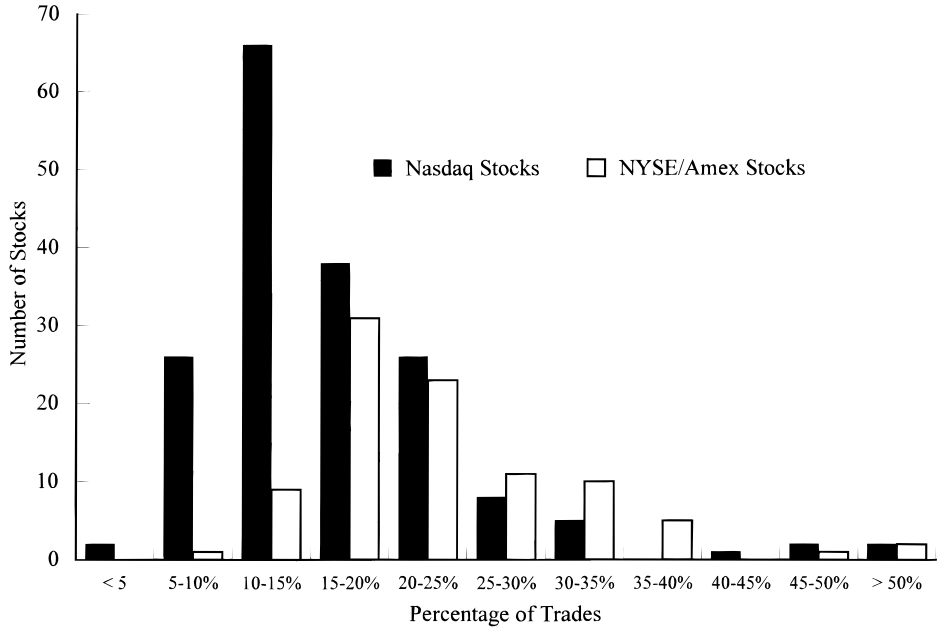

Figure 1. The distribution across stocks of the percentage of postsplit trades that are smaller than a presplit round lot.

stocks. For the first few days following the split, more than 180 sample stocks have more 100-share buy orders than sell orders while fewer than 20 have more 100-share sell orders. The net number of small buy orders, 6,400, suggests that 6,400 small investors were added to the shareholder bases of the 235 splitting firms on each of these two days. The number of buy orders declines over the three months following the split and the number of sell orders shows little change. However, even after 66 days, there are still about 1,000 more small buy orders than sell orders each day. This is consistent both with the findings of Kryzanowski and Zhang (1996) that small trades on the Toronto Stock Exchange are predominately buy orders following splits and with recent work by Angel et al. (1998) that documents far more small buy orders than sell orders following splits for a sample of NYSE stocks.

The predominance of small buy orders suggests that three months after the split an average of about four small shareholders is added to the shareholder base of each of the 232 sample stocks each day. Over the entire period, it appears that a few hundred small shareholders could be added to the shareholder base of each stock.[6] This is similar to the finding of Maloney

[6] Angel (1997) and others suggest that an expanded shareholder base increases the value of the firm. However, an alternative motivation for adding more small shareholders may be to make takeovers more difficult by making the shareholder base more diffuse. I am grateful to Michael Long for suggesting this explanation.

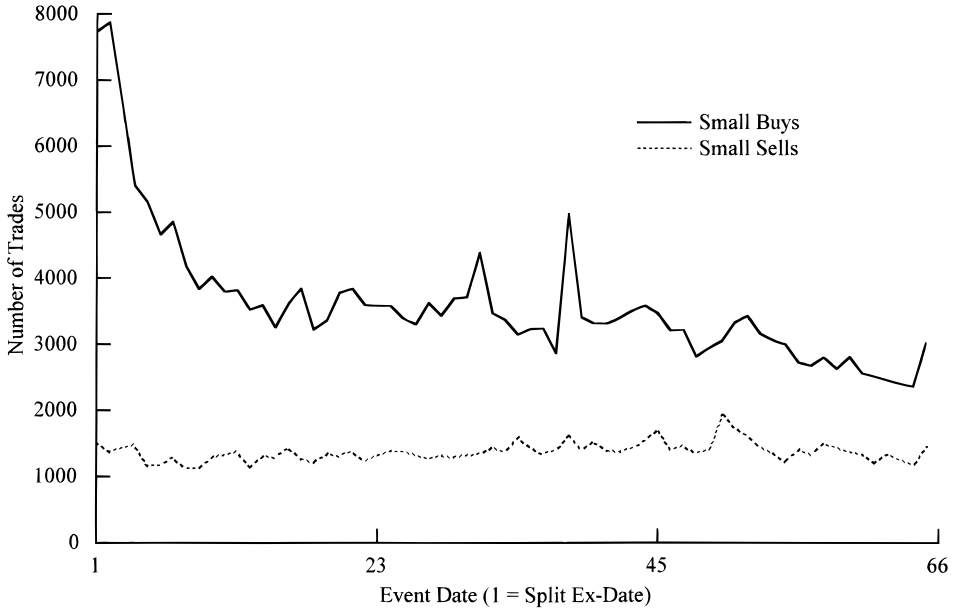

Figure 2. The aggregate number of trades that are small buys and small sells subsequent to splits. Trades are small if they are less than presplit round lots.

and Mulherin (1992) that the number of shareholders increases by about 20 percent following splits. This is consistent across stocks. For the 66 days following the split, the number of sample stocks with more 100-share buys than sells always exceeds the number with more 100-share sells than buys.

Are large investors selling while small investors buy? Figure 3 shows the total net buy volume across all stocks for small, medium, and large trades for 66 days before and after split ex-dates. Small trades are defined as fewer than 500 post-split shares, medium-size trades range from 501 to 10,000 post-split shares, and large trades exceed 10,000 post-split shares. Net buy volume is obtained by subtracting volume from trades at prices below the bid-ask midpoint from volume from trades at prices above the bid-ask midpoint. This procedure ignores the substantial number of trades that take place at the bid-ask midpoint. Figure 3 shows that the net buy volume from small trades is close to zero at the beginning of the sample period, it gradually increases over the three months prior to the split, then leaps to about two million shares at the ex-date and remains positive for the rest of the sample period. Net buy volume from medium-size trades is high in the month and a half or so before the split ex-date, suggesting that medium size trades are buys between the announcement and ex-date. Following the ex-date, net buy volume from medium-size trades, which had exceeded net buy volume from small trades, is consistently less than the net buy volume from small trades. Over this entire period, volume from large trades tends to be sells.

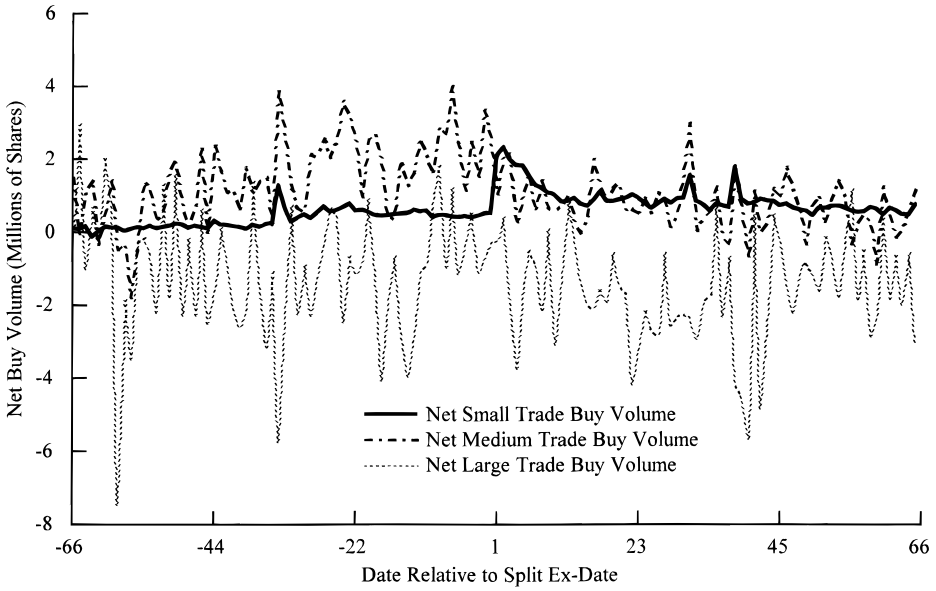

Figure 3. Net buy volume by trade size around split ex dates. Small trades are 500 or fewer postsplit shares. Medium-size trades are 501–10,000 postsplit shares. Large trades exceed 10,000 postsplit shares. Trades are defined as buys (sells) if the trade price is greater (less) than the bid-ask midpoint.

This deepens the mystery surrounding the long-run performance of stocks following splits. Ikenberry, Rankine, and Stice (1996) and Desai and Jain (1997) find that stocks earn abnormal returns of about seven percent in the year following the split announcement. The positive abnormal returns following splits has been interpreted by some researchers to mean that the market underreacts to the information contained in the split announcement. It is difficult to believe that it is the large investors who fail to respond correctly to the split announcement while the small investors draw the correct inferences and purchase stock.

IV. Evidence on Incentives to Promote Stocks Following Splits

A. Splits and Market Maker Revenues

Why do small investors rush to buy stocks following splits? It is not because they can finally avoid paying an odd-lot differential: the NYSE eliminated this extra fee for odd-lot trades in 1991. Angel (1997) suggests that larger transaction costs following stock splits may provide incentives for brokers to promote stocks.

A popular measure of transactions costs that allows for trades within or outside the quotes is the effective spread. The effective spread for trade t is estimated as twice the absolute value of the difference between the price of a trade and the contemporaneous bid-ask midpoint. That is,

$$\textit{Effective Spread}_t = 2 \cdot \left| P_t - \frac{B_t + A_t}{2} \right|, \tag{1}$$

where P_t = the price of trade t, B_t = the bid price when trade t took place, and A_t = the ask price when trade t took place. The percentage effective spread I use here is obtained by dividing the effective spread by the mean of the bid and ask prices.

I calculate the mean effective spread as a percentage of the stock price before and after splits for each stock for five trade size categories: ≤500 shares, 501–1,000 shares, 1,001–5,000 shares, 5,001–10,000 shares, and >10,000 shares. Trade sizes are measured in terms of postsplit shares. Thus a 3,000 share trade that occurs before a two-for-one split would be counted as a 6,000 share trade. The mean and median of the individual stocks' mean effective spreads is calculated and presented in Table II.

Here, as elsewhere in the paper, I test whether there are differences between the second and third periods and whether there are differences between the first and fourth periods. By testing whether there are differences between the period right after the announcement and the first month following the split, I examine changes over a sufficiently short period so that other changes in the stock's characteristics are unlikely to affect the proportion of trading costs or other variables of interest. By examining changes between the period before the announcement and the period more than one month after the split, I test whether changes in trading costs (or other variables) are permanent changes and not mere artifacts of an unusual period around the split.

Effective spreads between the announcement and ex-date and effective spreads in the first month following the ex-date are contrasted in Panel A of Table II. Longer term changes in effective spreads, obtained by comparing the effective spreads in the period before the announcement and effective spreads in the period more than one month after the ex-date, are shown in Panel B. The second column of the table shows effective spreads for trades of 500 or fewer postsplit shares. The mean effective spread is 0.96 percent between the announcement and the split and 1.28 percent in the month following the split. The difference in effective spreads is statistically significant with a t-statistic of 7.26. Of the sample stocks, 210 have an increase in effective spreads and 22 show a decrease. Similar results are found in the comparison of spreads over the longer term. The mean effective spread is 1.04 percent for trades of fewer than 500 (postsplit) shares prior to the announcement. For the period more than one month following the split, the mean effective spread is 1.25 percent. This difference is statistically signif-

Table II

Percentage Effective Spreads around Splits

The percentage effective spread for a trade is twice the absolute value of the difference between the trade price and the contemporaneous bid-ask midpoint divided by the midpoint. For each of the 235 sample stocks, the mean effective spread is computed for trades of various sizes before and after splits. A cross-sectional grand mean of the individual stock mean effective spreads is calculated and is reported below. Trade sizes are expressed in terms of postsplit shares. The *t*-statistics test whether the average difference in transaction costs across stocks is different from zero.

Trade Size	≤500 Shares	501–1,000 Shares	1,001–5,000 Shares	5,001–10,000 Shares	>10,000 Shares
Panel A: Changes in Effective Spreads around Split Ex-Dates					
Percentage effective spread announcement to ex-date	0.0096	0.0090	0.0065	0.0054	0.0048
Percentage effective spread first month after ex-date	0.0128	0.0107	0.0098	0.0080	0.0076
t-statistic for difference	7.26	2.61	9.12	7.50	4.54
Number of increases (decreases)	210 (22)	199 (35)	215 (14)	187 (21)	161 (20)
Panel B: Longer Term Effective Spread Changes					
Percentage effective spread before announcement	0.0104	0.0093	0.0080	0.0061	0.0050
Percentage effective spread more than month after ex-date	0.0125	0.0101	0.0094	0.0075	0.0069
t-statistic for difference	3.91	1.55	3.32	6.11	4.92
Number of increases (decreases)	202 (32)	182 (51)	193 (38)	177 (29)	123 (72)

icant at the 1 percent level. Table II reveals that effective spreads for all other trade sizes also show significant increases following splits. When stocks are separated by listing (not shown), it is evident that trading costs for Nasdaq and NYSE/AMEX stocks change in similar ways following splits.

B. Splits and the Costs of Making Markets

Larger effective spreads may not provide incentives to promote a stock if costs of market making increase following splits. Several authors, including Ohlson and Penman (1985), Dubofsky (1991), and Angel et al. (1998) document that volatilities increase subsequent to splits. Koski (1998) demonstrates that these increases in variances cannot be fully explained by measurement errors induced by price discreteness or bid-ask bounce. Wider spreads may reflect additional compensation that market makers or specialists require following volatility increases.

Although average volatilities increase following splits, many stocks experience no change or a decrease. Koski (1998) reports that volatility, measured using bid-to-bid returns, increased following splits for only 55 percent of the stocks in her sample. Similarly, I find that volatility increases for 165

Table III

Regression Results

Cross-sectional regressions are presented of the changes in the percentage spread from the period before the announcement to the period starting more than one month following the split on the split factor, the percentage of time that the spread is at the minimum during the first period, and the difference between the variance in the fourth period and the variance in the first period. Variance is measured as the mean squared daily percentage price change, where the daily price change is measured using the closing bid-ask midpoint. *t*-statistics are in parentheses.

	Intercept	Split Factor	Percentage of Time Spread is Minimum	Change in Variance	Adj. R^2	Obs.
≤500 shares	−0.00499	0.00340	0.00095	−0.7723	0.014	235
	(−1.64)	(2.43)	(0.26)	(−0.80)		
501–1,000 shares	−0.01065	0.00524	0.00539	−0.7486	0.066	235
	(−3.85)	(4.13)	(1.65)	(−0.85)		
1,001–5,000 shares	−0.00697	0.00373	0.00384	−0.0887	0.038	235
	(−2.82)	(3.28)	(1.31)	(−0.11)		
5,001–10,000 shares	−0.01031	0.00506	0.00621	−0.1600	0.046	235
	(−3.22)	(3.44)	(1.64)	(−0.16)		
>10,000 shares	−0.00229	0.00174	0.00232	0.2094	0.003	235
	(−1.03)	(1.70)	(0.88)	(0.30)		

of 234 stocks between the period before the announcement and the period more than one month after the ex-date, and for 162 of 235 stocks between the period from the announcement to the ex-date and the first month subsequent to the split. Thus, to test if increased trading costs are compensation to market makers for increased volatility, I regress changes in effective spreads from the period before the split announcement to the period more than one month after the split on the change in variance between the two periods, the split factor, and the percentage of time that quoted spread is at its minimum before the announcement. For listed stocks and Nasdaq stocks that traded using all price fractions I define the minimum spread as \$0.125. However, Christie and Schultz (1994) show that most Nasdaq stocks during the sample period are quoted exclusively in quarters. Thus, for Nasdaq stocks with fewer than 25 percent of quotes on odd-eighths I define the percentage of time with the minimum spread as the percentage of time that the spread is less than or equal to \$0.25. Regressions are run separately for trades of 500 shares or fewer, trades of 501 to 1,000 shares, trades of 1,001 to 5,000 shares, trades of 5,001 to 10,000 shares, and trades of more than 10,000 shares.

Regression results are in Table III. The split factor is positive in all regressions and is significant at least at the 5 percent level in all regressions except the one in which the effective spread on trades of more than 10,000

shares is the dependent variable. The percentage of time that the spread is at a minimum before the announcement is never significant, but it is always positive and has *t*-statistics of 1.65 for trades of 501 to 1,000 shares and 1.64 for trades of 5,001 to 10,000 shares. Most important, the change in variance is insignificant in all of the regressions, implying that the change in spreads is not compensation to market makers or specialists for bearing extra risk. When the regression is run separately for listed and Nasdaq stocks, the results are similar.

Some authors, including Angel (1997), Harris (1997), and Grossman et al. (1997), assert that a larger relative tick size may reduce the costs of making a market. In this case a split would reduce costs of market making and would provide an incentive to brokers to promote a stock even if trading costs to investors remain the same. Costs of market making could decline because the larger tick size reduces the number of costly errors, minimizes costly negotiations, or decreases the costs of providing firm quotes by making front-running and quote-matching more costly.

It is straightforward to test whether splits reduce the number of trading errors. The TAQ data contain codes for corrected trades, trades canceled due to error, and canceled trades. Corrected trades often involve obvious mistakes, such as a wrong price or trade price, that can be corrected immediately when noticed. They are often typographical errors in reporting trades rather than misunderstandings between counterparties. Trades canceled due to error often represent a misunderstanding between the two parties in the trade, or a mix-up between a broker and customer. For each stock, I calculate the percentage of trades that have one of these error codes in the period before the split announcement, in the period between the announcement and ex-date, in the first month (22 trading days) following the split, and in the remainder of the three calendar months following the split month. I then calculate the cross-sectional mean and median percentage of trades having these errors for all stocks, for all listed stocks, for all Nasdaq stocks, and for all stocks with split factors of 2.5 or greater. Results are reported in Panel A of Table IV.

When the period from the announcement to the ex-date is compared with the first month after the ex-date, we see that there is a small increase in trading errors for Nasdaq stocks and for all stocks and a small decline in trading errors for listed stocks. None of the differences is statistically significant. When the period before the announcement is compared with the period more than one month after the ex-date, the proportion of trading errors is seen to decline for all stocks and separately for NYSE/AMEX stocks and Nasdaq stocks. The result is only statistically significant for all stocks however, and it appears to be too small to provide a motivation for splits.

To see if the decline in trading errors is due to changes in volume or volatility I regress the change in the proportion of trades that are errors between the time before the announcement and the period more than one month following the split on the change in volume (measured in postsplit shares),

Table IV

Trading Errors, Quote Errors, and Trade Reporting Errors Before and After Splits

The reported proportions are the cross-sectional mean proportion of trades that are errors before and after splits. The sample consists of 235 splits of at least two-for-one that occurred over the 12 months of April 1993 through March 1984. There are 89 NYSE/AMEX stocks, and 146 Nasdaq stocks. There are 20 stocks with split factors of five-for-two or greater. Before-announcement observations include all trades from the third calendar month before the ex-date of the split through the split announcement. Succeeding months include all trades from 22 trading days following the split (about one calendar month) through the third calendar month following the ex-date month. *t*-statistics (in parentheses) under the percentage of errors in the first month following the ex-date test whether the proportion of errors in that period is different from the proportion between the announcement date and the ex-date. *t*-statistics under the percentage of errors in the succeeding months test whether the proportion of errors in that period is different from the proportion before the announcement date. Trade errors are trades that are coded on TAQ as corrected, canceled, or canceled due to error. Corrected trades typically represent obvious errors in reporting. Canceled trades are often the result of misunderstandings between brokers and customers or between counterparties to a trade. The cross-sectional regressions in Panel B have the change in trade errors between the period before the announcement of the split and the period more than one month after the split as the dependent variable. In Panel C, locked quotes are instances when the inside bid and inside ask quote are equal. Crossed quotes are instances when the inside bid quote exceeds the inside ask quote.

Panel A: Percentage of Trades that Are Errors

	Before Announcement	Announcement to Ex-Date	First Month After Ex-Date	Succeeding Months
All stocks	1.140	1.071	1.076 (0.06)	0.986 (−2.51)
NYSE/AMEX	0.477	0.454	0.408 (−1.29)	0.434 (−1.10)
Nasdaq	1.540	1.440	1.573 (0.88)	1.343 (−1.94)
Split ≥ 5-2	0.921	1.062	1.164 (0.30)	0.986 (0.37)

Panel B: Regressions of Changes in Percentage of Trades that Are Errors on Changes in Daily Volume, Daily Number of Trades, Daily Variance, and Number of Daily Quote Revisions

	Intercept	Change in Volume	Change in No. of Trades	Change in Variance	Change in Quote Revisions	Adj. R^2
Corrected trades	−0.00037 (−1.23)	0.00000 (0.10)	−0.00035 (−0.14)	0.3113 (0.60)	0.00380 (0.26)	0.00
Canceled due to error	−0.00114 (−1.92)	0.00000 (0.02)	−0.00159 (−0.32)	1.0860 (1.05)	0.00902 (0.31)	0.00
Canceled	−0.00010 (−0.81)	−0.00000 (−0.27)	−0.00071 (−0.67)	0.2657 (1.22)	−0.00168 (−0.27)	0.00
All errors	−0.00161 (−2.34)	0.00000 (0.01)	−0.00265 (−0.45)	1.6630 (1.39)	0.01114 (0.33)	0.00

Table IV—*Continued*

Panel C: Percentage of Time Quotes Are Locked or Crossed				
	Before Announcement	Announcement to Ex-Date	First Month after Ex-Date	Succeeding Months
NYSE/AMEX	0.2250	0.2586	0.2853 (0.89)	0.3255 (1.58)
Nasdaq	0.0849	0.1910	0.0932 (−1.90)	0.1650 (1.73)

the change in the number of trades, the change in the variance, and the change in the mean number of quote revisions per day. Results are reported in Panel B of Table IV. None of the explanatory variables is statistically significant at the 5 percent level. The intercept term is negative and significant in the regression with all errors as the dependent variable. Thus after adjustment for these other factors that change following splits, weak evidence of a decline in trading errors remains.

Along with trading errors, errors in posting quotes could be reduced with a larger tick. Panel C shows the proportion of the time that quotes are locked or crossed during the trading day in each of the four periods. A locked quote occurs when the inside bid and ask quotes are equal. A crossed quote occurs when the inside bid quote exceeds the inside ask. For Nasdaq stocks this occurs when one dealer's quotes are out of line with the quotes of other dealers. For listed stocks, this occurs when quotes from one exchange (e.g., the Chicago Stock Exchange) are out of line with other quotes. Locked or crossed quotes are most likely to occur when the market is volatile, spreads are narrow, and a large number of dealers are posting quotes. For Nasdaq stocks, locked or crossed quotes can result in losses for market makers as SOES bandits or other traders rush in to take advantage of pricing discrepancies. Harris and Schultz (1997) provide evidence consistent with intense bandit trading activity when quotes lock.

Locked or crossed quotes are unusual. For both Nasdaq and listed stocks, quotes are locked or crossed less than one percent of the time both before and after the splits. The results in Table IV, Panel C, indicate that for listed stocks the mean proportion of time that quotes are locked or crossed increases after the split. For Nasdaq stocks, the proportion of time that quotes are locked or crossed decreases when the month immediately following the split is compared with the period between the announcement and the split but increases when the period more than one month after the split is compared with the period before the announcement. None of these differences is statistically significant. Splits do not appear to reduce errors in posting quotes.

To summarize, there is some weak evidence that trading errors are reduced following splits, but the effect seems to be small. I find no support for the hypothesis that quote errors, as proxied by locked and crossed quotes, decrease following splits.

Table V

Quoted Sizes before and after Splits

For each of the 89 NYSE/AMEX stocks in the sample, the time-weighted mean inside bid and inside ask quote size is calculated before and after the split. The mean and median reported here are the cross-sectional mean and median of the individual stock quote sizes. Quote sizes are in terms of postsplit shares.

	Bid Quote Size	Ask Quote Size	Total Quote Size
Panel A: Changes in Quote Sizes around Split Ex-Dates			
Mean between announcement and ex-date	4,499	6,496	10,987
Mean in month after ex-date	4,698	6,387	11,083
t-statistic for difference	0.31	−0.13	0.06
Median between announcement and ex-date	3,400	5,000	8,300
Median in month after ex-date	3,400	4,700	7,800
No. of stocks with larger size before (after) ex-date	53 (34)	47 (37)	51 (37)
Panel B: Longer Term Changes in Quote Sizes			
Mean before announcement	5,183	6,169	11,346
Mean more than one month after ex-date	4,866	6,239	11,124
t-statistic for difference	−0.44	0.09	−0.15
Median before announcement	4,000	4,600	8,400
Median more than one month after ex-date	3,800	4,700	8,300
No. of stocks with larger size in earlier (later) period	55 (34)	48 (36)	56 (32)

A second prediction of the optimal tick size hypothesis is that quote matching should be reduced following splits. This implies that if quote matching is a serious problem then quoted depths increase, both because specialists are willing to display larger size and because investors submit more limit orders.[7] The TAQ data contains quote sizes for listed stocks, enabling me to test directly for changes in quote sizes following splits. For each NYSE/AMEX stock, I calculate the time-weighted mean bid size, mean ask size, and mean total size for the periods before and after the split. All quote sizes are expressed in terms of postsplit shares. That is, if a stock splits two-for-one, all quote sizes prior to the split are multiplied by two to make them comparable to quotes sizes before the split.

Table V provides data on the cross-sectional distribution of the individual stocks' mean quote sizes (in presplit shares) before and after splits. Panel A reports cross-sectional mean and median quote sizes in the period between the announcement and ex-date and in the month following the ex-date. Quote

[7] Arnold and Lipson (1997) examine limit order executions surrounding stock splits. They use a reduction in quoted display size following a trade as a proxy for the execution of limit orders. They find that following splits, a significantly larger proportion of trades result in a change in displayed sizes, which they interpret to mean that a larger proportion of trades are executing against limit orders. Their results are statistically significant and remain highly significant after adjusting for volume, a volatility measure and other factors.

sizes, which are expressed in terms of postsplit shares, are almost identical before and after the split. Total quoted size at both the bid and ask quotes averages 10,987 shares before the split and 11,083 in the month following the split. The median quote size is 8,300 shares between the announcement and split and 7,800 shares in the month following the split. None of the mean quote sizes, bid, ask or total, changes significantly from the period prior to the split to the month following the split. For the majority of stocks, quote sizes are actually larger before splits. Panel B provides quote sizes prior to the split announcement and for the period that is more than one month after the ex-date. Again, there is almost no difference in quote sizes and none of the differences is even close to statistical significance. So, in summary, the evidence in Table V provides no support for the hypothesis that the larger relative tick sizes following splits leads to an increase in quote sizes at the inside.

These results are surprising. Even if quote matching is not a problem we would still expect an increase in quote sizes following splits. After splits there are fewer possible prices for limit orders to take so more should be displayed at any particular price. Also, the wider spreads could lead investors who would have been indifferent between limit order and market orders to submit limit orders. These results are also surprising in light of recent studies of an analogous shift to a smaller tick size on the Toronto Stock Exchange. In April 1996, Canadian stock exchanges reduced the minimum tick size from \$0.125 to \$0.05 for stocks trading above \$5 and from \$0.05 to \$0.01 for stocks trading between \$3 and \$5. Studies by Bacidore (1997) and Ricker (1998) show that quoted depths at the inside market fell after the decrease in tick size.

It is more difficult to test directly whether splits reduce negotiating costs. However, trades that take place at the quotes are less likely to be negotiated than other trades. Thus I use the frequency of trades within the spread as a proxy for the proportion of trades that are negotiated. Further, it should be possible to identify stocks that can be expected to experience a particularly large decline in negotiating costs as a result of a split. If a stock typically trades with a one or two tick spread prior to a split, there are usually few prices for negotiators to haggle over, and the reduction in negotiating costs from a split is small. This is particularly true for listed stocks where exchange regulations prohibit trades from taking place at prices that are not tick multiples. For these stocks, it is implausible that a reduction in negotiation costs is an important motivation for a split. On the other hand, if the spread is often several ticks wide, traders can go back and forth between several prices and thus negotiating costs may be reduced substantially by a split.[8]

[8] Much of the price improvement on the NYSE is a result of the specialist stepping in front of the limit order book by improving the price. If limit orders are more common following a split, it is possible that the specialist would step in front of the limit order book more often. However, with a wider tick it becomes more costly to do so. In addition, the frequency of one tick spreads is almost certain to increase following splits and the specialist is unable to step in front of limit orders at all in these situations.

To see which stocks are most likely to experience a reduction in negotiation costs as the result of a split, I calculate the proportion of time that each sample stock trades with a spread of one tick, two ticks, three ticks, or four or more ticks using all spreads prior to the split announcements. Most of the Nasdaq stocks trading during this period were quoted only in prices ending in even eighths. Thus the de facto tick size for these stocks was ¼ although Nasdaq rules allowed them to be quoted in ⅛'s. To account for this I separate Nasdaq stocks that traded with a ¼ tick from those that traded with a ⅛ tick. The criteria that I use to define a stock traded in eighths is that at least 25 percent of the bid and ask quotes end in odd-eighths. Most stocks classified as having a tick size of a quarter had more than 98 percent of quotes on even-eighth price fractions.[9]

Panel A of Table VI shows the proportion of trades within the spread for stocks that had a one tick spread more than 50 percent of the time in the period before the announcement. Only seven NYSE/AMEX and three Nasdaq stocks fit this category. Presumably, there would be almost no reduction in negotiation costs for these stocks and therefore this would be an unlikely motivation for the splits of these stocks. For listed stocks, the proportion of trades within the spread declines from 27.97 percent just before the ex-date to 22 percent just after. The difference is statistically significant at the 1 percent level. The proportion of trades within the spread declines from 26.08 percent before the announcement to 20.94 percent during period more than one month following the split. This difference is statistically significant at the 5 percent level. The differences are not significant for Nasdaq stocks, but there are only three observations.

Panel B of Table VI shows the proportion of trades within the spread for stocks that had a two tick spread more than 50 percent of the time in the period before the announcement. For listed stocks, we again see a reduction in the proportion of trades executed within the spread following splits. The reduction is significant when the second and third periods and the first and fourth periods are compared. For Nasdaq stocks quoted in quarters, the proportion of trades within the spread actually increases slightly following splits. For Nasdaq stocks quoted with all price fractions, the proportion of trades within quotes is not significantly different between the second and third periods but does differ between the first and fourth.

Panel C shows proportion of trades within quotes for stocks that traded with spreads of more than four ticks most of the time. There is no change in the proportion for NYSE/AMEX stocks, but it is hard to draw inferences from only five observations. For Nasdaq stocks, the change in the proportion of trades within the spread is insignificant when the second and third periods are compared, but is significant at the 1 percent level when the first and fourth periods are compared. As a whole, results in Table VI indicate

[9] Christie and Schultz (1994) document the absence of odd-eighth quotes and attribute it to an understanding, or tacit collusion among Nasdaq market makers to maintain a minimum bid-ask spread of $0.25.

Table VI

Proportion of Trades within Spreads around Splits

The proportion of trades that take place within the spread is calculated for each stock for the period before the split announcement, for the days between the announcement and the ex-date, for the first month after the ex-date, and for the next two months. For each stock the proportion of time the inside spread is one, two, three, or four or more ticks wide is calculated for the period prior to the split announcement. For Nasdaq stocks quoted exclusively in quarters, the tick size is assumed to be ¼ although the stock could have been quoted with all price fractions. For each of the four periods a cross-sectional average proportion of trades within the spread is calculated for stocks that have a one tick spread more than 50 percent of the time, stocks with a spread of two ticks most of the time, and stocks with a spread of more than four ticks most of the time. A paired sample *t*-test is used to test whether the proportion in the first month after the ex-date is significantly different from the proportion between the announcement date and the ex-date. A second paired sample *t*-test is used to test whether the proportion in the second and third months after the ex-date is significantly different from the proportion before the announcement date.

Panel A: More Than 50 percent of the Time the Spread Is One Tick

	NYSE/AMEX	Nasdaq Odd ⅛'s Used	Nasdaq Only ¼'s
Number of securities	7	0	3
Before announcement	0.2608	0.2448	na
Announcement to ex-date	0.2797	0.3015	na
First month after ex-date	0.2200**	0.2281	na
More than month after ex-date	0.2094*	0.2261	na

Panel B: More Than 50 percent of the Time the Spread Is Two Ticks

	NYSE/AMEX	Nasdaq Odd ⅛'s used	Nasdaq Only ¼'s
Number of securities	58	15	40
Before announcement	0.3913	0.2663	0.2848
Announcement to ex-date	0.3899	0.2335	0.2666
First month after ex-date	0.3211**	0.2338	0.2752
More than one month after ex-date	0.3300**	0.2328**	0.3006

Panel C: Spread is Four Ticks more than 50 percent of the Time

	NYSE/AMEX	Nasdaq Odd ⅛'s Used	Nasdaq Only ¼'s
Number of securities	5	0	62
Before announcement	0.3202	na	0.4139
Announcement to ex-date	0.3199	na	0.3611
First month after ex-date	0.3347	na	0.3678
More than one month after ex-date	0.3127	na	0.3622**

*, ** Indicate difference from the previous proportion at the 5 percent and 1 percent levels.

that the proportion of trades within the spread falls for listed stocks following splits. However, the listed stocks typically have spreads two or fewer ticks wide most of the time. The time spent negotiating trades of these stocks would be minimal. Nasdaq stocks are more likely to have spreads four or more ticks wide and thus costs of negotiation could be significant. However, the proportion of trades executed within the spread falls only slightly before the announcement and remains high for Nasdaq stocks after splits.

V. Is Increased Sponsorship the Sole Reason for Small Investor Interest?

As we have seen, effective spreads increase for almost all stocks following splits, and there is some weak evidence that costs of market making decline following splits. Together, these results suggest that market makers and specialists find trading stocks to be more profitable following a split. This provides brokers who also make a market in the stock on Nasdaq with an incentive to promote the stock. If brokers receive payment for order flow for listed stocks, or if they have a specialist affiliate on a regional exchange, they have a similar incentive to promote listed stocks.

However, recent evidence on splits of mutual funds suggests that a wider tick and its incentives to promote a stock is not a complete explanation for the small purchases following stocks splits. Rozeff (1998) examines 131 splits and 36 large stock dividends of mutual funds over 1965 to 1991 and shows that splits of mutual funds are similar to stock splits in several ways. Split factors for funds and stocks are most often two-for-one. At the time of the split, mutual fund prices, like stock prices, tend to be higher than comparable funds and are similar to those of other funds after the split. The size of the split factor is positively related to the deviation of the fund price from that of other funds. Finally, funds, like stocks, tend to split following periods of rising stock prices. However, for mutual funds, unlike stocks, there is no tick size and thus a preferred tick size cannot provide a motivation for splits. Rozeff (1998) observes though that the relative infrequency of fund splits provides indirect support for the tick size hypothesis as an explanation for stock splits.

Fernando, Krishnamurthy, and Spindt (1997) also examine splits of mutual funds. Their sample consists of 194 mutual funds that split at least six-for-five between 1978 and 1993. Their data allows them to measure inflows of new money into the funds in their sample, and they find that splitting funds receive significantly larger mean and median inflows of money than a control sample consisting of funds with similar objectives and prior year performance. The number of new shareholders also increases dramatically. Fernando et al. conclude that fund managers use splits to enhance the marketability of their funds. Thus when prices are lowered, the marketability of the funds is increased for reasons other than a preferred tick size.

VI. Summary and Conclusions

In this paper I examine intraday trades and quotes around splits of 146 Nasdaq and 89 NYSE/AMEX stocks. I find that there are a lot of small orders subsequent to splits and the overwhelming majority of these orders are buys. These results are consistent with the traditional explanation that splits are used to increase the shareholder base for a stock.

Splits could expand the shareholder base if they increase revenues for market making. These market making profits could be passed back to brokers who promote the stock if the stock trades on the Nasdaq and if the broker is a market maker. Alternatively, if the stock is listed, increased market making revenues could go to the brokerage firm if the broker has an affiliate specialist on a regional exchange or if the broker receives payment for order flow.

I find evidence that market making is more profitable following splits. Effective spreads increase for all trade sizes for almost all stocks. Further, the increases in effective spreads appear to be accompanied by modest declines in some of the costs of making markets. Following splits, there is some weak evidence that trading errors decline. For listed stocks the proportion of trades within the spread declines, suggesting that fewer trades are negotiated and that negotiation costs decline following splits.

The evidence presented here is consistent with splits providing increased incentives to promote a stock. However, my results do not provide the complete explanation for the purchases by small investors. At the split announcement there is a sharp increase in small buy orders (not shown) while the spread increase occurs only when the split becomes effective. Likewise, similar splits of mutual funds can be explained by the desire for lower priced fund shares but not by the need for wider ticks as fund prices are not constrained by tick size. More work is needed.

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