

# Stock Splits and Liquidity: The Case of the Nasdaq-100 Index Tracking Stock \*

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# Stock Splits and Liquidity: The Case of the Nasdaq-100 Index Tracking Stock

## **Abstract**

In an attempt to disentangle the signaling effect from the liquidity effect of stock splits, I examine the liquidity changes following the two-for-one split of the Nasdaq-100 Index Tracking Stock. Since there can be no signaling with an index stock split, any difference in pre- and post-split trading may be driven by liquidity but not signaling effects. I find that though the post-split relative bid-ask spread is higher and daily turnover is unchanged, the frequency, share volume and dollar volume of small trades all increased after the split, indicating that the split improved liquidity for small trade-sizes.

# 1 Introduction

There are many hypotheses that have been proposed to explain stock splits, including signaling, liquidity, corporate control, and taxes. This paper focuses on disentangling the liquidity and signaling hypotheses. To test the liquidity hypothesis, many studies have compared the liquidity of a stock before and after a stock split. Some studies, such as Muscarella and Vetsuypens (1996) and Schultz (2000) find that volume, especially the small-sized trades, increase following a split, while other studies, such as Lakonishok and Lev (1987) find that volume decreases following a split. A problem arises in the interpretation of such a change in post-split liquidity. Post-split liquidity could be driven by the lower share price, which enables more investors to purchase the stock. However, post-split liquidity could also be driven by signaling. Specifically, the public may interpret a share split as a signal of good news by the manager, and subsequently increase their trading of the stock. Hence, the effect of a favorable signal and more liquidity (lower cost of capital) both can result in a positive announcement day return for the firm's stock.

The contribution of this study is that it examines a unique event that allows the effect of liquidity to be separated from that of signaling. On March 20, 2000 the National Association of Securities Dealers Automated Quotation System (Nasdaq) 100 Index Tracking Stock split two-for-one. The Nasdaq-100 Index Tracking Stock is an Electronically Traded Fund (ETF) that represents a claim of ownership in a portfolio of stocks that comprise the Nasdaq-100 Index. The Index is a market-capitalization weighted index of the 100 largest stocks on the Nasdaq. The tracking stock has the ticker "QQQ" and is casually referred to as the 'cubes'. Since it is an ETF, it trades on the AMEX like a stock: it can be bought or sold short, and one can place either market or limit orders to trade the stock. Dividends from the underlying portfolio of stocks are used to offset the ETF's annual expenses (20 basis points per annum), with any amount in excess of the fund's expenses paid to shareholders. The

central difference between the tracking stock and the stock of an individual firm is that the tracking stock represents a claim against a unit investment trust established to accumulate and hold a portfolio of the equity securities that comprise the Nasdaq-100 Index. In contrast, the stock of an individual firm represents a claim against the assets of that firm.

Unlike managers of individual firms, the managers of the trust do not have access to private information regarding the firms held in the trust. Hence, signaling cannot be a motive for splitting the stock. In fact, the Nasdaq's stated reason for splitting the QQQ Index Tracking Stock was to make them more attractive for retail investors.<sup>1</sup> The price of QQQ when the shares began to trade was \$100. At the time of the split the share price was \$240, and the QQQ administrator desired to get the price back into a "comfortable" range for individual investors. Examining the QQQ stock split provides a good test for the liquidity hypothesis since there cannot be a signaling motive for splitting the stock and the Tracking Stock was relatively expensive before the split. The average price of the Tracking Stock during the three months before the split was \$195 per share. A round lot of the Tracking Stock would cost nearly \$20,000, which is almost one-fourth of the size of the average individual investor's net worth of \$79,600.<sup>2</sup> In contrast, the average price of a stock in the Nasdaq-100 during the same time period was only \$82 per share.

For this particular event, any difference between post-split and pre-split trading activity may be explained by liquidity, but not by signaling. I examine pre-split and post-split differences in turnover, the number of trades, share volume, and the bid-ask spread. The turnover is no different after the split than before, and the relative bid ask spread actually increases after the split. While these measures seem to indicate the liquidity may be unchanged following the split, they are aggregate measures and potentially mask differences between small and large trades. When compared to the pre-split levels, the frequency of

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<sup>1</sup>Source: John Jacobs, Senior Vice President of Worldwide Marketing and Financial Products at Nasdaq.

<sup>2</sup>Source: Money Magazine, July 27, 1999.

trading, share volume and dollar volume indicate that the index split helped traders of small lot sizes by lowering the stock price.

## 2 Literature Review

Several hypotheses have been proposed to address the question of why firms split their stock. One hypothesis states that due to the information asymmetry between managers and shareholders, managers split their stock to signal good information to the public. This hypothesis holds that it is costly to falsely signal, since if bad news comes out about a firm subsequent to the split, the stock price may sink below the range that the managers and shareholders consider “optimal” (Brennan and Copeland (1988)). A second hypothesis states that managers split their firm’s stock to make the stock more liquid. By splitting the stock and lowering its price, more investors will be able to own it and liquidity should increase. A third hypothesis states that by increasing the ownership base of the firm, management makes it more difficult for any one group of shareholders to initiate action against them. Though this was one of the top three reasons that managers cite for splitting their stock (Baker and Gallagher (1980)), empirical evidence regarding this hypothesis is somewhat mixed. Both Lamourex and Poon (1987) and Mukherji, Kim and Walker (1997) find that the number of shareholders increases after a stock split, but Mukherji, Kim and Walker (1997) find that the proportion of institutional ownership remains unchanged following a stock split. A final hypothesis holds that since stock returns are more volatile following a split, the stock has a higher tax-option value (Constantinidies (1984)). Evidence on this is mixed as well. Lamourex and Poon (1987) present evidence that the tax-option value generates the positive announcement-day return of a stock split, In contrast, Dhatt, Kim and Mukherji (1997) test the hypothesis that the that reform act of 1986 should reduce the effect of the tax option, and their evidence is inconsistent with the tax-option hypothesis.

## **Signaling vs. liquidity**

While the empirical evidence regarding the signaling hypothesis is mixed, there is more evidence in favor of the signaling hypothesis than against it. Several studies find evidence in favor of a signaling explanation. Lakonishok and Lev (1987) find that firms that split have better-than-average earnings growth following the split. McNichols and Dravid (1990) find that the difference between actual and forecasted earnings following a split tends to be directly related to the size of the split factor: the higher the split factor, the better the earnings. Ikenberry, Rankine and Stice (1996) find that the post-split stock returns for firms that split their stock are higher than those of a control sample of firms that do not split their stock. Pilotte and Manuel (1996) find that when firms split their stock multiple times, the abnormal return at the announcement of the second split is directly proportional to the earnings surprise following the first split. There is also evidence that seems to refute the signaling explanation. Muscarella and Vetsuypens (1996) examine cases in which American Depository Receipts (ADRs) split in the U.S. but the home-country stock underlying the ADR did not. They have two observations that contradict the signaling hypothesis. First, they argue that if a firm wanted to signal good news it would split the home-country stock as well as the ADR. Second, they do not find above-average post-split earnings changes in firms that split their ADRs.

A second hypothesis regarding the motive for stock splits is liquidity. By making the share price lower, more individuals can afford to purchase the stock and liquidity should improve. Baker and Gallagher (1980) find survey evidence supporting this motive. They asked managers at firms that have split their stock what their reasons were for doing so and they found that 65% stated that they split their stock to attract small investors, and 32% stated that they split their stock to increase the liquidity of trading. More support for the liquidity effect is found in Muscarella and Vetsuypens (1996) and Schultz (2000), who find that the frequency and volume of small trades increase following a stock split. However,

Schultz (2000), Gray, Smith and Whaley (1999) and Conroy, Harris and Benet (1990) find that the bid-ask spread as a percentage of the stock price increases following stock splits, which is evidence that post-split liquidity decreases. Furthermore, Gray, Smith and Whaley (1999) find that the increase in the relative bid-ask spread is not offset by an increase in market depth.

### 3 Data

The list of the companies that comprise the Nasdaq-100, which was updated on December 20, 1999, was obtained directly from Nasdaq. The Nasdaq-100 Index Tracking Stock will be referred to throughout this paper by its ticker symbol, QQQ. Intraday data for the time, date, size, and transaction price for each trade from December 20, 1999 to June 20, 2000 for both QQQ and the component stocks in the Nasdaq-100 were obtained from the NYSE/AMEX Trade and Quote (TAQ) consolidated trade file. The time, date and bid-offer quotes for the same time period were obtained from the TAQ consolidated quote file. Last, the number of shares outstanding for both QQQ and the 100 stocks that comprise the Nasdaq-100 index were obtained from the Center for Research in Security Prices (CRSP). The two-for-one QQQ stock split was effective on March 20, 2000. Hence, the data set contains observations for 62 trading days before the split and 65 trading days after the split.

The turnover in QQQ is very large relative to that of the component stocks. While the average daily dollar volume<sup>3</sup> of the 100 Nasdaq stocks comprising the index during the sample period was \$49.3 billion, the average daily dollar volume for QQQ was \$2.7 billion, or roughly 1/20 of the dollar volume in the component stocks. The daily dollar volume in QQQ is large in the context of the market value of QQQ and the component stocks. Over the sample period, the market value of QQQ was only \$12 billion, or around 1/200 of the

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<sup>3</sup>The average daily dollar volume is defined as the number of shares traded times the closing price per share from CRSP.

market value of the component stocks of \$2.3 trillion. Furthermore, the turnover in QQQ, defined as the daily volume divided by the number of shares outstanding, was 23 percent per day, which is roughly ten times the average turnover in the component stocks of two percent per day.

## 4 Results

This section examines the effect of the two-for-one stock split on liquidity and trading activity. There are two main measures of liquidity used in the stock- splits literature: the size of the bid-ask spread and turnover. These measures of liquidity have their basis in the asset pricing literature. Amihud and Mendelson (1986) show that the bid/ask spread measure of liquidity is positively related to the expected return of a security. Similarly, Hu (1997) shows that turnover is negatively related to the expected return of these securities. Sections 4.1, 4.2, 4.3, and 4.4 examine different aspects of the turnover (volume) liquidity metric, and Section 4.5 examines the bid/ask spread.

### 4.1 *Turnover*

As a first step toward understanding the effect of the stock split on liquidity, I compute turnover, defined as the daily volume of QQQ divided by the number of shares of QQQ outstanding that day, before and after the split. The average daily turnover in QQQ before the split was 23.95 percent (62 observations), and after the split was 22.81 percent (65 observations). A t-test for difference in means fails to reject the hypothesis that the turnover in QQQ after the split is different from the turnover before the split (the t-statistic is 0.8).

Perhaps the absence of a statistically significant difference in the pre- to post-split turnover is masked by variation in the turnover of the stocks in the market in general. To see if this is the case, I compare the turnover in QQQ to the turnover in the stocks that comprise the Nasdaq-100 index. To compute the turnover of the stocks in the Nasdaq-100

index, I simply compute the arithmetic average of the daily turnovers of all the stocks in the Nasdaq-100. The ratio of the average daily turnover in QQQ to the turnover in the Nasdaq-100 before the split was 12.24 and the ratio after the split was 11.50. The t-statistic for a test of difference in means was 1.7, which is not statistically significant at the five-percent level.

The split does not appear to have increased turnover in the index shares. However, Baker and Gallagher (1980) found that 65 percent of managers stated that they split their stock to provide a better trading range and attract small investors. It is possible that the split does have this effect, but that it does not show up in the aggregate turnover statistics since the trading activity of small investors is swamped by the trading activity of large investors. I explore this issue in different ways in the next three sections.

## 4.2 *Number of trades*

One way to test if the split improved liquidity for small investors is to examine the number of trades as a function of the trade size. If the lower post-split price enabled more small investors to purchase the stock, then there should be an increase in the proportion of small trades after the split relative to the proportion of small trades before the split. Table 1 contains the number and proportion of trades in various trade-size categories before and after the two-for-one split. Since the TAQ database does not include odd-lot trades, all trade sizes are in multiples of 100 and there are no trades below 100 shares. Comparing the number of trades before and after the split, it is apparent that there were a little less than twice as many trades after the split than before. It is impossible to draw any inferences from the number of trades in each trade-size category for two reasons. First, the number of shares outstanding after the split is twice the number before the split, so we would expect some increase in the number of trades after the split. Second, the total number of trades each day in the market may have been different before and after the split, which makes it difficult to

directly compare the number of trades.

To compare the trading intensity in each trade-size category before and after the split while controlling for the new number of shares outstanding and any market-wide intertemporal variation in trading frequency, I use the percent of total trades in each trade-size category. This statistic is defined as the ratio of the number of trades in each trade-size category each day to the total number of trades that day, and its mean is tabulated in the fourth and fifth columns of Table 1. One pattern in the data is that trade sizes of 100, 200, 500, 1000, and 2000 seem to be the most popular. Though not directly relevant to the effect of stock splits, this pattern is interesting. While it seems understandable that 100 and 200 share trades would be popular since they are the smallest, why doesn't a trade size of 1,900 happen roughly the same percent of the time as a trade size of 2,000? The price of a share of the index tracking stock ranged from \$161 to \$230 over the pre-split sample period, so if at one price an investor wanted to buy 2,000 shares, at a slightly higher price the size of the trade should be 1,900 shares. Given that investors are rational and decide on a specific *dollar amount* of stock to purchase, the two trade sizes should occur in roughly the same proportion. It seems that investors and traders have a preference for certain sizes of trades.

Not surprisingly, small trades accounted for the vast majority of the number of trades. Trades in sizes from 100 to 500 shares accounted for nearly 60 percent of the number of trades, both before and after the split. The premise of the liquidity hypothesis is that the post-split lower share price allows investors who could not afford to purchase the stock before the split to do so. If this is true, then there should be an increase in the trading intensity in small-sized trades after the split. Using the frequency of the number of trades in each share-size category as a proxy for trading intensity, the fraction of the number of trades after the split does not appear to be much different than the fraction before the split.

Care must be taken when comparing the change in trading intensity before and after the split. First, consider an investor who wanted to buy exactly 100 shares before the split. The

same trade after the split would be a 200 share trade, not a 100 share trade. Hence, a trade of 100 pre-split shares is not directly comparable to a trade of 100 post-split shares, but rather to 200 post-split shares. Second, consider an investor who wanted to make a trade of less than 100 shares before the split, say 50 shares. They may still trade 100 shares before the split, perhaps due to a perception that trading in round lots is the market “norm”, but would be more willing to make a trade of 100 post-split shares, since it is equivalent to 50 pre-split shares. This increased willingness to trade 100 post-split shares may show up as an increase in the post-split trading intensity. Third, consider an investor who wanted to trade 50 shares before the split but did not on the grounds that it was “too expensive” to do so. After the split the investor would make the trade. Hence, to make a fair comparison, the pre-split trading intensity in the 100 share category is compared to that in the 100 and 200 share post-split trade-size categories. The sum of trading intensity in the 100 and 200 post-split trade-size categories captures three effects: the unchanged trading intensity from traders that wanted to and did make a 100 share pre-split trade, the increased intensity from traders who were reluctant to make a 100 share pre-split trade, and the new intensity from those that did not make a 100 share pre-split trade. A similar argument applies to comparing the trading intensity from 200 share pre-split trades to the sum of trading intensity in the 300 and 400 share post-split trades.

In this fashion the pre-split trades are matched with their equivalent post-split counterparts and the percentage of total trades in each category are tabulated in Table 2. Only post split trades of 1000 shares or less are included since I wish to focus on the effect of the split on smaller investors.

In Table 2, the difference between the percent of total trades before and after the split in the 100 to 200 post-split share category is both statistically and economically significant. The number of trades in this category increased almost 14 percent after the split, indicating that many more trades were occurring as a result of the lower share price. The sign of

the difference in trading intensity between the pre-split categories of 200, 300, 400, and 500 shares and their corresponding post-split categories varies. Though the sign varies for the individual share categories, in aggregate the percent of total trades accounted for by 100 to 1000 share size categories after the split is 75.5 percent, which is significantly larger than the percentage of total trades in the 100 to 500 share size categories before the split. The two-for-one split seems to have increased the number of small trades.

To shed more light on whether the increase in the number of small trades following the split is being driven by liquidity or signaling, I compute the number of small buys and small sells following the split. I define a small buy or sell as a trade of 500 shares or less. Using the method proposed by Lee and Ready (1991), I classify a trade as a small buy if the trade price is greater than the bid-ask midpoint of the most recent quote that occurred at least five seconds before the trade. Similarly, I classify a trade as a sell if the trade price is below the quoted bid-ask midpoint. Trades that occur at the bid-ask midpoint are classified as neither a buy nor a sell.

The daily number of small buys and sells before and after the split is shown in Figure 1. Consistent with Table 1, there are many more small trades after the split than before.<sup>4</sup> There is a striking difference when comparing Figure 1 to an equivalent figure for stock splits by individual firms in Schultz (2000).<sup>5</sup> While I find that the number of small buys is roughly equal to the number of small sells following the split of the Index Tracking Stock, Schultz (2000) finds that there are many more small buys than sells following a stock split by an individual firm. This result for individual firms could either be driven by liquidity or signaling: investors may be snapping up shares of the firm following the split because they can better afford them, or because they interpret the split as a signal of future good news.

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<sup>4</sup>I chose to define a small trade as 500 shares or less both before and after the split. Defining a small trade as less than 500 shares before the split and less than 1000 shares after the split would have increased the number of post-split small trades, increasing the pre-to-post split difference in Figure 1.

<sup>5</sup>See Figure 2 on page 436 of Schultz (2000).

However, the post-split effect for the Tracking Stock must be driven only by liquidity; there can be no signaling effect. Since I find that the number of small buys and sells following the Index Tracking Stock split are roughly the same, the positive net number of small buys for individual firms must be driven, at least partially, by small investors interpreting the split as a favorable signal.

It appears that splitting the Index Tracking Stock increased the trading intensity for the smallest trade-size category. Furthermore, contrasting the evidence on the number of post-split small buys and sells for the Tracking Stock with that of individual stocks leads to the conclusion that there is a distinct signaling effect driving the post-split trading patterns for individual firms. As mentioned before, examining only the number of trades does not tell the full story, since each trade can be for any number of shares. To address this I examine pre- to post-split share volume.

### **4.3** *Share volume*

The average daily volume of QQQ was 14.7 million shares per day before the split and 27.7 million shares per day after the split. While the average daily share volume after the split is almost twice the share volume before the split, the total daily aggregate volume does not tell us whether the share volume in the smaller-sized categories increased after the split. To assess the impact of the split on the share volume for smaller-sized trades, the average number of shares traded each day, sorted into various trade-size categories, is tabulated in Table 3. The total share volume is simply the average daily volume for all trades that have a size within the specified range. The percent of total volume is the daily total share volume within each trade-size category divided by the total share volume for that day. The means of both the total share volume and percent of total volume are computed for the 62 days before the split and the 65 days after the split are presented in the second through the fifth columns of Table 3.

Though trades in the 100 to 500 share range account for almost 60 percent of the number of trades, trades in this range represent only six percent of the total daily share volume. In contrast, trades in the range of 2000 shares and above account for 20 percent of the number of trades and 85 percent of the share volume.

By decomposing the data into volume statistics based on trade size, I am able to focus on the effects of the smaller investors. At first, there appears to be little increase in volume for the smaller trade-size categories after the split. Comparing the fraction of total volume in each trade-size category before and after the split, I find that in only two cases, the 20,000 to 49,900 and over 100,000 share ranges, is there statistically significant higher volume after the split. However, for the reasons outlined in the previous section, one should compare the percent of volume in the 100 share pre-split trade size category to the percent of combined volume in the 100 and 200 post-split trade-size categories. This data is tabulated in Table 4. Consistent with the data on the increase in the number of trades, the share volume in the 100 pre-split trade-size category increased from 1.1 percent before the split to 2.1 percent after the split. The increase is statistically significant at the one percent level. When measuring changes in trading activity around the split, the percent of volume may tell a different story than the frequency of trading since volume places a larger weight on the larger trades. It could be the case that the frequency of small trades increased after the split but the percent of volume did not increase if there were a higher number of large trades after the split. However, the results in Table 4 indicate that the percent of volume accounted for by the small trades increased after the split. Furthermore, while there was no consistent pattern in the frequency of trading before and after the split in the 200 to 500 pre-split trade-sized category, there is a statistically and economically significant increase in the percentage of volume in each of these categories after the split.

One potential bias in this analysis is that odd-lot volume is not reported in the TAQ data. However, the economic magnitude of this bias is small and it does not affect the

results. The NYSE fact book reports that the total odd-lot volume in 1999 was roughly one percent. From the data in Table 4, the total pre-split volume accounted for by trades less than 500 shares is six percent. In contrast, the post-split volume accounted for by trades less than 1000 shares is 11 percent. Even if we include the odd-lot volume reported by the NYSE in the pre-split volume, there is still much more volume after the split than before the split. While this number is from a different exchange, there is no reason to believe that it would be much different on the AMEX where QQQ is traded.

While there is more volume in the small trade-size categories after the split, at this point we do not know who are the net buyers and sellers. Knowing who is buying and who is selling may help us to more clearly distinguish between the signaling and liquidity effects. To determine who are the buyers and sellers, the daily net buy volume is computed by subtracting the number of shares sold from the number of shares purchased. The method used to determine whether a trade was a buy or a sell was discussed in the prior section and in Lee and Ready (1991). Figure 2 shows the net buy volume generated by both small (100 to 500 shares) and large (over 10,000 shares) trades. The graph shows that, on average, the net trade volume for both small trades and large trades is zero, meaning that both types of traders are neither net sellers nor buyers.<sup>6</sup> Indeed, a t-test cannot reject the hypothesis that the means of the post-split net buy volume generated by small and large trades are different from zero. As with the number of trades, the contrast of this result to the result for stock splits by individual firms yields insights into the liquidity and signaling effects. Schultz (2000) finds that after stock splits by individual firms, investors who execute small trades are net buyers and investors who execute large trades are net sellers. The fact that small trades have a positive net buy volume for splits by individual firms could be driven by either signaling or liquidity; the small investor may buy since the stock is less expensive

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<sup>6</sup>The large trades appear to be much more volatile than the small trades due to the scaling on the graph. In fact, the coefficient of variation of the large (small) trades is 8.5 (4.3), indicating that relative to their mean size large trades have roughly twice the variation of small trades.

or because he or she interprets the split as a good signal. In the case of the signal-free Index Tracking Stock split, small trades do not have positive net buy volume. This seems to indicate that the post-split effect of small-trade positive net buy volume for individual firms is being driven by signaling, not liquidity.

#### 4.4 *Dollar volume*

One problem with just examining volume statistics before and after the split is that the price of QQQ is quite volatile over the sample period. The share price ranged from a low of \$162 to a high of \$230 before the split, and from a low of \$75 to a high of \$118 after the split. Because of the share price variability, the volume statistics before and after the split may not provide a fair comparison. For example, if an investor wanted to purchase \$30,000 of the index, he or she would buy 185 shares at a share price of \$162, or 130 shares at a share price of \$230. Rounding to the nearest round lot, this would translate into a purchase of 200 shares in the first case, and 100 shares in the second case, though in both cases the investor wanted to purchase \$30,000 of the stock.

To mitigate the effect of price variability on any post-split effect of the small trades, the average daily total dollar-volume of trade as a function of the size of each trade in dollars is computed and tabulated in Table 5. This number represents the total dollar-volume of trade resulting from trades of a certain size. For example, trades in the range of \$18,000 to \$20,000 resulted in \$11.76 million in average daily volume before the split and \$9.67 million in daily volume after the split.

Though there appears to be no trade volume resulting from trades less than \$16,000 before the split, this is an artifact from the TAQ database. Specifically, the TAQ database does not report odd-lot trades, so the minimum trade size is 100 shares. Since the lowest share price during the sample period before the split was \$162, there are no trades less than \$16,200 before the split. However, after the split there was nearly \$30 million in volume each

day accounted for by trades less than \$16,000 in size. Trades of this size would have been impossible before the split using round lots.

As with the number of trades, one factor which may drive differences between post-split and pre-split dollar volume in shares of the Tracking Stock is a change in the trading activity in the Nasdaq-100 firms. To control for this, the daily dollar volume in QQQ was normalized by the daily dollar volume in the stocks underlying the Nasdaq-100. The daily dollar volume of trade in each range in Table 5 was computed for all stocks that comprise the Nasdaq-100. The daily dollar volume in QQQ for each range is then expressed as a fraction of the daily dollar volume in the corresponding range for all the stocks in the Nasdaq-100. For example, the daily dollar volume for all trades in QQQ between \$18,000 and \$20,000 averages 4.01 percent of the daily dollar volume for all trades in the Nasdaq-100 stocks between \$18,000 and \$20,000 over the 62 days before the split. The statistic was created in this way to provide a comparison between wealth-constrained investors who are deciding whether to invest a fixed sum in QQQ and those who are considering investing in one of the stocks underlying QQQ.

For all the dollar volume of trade categories, the only one in which there was a statistically significant decline in the percent of dollar volume in QQQ after the split was trade sizes between \$18,000 and \$20,000. In all other cases there was either no difference or a statistically significant increase in the percent of dollar volume. Also, the dollar volume generated by trade sizes over one million dollars is large, accounting for over 80 percent of the total dollar volume in the index shares. This volume almost certainly originates from trading by institutions, so it is not surprising that the stock split had a statistically insignificant effect on the percentage of total dollar volume for these large trades. Overall, the evidence indicates that the split increased the post-split dollar volume for trades less than \$16,000.

An obvious question is why didn't investors simply trade in odd-lots before the split to lower the dollar value of a trade? Most discount brokers have a fixed commission with no penalty for an odd-lot trade. For example, E\*Trade's commission at the time was \$15 for

any number of shares up to 5000. A split has no effect on brokerage commissions costs until one gets above 5000 shares, where an extra transaction cost of one cent per share for trades larger than 5000 shares is charged. Since QQQ was trading for \$240/share before the split, this fee would not be assessed unless the trade size was greater than \$1,200,000. It would have no real effect for small investors. Even though odd-lot trades have no real extra costs associated with them, investors have a preference for trading shares in lots of 100, 200, 500, 1000, 2000, 5000, etc. These are the so-called “prominent” numbers in our decimal system. This effect is statistically significant and very strong for all share prices (Dennis and Weston, 2001). Hence by effecting the two-for-one split, the QQQ administrators effectively reduced the dollar amount of these trades from  $(100)(240) = \$24,000$ ,  $(200)(240) = \$48,000$ , and  $(500)(240) = \$120,000$  to \$12,000, \$24,000, and \$60,000, respectively.

#### 4.5 *Spreads*

While the past sections have examined changes in the number and size of trades, one other measure of liquidity is the effective bid-ask spread. Studies such as Conroy, Harris and Benet (1990) Muscarella and Vetsuypens (1996) and Gray, Smith and Whaley (1999) have examined post-split changes in both the absolute and relative value of the bid-ask spread, where the relative spread is computed by dividing the absolute value of the spread by the stock price. These studies have found that while the absolute bid-ask spread decreases, the relative spread increases.

I examine changes in both the quoted and effective bid-ask spread. The absolute quoted spread is simply the difference between the quoted ask price and the quoted bid price. Since many trades take place inside the quoted spread, the effective spread, which captures the actual cost paid by a trader, is computed by taking the absolute difference between the trade price and the bid-ask midpoint, computed from the most recent bid-ask quote that has been in effect for at least five seconds (Lee (1993)). Relative spreads measure the spread

on a percentage basis and were computed by dividing the absolute spread by the price. A time series of daily spreads was computed by taking the arithmetic average of the quoted or effective spread throughout the day.

Consistent with prior studies, I find that the change in spreads following the split indicates a decrease in liquidity. While the quoted absolute spread declined from a daily average of 36.9 cents before the split to 30.3 cents after the split, the quoted relative spread increased from 19.1 basis points before the split to 32.8 basis points after the split. Though the effective spreads are tighter than the quoted spreads, a similar pre- to post-split pattern is present. The effective absolute spread declined from a daily average of 9.7 cents before the split to 7.9 cents after the split, while the effective relative spread increased from 5.0 basis points before the split to 8.5 basis points after the split. The increase in both the effective and quoted relative spreads is statistically significant at the one-percent level.

Since the number of small trades increased, the pre-to-post change in spreads may be different for small trades than for large trades. To see if this is the case, I repeated the spread analysis separately for small trades, defined as those between 100 to 1000 shares, and large trades, defined as those trades greater than 1000 shares. The median daily effective spread for *small* trades before the split was 5.4 basis points, and after the split it was 9.0 basis points. This difference is significant at the 1% level with a t-statistic of 7.4. The pattern for *large* trades is the same, with a median daily effective spread before the split of 5.9 basis points, and a median spread after the split of 8.9 basis points. This difference is significant at the 1% level with a t-statistic of 7.0. Finally, there is no statistically significant difference between the median effective relative spread after the split for small vs. large trades. This indicates that the additional number of small trades after the split did not reduce the spread relative to the large size trades.

Figure 3 shows the average daily effective relative spread as a function of the number of calendar days before and after the split. The split date of March 20, 2000 is denoted as  $t = 0$

on the x-axis. The figure shows a dramatic increase in the relative spread following the split. The average size and variability of the spread are largest in the 40 calendar days following the split, and though both the size and variability of the spread decline 40 to 80 days after the split, the spread in this time period is still statistically significantly larger than before the split.

## 5 Conclusion

Managers may be motivated to split their stock to improve its liquidity or to signal good news to the market. Past studies have found evidence that supports both of these hypotheses. In particular, the number and frequency of small trades appear to increase following a stock split. There is a problem with the interpretation of this fact. The number of small trades could increase either as a result of a signaling effect, a liquidity effect, or both. To disentangle these hypotheses, I examine liquidity changes following the two-for-one split of the Nasdaq-100 Index Tracking Stock. Since the stock only tracks the index, there can be no signaling effect as a result of the stock split. Measures of liquidity such as turnover, the number of small trades, volume, the dollar size of trades, and the bid-ask spread are compared before and after the split.

As a result of the split, the turnover is unchanged and the relative bid-ask spread increased. These quantities measure aggregate liquidity and do not distinguish between different classes of traders. When the frequency of trading, share volume and dollar volume are decomposed by trade size and compared before and after the split, liquidity seems to have improved for the smaller trades. Furthermore, when the number and volume of small buys after the Index Tracking Stock stock split are compared to those of a single-firm stock split, there appears to be a distinct signaling effect in the trading pattern of small trades following the single-firm stock split.

Overall, the post-split lower share price of the Index Tracking Stock seems to help smaller investors who like being able to trade in smaller lot sizes, but the post-split increased bid-ask spread hurts large traders who are not wealth constrained and whose primary trading cost is the bid-ask spread.

## References

- Amihud, Y. and H. Mendelson, 1986. Asset pricing and the bid-ask spread, *Journal of Financial Economics* 17, 223-249.
- Angel, J., 1997. Tick size, share prices, and stock splits, *Journal of Finance* 52, 655-681.
- Baker, H. K and P. L. Gallagher, 1980. Management's view of stock splits, *Financial Management* 9, 73-77.
- Brennan, M. J. and T. E. Copeland, 1988. Stock splits, stock prices, and transaction costs, *Journal of Financial Economics* 22, 83-101.
- Conroy, R., R. Harris, and B. Benet, 1990. The effects of stock splits on bid-ask spreads, *Journal of Finance* 65, 1285-1295.
- Constantinides, G., 1984. Optimal stock trading with personal taxes, *Journal of Financial Economics* 13, 65-89.
- Dennis, P. and J. Weston, 2001. Trade size: Determinants and implications. *Working Paper*, University of Virginia and Rice University.
- Dhatt, M. K. Yong and S. Mukherji, 1997. Did the 1986 Tax Reform Act affect market reactions to stock splits? A test of the tax-option hypothesis, *Financial Review* 32, 249-271.
- Gray, S., T. Smith, and R. Whaley, 2002. Stock splits: Implications for investor trading costs, *Forthcoming, Journal of Empirical Finance*.
- Hu, S., 1997. Trading turnover and expected stock returns: The trading frequency hypothesis and evidence from the Tokyo Stock Exchange. *Working Paper*, University of Chicago.
- Ikenberry, D., G. Rankine and E. Stice, 1996. What do stock splits really signal? *Journal of Financial and Quantitative Analysis* 31, 357-375.
- Lakonishok, J., and B. Lev, 1987. Stock splits and stock dividends: Why, who, and when, *Journal of Finance* 62, 913-932.
- Lamoureux, C. and P. Poon, 1987. The market reaction to splits, *Journal of Finance* 62, 1347-1370.
- Lee, C., 1993. Market integration and price execution for NYSE-listed securities, *Journal of Finance* 48, 1002-1038.
- Lee, C. and M. Ready, 1991. Inferring trade direction from intraday data, *Journal of Finance* 46, 733-746.
- Mukherji, S., Y. Kim, and M. Walker, 1997. The effect of stock splits on the ownership structure of firms, *Journal of Corporate Finance* 3, 167-188.
- Muscarella, C. and M. Vetsuypens, 1996. Stock splits: signaling or liquidity? The case of

ADR 'solo-splits', *Journal of Financial Economics* 42, 3-26.

McNichols, M., and A. Dravid, 1990. Stock dividends, stock splits, and signaling, *Journal of Finance* 45, 857-879.

Pilotte, E. and Manuel, T, 1996. The market's response to recurring events: The case of stock splits, *Journal of Financial Economics* 41, 111-127.

Schultz, P., 2000. Stock splits, tick size and sponsorship, *Journal of Finance* 55, 429-450.

Table 1:

**Pre- and Post- Split Trading Intensity**

This table contains the average of the number of trades each day before and after the split as a function of the size of each trade. Observations were taken over the 62 trading days before the split (from 12/20/1999 to 3/17/2000) and the 65 trading days after the split (from 3/20/2000 to 6/20/2000). The percent of total trades represents the mean of the ratio of the total number of trades in each share-size category to the total number of trades that day.

Number of Shares Traded	Number of Trades		Percent of Total Trades	
	Before	After	Before	After
100	1,600	3,064	25.5	25.8
200	773	1,544	12.4	13.4
300	406	705	6.6	6.3
400	220	413	3.6	3.8
500	652	1,082	10.6	9.8
600	121	183	2.0	1.7
700	87	129	1.4	1.2
800	87	144	1.4	1.4
900	71	88	1.2	0.8
1,000 to 1,400	702	1,348	11.5	12.4
1,500 to 1,900	217	264	3.6	2.5
2,000 to 4,900	700	1,110	11.4	10.5
5,000 to 9,900	273	474	4.4	4.4
10,000 to 19,900	143	260	2.3	2.4
20,000 to 49,900	82	186	1.3	1.6
50,000 to 99,900	31	62	0.5	0.5
over 100,000	19	42	0.3	0.4

Table 2:

**Pre- and Post- Split Trading Intensity Matched by Pre-Split Trade Size**

This table contains the trading intensity before and after the split matched by pre-split trade size. For example, trade sizes of 1 to 100 shares before the two-for-one split correspond to 2 to 200 shares after the split. Trade sizes of 1 to 200 shares before the split correspond to 2 to 400 shares after the split and so forth. Observations were taken over the 62 trading days before the split (from 12/20/1999 to 3/17/2000) and the 65 trading days after the split (from 3/20/2000 to 6/20/2000). The percent of total trades represents the mean of the ratio of the total number of trades in each share-size category to the total number of trades that day. The t-statistic is for a test of the difference of means of the percent of trades before the split to the percent of trades after the split for trades in each share-size category.

Trade Size (shares)		Percent of Total Trades		t-stat
Before	After	Before	After	
100	100 to 200	25.5	39.8	15.6
200	300 to 400	12.4	10.2	-14.3
300	500 to 600	6.6	11.7	31.9
400	700 to 800	3.6	2.6	-9.4
500	900 to 1000	10.6	11.2	2.6
Total:		58.7	75.5	32.0

Table 3:

**Pre- and Post- Split Volume Intensity**

This table contains the average of the number of shares traded each day before and after the split as a function of the size of each trade. Observations were taken over the 62 trading days before the split (from 12/20/1999 to 3/17/2000) and the 65 trading days after the split (from 3/20/2000 to 6/20/2000). The percent of total volume is the mean ratio of the total number of shares in each share-size category to the total number of shares traded that day.

Number of Shares Traded	Total Volume		Percent of Total Volume	
	Before	After	Before	After
100	160,037	306,429	1.1	1.0
200	154,645	308,837	1.1	1.1
300	121,694	211,532	0.9	0.8
400	87,819	165,219	0.6	0.6
500	326,161	541,238	2.3	2.0
600	72,629	109,855	0.5	0.4
700	60,640	90,085	0.4	0.3
800	69,729	115,089	0.5	0.4
900	64,016	79,228	0.5	0.3
1,000 to 1,400	745,021	1,399,152	5.3	5.1
1,500 to 1,900	353,584	427,954	2.5	1.6
2,000 to 4,900	1,991,708	3,114,766	14.0	11.6
5,000 to 9,900	1,721,745	2,978,280	11.8	10.9
10,000 to 19,900	1,766,392	3,263,949	11.8	11.6
20,000 to 49,900	2,193,331	5,067,043	14.4	17.3
50,000 to 99,900	1,839,124	3,616,063	12.4	11.9
over 100,000	3,021,187	6,859,606	19.8	22.7

Table 4:

**Pre- and Post- Split Volume Matched by Pre-Split Trade Size**

This table contains the volume before and after the split matched by pre-split trade size. For example, trade sizes of 1 to 100 shares before the two-for-one split correspond to 2 to 200 shares after the split. Trade sizes of 1 to 200 shares before the split correspond to 2 to 400 shares after the split and so forth. Observations were taken over the 62 trading days before the split (from 12/20/1999 to 3/17/2000) and the 65 trading days after the split (from 3/20/2000 to 6/20/2000). The percent of total volume is the ratio of the total number of shares in each share-size category to the total number of shares traded that day. The t-statistic is for a test of the difference of means of the percent of total shares traded before the split to the percent of total shares traded after the split for trades in each share-size category.

Trade Size (shares)		Percent of Total Volume		t-stat
Before	After	Before	After	
100	100 to 200	1.1	2.1	15.9
200	300 to 400	1.1	1.4	7.4
300	500 to 600	0.9	2.4	23.3
400	700 to 800	0.6	0.8	4.8
500	900 to 1000	2.3	4.4	15.7
Totals		5.9	11.1	19.1

Table 5:

**Dollar Volume Before and After the Split**

This table contains the average daily dollar-volume of trade before and after the split as a function of the size of each trade in dollars. The dollar-volume of trade each day is the sum of the dollar-value of all trades falling in the range  $l \leq dv < u$  for that day, where  $l$  and  $u$  are the lower dollar and upper dollar-value, respectively, and  $dv$  is the dollar-value of the trade. Observations were taken over the 62 trading days before the split (from 12/20/1999 to 3/17/2000) and the 65 trading days after the split (from 3/20/2000 to 6/20/2000). The percent of total dollar-volume is the mean of the daily ratio of the total dollar-volume for QQQ to the total dollar-volume for all components of QQQ in each dollar-volume-size category. The t-statistic is for a test of the difference of means of the percent of total dollar volume before the split to the percent of total dollar-volume after the split for trades in each dollar-volume-size category. Since the percentages are rounded to two decimal places, numbers less than 0.005 percent appear as “0.00” in the table. “n/a” means not applicable.

Dollar Value of Trade (thousands of \$)	Total Dollar Volume (thousands of \$)		Percent of Total Dollar Volume		t-stat
	Before	After	Before	After	
$0 \leq dv < 2$	0	0	0.00	0.00	n/a
$2 \leq dv < 4$	0	0	0.00	0.00	n/a
$4 \leq dv < 6$	0	0	0.00	0.00	n/a
$6 \leq dv < 8$	0	1,969	0.00	0.20	2.1
$8 \leq dv < 10$	0	18,437	0.00	2.29	10.2
$10 \leq dv < 12$	0	7,430	0.00	1.05	4.0
$12 \leq dv < 14$	0	25	0.00	0.01	1.0
$14 \leq dv < 16$	0	1,936	0.00	0.28	2.2
$16 \leq dv < 18$	6,107	9,353	2.13	1.53	-1.1
$18 \leq dv < 20$	11,756	9,666	4.01	1.58	-3.6
$20 \leq dv < 30$	2,658	4,501	0.47	0.78	3.8
$30 \leq dv < 40$	3,344	3,771	0.81	0.71	-1.1
$40 \leq dv < 100$	15,198	27,714	0.91	1.56	9.7
$100 \leq dv < 200$	13,851	14,229	1.92	2.48	6.3
$200 \leq dv < 400$	20,254	18,984	4.30	4.94	3.5
$400 \leq dv < 1,000$	131,329	129,185	7.09	8.19	3.8
$1,000 \leq dv < 2,000$	68,931	58,011	10.20	9.41	-1.7
$2,000 \leq dv$	1,668,022	1,361,927	31.01	28.01	-1.4

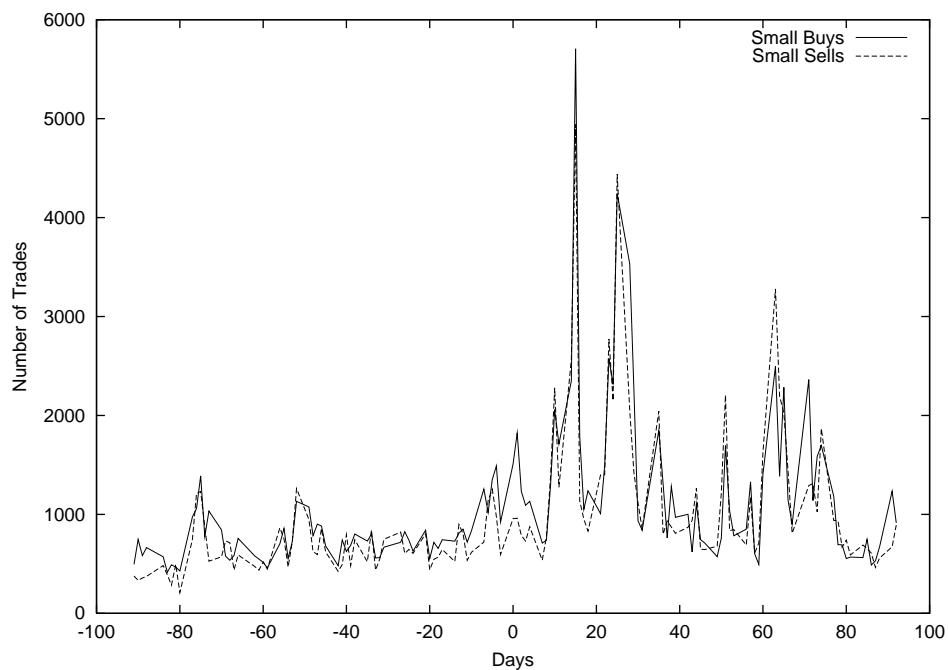


Figure 1: **Daily number of small buys and small sells**

This figure contains a plot of the daily number of small buys and small sells. A small buy or sell is defined as a trade of between 100 to 500 shares. Whether a trade is a buy or a sell is determined using the method of Lee and Ready (1991). The effective date for the split is March 20, 2000 which is denoted by  $t = 0$  on the x-axis.

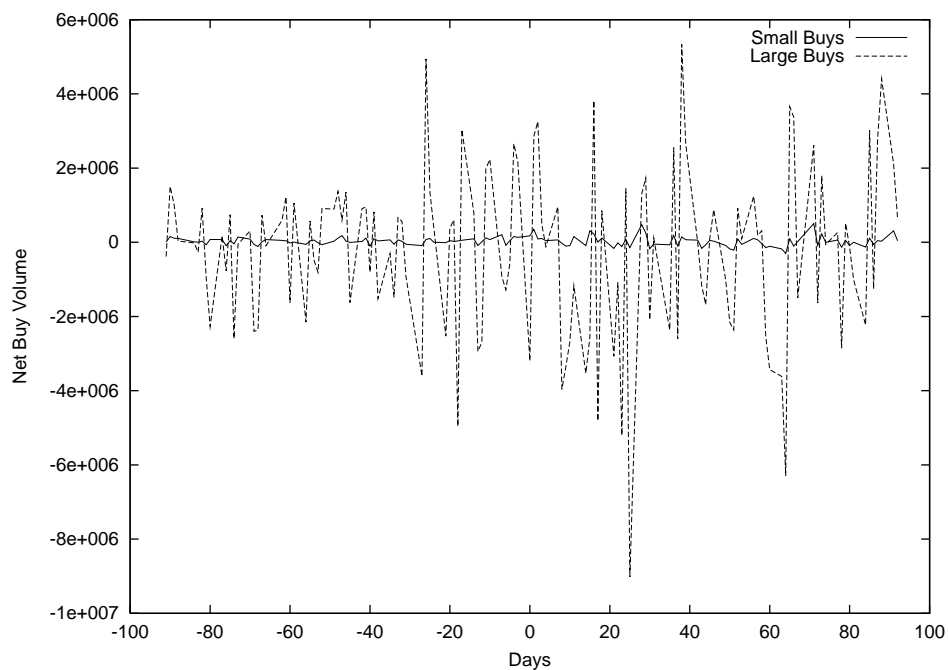


Figure 2: Net buy volume for small and large trades vs. time

This figure contains a plot of the daily net buy volume for small trades (100 to 500 shares) and large trades (10,000 shares and over) for QQQ before and after the split. The daily net buy volume is defined as the volume accounted for by purchases minus the volume accounted for by sales within each trade-size category. The effective date for the split is March 20, 2000 which is denoted by  $t = 0$  on the x-axis. The coefficient of variation for small trades is 4.3 and for large trades is 8.5.

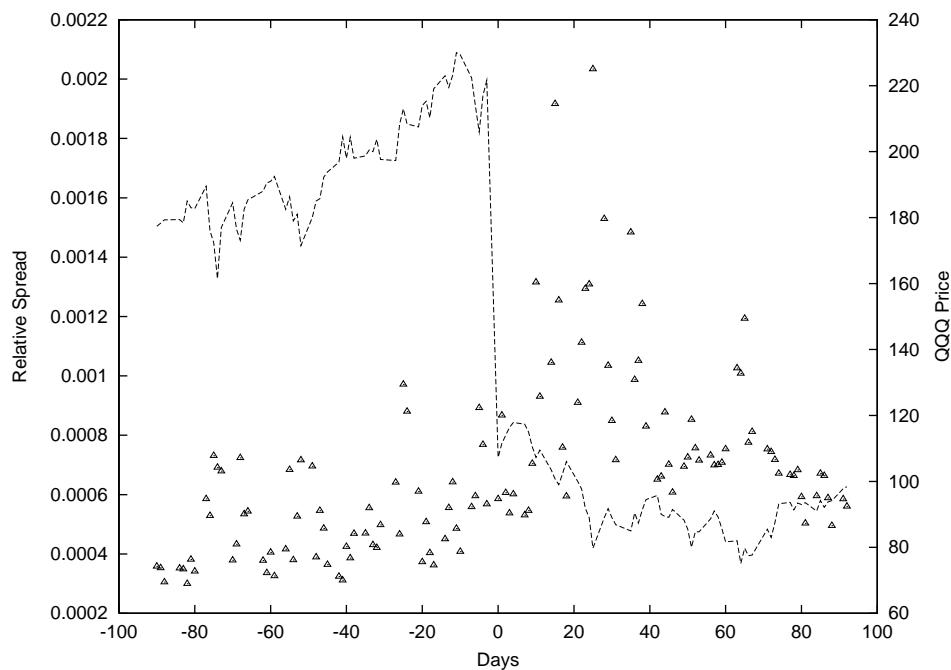


Figure 3: **Effective spread and share price vs. time**

This figure contains a plot of the relative effective spread for the NASDAQ 100 index tracking stock (triangles, left hand scale) and the share price of the index tracking stock (dashed line, right hand scale) as a function of the number of calendar days before and after the split. The effective date for the split is March 20, 2000 which is denoted by  $t = 0$  on the x-axis.