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# The Effects of Transaction Costs on Stock Prices and Trading Volume*

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We study the effects of changes in bid–ask spreads on the prices and trading volumes of stocks that move from Nasdaq to the NYSE or Amex and stocks that move from Amex to Nasdaq. When stocks move from Nasdaq to an exchange, their spreads typically decrease, but the reduction in spreads is larger when Nasdaq market makers avoid odd-eighth quotes. When stocks move from Amex to Nasdaq, their spreads typically increase, but again, the increase is larger when Nasdaq market makers avoid odd eighths. We use this data to isolate the effects of transaction costs on trading volume and expected returns. We find that higher transaction costs significantly reduce trading volume, but do not have a significant effect on prices. *Journal of Economic Literature* Classification Numbers: G10, G14. © 1998 Academic Press

## 1. INTRODUCTION

We study the effects of changes in transaction costs (as proxied by bid–ask spreads) on stock prices and trading volumes. The theoretical literature predicts that higher transaction costs lead to higher risk-adjusted expected

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returns. Investors seeking to maximize their net returns demand compensation for investing in securities with high transaction costs. Thus, they discount the value of these securities and increase the required rate of return. Higher transaction costs also lead to longer average holding periods and lower trading volume since the higher expected returns offered by high transaction-cost securities appeal to investors with longer holding periods, who can amortize the higher trading costs over longer investment horizons.

Although there is general agreement that higher transaction costs lead to higher expected returns and lower trading volume, there is disagreement in the literature on the relative magnitudes of these effects. Amihud and Mendelson (1986a, 1986b, 1990) find that expected returns are highly sensitive to changes in transaction costs. Brennan *et al.* (1998) use dollar trading volume as a proxy for transaction costs and also find significant evidence of a liquidity premium. Constantinides (1986) and Vayanos (1998), on the other hand, argue that changes in transaction costs primarily affect holding periods and trading volumes, and that the effect on expected returns is second-order. Consistent with the predictions of Constantinides (1986) and Vayanos (1998), Michaely and Vila (1996) show that volume is decreasing in transaction costs. In an experiment similar to ours, Kadlec and McConnell (1994) also find that bid–ask spreads have only a small effect on expected returns. Taken together, these studies leave us with the open question: how sensitive are expected returns to transaction costs?

In this paper, we use an event-study approach to estimate the sensitivity of price and volume to changes in transaction costs. We exploit a feature of the Nasdaq market first noted by Christie and Schultz (1994)—in roughly 70% of the stocks in their sample, market makers routinely avoid quoting prices in increments of one-eighth, using instead increments of one-quarter.[1] Barclay (1997) shows that when stocks move from Nasdaq to the NYSE or Amex, the decrease in spreads is much larger for stocks that are not quoted on odd eighths while on Nasdaq.[2] Similarly, Clyde *et al.* (1997) show that when firms voluntarily delist from the Amex and return to Nasdaq, the increase in spreads is much larger for stocks that are not quoted on odd eighths on Nasdaq. Thus, although changing trading locations is not an exogenous event, the change in spread associated with a move to or from Nasdaq is due mainly to the use or avoidance of odd-eighth quotes on Nasdaq.

[1] Odd-eighth avoidance causes spreads to increase on average by more than $0.20, or 1% of the stock price (see estimates in Barclay, 1997; Benston and Wood, 1997; Bessembinder, 1997; Christie and Schultz, 1997; Clyde *et al.* 1996; and Kandel and Marx, 1997). For further documentation of odd-eighth avoidance, see the reports released by the Department of Justice (1996) and the SEC (1996).

[2] See Christie and Huang (1994) for additional evidence on the effects of moving from Nasdaq to the NYSE and Amex.

Because of institutional differences between Nasdaq and the NYSE or Amex, simple comparisons of securities before and after they change trading locations can be problematic. We address this problem by focusing on the differences between two subsamples, one containing stocks that are not quoted on odd eighths on Nasdaq (and, thus, with large changes in bid–ask spreads) and the other containing stocks that are quoted on both odd and even eighths on Nasdaq (and, thus, with much smaller changes in bid–ask spreads). This allows us to control for institutional differences between Nasdaq and the NYSE or Amex, such as the interdealer trading on Nasdaq or differences in the extent of trading by institutional investors. By looking at the same securities before and after they move, we also control for firm-specific differences. Thus, data on stocks that move from Nasdaq to the NYSE or Amex, and stocks that move from the Amex to Nasdaq, allow us to isolate the effects of changes in transaction costs on stock prices and trading volumes.

We examine 224 stocks that move from Nasdaq to the NYSE or Amex, and 32 stocks that move from the Amex to Nasdaq, from January 1, 1990 to May 31, 1994.[3] We find a significant negative relation between changes in bid–ask spreads and trading volume, but we find no significant relation between changes in bid–ask spreads and changes in stock prices and expected returns.

In Section 2 we use the existing literature to formulate three hypotheses on how changes in bid–ask spreads affect abnormal returns and trading volume. In Section 3, we present our results. Section 4 concludes.

## 2. HYPOTHESES

There is consensus in the theoretical literature that higher proportional transaction costs result in higher expected returns. There is no widespread agreement, however, on the magnitude of this effect. Amihud and Mendelson (1986a) present a model in which the expected return is an increasing, concave function of the bid–ask spread. They estimate the sensitivity of expected returns to variation in the bid–ask spread using a cross-section of NYSE stocks. In their sample, an increase in the proportional bid–ask spread is associated with a large and statistically significant increase in the monthly risk-adjusted excess return.

In contrast, Constantinides (1986) presents a multiperiod general-equilibrium model with two securities and shows that the main effect of a change in transaction costs is to lengthen the time that investors hold a security.

[3] The endpoint for the sample, May 31, 1994, coincides with the initial publicity surrounding Christie and Schultz (1994).

This holding-period effect implies that higher transaction costs lead to lower trading volume, but, in Constantinides' model, transaction costs have only a second-order effect on the expected returns. Heaton and Lucas (1996) reach similar conclusions in a model with incomplete markets and short-selling constraints.

Finally, Vayanos (1998) studies a continuous-time overlapping-generations model with many stocks and a riskless, perfectly liquid bond. Vayanos shows that an increase in transaction costs has two effects on the price of the stock: agents both buy fewer shares and hold their shares for longer periods. If agents are long-lived, then the second effect dominates, and the price can actually rise as a result of increased transaction costs. Thus, Vayanos' model predicts that an exogenous increase in transaction costs reduces trading volume, but has a small effect (with ambiguous sign) on price.

Based on this literature, we form the following hypotheses:

(H1) An exogenous increase in the bid–ask spread causes an increase in expected returns and a negative abnormal return at the time of the change.

(H2) Abnormal returns are highly sensitive to changes in transaction costs.

(H3) An exogenous increase in the bid–ask spread decreases trading volume.

As we show in the following section, our data are consistent with (H3), but are inconsistent with (H1) and (H2).

## 3. RESULTS

The natural way to estimate the effects of transaction costs on expected returns and trading volumes is to identify events that affect bid–ask spreads without affecting other determinants of firm value. The events we consider are firms moving from Nasdaq to the NYSE or Amex, and firms moving from Amex to Nasdaq. Barclay (1997) examines securities that move from Nasdaq to an exchange between 1983 and 1992 and shows that the decrease in spreads is much larger for stocks that are not quoted on odd eighths on Nasdaq than for stocks that are quoted on both odd and even eighths. Similarly, Clyde *et al.* (1997) show that spreads increase when firms move from the Amex to Nasdaq, and that the increase is much larger for stocks that are not quoted on odd eighths on Nasdaq.

Although a stock's move from Nasdaq to an exchange, or its move from the Amex to Nasdaq, is not an exogenous event, the use or avoidance of odd-eighth quotes on Nasdaq accounts for most of the change in spread associated with the move. Since we look at the same securities before and after they move, we control for firm-specific differences. In addition, we

use the sample of stocks that are quoted on both odd and even eighths on Nasdaq as a control for institutional differences between Nasdaq and the NYSE and Amex, such as the interdealer trading on Nasdaq or differences in the interest and trading volume of institutional investors.

We focus on 224 securities that moved from Nasdaq to an exchange and 32 securities that moved from Amex to Nasdaq between January 1, 1990 and May 31, 1994. The intraday price and quote data needed to calculate effective spreads are not available before 1990 for Nasdaq securities. We do not consider moves after May 31, 1994, since there is evidence that publicity surrounding Christie and Schultz's 1994 paper affected the behavior of Nasdaq dealers and the relation between bid–ask spreads and the avoidance of odd-eighth quotes. The first day of trading on the NYSE or Amex is identified from CRSP, and the announcement dates for the listings and delistings are identified from a search of the *Wall Street Journal* and the Dow Jones News Service using the Dow Jones News Retrieval Service.

We classify stocks as not quoted on odd eighths if more than 90% of the quotes (on a time-weighted basis) end with an even eighth. For stocks that move from Nasdaq to the NYSE or Amex, we measure the percentage of odd-eighth quotes from 40 days before through 1 day before the move. For stocks that move from the Amex to Nasdaq, we measure the percentage of odd-eighth quotes from 1 day after to 40 days after the move.[4]

Table 1a shows statistics on spreads for the sample of stocks that move from Nasdaq to an exchange.[5] Quoted spreads are time-weighted for each stock and then equally weighted across stocks. Effective spreads are volume weighted for each stock and then equally weighted across stocks. Consistent with the results in Barclay (1997), when securities move from Nasdaq to an exchange, the average quoted bid–ask spread decreases by 33 cents (2.4% of the stock price), and the average effective spread decreases by 28 cents (2.1% of the stock price). Most of the decrease in spreads comes from securities that are not quoted on odd eighths on Nasdaq. For these securities, the decrease in the average effective spread is 41 cents (2.5% of the stock price). For the securities that are quoted on both odd and even eighths on Nasdaq, the average effective spread decreases by only 8 cents (1.4% of the stock price). Table 1a also shows that the decrease in spread is smaller for larger trade sizes. Prices for large trades on Nasdaq are frequently negotiated, resulting in smaller average spreads for large trades.

[4] Stocks for which odd eighths are avoided tend to have very few odd-eighth quotes on Nasdaq (often less than 0.1%), and they establish or discontinue this pattern abruptly upon moving to or from Nasdaq. Thus, our sample partition is not sensitive to the estimation window or to the avoidance threshold.

[5] In both of our samples (exchange listings and Amex delistings), the average price of stocks that are not quoted on odd eighths is approximately twice that of stocks that are quoted on both odd and even eighths.

TABLE 1
Quoted and Effective Spreads for Securities That Move from Nasdaq to the NYSE or Amex and Securities That Move from Amex to Nasdaq

| | Pooled | | | No odd quotes | | | Odd and even quotes | | |
|---|---|---|---|---|---|---|---|---|---|
| | Before | After | Change | Before | After | Change | Before | After | Change |
| Panel a: Securities that moved from Nasdaq to the NYSE or Amex | | | | | | | | | |
| Average quoted spread | 0.60 | 0.28 | −0.33 | 0.82 | 0.30 | −0.52 | 0.29 | 0.24 | −0.05 |
| | (0.58) | (0.11) | *−8.26* | (0.67) | (0.12) | *−8.84* | (0.14) | (0.08) | *−2.92* |
| Average effective spread | 0.44 | 0.16 | −0.28 | 0.59 | 0.17 | −0.41 | 0.22 | 0.14 | −0.08 |
| | (0.45) | (0.07) | *−9.20* | (0.53) | (0.08) | *−8.89* | (0.11) | (0.04) | *−6.31* |
| Average effective spread by trade size | | | | | | | | | |
| 0–900 shares | 0.50 | 0.16 | −0.34 | 0.67 | 0.17 | −0.51 | 0.25 | 0.14 | −0.11 |
| | (0.47) | (0.06) | *−10.70* | (0.54) | (0.08) | *−10.62* | (0.12) | (0.04) | *−8.54* |
| 1000 shares | 0.39 | 0.15 | −0.24 | 0.53 | 0.17 | −0.36 | 0.20 | 0.14 | −0.07 |
| | (0.44) | (0.05) | *−8.05* | (0.53) | (0.06) | *−7.67* | (0.12) | (0.04) | *−5.18* |
| 1,100–9,900 shares | 0.39 | 0.16 | −0.23 | 0.53 | 0.18 | −0.35 | 0.20 | 0.14 | −0.06 |
| | (0.45) | (0.08) | *−7.42* | (0.54) | (0.09) | *−7.39* | (0.10) | (0.05) | *−4.98* |
| 10,000 or more shares | 0.32 | 0.16 | −0.16 | 0.41 | 0.17 | −0.24 | 0.20 | 0.14 | −0.05 |
| | (0.23) | (0.09) | *−8.45* | (0.26) | (0.09) | *−8.35* | (0.09) | (0.07) | *−3.95* |
| Avg proportional quoted spread | 4.82 | 2.44 | −2.38 | 5.05 | 1.70 | −3.35 | 4.50 | 3.51 | −0.99 |
| | (4.98) | (2.03) | *−6.62* | (5.30) | (0.96) | *−7.14* | (4.48) | (2.62) | *−1.83* |
| Avg proportional effective spread | 3.54 | 1.47 | −2.07 | 3.57 | 1.03 | −2.54 | 3.50 | 2.10 | −1.40 |
| | (3.59) | (1.22) | *−8.19* | (3.51) | (0.68) | *−8.17* | (3.71) | (1.51) | *−3.36* |
| Avg proportional effective spread by trade size | | | | | | | | | |
| 0–900 shares | 3.94 | 1.44 | −2.50 | 3.97 | 1.00 | −2.97 | 3.89 | 2.07 | −1.82 |
| | (3.79) | (1.21) | *−9.39* | (3.76) | (0.69) | *−8.89* | (3.85) | (1.49) | *−4.23* |
| 1,000 shares | 3.21 | 1.44 | −1.77 | 3.10 | 0.98 | −2.12 | 3.36 | 2.09 | −1.27 |
| | (3.40) | (1.31) | *−7.21* | (3.04) | (0.66) | *−7.73* | (3.86) | (1.68) | *−2.89* |
| 1,100–9,900 shares | 3.12 | 1.50 | −1.62 | 3.10 | 1.02 | −2.08 | 3.14 | 2.18 | −0.96 |
| | (3.08) | (1.36) | *−7.18* | (3.03) | (0.74) | *−7.64* | (3.17) | (1.70) | *−2.57* |
| 10,000 or more shares | 2.43 | 1.35 | −1.08 | 2.21 | 0.88 | −1.33 | 2.72 | 1.99 | −0.72 |
| | (2.38) | (1.37) | *−5.12* | (1.99) | (0.65) | *−6.19* | (2.78) | (1.79) | *−1.88* |
| Number of observations | | | 224 | | | 132 | | | 92 |

*Continued*

TABLE 1—*Continued*

| | Pooled | | | No odd quotes | | | Odd and even quotes | | |
|---|---|---|---|---|---|---|---|---|---|
| | Before | After | Change | Before | After | Change | Before | After | Change |
| Panel b: Securities that moved from Amex to Nasdaq | | | | | | | | | |
| Average quoted spread | 0.23 | 0.42 | 0.19 | 0.26 | 0.57 | 0.31 | 0.20 | 0.32 | 0.11 |
| | (0.06) | (0.18) | *5.67* | (0.06) | (0.13) | *7.68* | (0.04) | (0.14) | *3.43* |
| Average effective spread | 0.16 | 0.32 | 0.16 | 0.18 | 0.41 | 0.22 | 0.14 | 0.25 | 0.11 |
| | (0.04) | (0.17) | *5.29* | (0.04) | (0.16) | *4.91* | (0.02) | (0.14) | *3.29* |
| Average effective spread by trade size | | | | | | | | | |
| 0–900 shares | 0.15 | 0.37 | 0.21 | 0.18 | 0.47 | 0.29 | 0.14 | 0.29 | 0.15 |
| | (0.04) | (0.15) | *7.41* | (0.03) | (0.10) | *9.70* | (0.03) | (0.14) | *4.28* |
| 1,000 shares | 0.16 | 0.30 | 0.14 | 0.19 | 0.40 | 0.22 | 0.14 | 0.23 | 0.08 |
| | (0.04) | (0.18) | *4.29* | (0.05) | (0.19) | *3.97* | (0.03) | (0.13) | *2.71* |
| 1100–9900 shares | 0.16 | 0.31 | 0.14 | 0.19 | 0.39 | 0.20 | 0.14 | 0.24 | 0.10 |
| | (0.06) | (0.18) | *4.18* | (0.09) | (0.20) | *3.36* | (0.02) | (0.14) | *2.92* |
| 10,000 or more shares | 0.19 | 0.22 | 0.03 | 0.20 | 0.26 | 0.07 | 0.19 | 0.19 | 0.00 |
| | (0.18) | (0.12) | *0.59* | (0.25) | (0.11) | *0.64* | (0.16) | (0.12) | −0.02 |
| Avg proportional quoted spread | 3.30 | 5.22 | 1.92 | 2.24 | 5.03 | 2.78 | 4.02 | 5.34 | 1.33 |
| | (2.48) | (3.87) | *2.36* | (1.23) | (5.35) | *1.83* | (2.87) | (2.57) | *1.50* |
| Avg proportional effective spread | 2.29 | 3.94 | 1.65 | 1.60 | 3.90 | 2.29 | 2.76 | 3.97 | 1.21 |
| | (1.53) | (3.80) | *2.28* | (1.00) | (5.27) | *1.54* | (1.67) | (2.30) | *1.86* |
| Avg proportional effective spread by trade size | | | | | | | | | |
| 0–900 shares | 2.23 | 4.44 | 2.21 | 1.58 | 4.21 | 2.63 | 2.68 | 4.61 | 1.94 |
| | (1.57) | (3.47) | *3.19* | (1.06) | (4.57) | *2.02* | (1.72) | (2.48) | *2.69* |
| 1,000 shares | 2.25 | 3.70 | 1.44 | 1.56 | 3.79 | 2.23 | 2.73 | 3.62 | 0.90 |
| | (1.63) | (3.72) | *1.95* | (0.83) | (5.26) | *1.51* | (1.87) | (2.10) | *1.35* |
| 1,100–9,900 shares | 2.25 | 3.71 | 1.45 | 1.54 | 3.53 | 1.98 | 2.74 | 3.84 | 1.11 |
| | (1.57) | (3.48) | *2.10* | (0.95) | (4.72) | *1.48* | (1.74) | (2.27) | *1.62* |
| 10,000 or more shares | 2.47 | 2.40 | −0.07 | 1.20 | 1.76 | 0.57 | 3.00 | 2.83 | −0.17 |
| | (2.48) | (2.18) | *−0.11* | (1.33) | (0.83) | *0.99* | (2.68) | (2.68) | *−0.17* |
| Number of observations | | | 32 | | | 13 | | | 19 |

*Note.* Panel *a* is for the sample of 224 stocks that move from Nasdaq to the NYSE or Amex. Panel *b* is for the sample of 32 stocks that move from Amex to Nasdaq. The averages are calculated across firms using days −40 to −10 for the "before" period and 10 to 40 for the "after" period. Quoted spreads are time weighted for each stock and then equally weighted across stocks. Effective spreads are volume weighted for each stock and then equally weighted across stocks. Standard deviations are in parentheses. Below the values for the changes in average spreads, we show the *t*-statistics in italics.

Table 1b shows summary statistics for the sample of stocks that move from the Amex to Nasdaq. As noted by Clyde *et al.* (1997), the sample of securities that move from Amex to Nasdaq is somewhat peculiar. In relation to the typical Amex security, this sample has much smaller firms, with lower prices per share. In our sample, half of the securities have average closing prices below $10, and one-fifth have average closing prices below $5. These low share prices result in high proportional bid–ask spreads and imply that relatively small changes in the dollar spread cause large changes in the proportional spread.

When securities move from the Amex to Nasdaq, the average quoted bid–ask spread increases by 19 cents (1.9% of the stock price), and the average effective spread increases by 16 cents (1.6%). As in the sample of exchange listings, most of the change in spreads comes from securities that are not quoted on odd eighths on Nasdaq. For these securities, the increase in the average effective spread is 22 cents (2.3% of the stock price). For the securities that are quoted on both odd and even eighths on Nasdaq, the increase in the average effective spread is only 11 cents (1.2%).

Although the increase in bid–ask spreads is larger for the securities that are not quoted on odd eighths on Nasdaq, Table 1b shows that these securities have lower proportional spreads, both before and after the move to Nasdaq, than the securities quoted on both odd and even eighths. This result highlights the peculiar nonrandom selection process for the Amex-to-Nasdaq sample. Many securities that move from Amex to Nasdaq are small companies with low share prices. As noted above, half of the securities in our sample have prices less than $10. Consistent with the results in Kandel and Marx (1997), securities with prices below $10 almost always are quoted on both odd and even eighths on Nasdaq. In our sample, 16 of the 19 securities that are quoted on both odd and even eighths have prices below $10, while only 1 of the 13 securities that are quoted only on even eighths has a price below $10.[6] The low share prices for the securities quoted on both odd and even eighths result in high proportional bid–ask spreads.

Figure 1a shows the average effective spreads for stocks that move from Nasdaq to the NYSE or Amex, and Fig. 1b shows the average effective spreads for stocks that move from Amex to Nasdaq, from 40 days before through 40 days after the move. The figures illustrate several important points. First, as reported in Table 1, there is a large change in effective

[6] The sole security with a price less than $10 that is quoted only on even eighths on Nasdaq is Medical Management of America (MMA). MMA has an average price of approximately $4 per share. On the Amex, its average effective spread was 21%; on Nasdaq, its average effective spread increased to 37%. To determine whether this large percentage spread caused MMA to have a disproportionate effect on our results, we recalculated the results excluding MMA. Excluding MMA reduces the average percentage spreads for the Amex-to-Nasdaq sample, but has no other material effect on our results.

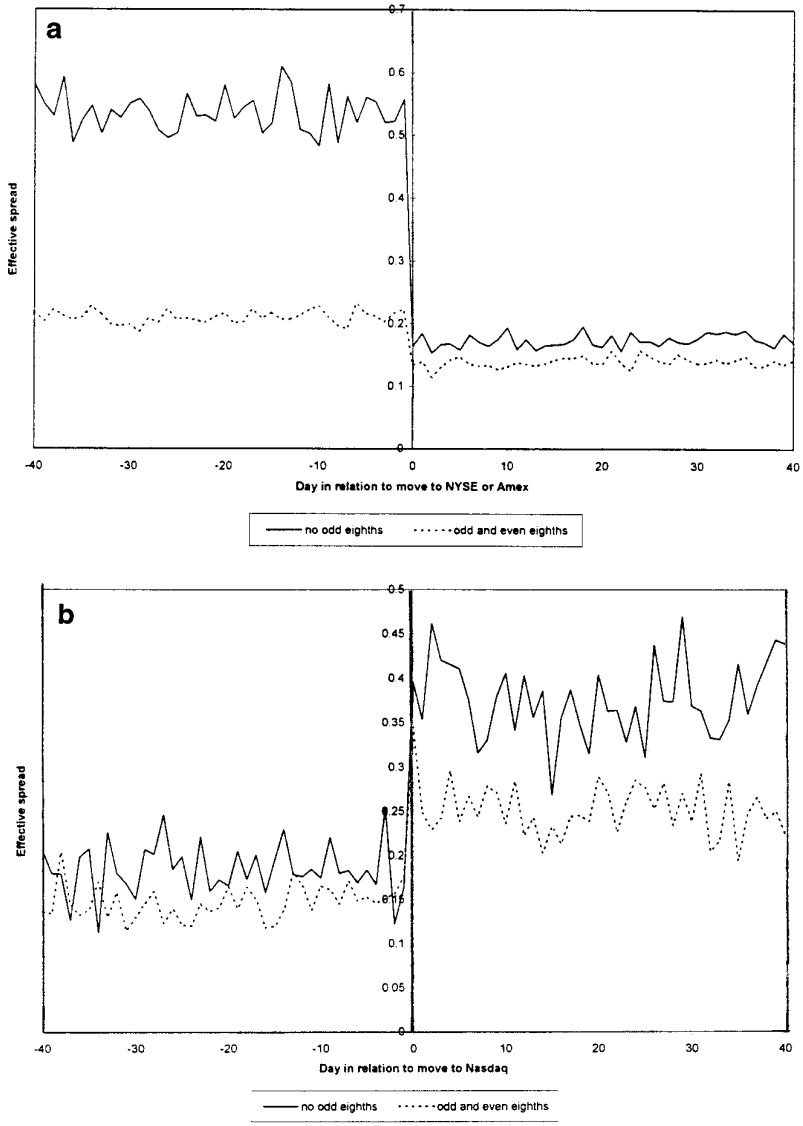


**FIG. 1.** Effective spreads for securities that moved from Nasdaq to the NYSE or Amex (a) and securities that moved from Amex to Nasdaq (b). The figures show average effective spreads for stocks that are not quoted on odd eighths on Nasdaq and for stocks that are quoted on both odd and even eighths on Nasdaq. Average effective spreads are volume weighted for each stock and then equally weighted across stocks. The panels show days −40 to 40 in relation to the exchange listing. Day 0 is the first trading day after the move.

spreads when securities move to or from Nasdaq. Securities that move from Nasdaq to the NYSE or Amex experience a significant decrease in effective spreads, and securities that move from Amex to Nasdaq experience a significant increase in effective spreads. Second, the change in effective spreads is related to whether the security is quoted on both odd and even eighths on Nasdaq. Finally, the change in effective spreads occurs abruptly on the first day of trading in the new trading location. The abrupt change in effective spreads when securities move to or from Nasdaq implies that the change is caused by differences between Nasdaq and the NYSE or Amex, and not by changes in firm-specific fundamentals.

Although a firm's decision to move from one trading location to another is not exogenous, we view the Nasdaq market makers' decision to use or avoid odd-eighth quotes as largely unrelated to the choices made by the firms. Since the market makers' decision to use or avoid odd-eighths has a significant effect on bid–ask spreads, this decision provides a largely exogenous component to the change in spreads, which allows us to determine the effect of changes in spreads on stock returns and volume. We present results for returns in Section 3.1 and results for volume in Section 3.2.

### 3.1. *Effects on Returns*

Table 2 reports the cumulative abnormal return (CAR) over four event windows: (i) from 1 day before through 1 day after the announcement of the move; (ii) from 1 day before through 1 day after the move; (iii) from 1 day before the announcement through 1 day after the move; and (iv) from 1 day before the announcement through 10 days after the move.[7] For stocks that move from Nasdaq to the NYSE or Amex, investors could forecast a larger decrease in spreads for stocks that are not quoted on odd eighths than for stocks quoted on both odd and even eighths. If investors can accurately forecast the change in spreads when stocks move from Nasdaq to the NYSE or Amex, then most of the abnormal return will occur at the time of the announcement. However, for stocks that move from the Amex to Nasdaq, there is more uncertainty about the change in spread at the time of the announcement since it is not known whether the stock will be quoted on odd eighths until it begins trading on Nasdaq. For this subsample, the abnormal return could be split between the announcement day and several days following the move.

Consistent with the results in Christie and Huang (1994) and Kadlec and McConnell (1994), the announcement of a move from Nasdaq to an exchange is associated with a positive abnormal stock return. For the sample

[7] Many firms do not announce their intention to move from one trading location to another until the day before the move. Thus, for many firms, these windows overlap.

TABLE II
Cumulative Abnormal Returns for Securities That Move from Nasdaq to the NYSE or Amex and Securities That Move from Amex to Nasdaq

| | Panel a: Securities that moved from Nasdaq to the NYSE or Amex | | | | Panel b: Securities that moved from Amex to Nasdaq | | | |
|---|---|---|---|---|---|---|---|---|
| | Pooled | No odd quotes | Odd and even quotes | Difference (no odd quotes minus odd and even quotes) | Pooled | No odd quotes | Odd and even quotes | Difference (no odd quotes minus odd and even quotes) |
| (i) Abnormal return from one day before until one day after the announcement | 2.0% | 1.5% | 2.6% | −1.1% | 2.7% | 2.4% | 2.9% | −0.5% |
| | *4.23* | *2.71* | *3.28* | *−1.14* | *2.31* | 1.49 | *1.74* | *−0.22* |
| (ii) Abnormal return from one day before until one day after first day of trading after the move | 1.4% | 0.8% | 2.2% | −1.4% | 0.7% | 1.1% | 0.4% | 0.7% |
| | *3.14* | *1.52* | *2.97* | *−1.54* | *0.53* | *0.46* | *0.26* | *0.25* |
| (iii) Abnormal return from one day before the announcement to one day after the move | 2.6% | 2.0% | 3.3% | −1.3% | *5.1%* | 3.6% | 6.1% | −2.5% |
| | *4.82* | *3.13* | *3.70* | *−1.18* | *2.32* | *1.21* | *1.96* | *−0.58* |
| (iv) Abnormal return from one day before the announcement to ten days after the move | 0.9% | 0.6% | 1.3% | −0.7% | 3.7% | 2.9% | 4.3% | −1.4% |
| | *1.06* | *0.59* | *0.91* | *−0.40* | *1.74* | *0.89* | *1.49* | *−0.32* |
| Number of observations | 223 | 131 | 92 | | 32 | 13 | 19 | |

*Note.* Panel *a* is for the sample of 224 rocks that move from Nasdaq to the NYSE or Amex. Panel *b* is for the sample of 32 stocks that move from Amex to Nasdaq. The *t*-statistics are in italics.

of exchange listings as a whole, Table 2a shows that the announcement is associated with a three-day CAR of 2.0% ($t = 4.23$). This positive CAR reflects a variety of information that is likely to be revealed when a security announces a move from Nasdaq to an exchange. Thus, we focus on the difference between the CARs for the subsample with large decreases in spreads (stocks that are not quoted on odd eighths on Nasdaq) and the subsample with smaller decreases in spreads (stocks that are quoted on both odd and even eighths on Nasdaq). The announcement CARs for these two subsamples are 1.5% ($t = 2.71$) and 2.6% ($t = 3.28$), respectively. The CARs are not significantly different from each other, and the point estimate for the stocks that are not quoted on odd eighths on Nasdaq is smaller than the point estimate for stocks that are quoted on both odd and even eighths on Nasdaq. These results are inconsistent with hypotheses (H1) and (H2).

Table 2b shows results for stocks that move from Amex to Nasdaq. Consistent with Clyde *et al*. (1997), the abnormal returns are positive when securities move from the Amex to Nasdaq, even though the move results in significantly higher trading costs. In the sample of Amex delistings, we expect stocks that are not quoted on odd eighths on Nasdaq (and, thus, have large increases in trading costs) to have smaller CARs than stocks that are quoted on both odd and even eighths on Nasdaq. Since it is not known whether Nasdaq market makers will use or avoid odd eighths until the security begins trading on Nasdaq, we examine CARs both for the period surrounding the announcement and for the period surrounding the move. In three of the four windows we consider, the CAR is smaller for stocks that are not quoted on odd eighths on Nasdaq, but the difference between the CARs for the two subsamples is not statistically significant. Thus, these results are also inconsistent with hypotheses (H1) and (H2).

*Regression Results*. We now continue our analysis using a regression approach. We regress cumulative abnormal returns from the day before through the day after the announcement, and from the day before the announcement through the day after the move, on two measures of the change in spreads. The change in effective spread for a stock is calculated as the stock's average volume-weighted effective spread after the move (days 10 to 40) minus the stock's average volume-weighted effective spread before the move (days $-40$ to $-10$). The change in the proportional effective spread is calculated similarly. We argue that any systematic effects of listing on the NYSE or Amex on the value of the security will be captured in the intercept, and that the slope coefficients will reflect the relation between abnormal returns and changes in spreads. The results are reported in Table 3.

The intercepts of the regressions in Table 3a for the sample of exchange

TABLE III
Regressions of Cumulative Abnormal Returns on the Change in Bid–Ask Spreads when Securities Move from Nasdaq to the NYSE or Amex or from Amex to Nasdaq

| Dependent variable | Announcement abnormal return | | Announcement through move abnormal return | |
|---|---|---|---|---|
| Panel a: Securities that moved from Nasdaq to the NYSE or Amex | | | | |
| Intercept | 0.02 | 0.02 | 0.03 | 0.02 |
| | (3.22) | (2.73) | (4.77) | (3.29) |
| Change in effective spread | −0.01 | | 0.02 | |
| | (−0.59) | | (1.33) | |
| Change in proportional effective spread | | −0.002 | | −0.002 |
| | | (−1.38) | | (−1.25) |
| $R^2$ | 0.002 | 0.009 | 0.008 | 0.007 |
| $N$ | 223 | 223 | 223 | 223 |
| Panel b: Securities that moved from Amex to Nasdaq | | | | |
| Intercept | 0.04 | 0.04 | 0.09 | 0.08 |
| | (2.23) | (2.76) | (2.87) | (3.50) |
| Change in effective spread | −0.07 | | −0.25 | |
| | (−0.82) | | (−1.70) | |
| Change in proportional effective spread | | −0.01 | | −0.02 |
| | | (−1.37) | | (−2.67) |
| $R^2$ | 0.02 | 0.06 | 0.09 | 0.20 |
| $N$ | 30 | 30 | 30 | 30 |

*Note.* Panel *a* is for the sample of 224 stocks that moved from Nasdaq to the NYSE or Amex. Panel *b* is for the same of 32 stocks that moved from Amex to Nasdaq. The dependent variables are the announcement abnormal return, calculated as the abnormal return from one day before through one day after the announcement of the move, and the announcement-through-move abnormal return, calculated as the abnormal return from one day before the announcement through one day after the move. The change in effective spread for a stock is calculated as the stock's average volume-weighted effective spread after the move (days 10 to 40) minus the stock's average volume-weighted effective spread before the move (days −40 to −10), and similarly for the change in the proportional effective spread. The *t*-statistics are in parentheses.

listings are positive and statistically significant, indicating that listing on the NYSE or Amex is associated with a significantly positive abnormal return. However, none of the slope coefficients is statistically significant, and the $R^2$ statistics are close to zero. Thus, we find no significant relation between changes in spreads and abnormal returns, which is inconsistent with the Amihud–Mendelson model of the liquidity premium and inconsistent with hypotheses (H1) and (H2).

Table 3b shows results for the sample of stocks that move from Amex to Nasdaq. As expected, the slope coefficients are negative; however, only one is statistically significant. The magnitudes of the slope coefficients in

Table 3b are larger than those in Table 3a, but the slope coefficients are still much smaller than one would expect under hypothesis (H2).[8]

### 3.2. *Effects on Volume*

Table 4 reports the changes in standardized daily trading volume for securities that move from Nasdaq to an exchange (Panel *a*) and for securities that move from Amex to Nasdaq (Panel *b*). Standardized volume for each security on each day is calculated by taking the log of the daily share volume, subtracting the mean, and dividing by the standard deviation.[9] The mean and standard deviation of log share volume are calculated over days −80 to −41 in relation to the first day of trading after the move. The change in average standardized volume indicates the number of standard deviations by which the average of the log of share volume increases or decreases following the move. To account for differences in how trades are reported on Nasdaq, NYSE, and Amex, we multiply NYSE and Amex volumes by 2 before standardizing.[10]

We first consider the results for the sample of stocks that move from Nasdaq to an exchange, shown in Table 4a. For the sample as a whole, average standardized trading volume increases when the stocks move to an exchange. This increase is difficult to interpret, however, because of institutional differences between Nasdaq and the exchanges. Thus, we focus on differences between the subsample for which the change in spreads is large (i.e., the subsample of stocks that are not quoted on odd eighths on Nasdaq) and the subsample for which the change in spreads is small (i.e., the subsample of stocks that are quoted on both odd and even eighths on Nasdaq). This comparison holds constant many of the changes that occur when securities move from Nasdaq to the NYSE or Amex, and focuses on the effect of the change in spreads.

Table 4a shows that for the subsample of stocks that are not quoted on odd eighths on Nasdaq, the change in average standardized volume is 0.45, i.e., average of the log of volume plus 1000 increases by 0.45 standard

[8] When the stock MMA is deleted from the sample, three of the four slope coefficients are closer to zero and all are less significant.

[9] Since daily volume is sometimes zero, we must add a constant before taking logs. A constant of 1000 was chosen because it results in standardized volume having low skewness. Smaller powers of 10 result in negative skewness (due to the zero-volume days) and larger powers of 10 result in positive skewness (due to the presence of some high-volume days).

[10] This adjustment to volume is commonly made to account for the fact that many customer-to-customer trades on the NYSE or Amex are recorded as a single transaction. Since all Nasdaq trades go through a market maker, customer-to-customer trades are recorded as two (and sometimes three) transactions. Several firms in our sample split their shares during the period we examine. All of our volume figures are split adjusted. If we exclude firms with a stock split during our sample period, our results are not affected.

TABLE IV

Standardized Trading Volume for Securities That Move from Nasdaq to the NYSE or Amex and Securities That Move from Amex to Nasdaq

| | Pooled | | | No odd quotes | | | Odd and even quotes | | |
|---|---|---|---|---|---|---|---|---|---|
| | Before | After | Change | Before | After | Change | Before | After | Change |
| Panel a: Securities that moved from Nasdaq to the NYSE or Amex | | | | | | | | | |
| Average standarized volume | 0.13 | 0.49 | 0.36 | 0.15 | 0.60 | 0.45 | 0.10 | 0.32 | 0.22 |
| | (0.60) | (1.32) | *3.72* | (0.57) | (1.47) | *3.27* | (0.63) | (1.05) | *1.58* |
| Average standardized volume by trade size | | | | | | | | | |
| 0–900 shares | 0.19 | 1.46 | 1.27 | 0.23 | 1.48 | 1.25 | 0.14 | 1.44 | 1.30 |
| | (0.68) | (1.74) | *10.18* | (0.64) | (1.58) | *8.43* | (0.73) | (1.96) | *5.96* |
| 1,000 shares | 0.14 | 0.00 | −0.14 | 0.14 | −0.01 | −0.14 | 0.14 | 0.00 | −0.14 |
| | (0.51) | (1.05) | *−1.81* | (0.45) | (0.89) | *−1.64* | (0.58) | (1.26) | *−0.96* |
| 1,100–9,900 shares | 0.11 | 0.18 | 0.07 | 0.12 | 0.23 | 0.11 | 0.08 | 0.10 | 0.02 |
| | (0.52) | (0.80) | *1.10* | (0.46) | (0.65) | *1.54* | (0.60) | (0.98) | *0.15* |
| 10,100 or more shares | 0.05 | −0.04 | −0.10 | 0.03 | −0.03 | −0.06 | 0.09 | −0.06 | −0.15 |
| | (0.42) | (0.50) | *−1.94* | (0.35) | (0.45) | *−0.98* | (0.50) | (0.55) | *−1.69* |
| Number of observations | | | 224 | | | 132 | | | 92 |
| Panel b: Securities that moved from Amex to Nasdaq | | | | | | | | | |
| Average standardized volume | 0.23 | −0.08 | −0.31 | 0.02 | 0.12 | 0.11 | 0.38 | −0.22 | −0.60 |
| | (0.55) | (0.82) | *−1.79* | (0.40) | (0.77) | *0.46* | (0.60) | (0.84) | −2.01 |
| Average standardized volume by trade size | | | | | | | | | |
| 0–900 shares | 0.32 | −0.64 | −0.95 | 0.07 | −0.79 | −0.86 | 0.48 | −0.54 | −1.02 |
| | (0.58) | (0.87) | −5.13 | (0.43) | (0.98) | *−2.88* | (0.62) | (0.81) | *−4.37* |
| 1,000 shares | 0.18 | 0.26 | 0.08 | 0.03 | 0.44 | 0.41 | 0.29 | 0.14 | −0.15 |
| | (0.47) | (0.77) | 0.48 | (0.34) | (0.70) | *1.87* | (0.53) | (0.81) | *−0.66* |
| 1,100–9,900 shares | 0.17 | 0.20 | 0.02 | 0.03 | 0.50 | 0.47 | 0.27 | −0.01 | −0.28 |
| | (0.46) | (0.72) | *0.16* | (0.35) | (0.68) | *2.23* | (0.51) | (0.68) | *−1.45* |
| 10,000 or more shares | (0.11) | (0.25) | 0.14 | 0.01 | 0.27 | 0.26 | 0.18 | 0.23 | 0.05 |
| | (0.44) | (0.43) | *0.97* | (0.39) | (0.33) | *1.33* | (0.47) | (0.50) | *0.27* |
| Number of observations | | | 32 | | | 13 | | | 19 |

Panel *a* is for the sample of 224 stocks that moved from Nasdaq to the NYSE or Amex. Panel *b* is for the sample of 32 stocks that moved from Amex to Nasdaq. The averages are calculated across firms using days −40 to −10 for the "before" period and 10 to 40 for the "after" period. Standardized volume is the log of daily share volume, minus the mean and divided by the standard deviation. The mean and standard deviation of the log of share volume are calculated over days −80 to −41. Standard deviations are in parentheses. Below the values for the changes in average spreads, we show the *t*-statistics in italics.

deviations, which is statistically significant ($t = 3.27$). For this subsample, the average effective spread decreases by 41 cents. For stocks that are quoted on both odd and even eighths on Nasdaq, the change in average standardized volume is only 0.22, which is not statistically significant ($t = 1.58$). The average effective spread for this subsample decreases by only 8 cents. Thus, consistent with hypothesis (H3), the increase in average standardized volume is larger for the subsample of stocks that has a larger decrease in its average spread. Although the difference in the change in standardized volume across these subsamples is not statistically significant using a difference of means test, we find a statistically significant relation between changes in bid–ask spreads and changes in standardized trading volume in the regressions reported below.

Table 1a shows a monotonic relation between trade size and the change in average effective spread (smaller trade sizes have larger decreases in spreads). With the exception of the 1000-share category, Table 4a shows a corresponding monotonic relation between trade size and the change in average standardized volume (smaller trade sizes have larger increases in volume). This suggests a relation between changes in spreads and changes in volume that is consistent with hypothesis (H3). The large decrease in 1,000-share volume is expected since Nasdaq's automatic execution system creates a bias toward trades of this size.

Figure 2a shows standardized volume from 40 days before the move from Nasdaq to an exchange to 40 days after the move. It shows that, after a temporary spike in volume associated with the move, stocks that are not quoted on odd eighths on Nasdaq experience a larger increase in standardized volume than stocks that are quoted on both odd and even eighths on Nasdaq.

We look for a similar relation between changes in spreads and changes in volume in the sample of stocks that move from Amex to Nasdaq. The evidence from the Amex-to-Nasdaq sample provides less support for (H3). Table 4b shows that for the subsample of stocks that are not quoted on odd eighths on Nasdaq, the change in average standardized volume is 0.11, and for stocks that are quoted on both odd and even eighths on Nasdaq, the change is $-0.60$. Thus, the subsample that is not quoted on odd eighths on Nasdaq (and thus has larger increases in bid–ask spreads) experiences a larger increase in volume than the subsample that is quoted on both odd and even eighths on Nasdaq. However, neither the change in average effective spreads nor the change in average standardized volume is statistically significant. Thus, although the point estimates are opposite from the predictions of (H3), the results are not significant. Figure 2b shows little change in average standardized volume for stocks that are not quoted on odd eighths on Nasdaq, but shows a decrease in average standardized volume for stocks that are quoted on both odd and even eighths on Nasdaq.

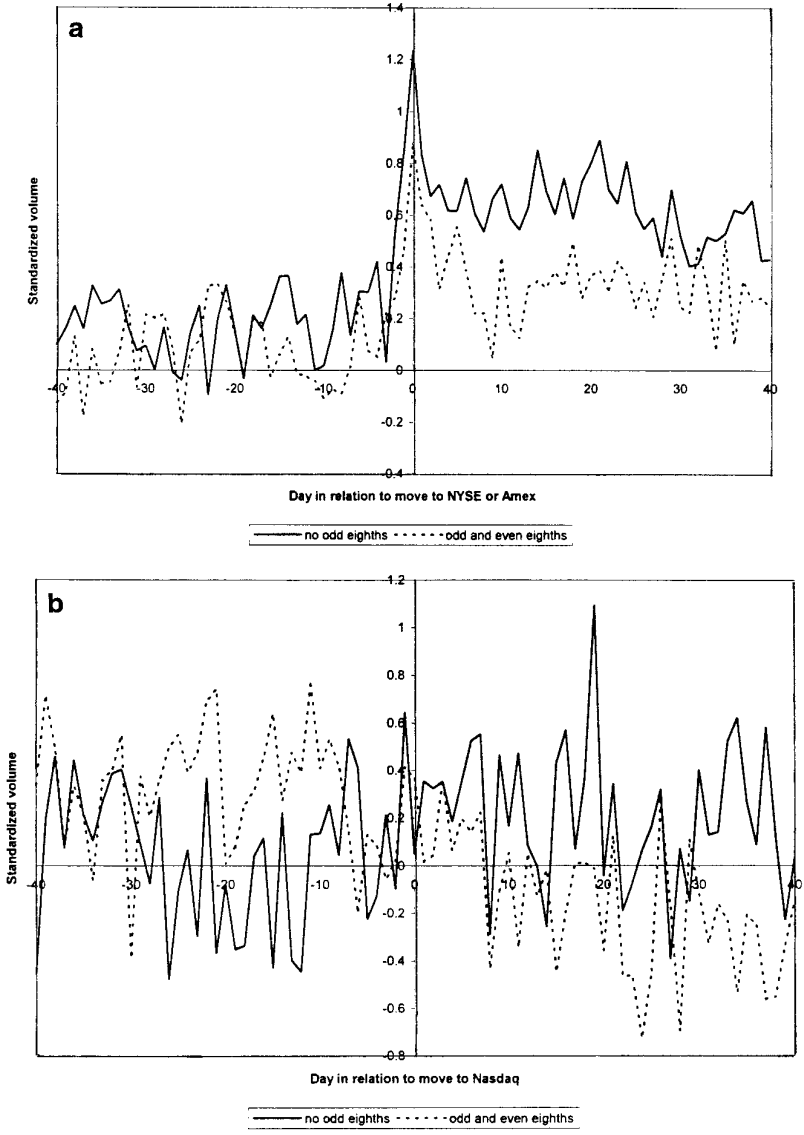


**FIG. 2.** Standardized volumes for securities that moved from Nasdaq to the NYSE or Amex (a) and securities that moved from Amex to Nasdaq (b). Standardized volume is the log of daily share volume, minus the mean and divided by the standard deviation. The mean and standard deviation of the log of share volume are calculated over days −80 to −41. Results are reported separately for stocks that are not quoted on odd eighths on Nasdaq and for stocks that are quoted on both odd and even eighths on Nasdaq. The figure shows days −40 to 40 in relation to the change in exchange listing. Day 0 is the first trading day after the move.

Table 1b shows that the increase in average spreads is larger for the smaller trade sizes. Consistent with hypothesis (H3), 4b shows that, with the exception of the 1000-share category, there is a corresponding relation in the change in average standardized volume (smaller trade sizes generally have larger decreases in volume). Again, the increase in 1,000-share volume is likely to be caused by Nasdaq's automatic execution system.

*Regression Results.* We continue to explore the possible relation between changes in spreads and changes in volume in a regression context. We regress the change in standardized volume on three measures of the change in spreads and on the change in volatility (measured as the standard deviation of returns), which is included to control for the known relation between trading volume and volatility. The first two measures of the change in spreads are the same as those used in the return regressions in Table 3: the change in effective spread and the change in the proportional effective spread. The third measure is a dummy variable that is one if the stock is quoted on odd eighths on Nasdaq and zero otherwise. Using a dummy variable that indicates whether the stock is quoted on odd eighths on Nasdaq avoids any potential ambiguity about the direction of causality, i.e., whether changes in spreads affect changes in volume or whether changes in volume affect changes in spreads. However, the change from a continuous to a discrete explanatory variable also reduces the power of the test.

Again, we argue that systematic differences in trading volume between Nasdaq and the NYSE or Amex are absorbed in the intercept, and that the slope coefficients capture the relation between changes in spreads and changes in trading volume. Regression results are shown in Table 5. Panel *a* shows results for the sample of stocks that move from Nasdaq to an exchange, and Panel *b* shows results for the sample of stocks that move from the Amex to Nasdaq.

Consistent with (H3), the coefficient on the change-in-spread variable is negative in the four regressions that use the change in effective spread or change in proportional effective spread as an independent variable, and the coefficients are significant in three of the four regressions. For example, the coefficient on the change in proportional effective spread in Table 5a, $-0.17$ ($t = -7.68$), indicates that, if the proportional effective spread decreases by one percentage point, then the log of volume plus 1000 increases by 0.17 standard deviations. In the regression in Table 5a that uses the dummy variable for stocks that are not quoted on odd eighths on Nasdaq, we expect the coefficient to be positive since stocks that are not quoted on odd eighths on Nasdaq have larger decreases in their spreads, and so are expected to have larger increases in their volumes. Thus, the coefficient on the dummy variable in Table 5a has the expected sign, but it is insignificant. In the regression in Table 5b that uses the dummy variable,

TABLE V
Regressions of the Change in Standardized Volume on the Change in Bid–Ask Spreads for Securities that Moved from Nasdaq to the NYSE or Amex or from Amex to Nasdaq

| Dependent variable | Panel *a*: Securities that moved from Nasdaq to the NYSE or Amex—Change in standardized volume | | | Panel *b*: Securities that moved from Amex to Nasdaq—Change in standardized volume | | |
|---|---|---|---|---|---|---|
| Intercept | 0.02 | −0.03 | 0.20 | 0.02 | 0.07 | −0.53 |
| | (0.207) | (−0.36) | (1.61) | (0.11) | (0.48) | (−2.94) |
| Change in effective spread | −1.12 | | | −1.77 | | |
| | (−6.687) | | | (−1.75) | | |
| Change in proportional effective spread | | −0.17 | | | −0.19 | |
| | | (−7.68) | | | (−3.54) | |
| Dummy for no odd-eighth quotes on Nasdaq | | | 0.22 | | | 0.67 |
| | | | (1.41) | | | (2.37) |
| Change in std. dev. of returns | 12.01 | 10.38 | 12.09 | 2.67 | 10.06 | −1.51 |
| | (4.00) | (3.54) | (3.69) | (0.81) | (2.64) | (−0.51) |
| $R^2$ | 0.22 | 0.26 | 0.07 | 0.10 | 0.32 | 0.17 |
| $N$ | 224 | 224 | 224 | 30 | 30 | 30 |

*Note.* Panel *a* shows results for the sample of 224 stocks that moved from Nasdaq to the NYSE or Amex. Panel *b* shows results for the sample of 32 stocks that moved from Amex to Nasdaq. The dependent variable is the change in standardized volume, which is the log of daily share volume, minus the mean and divided by the standard deviation. The mean and standard deviation of the log of share volume are calculated over days −80 to −41. The independent variables are an intercept, the change in the effective spread, the change in the proportional effective spread, a dummy that is one if the stock is not quoted on odd eighths on Nasdaq and zero if the stock is quoted on both odd and even eighths on Nasdaq, and the change in the standard deviation of returns. The change in effective spread for a stock is calculated as the stock's average volume-weighted effective spread after the move (days 10 to 40) minus the stock's average volume-weighted effective spread before the move (days −40 to −10), and similarly for the change in the proportional effective spread. The *t*-statistics are in parentheses.

we expect the coefficient to be negative since stocks that are not quoted on odd eighths on Nasdaq have larger increases in their spreads, and so are expected to have larger decreases in their volumes. However, the coefficient on the dummy variable in Table 5b is positive and significant.[11] Despite the weak results in the regressions using the dummy variable, the evidence

[11] In Table 5b, when the stock MMA is deleted from the sample, the signs of the slope coefficients on the spread variables do not change, and whether they are significant at the 5% level does not change. However, the coefficient on the control variable, the standard deviation of returns, is materially affected.

from these regressions, together with our earlier results, suggest a significant negative relation between bid–ask spreads and trading volume, consistent with hypothesis (H3).

## 4. CONCLUSIONS

We study the effect of exogenous changes in a stock's bid–ask spread on its price and trading volume. The theoretical literature on transaction costs suggests that, all else constant, an increase in a stock's bid–ask spread lengthens the average period that investors hold the stock, thus reducing trading volume. An increase in the bid–ask spread also increases future expected returns (due to the higher liquidity premium demanded by investors), causing a negative abnormal return when the transaction cost increase becomes known. The literature is divided, however, on the magnitude of the liquidity premium.

We use an event-study approach that allows us to estimate the effect of a change in transaction costs on changes in stock prices and trading volumes. We argue that differences in the change in bid–ask spreads when stocks move from Nasdaq to the NYSE or Amex, or from the Amex to Nasdaq, are primarily due to the use or avoidance of odd-eighth quotes while the stocks are on Nasdaq, rather than changes in company-specific fundamentals. This makes our tests less subject to the endogeneity problems inherent in cross-sectional estimation of the relation between bid–ask spreads, expected returns, and volume.

We find that changes in bid–ask spreads do not have an economically significant effect on stock prices. This implies the effects of transaction costs on liquidity premiums are minimal. These results contradict Amihud and Mendelson's (1986a, 1986b) estimates of a high elasticity of expected returns with respect to transaction costs. Our results are consistent with the predictions of Constantinides (1986) and Vayanos (1998), who argue that the effect of a change in bid–ask spreads on price is second order because of an accompanying change in the average holding period. We also find that the relation between the change in bid–ask spreads and the change in volume is statistically significant and has the expected sign.

## REFERENCES

Amihud, Y., and Mendelson, H. (1986a). Asset pricing and the bid–ask spread, *J. Finan. Econ.* **17,** 223–249.

Amihud, Y., and Mendelson, H. (1986b). Liquidity and stock returns, *Financial Analysts J.* May–June, 43–48.

Amihud, Y., and Mendelson, H. (1990). The effect of a transaction tax on securities returns and values, unpublished manuscript, New York University.

Barclay, M. J. (1997). Bid–ask spreads and the avoidance of odd-eighth quotes on Nasdaq: An examination of exchange listings, *J. Finan. Econ.* **45,** 35–60.

Benston, G. J., and Wood, R. (1997). Spreads and even eighths quotations on Nasdaq, unpublished manuscript, Emory University.

Bessembinder, H. (1997). The degree of price resolution and equity trading costs, *J. Finan. Econ.* **45,** 9–34.

Brennan, M. J., Chordia, T., and Subrahmanyam, A. (1998). Alternative factor specifications, security characteristics, and the cross-section of expected stock returns, *J. Finan. Econ*., in press.

Christie, W. G., and Huang, R. D. (1994). Market structures and liquidity: A transactions data study of exchange listings, *J. Finan. Intermed.* **3**, 300–326.

Christie, W. G., and Schultz, P. H. (1994). Why do Nasdaq market makers avoid odd-eighth quotes? *J. Finance* **49,** 1813–1840.

Christie, W. G., and Schultz, P. H. (1997). The initiation and withdrawal of odd-eighth quotes among Nasdaq stocks: An empirical analysis, *J. Finan. Econ*., in press.

Clyde, P., Schultz, P. H., and Zaman, M. (1997). Trading costs and exchange delisting: The case of firms that voluntarily move from the American Stock Exchange to the Nasdaq, *J. Finance* **52,** 2103–2112.

Constantinides, G. M. (1986). Capital market equilibrium with transaction costs, *J. Polit. Econ.* **94,** 842–862.

Department of Justice (1996), Economic Impact Statement, U.S. District Court for the Southern District of New York, USA vs. Alex Brown & Sons, *et al*.

Heaton, J., and Lucas, D. (1996). Evaluating the effects of incomplete markets on risk sharing and asset pricing, *J. Polit. Econ.* **104,** 443–487.

Kadlec, G. B., and McConnell, J. J. (1994). The effect of market segmentation and illiquidity on asset prices: Evidence from exchange listings, *J. Finance* **69,** 611–636.

Kandel, E., and Marx, L. M. (1997). Nasdaq market structure and spread patterns, *J. Finan. Econ.* **45,** 61–90.

Michaely, R., and Vila, J.-L. (1996). Trading volume with private valuation: Evidence from the ex-dividend day, *Rev. Fin. Stud.* **9,** 471–509.

Securities and Exchange Commission (1996), Report Pursuant to Section 21(a) of the Securities and Exchange Act of 1934, Regarding the NASD and the Nasdaq market, Release no. 34-3754.

Vayanos, D. (1998). Transaction costs and asset prices: A dynamic equilibrium model, *Rev. Fin. Stud.* **11,** 1–58.