Market Structure, Fragmentation and Market Quality
- Evidence from Recent Listing Switches

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Abstract

Have structural changes in the U.S. equities markets, such as decimalization, the growth of ECNs, and the improvements in order routing technologies, shifted the competitive landscape to the advantage of decentralized Nasdaq-listed trading? We examine a range of market quality indicators for companies that have recently switched listings from Nasdaq to the NYSE, in 2002-3. We find that, consistent with pre-decimal, pre-ECN studies, the switching stocks have showed significant reductions in price volatility and quoted spreads, improvements in the information efficiency of prices, and reductions in trading costs. The improvements appear to stem from the consolidated NYSE order flow. To explore this hypothesis further, we examine cross-sectional variation in the degree of order flow fragmentation for the switching stocks. We find that the improvements in key indicators tend to be greater for companies whose Nasdaq order flows are more fragmented, providing additional evidence that order flow consolidation improves market quality. We also provide several types of evidence that our findings are not influenced by sample selection bias.

1. Introduction

Recent structural changes in equities markets and the introduction of new trading mechanisms have raised questions about what type of market design works best, in terms of transactions costs, price efficiency, and liquidity.[1] One change was the introduction of decimals pricing in early 2001.[2] Another has been the growth of electronic communications networks (ECNs), which now account for a majority of executions in Nasdaq-listed stocks. In addition, there has been a spread of automated order routing technologies and of strategies that rely on fast order submissions, cancellations, and resubmissions. There also has been a large increase in computer-supported list, or "program" trading. There is evidence that the distribution of the NYSE limit order book information in 2002 has affected trading strategies, and automatic order executions on the NYSE have grown rapidly and steadily.[3] There also is evidence that ECNs contribute to market efficiency for very liquid securities (see Huang (2002) and Jones and Lipson (2003)).[4] It is possible that this succession of changes may have affected the relative advantages of one type of market structure compared to another.

A number of past studies, using several different methods, have implicitly compared the relative advantages of different market structures by comparing the trading characteristics of NYSE listed and Nasdaq listed stocks. Christie and Huang (1994), Barclay (1997), Heidle and Huang (1999) found that Nasdaq stocks switching to the NYSE had their effective and quoted spreads significantly reduced. Bessimbinder (1999) examined 190 companies that switched from Nasdaq to the NYSE during 1996-7 and found lower daily volatility on the NYSE. Huang and

[1] See Lee (1993), Christie and Huang (1994), Barclay (1997), Bessembinder and Kaufman (1997), Bessembinder (1999), Heidle and Huang (1999), Huang and Stoll (1999), Venkataraman (2000), Jones and Lipson (1999a), Bessembinder (2003), Boehmer (2003), among others.

[2] Jones and Lipson (1999) and Bollen and Busse (2003) provide evidence that the $1/16 tick size and decimalization changed the institutional trading and raised institutional trading costs.

[3] Regarding the dissemination of real-time order book data for NYSE stocks, see Boehmer, Saar and Yu (2002).

[4] Huang (2002) provides evidence that the proliferation of ECNs promotes Nasdaq quote quality rather than fragmenting the market. Jones and Lipson (2003) find evidence that the Island ECN contributed to the price discovery of the three most active ETFs, and that after Island stopped posting quotes on September 23, 2002, trading costs rose and quotes adjusted more slowly for the ETFs.

Stoll (1996), LaPlante and Muscarella (1997), Keim and Madhavan (1996), Bessimbinder and Kaufman (1997), SEC (2001), and Boehmer (2003) used matched sample methodologies and found that that execution costs for similar stocks were generally lower on the NYSE. Jones and Lipson (1999) found that, compared to NYSE price quotes, Nasdaq quotes adjusted more slowly to new information.

One basic question is why the markets have had such different trading characteristics. Several studies have examined the effects of decentralized, or "fragmented", trading on market quality. Cohen, Conroy and Maier (1985) show that a fragmented market may result in a wider bid-ask spread because of decreased opportunity for order interaction. Cohen, Mair, Schwartz and Whitecomb (1982) point out that off-exchange executions may benefit brokers but harm the market as a whole. Mendelson (1987) finds that the fragmented market has less liquidity and increases price variances faced by investors. Madhavan (1995) shows that fragmentation results in higher price volatility and violations of price efficiency. Amihud, Lauterbach and Mendelson (2002) provide evidence that order consolidation improves liquidity and pricing.

A basic question is whether and how the recent technological and structural changes may have altered the conclusions that emerged from the earlier research regarding the relative advantages of NYSE and Nasdaq listings. In this paper, we examine stocks that transfer between markets in 2002-3. We find that, as in earlier studies, the stocks that switch listings to the NYSE experience a significant reduction in price volatility, in particular the short-term return volatility, which is also associated with improvements of several measures of price efficiency. We also find that stocks have tighter quoted spreads and lower execution costs after switching. Although we use several methodologies to test for the possibility that these results might be affected by a sample selection bias, we find no evidence of such a bias. In addition, we investigate in more depth the hypothesis that the fragmentation of the order flow for Nasdaq-listed stocks accounts for the improvement when stocks shift to NYSE. Controlling for market capitalization and volume, we find that stocks with more fragmented Nasdaq order flows experience larger drops in

price volatility when they move to NYSE, and this leads to tighter quotes and lower execution costs.

Our paper proceeds as follows. Section 2 introduces our sample and data for the stocks that switched markets, and describes our methodology. Section 3 presents the findings on changes in volatility and information efficiency of prices for switching stocks. Section 4 presents the evidence on quoted and effective spreads. Section 5 examines and rejects the hypothesis of selection bias for the switching stocks. Section 6 gives the additional evidence for fragmentation effects, making use of cross-sectional differences among switching stocks.

2. Sample and Data

Our sample consists of 39 U.S. companies that voluntarily switched their listings from Nasdaq to the NYSE between January 2002 and March 2003.[5] The data that has been used in this study are from publicly available sources.[6] The sample statistics are summarized and reported in **Table 1** for the 39 companies that switched, as well as for the 660 Nasdaq-listed companies that appeared eligible to list on NYSE as of December 2001 but did not.[7] **Appendix A** presents more details about the 39 transferred stocks during 60 days prior to their switches.

The sample of switching stocks has an average market capitalization of $1.5 billion, as shown in Appendix A, ranging from $8 billion to about $160 million. The daily volatility, measured by the standard deviation of close-to-close return, of the sample is about 3 – 4 %, slightly below average for Nasdaq stocks.[8] The average daily closing price for the sample stocks range from $10 to $58, with the mean of $24. As shown in the lower panel of Table 1, the

[5] No firms voluntarily switched from the NYSE to Nasdaq during this period. Several delisted NYSE firms, such as Kmart, subsequently traded on Nasdaq market, at low prices and liquidity.

[6] Stock prices, trading volumes, numbers of trades, and trade sizes are from the TaQ database. Market capitalization, shares outstanding and other company-specific data are from the CRSP database. Effective spreads are from the market quality data reports by markets under SEC Rule 11Ac1-5.

[7] We will treat the timing of switches as exogenous. Although one might hypothesize that switches are timed to increase their effect on market quality, the selection bias correction applied later in our study mitigates any such hypothetical effect. In any case, it is unlikely to be significant because the timing of switches is planned in advance and not well suited to capture short-term fluctuations in the relative trading conditions between the two markets, even if these were foreseeable.

[8] The average daily volatility for Nasdaq stocks is 4 – 5 % during 2002 based on the daily CRSP data.

median market capitalization and other variables for the 660 Nasdaq listed firms that are eligible for the NYSE listing standards are generally similar to those for the 39 switchers.

Quoted spreads for out study are National Best Bids and Offers (NBBO). We compile the NBBO quotes from the TAQ database.[9] Data on execution quality and measures of market fragmentation are from the data reported by market centers under the requirement of the SEC Rule 11Ac1-5. **Table 2** summarizes and reports the 11Ac1-5 data (also called Dash5 data in our paper) for our 39 sample stocks.[10] The 11Ac1-5 statistics show that trading strategies are different for the NYSE and Nasdaq orders, the latter being more weighted toward marketable limits rather than market orders, and on average 35% of the (share-weighted) orders placed on Nasdaq are cancelled and 61.7% shares are executed.[11] Comparable NYSE numbers are 11% cancelled and 88% executed.[12] We implicitly assume that the cancellation rate and order type differences reflect different strategies adapted for different market structures, rather than market quality measures *per se*.

Panel B in Table 2 reports the market fragmentation information on Nasdaq and on the NYSE. We propose two measures as proxies of market fragmentation. One is the Herfindahl-Hirschman Index (HHI), based on the distribution of the orders that are covered in 11Ac1-5 reports across market centers.[13] The table shows basic statistics for the HHI, which increases in median value from 0.441 to 0.971 for the stocks that have switched. This finding is consistent

[9] In the TAQ database, quotes from Nasdaq dealers or ECNs are labeled as "T." In compiling the NBBO quotes, we use all quotes from the NYSE, Nasdaq, and all regional stock exchanges.

[10] Rule 11Ac1-5 requires market centers to make available to the public monthly electronic reports that include uniform statistical measures of execution quality. For every security and month, each market center is required to report execution quality measures, including effective spreads, realized spreads, and execution speed, for various order types and sizes. While 65 firms transferred from Nasdaq to NYSE after decimal pricing was introduced, 39 of these (36 in 2002 and 3 in the first quarter of 2003) transferred after sufficient 11Ac1-5 data were available.

[11] The executed percentage and the cancellation rate can be effected by double counting that have been practiced in reporting the 11Ac1-5 data.

[12] 11Ac1-5 executions, cancellations, and order data, when aggregated across reporting market centers, include double counting due to orders received by a market that then routes the orders elsewhere for execution. Such practices occur considerably more for Nasdaq listed stocks, and the aggregated data must be interpreted with caution.

[13] The market center in 11Ac1-5 reports is the individual market venue that provides execution service.

with the current market structure of the Nasdaq, an ECN-dealership market, versus the NYSE, a centralized auction market with about 80% market share of its listed stocks.

We also measure fragmentation simply as the number of market centers that file Dash5 reports for a given stock. The average number of market centers that receive order flows and provide executions is 22 per stock on Nasdaq, with a maximum of 59 market centers. In comparison, the NYSE has on average 7 market centers.[14] The standard deviations of the two fragmentation measures are also higher on Nasdaq market.

3. Volatility and Price Efficiency

In this section we examine price volatility and price efficiency. We find that volatility, in particular short-term volatility, falls when stocks switch, which is an improvement if lower volatility means less extraneous price movement unreflective of information relevant to the stock. At the other end of the spectrum, it is possible to have too little volatility, in the sense that prices adjust sluggishly. Using several methods we find that the volatility related to transitory price movements has fell and the information efficiency of prices improves after the stocks trade on the NYSE.

3.1. Volatility Measures

We examine several volatility measures. One is the standard deviation of daily returns. Variants are computed based on daily prices during 60 trading days before and 60 trading days after switches, relative to each stock's switching date. Since daily return volatilities may reflect the arrival of market and company news, we also focus on return volatility for a shorter horizon, such as 5-minute interval, which should be more reflective of transitory price change due to

[14] The SEC grants certain exemptions from the 11Ac1-5 rule, one for very inactively traded securities and one for small market centers that do not focus their business on active trading of the securities. First, the SEC exempts any national market system security that did not average more than 5 reported transactions per trading day, as disseminated pursuant to an effective transaction reporting plan, for each of the preceding six months (or such shorter time that the security has been designated a national market system security). Second, the SEC is exempting any market center that reported fewer than 200 transactions per trading day on average over the preceding six-month period in securities that are covered by the Rule. For further information, please see SEC, 2001**, "**Exemptive Order: NASD Small Firm Advisory Board on Rule 11Ac1-5," June 22, 2001.

market structure differences and order imbalance. In addition, we also examine price high-low ranges in the 5-minute intervals. The price high-low range is a simple and widely used volatility measure that gives particular weight to extreme values.[15] Studies have shown that the extreme value volatility estimators have good empirical performance and closely relate to market structure.[16]

Panel A of **Table 3** shows mean and median values of the daily return volatility measures for the 39 stocks. We have measured returns based on both trade prices and quote midpoint prices, since trade price return is affected by bid-ask spread.[17] We also use open-to-open and close-to-close intervals in our measure. Panel B shows the return volatilities over 5 minute periods, and Panel C measures the high-low price ranges for 5-minute periods. Our evidence is

[15] We have thoroughly screened our trade data to exclude any problematic transactions or transactions that might have effects on the high-low range measure. In our study, we have excluded the following trades:

1.) Trades are done outside of the regular market hours between 9:30AM – 4:00PM.
2.) Cancelled Trades (CORR = 7 – 12 in TAQ): trades cancelled due to errors, such as wrong time stamps or prices.
3.) Bunched trades (COND = B in TAQ): a trade representing an aggregate of two or more regular trades.
4.) Bunched sold trade (COND = G in TAQ): a bunched trade not reported within 90 seconds of execution.
5.) Sold last trade (COND = L in TAQ): a transaction that occurs in sequence but is reported to the tape at a later time.
6.) Opened last trade (COND = O in TAQ): an opening trade that occurs in sequence but is reported to the tape at a later time.
7.) Pre- and Post-Market Close Trades (COND = T in TAQ): a Nasdaq trade that occurred within the current trading day, but is reported outside of the current market hours.
8.) Average Price Trades (COND = W in TAQ): A trade where the price reported is an average of the prices for transactions during all or any portion of the trading day.
9.) Sold Sale (COND = Z in TAQ): a transaction that is reported to the tape at a time later than it occurred.
10.) A trade in regular market hours whose price is 20% more or less than the previous trade.

We also exclude the following quotes in our analysis:

1.) Quotes outside the regular market hours between 9:30AM – 4:00PM.
2.) Quotes whose spread is greater than $2.00 or 10% greater than the quote midpoint.
3.) Quotes whose midpoint rose or fell 20% or more from the previous quote midpoint.
4.) Quotes associated with special market conditions, such as trading halt, news pending, or news dissemination.

Overall, we have deleted less than 0.1% of the trades and quotes from the CT and CQ files.

[16] See Parkinson (1980), Li and Weinbaum (2000), Spurgin and Schneeweis (1997), among others.

[17] We also replicate the study by examining bid-to-bid and ask-to-ask returns. The results are not different materially.

consistent with the theory that returns measured using trade prices are generally higher than the returns from the quote midpoints, which are free from the bid-ask bounds.

The daily return volatilities show slight declines that are marginally statistically significant after listing switches. The short-term return volatilities in 5-minute intervals fall and the fall is highly significant. The average 5-minute high-low price range, measured in dollar terms, shown in cents, as well as in relative terms, shown in basis points, falls more than half (from 8.5 to 4 cents). This low volatility in terms of price high-low range reflects the essence of the auction market: specialists act as catalysts or principals when liquidity is needed, thus dampening transitory shocks on prices due to order imbalance. More generally, the consolidation of order flows increases the likelihood that buy and sell orders meet with each other, mitigating price impact.

Figure 1 depicts the daily average of the 5-minute interval price range for the 60-day window before and 60-day window after the switch. There is no apparent trend prior to or after the switches, consistent with the notion that the drop reflects more market structure differences. **Figure 2** plots the average intraday patterns of the 5-minute volatilities before and after switches. While the largest differences are at the opening (reflecting the NYSE opening auction procedures) and to a lesser extent at the close, the volatility improvement is apparent all day long. This is consistent with the finding that the daily returns are less volatile on the NYSE even when based on mid-day prices. Weaver (2002) reaches a similar conclusion using a matching sample approach.

3.2. Effects of Switching on Price Efficiency

As noted, a decline in volatility improves market quality primarily to the extent that it eliminates price movements that are noisy or extraneous, not those that reflect the arrival of information. Jones and Lipson (1999) provided evidence that Nasdaq prices adjust more slowly to new information, which might imply that the information-based components of price movements on Nasdaq should be positively auto-correlated across short time intervals, as

information creates short-lived trends in price quotes and transactions prices. As for overall prices, the effect of non-information based price movements must also be included. The decentralized trading of a stock across a number of markets, each with limited depth and providing only a partial picture of order flow, might lead to reported prices swinging up and down for liquidity reasons, although the pure noise swings could be expected to be at least partially unwound subsequently. In a well functioning market, the prices in one period would be essentially uncorrelated with subsequent prices, with neither positive nor negative auto-correlation, and the noise component of prices would be small.

We use three measures of price efficiency. The first is the autocorrelation of short-term price returns from one period to the next. A measurement challenge is that trade prices bouncing between bid and ask tend to give the return autocorrelation a negative value. While narrower bid-ask spreads under decimalization may have reduced this source of statistical bias, we compute autocorrelations based on of the midpoints of the quoted prices.

The second measure of price efficiency compares the variances of price returns in two separate 5-minute periods with the variance over the combined 10- minute period. If the prices are not affected by autocorrelation, these variance ratios should be equal to one. If they are positively auto-correlated, so that, for example, an upswing in prices for five minutes tends to be followed by a down-swing for liquidity reasons, then the variance in the overall10 minute period would be less than the sum of variances in the two five minute periods.

The last measure of examining price efficiency is based on Hasbrouck (1993) variance decomposition approach. Hasbrouck (1993) assumes the transaction price has two parts, the efficient price that follows the random walk and the pricing error due to noise, and decomposes the variance of transaction price into variance of the efficient price and the variance of noise. The approach separates the noise variance component of price movements from the information-based variance component.

Tables 4 - 6 show these measures of price efficiency, all of which improve when the stocks switch from Nasdaq to NYSE. The auto-correlation of returns based on quote midpoint movements, as shown in **Table 4,** declines a statistically significant amount. **Table 5** shows that the variance of pricing error, following the Hasbrouck (1993) variance decomposition approach, drops as well, by a statistically significant amount. **Table 5** also shows a version of the Hasbrouck measure as the ratio of the standard deviation of noisy trade-to-trade price movements to the price, allowing us to express the noise reduction in basis points. **Table 6** shows the ratio of the 10-minute price return variances to the sum of the 5-minute price variances rises a statistically significant amount, in the direction of unity. The improvements in the various measures of price efficiency are statistically significant, so the variance reduction of switching stocks should be viewed as improvements.

4. Effects of Switching on Quoted and Effective Spreads

A quoted spread compensates a dealer, specialist, or limit order submitter for providing liquidity and bearing risk due to adverse selection. That volatility falls and price information efficiency increases when stocks switch to the NYSE suggests that quoted spreads would narrow as well.[18] Goldstein (1994) found that effective, as well as quoted, spreads were narrower on the NYSE than Nasdaq, controlling for individual stock characteristics.[19] In this section we check to see whether the declines in volatility and improvements in price efficiency led to narrower quoted and effective spreads after stocks switched to the NYSE.

[18] A different hypothesis might be, for example, that the 5 minute price volatility differences between NYSE and Nasdaq reflect the dispersion of liquidity on Nasdaq and the associated idiosyncratic risk of pushing prices up when buying or down when selling at a particular market center. But if these mismatches of demand and supply of liquidity were idiosyncratic, unconnected events, then these risks would be diversifiable and would not necessarily imply that the inside quotes would be wider on the Nasdaq market. On the other hand, if the dispersed market structure created not only more price volatility but also more undiversifiable risk for dealers or limit order providers due to less complete information about order flow and market direction, then the quotes would be wider as well. Similarly, the effective spread, reflecting the (required) execution cost in the competitive market should also be narrower in a market with a lower price volatility and better information.

[19] For a discussion of effective spreads, see Blume and Goldstein (1997).

The National Best Bid and Offer (NBBO) for each switching stock is derived from the CQ file of the TAQ database. We weight quote values by how long they are in effect. We also have NBBO effective spreads from the 11Ac1-5 reports. Because these 11Ac1-5 effective spreads are conditional on order type and size, we weight each value by the number of shares bought or sold at that value.

As in the preceding section, we use 60-trading day pre- and post-switch windows in studying the quoted spreads from the NBBO files. When using the (monthly) 11Ac1-5 data on effective spreads, we compare 3 months of data prior to and 3 months after each of the switches, skipping the switching month.

4.1. Changes in Quoted Spreads

The evidence in **Table 7** is strong that quoted spreads fall, both in cents and in basis points, when stocks switch to NYSE. We employ the t test and the Wilcoxon non-parametric test of the statistical significance of the mean and the median differences. The results are also shown in **Figure 3**, where we depict the time series of daily time-weighted NBBO quoted spread during (-60, -1) and (0, +59). The quoted spreads on average drop 40% when the stocks switch to the NYSE. In addition, the coefficient of (day to day) variation for the Nasdaq quote is 69.8%, compared with 46.7% for the NYSE quote.[20]

Figure 4 shows the intraday comparison of quoted spreads for each of the seventy-eight 5-minute intervals. As with price volatility, the NYSE improvement is particularly large at the opening and at the close, but again the NYSE average quoted spreads are tighter throughout the trading day.

4.2. Changes in Effective Spreads

We next examine the effects of switching listings on execution costs, using effective spreads from the 11Ac1-5 data. These effective spread measures are of interest in the current

[20] The standard deviation for the daily NBBO quote spread is 0.00641 for Nasdaq and 0.00279 for the NYSE. The coefficient of variation for Nasdaq quote is 0.00641 / 0.0919 = 69.8%, and the coefficient of variation for NYSE quote is 0.00279 / 0.0597 = 46.7%.

context because they compare execution prices with order-arrival-time mid-quotes. Hence they are sensitive to the amount of time it takes for orders to execute. One putative advantage of the ECN-based system is that it is fast to execute orders. Particularly during a period of price movement, traders believe that a fast execution speed results in better trading opportunities and executions.

Table 8, however, shows that effective spreads decline significantly when the stocks shift to the NYSE. On average, the per-share effective spread across the 39 stocks decreases by about half, from 11.2 cents to 5.7 cents. **Figure 5** illustrates the drop. This finding is consistent with the evidence of the reduction of volatility and quoted spreads.

An alternative approach to measuring transaction costs is developed by Hasbrouck (1993). Following that method, we calculate expected transaction costs to be 0.141 % on Nasdaq and 0.048 % on the NYSE.[21]

5. Selection Bias

5.1. Sample Comparison

If the switching companies are not typical of Nasdaq firms who are eligible to switch, then the before-and-after analysis might contain statistical biases. One check on this is to compare the firms that have switched with those that do not. As **Table 1** illustrated, the 39 stocks that have switched have median values of the observable measures that are very similar to the median values of all the eligible Nasdaq firms.

5.2. Matching Sample

[21] In Hasbrouck (1993), the expected transaction cost can be computed as the expected value of the deviation, $E|s_t| = \sqrt{\frac{2}{p}}\sigma_s$. Using the average variance of deviation reported in table **6**, we can get the expected transaction cost for Nasdaq is: $E|s_t| = \sqrt{\frac{2}{p}}\sigma_s$ = 0.8 * (SQRT (1.176e-6)) = 0.8 * (0.00176) = 0.00141; and the expected transaction cost for the NYSE is: $E|s_t| = \sqrt{\frac{2}{p}}\sigma_s$ = 0.8 * (SQRT (0.61156e-6)) = 0.8 *(0.0006) = 0.00048.

A more elaborate check is to match the switching stocks with non-switching Nasdaq stocks, based on observable characteristics, and see whether and how volatility and spreads for these "sister" stocks changed before and after. We have used market cap, trading volume, price, and return volatility to select 39 matching stocks out of over 3600 Nasdaq securities, the universe of Nasdaq traded stocks.[22] **Appendix 2** lists the details of the transferred and their matching Nasdaq stocks. **Appendix 3** provides summary statistics of the two samples, the transferred sample and the matching sample. **Appendix 4** summarizes return volatility, autocorrelation, quoted spread, and effective spread for the 39 matching and non-switchers around the 60-day period when their "sister" stocks have switched. Based on daily or 5-minute intervals, the various measures of volatility, quoted spreads, and effective spreads did not change for the non-switching group. The evidence suggests that the changes observed for the switches are due to the listing change.

5.3. The Two-Stage Probit Model

Besides the matching sample approach to control selection bias, another way of assuring that our conclusions are robust is to use a two-stage procedure controlling for selection bias developed in Heckman (1979), Maddala (1983), and Amemiya (1985). The two-stage procedure first uses a probit model to explain the influences of a number of firm characteristics on the company's decision to switch listings. Intuitively, in the first stage we include explanatory variables that try to predict which firms will switch (other than the prospective changes in their volatilities or other market quality indicators). In the second stage, we compute the inverse Mills ratio from the results out from the first stage probit model. We then use the inverse Mills ratio as a control variable in our regressions that study the changes of market quality to control selection bias in the coefficient estimates.

The probit regression requires a sample of all Nasdaq stocks that meet the NYSE listing standards. We gather the company information that relates to the NYSE listing standards, such as

[22] Our matching criterion is consistent with the matching criterion used in the SEC (2001).

the number of round-lot shareholder, monthly volume, market capitalization, the number of shares outstanding, pretax earnings, operating cash flow, and etc, from the CRSP and COMPUSTAT datasets.[23]

For market capitalization, shares outstanding, and trading volume, we computed monthly averages during January 2001 – December 2001. For earning and operating cash flow, we calculate the annual averages during 2001 – 2002. We find market capitalization and trading volume to be the most binding variables in selecting the eligible Nasdaq stocks for listing on the NYSE.[24] We have identified 663 companies from over 3600 Nasdaq-listed firms that meet the NYSE listing standards as of December 2001 (including the 39 who subsequently switched). We exclude 3 companies from the 663 Nasdaq NYSE-eligible sample firms due to data missing in the CRSP or Compustat database. As a result, our total number of sample stocks is 660.

We estimate the following probit model across the 660 companies that meet the NYSE listing requirements until December 2001:

$$\text{Prob}_j(\text{transfer}) = \alpha + \beta_1 \ln(\text{mcap}_j) + \beta_2 \ln(\text{shareout}_j) + \beta_3 \ln(\text{volume}_j) + \beta_4 \ln(\text{price}_j) + \beta_5 \ln(\text{mmcnt}_j) + \beta_6(\text{volatility}_j) + \beta_7(\text{return}_j) + \beta_8(\text{close\_spread}) + \beta_9 \ln(\text{distance}_j) + \beta_{10} \ln(\text{hsicmg\_num}_j) + \beta_{11}(\text{ex\_cindex}_j) + e_j$$

where

1.) $\text{Prob}_j(\text{transfer}) = \rho$, and ρ has the value 1 for the 39 transferred companies, and zero otherwise for the rest sample stocks;

2.) mcap (market capitalization) is the product of the number of shares outstanding and the price; price is the daily average close price;

[23] For the detailed NYSE listing standards for the domestic companies, please see Section 102.00 of the NYSE Listed Company Manual.

[24] The NYSE listing standards requires that the company have to have at least 500 round-lot shareholders if it has at least 1,000,000 shares monthly trading volume in the last 12 months, or 2,200 round-lot shareholders if the average monthly trading volume is at least 100,000, or 2,200 round-lot shareholders.

3.) volatility is measured as the standard deviation of daily close-to-close return; volume is the daily trading volume in shares;

4.) mmcnt is the the number of registered Nasdaq market maker;

5.) close_spread is the ratio of the quote spread between the closing ask and the closing bid to the quote midpoint;

6.) distance is the geographic distance between the firm to the New York Stock Exchange, measured between the New York City and the capital city of the US state in which the firm is located until December 31, 2001;

7.) hsicmg_num is the total number of listed companies in the major group of the Standard Industry Classification (SIC) in which a firm belongs to;

8.) ex_cindex is the Exchange Industry Concentration Index (EICI), which is the defined as the ratio between the total market cap of all Nasdaq NYSE-eligible firms to the total market cap of the NYSE firms and the Nasdaq NYSE-eligible firms in the SIC major group.

All the above variables are estimated during the period from January 1, 2001 to December 31, 2001. The estimation results are reported in **Appendix 5**. They show that trading volume, the registered market maker number, the daily return, and the exchange industry concentration index have significant explanatory power in the probit model.

The evidence suggests that when the stocks have experienced positive returns and are active, they have a lower tendency to switch listings. Of particular interest, we have found that stocks with a higher number of Nasdaq market markets tend to switch, suggesting that order fragmentation may play a role. In addition, the evidence from the exchange industry concentration index suggests that the higher the industry concentration on the Nasdaq, the higher the probability that companies leave Nasdaq and switch to the NYSE.

For example, industry group 73 is one of the top 15 SIC major groups with the highest Nasdaq concentration index, about 56%.[25] Among the 39 transferred stocks, we have 4 companies in the "73" SIC major group. The probit model indicates that although this group is over-represented on Nasdaq, these companies' probabilities of switching to NYSE are relatively high. Besides the above variables, daily return volatility is marginally significant, implying that stocks with higher daily return volatility tend to switch to the NYSE.

For sensitivity analysis, we also used two other variables in the regression in replacing the hsicmg_num: (1) the total market capitalization of listed companies in each of the SIC industry major group, and (2) the total market capitalization of the listed companies on Nasdaq in each of the SIC industry major group. Including these do not materially affect the estimates. In addition, we also replace the daily return volatility with the daily average price range, measured as the ratio of the difference of daily high and low price to the daily closing price, and the results do not change much either. In addition, changing the sample period from January 2001 – December 2001 to the second half year of 2001 had little effect.

After we obtain the fitted probit value ρ_j for each stock in the first stage PROBIT regression, we compute the inverse Mills ratio:

$$\lambda_j = \varphi(\rho_j) / \Phi(\rho_j) \qquad (4)$$

where $\varphi(\rho_j)$ is the standard normal density function, and $\Phi(\rho_j)$ is the standard normal distribution function. To control for selection bias, we insert the inverse Mills ratio as a dependent variable into regression equations that explain improvements in volatility and spreads, conditional on firm characteristics and the degree of fragmentation of order flow in that stock.

6. Fragmentation Effects

[3] The "73" SIC industry group is classified as "Business Service" by the US Census Bureau. Microsoft (MSFT) is in this group.

We predict the degree of volatility reduction for switching stocks, based on pre-switch market capitalization, pre-switch trading volume, and the degree of market fragmentation in orders and executions. We insert the inverse Mills ratio estimates to control for possible selection bias.

Table 9 shows the results for daily volatility, 5-minute volatility, and 5-minute high-low price ranges. For all three volatility measures, the fragmentation indicators are statistically significant and of the expected sign. More fragmentation on Nasdaq is associated with a bigger reduction in volatility when the stocks switch. The inverse Mills ratio coefficients are not statistically significant.

Table 10 reports regressions of a similar form, except that the dependent variable is the degree of tightening in the NBBO quoted spread (measured in cents or basis points and in absolute or proportional changes). Again controlling for market capitalization and volume on Nasdaq, and also controlling for daily volatility, which may reflect news arrival rates, we examine quoted spread changes before and after the switches. In these regressions, the fragmentation measures have the expected signs and p-values of between .09 and .02, depending on the exact specification. The inverse Mills ratio is significant in these regressions.

Table 11 makes use of the 11Ac1-5 data to check how effective and quoted spreads were influenced by the switches, but controlling for other competing explanations other than market structure differences. The changes in the market capitalization, in trading volumes, and in daily volatility were entered as explanatory variables, along with inverse Mills ratios. Regressions were estimated by different order size categories. In these specifications, the constant terms in the regressions provide a simple measure of the conditional improvement in effective spreads.

The results in Table 11 are significant for market orders in the two small order categories from 100 shares to 1,999 shares. R-squared values are plummeting and coefficient estimates are failing to obtain statistical significance for the two large order categories with orders above 2000 shares and below 10,000 shares. We find weak evidence for marketable limit orders. The

constant terms for the two smaller market order categories display the strongest and most consistent statistical significance, providing indications of the drops in effective and quoted spreads, with improvements ranging from 3 to 5 cents, conditioning on changes of market capitalization, daily return volatility, and trading volume. We attribute the improvement of quoted spread and effective spread for the 39 switching stocks to the change of market structure and order flow consolidation.

7. Summary and Conclusion

Examining the stocks of companies that switched listings during 2002-3, after the introduction of decimals and the rapid growth of ECNs, this article found that, after switching, volatility was smaller and price efficiency greater. Quoted spreads were smaller and execution costs fell. We tested for and controlled for selection bias, and the results do not appear affected by such bias, to the limited extent we could find evidence of it. The paper develops measures of fragmentation of order flow and provides evidence linking the declines in such fragmentation when firms switch to NYSE and the switching-related improvements in volatility and spreads.

We conclude that (1) the NYSE continues to provide less volatility, tighter spreads, and lower execution costs in the wake of decimalization, the spread of ECNs on Nasdaq, and other improvements in automation in the market; (2) the key to the market quality of NYSE appears to the consolidation of order flows, and conversely the ability of Nasdaq-listed stocks to obtain good executions and low volatility appears to be inversely related to the degree of order flow fragmentation. For the purpose of designing effectively functioning markets, these results underline the importance of order flow consolidation in a single primary market where buy and sell orders can interact competitively and prices can be discovered more efficiently.

References

Amemiya, Yasuo, 1985, "Instrumental Variable Estimator For The Nonlinear Errors-In-Variables Model," *Journal of Econometrics*, v28(3), 273-290.

Amihud, Lauterbach and Mendelson, 2002, "The Value Of Trading Consolidation: Evidence From The Exercise Of Warrants," Working Paper, New York University.

Andersen, Bollerslev, Diebold and Labys, 1999, "Realized Volatility And Correlation," Working Paper, Northwestern University.

Barclay, Michael J., 1997, "Bid-Ask Spreads And The Avoidance Of Odd-Eights Quotes On Nasdaq: An Examination Of Exchange Listings," *Journal of Financial Economics*, v45 (1,Jul), 35-60.

Bessembinder, 2003, "Selection Biases And Cross-Market Trading Cost Comparisons," Working Paper, University of Utah.

Bessembinder, Hendrik, 1999, "Trade Execution Costs On NASDAQ And The NYSE: A Post-Reform Comparison," *Journal of Financial and Quantitative Analysis*, v34[3,Sep], 387-407.

Bessembinder, Hendrik and Herbet M. Kaufman, 1997, "A Comparison Of Trade Execution Costs For NYSE and NASDAQ-Listed Stocks," *Journal of Financial and Quantitative Analysis*, v32[3,Sep], 287-310.

Bessembinder, Hendrik and Herbert M. Kaufman, 1998, "Trading Costs And Volatility For Technology Stocks," *Financial Analyst Journal*, v54(5,Sep/Oct), 64-71.

Blume, Marshall E. and Michael A. Goldstein. "Quotes, Order Flow, And Price Discovery," Journal of Finance, 1997, v52(1,Mar), 221-244.

Boehmer, 2003, "Dimensions Of Execution Quality: Recent Evidence For U.S. Equity Markets," Working Paper, New York Stock Exchange.

Boehmer, Jennings and Wei, 2003, "Public Disclosure And Private Decisions: The Case Of Equity Market Execution Quality," Working Paper, New York Stock Exchange.

Boehmer, Saar and Yu, 2002, "Lifting The Veil: Analysis Of Pre-Trade Transparency At The NYSE," Working Paper, New York Stock Exchange.

Christie, William G. and Roger D. Huang, 1994, "Market Structures and Liquidity: A Transactions Data Study Of Exchange Listings," *Journal of Financial Intermediation*, v3[3], 300-326.

Cohen, Kalman J., Robert M. Conroy and Steven F. Maier, 1985, "Order Flow And Quality Of The Market," In Market Making And The Changing Structure Of The Securities Industry, Y. Amihud, T. Ho and R. Schwartz, eds, Lexington Books.

Cohen, Kalman J., Steven F. Maier, Robert A. Schwartz and David K. Whitcomb, 1982, "An Analysis Of The Economic Justification For Consolidation In A Secondary Security Market," *Journal of Banking and Finance*, v6(1), 117-136.

Coughenour, Jay and Larry Harris, 2003, "Specialist Profits And The Minimum Price Increment," Working Paper, the U.S. Securities and Exchange Commission.
Dyl, E. and A. Atkins, 1997, "Market Structure and Reported Trading Volume: Nasdaq versus the NYSE," *Journal of Financial Research,* 20 (Fall 1997)

Hamilton, James L., 1979, "Marketplace Fragmentation, Competition, And The Efficiency Of The Stock Exchange," *Journal of Finance*, v34(1), 171-187

Harris, L., 1993, "Consolidation, Fragmentation, Segmentation and Regulation," Financial Markets, Institutions & Instruments, v2, no. 5, December 1993, 1-28

Hasbrouck, J., 1993, **"**Assessing the quality of a security market: a new approach to transaction-cost measurement," *Review of Financial Studies*, v6, 191-212

Heckman, James J., 1979, "Sample Bias As A Specification Error," *Econometrica*, v47(1), 153-162.

Heidle, H. and R. Huang, 2002, "Information-Based Trading in Dealer and Auction Markets: An Analysis of Exchange Listings," *Journal of Financial and Quantitative Analysis*, 37, 391-424.

Hendershott, Terry and Charles Jones, 2003, "Island Goes Dark: Transpaency, Fragmentation, and Liquidity Externalities," working paper, University of California – Berkeley.

Huang, Roger D., 2002, "The Quality of ECN and Nasdaq Market Maker Quotes," *Journal of Finance*, v57(Jun), 1285–1319.

Huang, Roger D. and Hans R. Stoll, 1996, "Dealer Versus Auction Markets: A Paired Comparison Of Execution Costs On NASDAQ And The NYSE," *Journal of Financial Economics*, v41(3,Jul), 313-357.

Jones, Charles M. and Marc L. Lipson, 1999, "Execution Costs Of Institutional Equity Orders," *Journal of Financial Intermediation*, v8(3,Jul), 123-140.

Jones, C., G. Kaul, and M. Lipson, 1994, "Information, Trading, and Volatility," *Journal of Financial Economics*, v 36, 127-154.

Jones, Charles M. and Paul J. Seguin, 1997, "Transaction Costs And Price Volatility: Evidence From Commission Deregulation," *American Economic Review*, v87(4,Sep), 728-737.

Keim, Donald B. and Ananth Madhavan, 1996, "The Upstairs Market For Large-Block Transactions: Analysis And Measurement Of Price Effects," *Review of Financial Studies*, v9(1,Spring), 1-36.

LaPlante, Michele and Chris J. Muscarella, 1997, "Do Institutions Receive Comparable Execution In The NYSE And Nasdaq Markets? A Transaction Study Of Block Trades," *Journal of Financial Economics*, v45(1,Jul), 97-134.

Lee, Charles M. C., 1993, "Market Integration And Price Execution For NYSE-Listed Securities," *Journal of Finance*, v48(3), 1009-1038.

Lee, Charles M. C., Mark J. Ready and Paul J. Seguin, 1994, "Volume, Volatility, And New York Stock Exchange Trading Halts," *Journal of Finance*, v49(1), 183-214.

Li and Weinbaum, 2000, "The Empirical Performance Of Alternative Extreme Value Volatility Estimators," Working Paper, New York University.

Macey, Jonathan R. and Maureen O'Hara, 1997, "The Law and Economics of Best Execution," *Journal of Financial Intermediation*, 6, 188-223.

Maddala, G., 1983, "Limited Dependent And Qualitative Variables In Econometrics," Cambridge University Press.

Madhavan, Ananth, 1995, "Consolidation, Fragmentation, And The Disclosure Of Trading Information," *Review of Financial Studies*, v8(3), 579-603.

Mendelson, Haim, 1987, "Consolidation, Fragmentation, And Market Performance," *Journal of Financial and Quantitative Analysis*, v22(2), 189-208.

McVey, H. and Parul J. Saini, 2003, "US Equity Trading: Thinking Aloud," Industry Report, Morgan Stanley.

Parkinson, Michael, 1980, "The Extreme Value Method For Estimating The Variance Of The Rate Of Return," *Journal of Business*, v53(1), 61-66.

Peterson, M. and E. Sirri, 2002, "Order Submission Strategy And the Curious Case of the Marketable Limit Orders," Journal of Financial and Quantitative Analysis 37, 221 – 214.

Porter, David C. and John G. Thatcher, 1998, "Fragmentation, Competition, And Limit Orders: New Evidence From Interday Spreads," *Quarterly Review of Economics and Finance*, v38(1,Spring), 111-128.

Spurgin, R. and T. Schneeweis, 1997, "Efficient Estimation of Intraday Volatility," CISDM working paper, Clark University

Stein, Jeremy C., 1987, "Informational Externalities And Welfare-Reducing Speculation," *Journal of Political Economy*, v95(6), 1123-1145.

Stoll, Hans R., 2001, "Market Fragmentation," *Financial Analyst Journal*, v57(4,Jul/Aug), 16-20.

Summers, Lawrence H. and Victoria P. Summers,1989, "When Financial Markets Work Too Well: A Cautious Case For A Securities Transactions Tax," *Journal of Financial Services Research*, v3(2/3), 261-286.

Umlauf, Steven R, 1993, "Transaction Taxes And The Behavior Of The Swedish Stock Market," *Journal of Financial Economics*, v33(2), 227-240.

U.S. Securities And Exchange Commission, 2001, "Report On The Comparison Of Order Execution Across Equity Market Structures," SEC.

Venkataraman, K., 2001, "Automated versus Floor Trading: An analysis of execution costs on the Paris and New York Exchanges," *Journal of Finance*, v56, No4, pg. 1445-1885.

Weaver, D., 2002, “Intraday Volatility on the NYSE and Nasdaq,” working paper, Baruch College

Table 1: Sample Descriptive Statistics and Comparison

We report 13 variables for the 39 transferred stocks and the 660 Nasdaq NYSE-eligible firms that are eligible for the NYSE listing standards until December 2001. For each variable, we report the mean, median, maximum, minimum, the 25 percentile, and the 75 percentile across the sample firms. Among the 13 reported variables, except for the Distance, all other variables are computed using the CRSP daily file during January 1, 2001 to December 31, 2001. Distance is measured between the New York City and the capital city of the US state in which the firm is located until December 31, 2001. SIC Index by number of firm is computed as the ratio between the number of Nasdaq firms, who are eligble for the NYSE listing standards, in a particule SIC major group to the total number of the NYSE firms and the Nasdaq NYSE-eligible firms in that SIC major group. SIC Index by Market Cap is computed as the ratio between the total market cap of all Nasdaq NYSE-eligible firms to the total market cap of the NYSE firms and the Nasdaq NYSE-eligible firms in that SIC major group.

PANEL A: The 39 Transferred Firms							
Variable Description	**Number of Firm**	**MEAN**	**MEDIAN**	**25%**	**75%**	**MAX**	**MIN**
Market Cap ($M)	39	1,379.82	687.28	339.62	1,507.32	12,328.38	92.64
Daily volume (shares)	39	671,126.30	273,180.09	116,898.30	545,231.41	7,000,596.13	4,735.41
Daily Closing Price (unit=$)	39	25.88	23.46	18.33	31.01	53.33	6.50
Daily High-Low Price Range (%)	39	4.86	4.62	3.61	6.20	11.07	1.76
Share Outstanding (Million Shares)	39	52.40	27.85	16.03	58.64	307.07	4.77
Daily Close-to-Close Return (%)	39	0.25	0.16	0.05	0.38	1.18	-0.11
Daily Closing Spread ($0.01)	39	13.77	10.78	7.04	16.13	59.79	3.00
Relative Daily Close Spread (%)	39	0.65	0.49	0.35	0.83	2.01	0.08
Registered Market Maker Count	39	27.28	24.33	18.50	32.64	66.75	9.33
Daily Return Std (%)	39	3.69	3.45	2.68	4.66	9.22	1.32
Distance (miles)	39	1,075.85	832.00	288.00	1,629.00	4,968.00	1.00
SIC Index by Firm Number	39	0.34	0.32	0.19	0.55	0.63	0.05
SIC Index by Market Cap	39	0.18	0.12	0.03	0.16	0.54	0.01
PANEL B: 660 Nasdaq NYSE-Eligible Firms							
Market Cap ($M)	660	3,512.89	764.29	370.17	1,813.06	335,834.13	54.68
Daily volume (shares)	660	1,846,647.01	279,545.39	85,779.40	947,381.12	85,869,764.06	3,627.12
Daily Closing Price (unit=$)	660	25.97	23.36	16.46	32.50	93.85	5.05
Daily High-Low Price Range (%)	660	5.44	5.12	3.75	6.72	12.38	1.54
Share Outstanding (Million Shares)	660	126.58	32.79	18.60	75.81	7,301.24	1.91
Daily Close-to-Close Return (%)	660	0.11	0.11	0.01	0.20	3.58	-7.80
Daily Closing Spread ($0.01)	660	12.98	10.27	6.06	16.60	106.95	-2.29
Relative Daily Close Spread (%)	660	0.61	0.50	0.26	0.84	3.13	-0.40
Registered Market Maker Count	660	32.10	26.08	18.63	39.96	110.58	6.17
Daily Return Std (%)	660	4.12	3.84	2.78	5.20	9.78	1.26
Distance (miles)	660	1,243.31	912.00	273.00	2,509.00	4,968.00	1.00
SIC Index by Firm Number	660	0.42	0.42	0.25	0.55	1.00	0.00
SIC Index by Market Cap	660	0.28	0.16	0.12	0.47	1.00	0.00

Note: 663 Nasdaq stocks satisfied the NYSE listing standards are eligible to switch as of December 2001. There are 3 companies that have missing data in the CRSP and the Compustate databases. As a result, our sample size for the Nasdaq NYSE-eligible stocks is 660.

Table 2: 11Ac1-5 Report Summary

We report the monthly averages of the descriptive statistics in the 11Ac1-5 data. Our sample includes the 39 stocks that have transferred their listings from the Nasdaq to the NYSE during January 2002 to March 2003. Our Dash5 data only includes market order and marketable limit order. We obtain separate results by order type (market orders and marketable limit orders) and by order size (size 21 = 100 – 499 shares, 22 = 500 – 1999 share; 23 = 2000 – 4999 shares; 24 = 5000 – 9999 shares). Executed Percentage is the ratio of the Executed Share to the Covered Share; Cancelled Percentage is the ratio of the Cancelled Shares to the Covered Shares; Executed Away Percentage is the ratio of the Executed Away Shares to the Executed Shares. HHI is computed as the sum of the squared market share of covered orders of each market center reported in the 11Ac1-5. MCNUM is the number of market centers in the 11Ac1-5 data. The investigation window is (-3, -1) for the Nasdaq and (+1, +3) for the NYSE, relative to the switching month of each stock. We exclude the month in which the stock switched from Nasdaq to the NYSE. Our sample period is from October 2001 to June 2003.

PANEL A: Shares Covered, Executed, and Cencelled in Dash5

	Sample	Order Type or Size	Covered Shares	Weight of Covered Shares	Executed Shares	Weight of Executed Shares	Executed Percentage	Cancelled Shares	Cancelled %	Executed Away Shares	Executed Away %
						Overall					
Nasdaq	39	all	15,532,449	1.000	9,402,594	1.000	0.617	5,952,427	0.353	1,499,942	0.200
NYSE	39	all	5,283,117	1.000	4,677,901	1.000	0.879	571,196	0.112	41,766	0.010
						by Order Type					
Nasdaq	39	Market	1,883,886	0.121	1,810,218	0.193	0.898	43,377	0.057	377,091	0.221
Nasdaq	39	M.Limit	13,648,562	0.879	7,592,376	0.807	0.577	5,909,050	0.396	1,122,852	0.197
NYSE	39	Market	2,361,153	0.447	2,319,427	0.496	0.982	30,797	0.012	30,863	0.019
NYSE	39	M.Limit	2,921,964	0.553	2,358,474	0.504	0.812	540,398	0.177	10,903	0.003
						by Order Size					
Nasdaq	39	100-500	2,936,963	0.189	2,130,746	0.227	0.825	843,170	0.184	311,087	0.200
Nasdaq	39	500-1999	7,131,419	0.459	4,540,763	0.483	0.649	2,534,793	0.327	665,296	0.197
Nasdaq	39	2000-4999	3,111,898	0.200	1,686,506	0.179	0.495	1,356,472	0.450	292,255	0.196
Nasdaq	39	5000-9999	2,352,168	0.151	1,044,579	0.111	0.358	1,217,993	0.552	231,303	0.199
NYSE	39	100-500	1,173,371	0.222	1,066,680	0.228	0.918	104,667	0.080	5,192	0.005
NYSE	39	500-1999	2,195,508	0.416	1,965,077	0.420	0.894	220,111	0.099	18,778	0.012
NYSE	39	2000-4999	1,182,241	0.224	1,035,299	0.221	0.834	136,012	0.152	10,877	0.011
NYSE	39	5000-9999	731,998	0.139	610,845	0.131	0.771	110,406	0.199	6,919	0.010

PANEL B: Market Concentration: Herfindahl-Hirschman Index (HHI)

		Nasdaq					NYSE				
	Sample	Mean	Median	STD	Max	Min	Mean	Median	STD	Max	Min
HHI	39	0.471	0.441	0.124	0.700	0.288	0.946	0.971	0.065	0.995	0.683
MCNUM	39	22	20	10	58	6	7	6	3	16	3

Note: We have noticed that the sum of the cancellation rate and the execution rate is less than 100%. This inconsistency might be due to order double counting or data error in the 11Ac1-5 data.

Table 3: Change of Volatility

We report the daily return volatility, the 5-minute return volatility, and the 5-minute price range based on trade price as well as quote midpoint price. Our sample includes the 39 stocks that have transferred their listings from the Nasdaq to the NYSE during January 2002 to March 2003. The tick-by-tick trade and quote data is from the TAQ database. We divide the daily trading regular hour (9:30AM - 4:00PM) into 78 5-minute intervals. For each stock in each interval, we compute the interval close-to-close and open-to-open return based on trade price as well as quote midpoint price. Daily (5-minute) return volatility is measured as the standard deviation of the daily (5-minute) trade price return or the quote midpoint return from the close-to-close and open-to-open. Interval price range is measured as the difference between the interval high and low trade price or the quote midpoint. We obtain the relative interval price range by dividing the interval price range by the interval open and close trade price or the quote midpoint. We also conduct the t tests for the mean difference and the Wilcoxon test for the median difference, and provide p values in parentheses. Our computation window is (-60, -1) for Nasdaq trading and (0, 59) for the NYSE trading relative to each stock's transfer date. Our sample period is from October 2001 to June 2003.

PANEL A: Daily Volatility

		Daily Open-to-Open Trade Price Return			Daily Close-to-Close Trade Price Return		
	Sample	Nasdaq (%)	NYSE (%)	NYSE - Nasdaq (%)	Nasdaq (%)	NYSE (%)	NYSE - Nasdaq (%)
Mean	39	3.429	2.799	-0.630 (0.033)	3.385	2.706	-0.679 (0.012)
Median	39	3.178	2.427	-0.560 (0.064)	3.107	2.499	-0.562(0.021)

		Daily Open-to-Open Quote Midpoint Return			Daily Close-to-Close Quote Midpoint Return		
	Sample	Nasdaq (%)	NYSE (%)	NYSE - Nasdaq (%)	Nasdaq (%)	NYSE (%)	NYSE - Nasdaq (%)
Mean	39	3.34061	2.87310	-0.467 (0.113)	3.34130	2.66807	-0.673 (0.012)
Median	39	2.93048	2.55599	-0.476 (0.328)	2.98162	2.43501	-0.593(0.028)

PANEL B: 5-Minute Interval Volatility

		Interval Open-to-Open Trade Price Return			Interval Close-to-Close Trade Price Return		
	Sample	Nasdaq (%)	NYSE (%)	NYSE - Nasdaq (%)	Nasdaq (%)	NYSE (%)	NYSE - Nasdaq (%)
Mean	39	0.403	0.248	-0.156 (0.000)	0.429	0.259	-0.170 (0.000)
Median	39	0.378	0.206	-0.135 (0.000)	0.415	0.225	-0.144 (0.000)

		Interval Open-to-Open Quote Midpoint Return			Interval Close-to-Close Quote Midpoint Return		
	Sample	Nasdaq (%)	NYSE (%)	NYSE - Nasdaq (%)	Nasdaq (%)	NYSE (%)	NYSE - Nasdaq (%)
Mean	39	0.322	0.252	-0.007 (0.002)	0.319	0.242	-0.077 (0.000)
Median	39	0.323	0.225	-0.062 (0.000)	0.318	0.214	-0.069 (0.000)

PANEL C: 5-Minute Price Range

		Interval Trade Price Range			Relative to Interval Close Trade Price		
	Sample	Nasdaq ($0.01)	NYSE ($0.01)	NYSE -Nasdaq ($0.01)	Nasdaq (bps)	NYSE (bps)	NYSE -Nasdaq ($0.01)
Mean	39	8.468	4.097	-4.37 (0.000)	33.821	17.354	-16.469 (0.000)
Median	39	6.786	3.001	-4.036 (0.000)	28.461	13.028	-15.308 (0.000)

		Interval Quote Midpoint Price Range			Relative to Interval Close Quote Midpoint		
	Sample	Nasdaq ($0.01)	NYSE ($0.01)	NYSE -Nasdaq ($0.01)	Nasdaq (bps)	NYSE (bps)	NYSE -Nasdaq ($0.01)
Mean	39	7.894	4.838	-3.026 (0.000)	31.234	20.395	-10.727 (0.000)
Median	39	5.000	2.500	-2.733 (0.000)	19.581	11.208	-9.112 (0.000)

Note: We also did the bid-to-bid and ask-to-ask return for return volatility. The results are similar to quote-midpoint return, and the evidence reach the same conclusion.

Table 4: Price Reversals: the Autocorrelation Analysis

We report the autocorrelation of the daily return, the interval 5-minute trade price return, and the interval 5-minute quote return, as measured by midpoint-to-midpoint, bid-to-bid, and ask-to-ask, in Panel A, B, and C in the table. Our sample includes the 39 stocks that have transferred their listings from the Nasdaq to the NYSE during January 2002 to March 2003. The tick-by-tick trade and quote data is from the TAQ database. We recompile the National Best Bid and Offer (NBBO) from the CQ file. We divide the daily trading regular hour (9:30AM - 4:00PM) into 78 5-minute intervals. For each stock in each interval, we compute the interval close-to-close and open-to-open return based on trade price as well as quote midpoint, bid, and ask price. We calculate the autocorrelation of the daily return series, and average them to get the autocorrelation for the sample period for each sample stock. We conduct the t tests for the mean difference and the Wilcoxon test for the median difference, and provide p values in parentheses. Our computation window is (-60, -1) for Nasdaq trading, and (0, 59) for the NYSE trading, and our investigation period is from October 2001 to June 2003.

PANEL A: Daily Trade Price Return Autocorrelation

		Open-to-Open Trade Price Return			Close-to-Close Trade Price Return		
	Sample	Nasdaq	NYSE	NYSE - Nasdaq	Nasdaq	NYSE	NYSE - Nasdaq
Mean	39	-0.117 (0.000)	-0.062 (0.000)	0.054 (0.000)	-0.110 (0.000)	-0.035 (0.203)	0.075 (0.000)
Median	39	-0.083 (0.000)	-0.041 (0.044)	0.130 (0.000)	-0.094(0.000)	-0.014 (0.276)	0.144 (0.000)

		Open-to-Open Quote-Midpoint Return			Close-to-Close Quote Midpoint Return		
	Sample	Nasdaq	NYSE	NYSE - Nasdaq	Nasdaq	NYSE	NYSE - Nasdaq
Mean	39	-0.096 (0.000)	-0.088 (0.003)	0.007 (0.840)	-0.092 (0.000)	-0.016 (0.553)	0.076 (0.064)
Median	39	-0.086 (0.000)	-0.056 (0.003)	0.004 (0.978)	-0.089 (0.000)	0.023 (0.681)	0.047 (0.013)

PANEL B: 5-Minute Interval Trade Price Return Autocorrelation

		Open-to-Open Trade Price Return			Close-to-Close Trade Price Return		
	Sample	Nasdaq	NYSE	NYSE - Nasdaq	Nasdaq	NYSE	NYSE - Nasdaq
Mean	39	-0.123 (0.000)	0.0173 (0.000)	0.141 (0.000)	-0.159 (0.000)	-0.008 (0.462)	0.151 (0.000)
Median	39	-0.111 (0.000)	0.009 (0.061)	0.130 (0.000)	-0.157 (0.000)	-0.005 (0.612)	0.144 (0.000)
p-value							

PANEL C: 5-Minute Quote Return Autocorrelation

		Interval Open Quote Midpoint			Interval Close Quote Midpoint		
	Sample	Nasdaq	NYSE	NYSE - Nasdaq	Nasdaq	NYSE	NYSE - Nasdaq
Mean	39	-0.028 (0.002)	0.008 (0.575)	0.036 (0.005)	-0.040 (0.000)	0.010 (0.376)	0.050 (0.000)
Median	39	-0.016 (0.002)	0.001 (0.555)	0.037 (0.003)	-0.038 (0.000)	-0.002 (0.356)	0.062 (0.000)

		Interval Open Bid-to-Bid			Interval Close Bid-to-Bid		
	Sample	Nasdaq	NYSE	NYSE - Nasdaq	Nasdaq	NYSE	NYSE - Nasdaq
Mean	39	-0.067 (0.000)	-0.059 (0.000)	0.008 (0.000)	-0.067 (0.000)	-0.046 (0.000)	0.021 (0.000)
Median	39	-0.054 (0.000)	-0.052 (0.000)	0.004 (0.000)	-0.060 (0.000)	-0.046 (0.000)	0.025 (0.000)

		Interval Open Ask-to-Ask			Interval Close Ask-to-Ask		
	Sample	Nasdaq	NYSE	NYSE - Nasdaq	Nasdaq	NYSE	NYSE - Nasdaq
Mean	39	-0.072 (0.000)	-0.054 (0.000)	0.018 (0.000)	-0.081 (0.000)	-0.045 (0.000)	0.036 (0.000)
Median	39	-0.068 (0.000)	-0.051 (0.000)	0.017 (0.000)	-0.072 (0.000)	-0.047 (0.000)	0.037 (0.000)

Note: We also compute the autocorrelation for the daily noon-to-noon return to control for the opening and closing effects. The results are not materially different from the results from the daily close-to-close return.

Table 5: Variance Decomposition following Hasbrouck (1993)

We report the results for the variance decomposition using the Hasbrouck (1993) method for the sample stocks in the following table. Hasbrouck (1993) decompose the variance of transaction prices into variance of efficient prices and variance due to pricing error. Our sample includes the 39 stocks that have transferred their listings from the Nasdaq to the NYSE during January 2002 to March 2003. Var (S) is the variance of the pricing error or noise, and STD (S) is the standard deviation of the variance of noise. VAR (P) is the variance of log price. We conduct the t tests for the mean difference and the Wilcoxon test for the median difference, and provide p values in the parentheses. Our computation window is (-60, -1) for Nasdaq trading, and (0, 59) for the NYSE trading, and our sample period is from October 2001 to June 2003.

PANEL A: Variance of the Noise (VAR(S))

	Mean			Median		
Sample	Nasdaq (1e-6)	NYSE (1e-6)	NYSE - Nasdaq (1e-6)	Nasdaq (1e-6)	NYSE (1e-6)	NYSE - Nasdaq (1e-6)
39	1.384	0.374	-1.010 (0.000)	0.603	0.303	).300 (0.000)

PANEL B: Variance of Noise Relative to the Variance of Price (VAR(S) / VAR(P))

	Mean			Median		
Sample	Nasdaq (1e-6)	NYSE (1e-6)	NYSE - Nasdaq (1e-6)	Nasdaq (1e-6)	NYSE (1e-6)	Nasdaq (1e-6)
39	322.712	119.719	-202.993 (0.004)	104.842	53.377	6.773 (0.000)

PANEL C: Standard Deviation of Noise Relative to Price (STD(S)/P)

	Mean			Median		
Sample	Nasdaq (1e-6)	NYSE (1e-6)	NYSE - Nasdaq (1e-6)	Nasdaq (1e-6)	NYSE (1e-6)	Nasdaq (1e-6)
39	324.069	183.824	-140.245 (0.000)	235.712	160.473	8.453 (0.000)

Table 6: Variance Ratio Test

We report the variance ratio test results in the table. Our sample includes the 39 stocks that have transferred their listings from Nasdaq to the NYSE during January 2002 to March 2003. The variance ratio is computed as dividing the 10-minute return variance by twice of the 5-minute return variance. We compute the returns based on trade price as well as on quote midpoint. For on trade price return, we compute both the open-to-open and the close-to-close return. For quote midpoint returns, we do the same. For each of our sample stocks, we first compute the daily variance ratio during the normal trading hour 9:30AM – 4:00PM. We then exclude 15 minutes and 30 minutes from both the opening and closing trading, and replicate the results for two different trading time periods: 9:45AM – 3:45PM and 10:00AM – 3:30PM. These results are reported in Panel B. We conduct the t tests for the mean difference and the Wilcoxon test for the median difference, and provide the p values in parentheses. Our computation window is (-60, -1) for Nasdaq trading, and (0, 59) for the NYSE trading relative to each stock's switching date. Our sample period is Octob

PANEL A: Return based on Trade Price

		Open-to-Open Return			Close-to-Close Return		
	Sample	Nasdaq	NYSE	NYSE - Nasdaq	Nasdaq	NYSE	NYSE - Nasdaq
Mean	39	0.811	0.909	0.098 (0.000)	0.758	0.879	0.121 (0.000)
Median	39	0.797	0.910	0.087 (0.000)	0.739	0.867	0.116 (0.000)

PANEL B: Return Based on Quote Midpoint

		Open Midpoint-to-Midpoint Return			Close Midpoint-to-Midpoint Return		
		9:30AM - 4:00PM			9:30AM - 4:00PM		
	Sample	Nasdaq	NYSE	NYSE - Nasdaq	Nasdaq	NYSE	NYSE - Nasdaq
Mean	39	0.896	0.929	0.032 (0.000)	0.852	0.907	0.054 (0.000)
Median	39	0.903	0.936	0.039 (0.000)	0.852	0.910	0.061 (0.000)
	Sample	9:45AM - 3:45PM			9:45AM - 3:45PM		
Mean	39	0.907	0.939	0.032 (0.020)	0.789	0.898	0.109 (0.000)
Median	39	0.844	0.924	0.033 (0.000)	0.776	0.885	0.115 (0.000)
	Sample	10:00AM - 3:30PM			10:00AM - 3:30PM		
Mean	39	0.825	0.92	0.095 (0.000)	0.782	0.882	0.100 (0.000)
Median	39	0.797	0.905	0.077 (0.000)	0.769	0.875	0.107 (0.000)

Note: We also compute the variance ratio on trade-to-trade return during 9:45AM - 3:45PM and 10:00AM - 3:30PM. The results are comparable to those from the trade-to-trade return during 9:30AM - 4:00PM, and reach the similar conclusion.

Table 7: Change of the NBBO Quoted Spread

We report the unconditional changes of the quoted spread and the relative quoted spread in the table. Our sample includes the 39 stocks that have transferred their listings from the Nasdaq to the NYSE during January 2002 to March 2003. The tick-by-tick quote data is obtained from the CQ file in the TAQ database. We recompile the National Best Bid and Offer (NBBO) from the CQ file. Panel A reports the change of the NBBO quoted spread. We compute the time-weighted average quote spread and the time-weighted average relative quoted spread from the NBBO file. For each stock in each month, we compute the share-weighted quoted spread using the Dash5 data. We obtain separate results by order size (size 21 = 100 – 499 shares, 22 = 500 – 1999 share; 23 = 2000 – 4999 shares; 24 = 5000 – 9999 shares). Panel B reports the change details of the Dash5 quoted spread. We conduct the t tests for the mean difference and the Wilcoxon test for the median difference, and provide p values.
Our investigation window is (-3, -1) for the Nasdaq and (+1, +3) for the NYSE relative to each stock's transfer month, and our sample period is from October 2001 to June 2003.

Panel A: NBBO Quoted Spread

		Quoted Spread ($0.01)				Relative Quoted Spread (bps)			
	OBS	Nasdaq	NYSE	NYSE-Nasdaq	p-value	Nasdaq	NYSE	NYSE-Nasdaq	p-value
Mean	39	9.192	5.942	-3.250	0.001	37.132	27.327	-9.805	0.006
Median		7.630	5.841	-1.705	0.000	31.567	23.371	-4.898	0.005

Panel B: Dash5 Quoted Spread

by Stock

	OBS	Nasdaq	NYSE	NYSE-Nasdaq	p-value	Nasdaq	NYSE	NYSE-Nasdaq	p-value
Mean	39	9.988	4.741	-5.248	0.101	39.254	21.764	-17.489	0.140
Median		5.695	4.337	-1.025	0.000	23.616	18.649	-3.336	0.006

by Order Size

	Order Size	OBS	Nasdaq	NYSE	NYSE-Nasdaq	p-value	Nasdaq	NYSE	NYSE-Nasdaq	p-value
Mean	21	39	8.714	4.640	-4.074	0.027	34.492	21.232	-13.260	0.050
Median			5.737	4.073	-1.195	0.000	23.768	18.373	-4.929	0.001
Mean	22	39	10.547	4.728	-5.819	0.126	41.429	21.749	-19.681	0.164
Median			5.585	4.366	-1.127	0.000	24.075	18.377	-3.074	0.007
Mean	23	39	10.523	4.860	-5.663	0.122	41.140	22.220	-18.920	0.161
Median			5.829	4.523	-0.771	0.000	22.701	19.937	-1.782	0.057
Mean	24	38	6.451	5.040	-1.536	0.012	26.259	23.017	-2.569	0.296
Median			5.336	4.521	-0.428	0.008	21.757	19.603	-1.155	0.467

Table 8: Change of Effective Spread

We report the unconditional changes of the effective spread and the relative effective spread in the table. Our sample includes the 39 stocks that have transferred their listings from the Nasdaq to the NYSE during January 2002 to March 2003. We obtain the order level effective spread from the monthly Dash5 report. For each stock in each month, we compute the share-weighted effective spread and share-weighted relative effective spread from the Dash5 data. We also obtain separate results by order type (market order and marketable limit order) and by order size. Panel A reports the changes by stock, Panel B reports the changed by order size, and Panel C reports the changes by order type and order size (size 21 = 100 – 499 shares, 22 = 500 – 1999 share; 23 = 2000 – 4999 shares; 24 = 5000 – 9999 shares). We also conduct the t tests for the mean difference and the Wilcoxon test for the median difference, and provide p values. Our investigation window is (-3, -1) for the Nasdaq and (+1, +3) for the NYSE relative to each stock's transfer month, and our sample period is from October 2001 to June 2003.

Panel A: Share-Weighted Effective Spread across Stocks

		Effective Spread ($0.01)				Relative Effective Spread (bps)			
	OBS	Nasdaq	NYSE	NYSE-Nasdaq	p-value	Nasdaq	NYSE	NYSE-Nasdaq	p-value
Mean	39	11.263	5.734	-5.528	0.086	44.602	26.235	-18.367	0.126
Median		6.513	5.252	-1.067	0.000	29.259	23.503	-3.268	0.007

Panel B: Share-weighted Effective Spread across Order Size

	Order Size		Effective Spread ($0.01)				Relative Effective Spread (bps)			
		OBS	Nasdaq	NYSE	NYSE-Nasdaq	p-value	Nasdaq	NYSE	NYSE-Nasdaq	p-value
Mean	21	39	9.234	3.556	-5.678	0.003	36.511	15.889	-20.622	0.004
Median			6.075	3.003	-2.565	0.000	26.623	13.513	-11.713	0.000
Mean	22	39	11.569	5.302	-6.267	0.098	45.437	23.875	-21.562	0.127
Median			6.116	4.726	-1.680	0.000	27.734	20.084	-4.879	0.000
Mean	23	39	13.027	8.745	-4.282	0.232	51.896	38.888	-13.008	0.332
Median			8.042	8.265	0.132	0.989	32.615	31.845	4.080	0.282
Mean	24	38	9.831	11.571	1.395	0.207	40.932	52.268	12.385	0.064
Median			7.985	10.769	1.943	0.014	30.753	45.827	11.817	0.005

Panel C: Share-weighted Effective Spread across Order Type and Size (Effective Spread only)

		Market Orders ($0.01)					Marketable Limit Order ($0.01)				
	Order Size	OBS	Nasdaq	NYSE	NYSE-Nasdaq	p-value	OBS	Nasdaq	NYSE	NYSE-Nasdaq	p-value
Mean	21	39	8.152	4.087	-4.065	0.000	39	9.328	2.929	-6.399	0.003
Median			7.195	3.445	-2.636	0.000		6.018	2.650	-3.254	0.000
Mean	22	38	10.086	7.563	-2.724	0.003	39	10.966	3.528	-7.438	0.054
Median			7.723	6.700	-0.741	0.005		5.896	3.341	-2.730	0.000
Mean	23	38	15.972	16.535	-0.076	0.966	39	11.064	5.136	-5.929	0.097
Median			13.350	15.219	1.107	0.254		6.323	4.462	-1.778	0.000
Mean	24	36	15.595	27.329	12.197	0.004	38	7.346	6.650	-1.171	0.133
Median			11.583	22.629	5.819	0.000		5.965	5.793	-0.828	0.038

Table 9: Impact of Market Fragmentation on the Reduction of Volatility

We report the results of regressing the change of volatility when a stock switches from Nasdaq to the NYSE on the fragmentation proxy and control variables. Our sample includes the 39 stocks that have transferred their listings from the Nasdaq to the NYSE during January 2002 to March 2003. Market capitalization and the trading volume are the monthly average during (-3, -1) from the CRSP. We propose two measures to proxy market fragmentation: Herfindahl-Hirschman Index (HHI) is computed as the sum of the squared market share of the number of covered orders of each market center reported in the 11Ac1-5; the number of market centers (MCNUM) is the number of market centers that are recorded in the 11Ac1-5 data. The Inverse Mills Ratio is obtained from the first stage probit regression. Each regression has 39 observations. Panel A, B, and C report the change of daily return volatility, the 5-minute return volatility, and the 5-minute price range, respectively. Our investigation window is (-3, -1) for the Nasdaq and (+1, +3) for the NYSE relative to each stock's switching month, and our sample period is from October 2001 to June 2003.

PANEL A: Daily Volatility Measured as Standard Deviation								
	HHI				the Number of Market Centers			
Independent Variables	Change of Volatility (Nasdaq - NYSE)	P Value	% Change of Volatility (1-NYSE / Nasdaq)	P Value	Change of Volatility (Nasdaq - NYSE)	P Value	% Change of Volatility (1-NYSE / Nasdaq)	P Value
Intercept	1.920	0.435	0.330	0.571	4.912	0.041	1.336	0.030
ln (Market Cap)	0.387	0.460	0.030	0.810	0.119	0.793	-0.100	0.385
ln (Trading Volume)	-0.150	0.616	0.039	0.585	-1.237	0.022	-0.257	0.058
HHI	-4.216	0.180	-1.941	0.012				
ln (MCNUM)					3.457	0.027	0.889	0.025
Inverse Mills Ratio	-0.349	0.814	0.037	0.917	-0.327	0.816	-0.031	0.930
R2	0.093		0.217		0.173		0.187	
PANEL B: 5-Minute Return Volatility Measured as Standard Deviation								
Intercept	0.984	<.0001	1.307	0.000	1.839	<.0001	2.981	<.0001
ln (Market Cap)	-0.008	0.835	0.060	0.356	-0.034	0.299	-0.027	0.674
ln (Trading Volume)	-0.043	0.050	-0.062	0.099	-0.140	0.001	-0.244	0.002
HHI	-0.475	0.039	-1.389	0.001				
ln (MCNUM)					0.013	0.010	0.023	0.016
Inverse Mills Ratio	-0.017	0.871	0.128	0.484	0.024	0.818	0.156	0.444
R2	0.531		0.527		0.563		0.445	
PANEL C: 5-Minute Price Range								
Intercept	-0.652	0.961	0.996	0.000	65.271	0.011	2.223	<.0001
ln (Market Cap)	-2.406	0.398	0.024	0.650	-5.089	0.057	-0.041	0.429
ln (Trading Volume)	4.518	0.008	-0.016	0.603	-2.806	0.355	-0.149	0.016
HHI	-45.141	0.011	-1.039	0.002				
ln (MCNUM)					0.970	0.015	0.017	0.029
Inverse Mills Ratio	-2.304	0.775	0.035	0.813	-0.090	0.991	0.053	0.747
R2	0.278		0.409		0.264		0.317	

Table 10: Impact of Volatility and Market Fragmentation on NBBO Quoted Spread

We report the results of regressing the NBBO quoted spread on volatility, market fragmentation proxy, and other control variables. Our sample includes the 39 transferred stocks from the Nasdaq to the NYSE during January 2002 to March 2003. Market capitalization and the trading volume are the monthly average during (-3, -1). Daily volatility is measured as the standard deviation of the daily return during (-60, -1). We propose two measures to proxy market fragmentation: Herfindahl-Hirschman Index (HHI) is computed as the sum of the squared market share of the number of covered orders of each market center reported in the 11Ac1-5; the number of market centers (MCNUM) is the number of market centers that are recorded in the 11Ac1-5 data. The Inverse mills ratio is from the first stage probit regression. Each regression has 39 observations. Panel A and B report the results for quote spread and the relative quote spread respectively. Our investigation window is (-3, -1) for the Nasdaq and (+1, +3) for the NYSE relative to each stock's transfer month, and our sample period is from October 2001 to June 2003.

PANEL A: NBBO Quoted Spread ($)								
	HHI				the Number of Market Centers			
Independent Variables	Change of NBBO Spread (Nasdaq - NYSE)	P Value	% Change of NBBO Spread (1-NYSE / Nasdaq)	P Value	Change of NBBO Spread (Nasdaq - NYSE)	P Value	% Change of NBBO Spread (1-NYSE / Nasdaq)	P Value
Intercept	0.313	<.0001	2.063	<.0001	0.493	<.0001	2.651	0.000
ln (Market Cap)	0.026	0.028	0.140	0.059	0.018	0.082	0.084	0.223
ln (Trading Volume)	-0.040	<.0001	-0.236	<.0001	-0.057	<.0001	-0.287	0.000
Daily Volatility	0.018	<.0001	0.063	0.017	0.015	0.001	0.053	0.062
HHI	-0.085	0.171	-0.684	0.087				
ln (MCNUM)					0.003	0.063	0.007	0.082
Inverse Mills Ratio	0.041	0.171	0.551	0.007	0.046	0.122	0.519	0.013
R2	0.726		0.719		0.739		0.697	
PANEL B: NBBO Spread Relative to Quote Midpoint (bps)								
Intercept	118.436	<.0001	2.392	<.0001	202.167	<.0001	3.695	0.000
ln (Market Cap)	8.466	0.076	0.251	0.017	5.111	0.215	0.151	0.121
ln (Trading Volume)	-13.674	<.0001	-0.305	<.0001	-21.856	<.0001	-0.423	0.000
Daily Volatility	3.914	0.022	0.015	0.675	2.494	0.140	-0.007	0.849
HHI	-35.319	0.169	-1.197	0.034				
ln (MCNUM)					1.281	0.033	0.017	0.026
Inverse Mills Ratio	18.083	0.151	0.865	0.003	20.808	0.090	0.831	0.006
R2	0.651		0.687		0.678		0.656	

Note: We replace the daily volatility with the 5-minute volatility and the 5-minute price range, and re-do the above regressions. The results are very similar and reach the same conclusion. We also run the above regression for the quoted spread from the 11Ac1-5 data. We find the results are more distinctive and significant for market orders, but not for market limit orders.

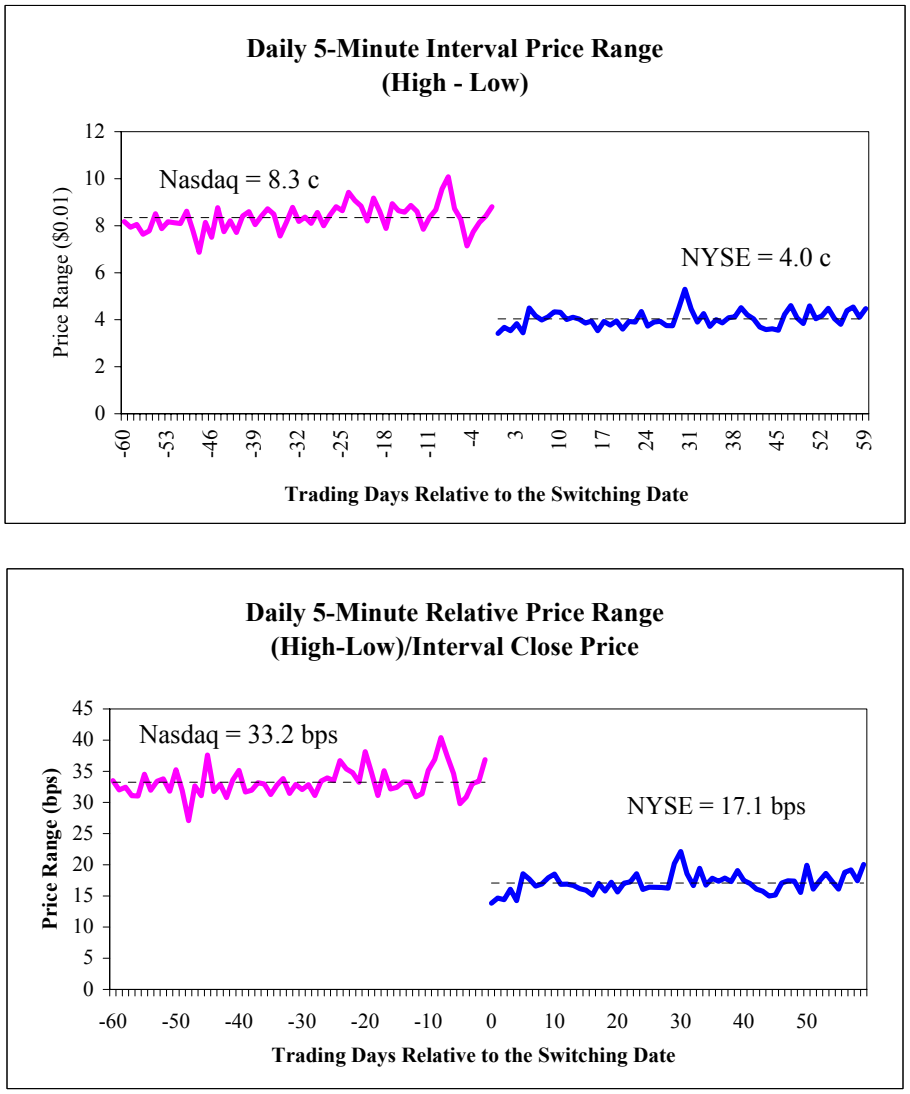
Table 11: Conditional Change of Effective Spread and Quoted Spread

We report the conditional changes of the effective spread and quoted spread for the market order in the table. Our sample includes the 39 stocks that have transferred their listings from Nasdaq to the NYSE during January 2002 to March 2003. Market Capitalization and volume are monthly average during (-3, -1) for Nasdaq and (+1, +3) for the NYSE. Daily volatility is measured as the standard deviation of the daily return during (-60, -1) for Nasdaq and (+0, +59) for the NYSE. The Change of ln (mcap) = [ln (Nasdaq_mcap) – ln(NYSE_mcap)], and the change of ln(volume) = [ln (0.7*Nasdaq_volume) – ln (0.85*NYSE_volume)]. The change of the effective spread (ES), the change of the relative effective spread (RES), the change of the quoted spread (QS), and the change of the relative quoted spread (RQS) are computed as (Nasdaq – NYSE). The inverse Mills ratio is obtained from the first stage probit regression. Each regression has 39 observations. We separate our analysis for order size. Our investigation window is (-3, -1) and (+1, +3) relative to each stock's transfer month, and our investigation period is October 2001 and June 2003.

Independent Variables	Change of ES (Nasdaq - NYSE)	P Value	Change of Relative ES (Nasdaq - NYSE)	P Value	Change of QS (Nasdaq - NYSE)	P Value	Change of Relative QS (Nasdaq - NYSE)	P Value
PANEL A: Order Size = 21 (100 - 499 Shares)								
Intercept	5.170	<.0001	0.192	0.000	3.849	0.001	0.127	0.002
Change of [log (Mcap)]	-5.528	0.052	-0.266	0.027	-5.297	0.064	-0.300	0.005
Change of [log (Volume)]	-4.330	0.014	-0.085	0.237	-5.064	0.005	-0.108	0.080
Change of [Daily Volatilty]	1.023	0.013	0.018	0.290	1.071	0.010	0.018	0.204
Inverse Mill Ratio	-6.379	0.066	-0.232	0.110	-4.553	0.187	-0.175	0.158
R2	0.441		0.273		0.453		0.388	
PANEL B: Order Size = 22 (500 - 1,999 Shares)								
Intercept	3.480	0.005	0.108	0.040	3.086	0.003	0.088	0.007
Change of [log (Mcap)]	-7.099	0.024	-0.371	0.008	-5.705	0.026	-0.313	0.000
Change of [log (Volume)]	-5.125	0.008	-0.103	0.197	-5.031	0.002	-0.112	0.025
Change of [Daily Volatilty]	1.163	0.010	0.017	0.378	0.892	0.015	0.012	0.277
Inverse Mill Ratio	-5.348	0.150	-0.189	0.239	-3.773	0.213	-0.128	0.188
R2	0.485		0.333		0.504		0.506	
PANEL C: Order Size = 23 (2000 - 4,999 Shares)								
Intercept	1.567	0.623	0.062	0.732	4.285	0.005	0.143	0.014
Change of [log (Mcap)]	-2.942	0.722	-0.480	0.306	-7.588	0.047	-0.394	0.009
Change of [log (Volume)]	-4.572	0.361	-0.031	0.911	-4.412	0.055	-0.065	0.458
Change of [Daily Volatilty]	1.501	0.206	0.017	0.795	1.566	0.005	0.033	0.118
Inverse Mill Ratio	-8.862	0.379	-0.546	0.337	-7.721	0.093	-0.297	0.095
R2	0.110		0.058		0.442		0.340	
PANEL D: Order Size = 24 (5000 - 9,999 Shares)								
Intercept	-8.933	0.231	-0.350	0.436	1.847	0.198	0.027	0.661
change of [log (Mcap)]	16.975	0.375	0.211	0.855	-2.860	0.436	-0.161	0.310
Change of [log (Volume)]	7.237	0.567	0.152	0.843	0.356	0.883	0.107	0.306
Change of [Daily Volatilty]	-0.794	0.789	-0.070	0.699	0.187	0.743	-0.008	0.757
Inverse Mill Ratio	-12.981	0.573	-0.936	0.504	-4.034	0.364	-0.137	0.470
R2	0.083		0.030		0.040		0.057	

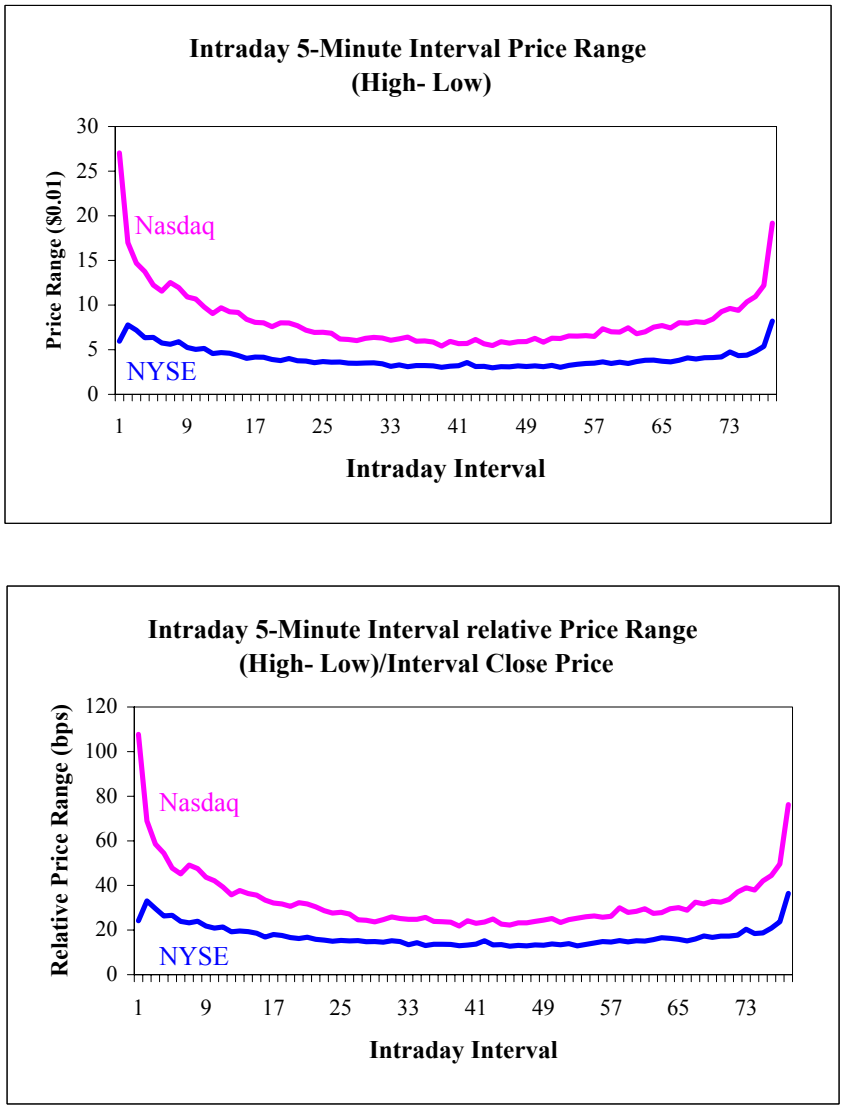
Note: We replicate the above examination for the marketable limit orders, and find less significant results.

Figure 1: 5-Minute Price Range and Relative Price Range



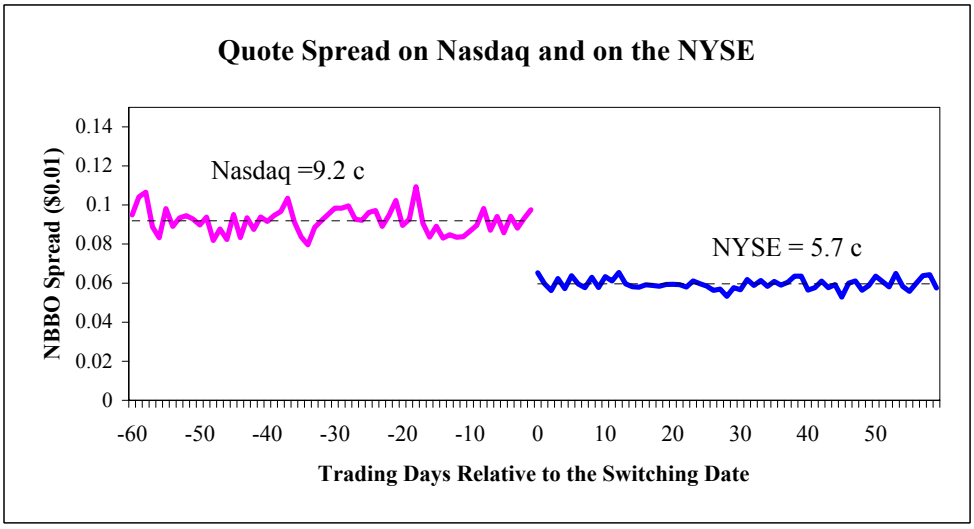
The figure is the daily average of the 5-minute interval price range and the relative price range across the sample stocks. We divide a trading day into 78 5-minute intervals. Interval #1 is from 9:30-9:35AM, and Interval #78 is between 3:55-4:00PM. For each stock, we compute its daily average of interval price range and relative price ranges across 78 intervals. Interval Price range is defined as the difference between the interval high price and the interval low price, and the interval relative price range is the ratio between the price range and the interval close price. Our sample includes the 39 stocks that have transferred their listings from the Nasdaq to the NYSE during January 2002 to March 2003. Our investigation window is (-60, -1) relative to each stock's transfer date, and our sample period is from October 2001 to January 2003.

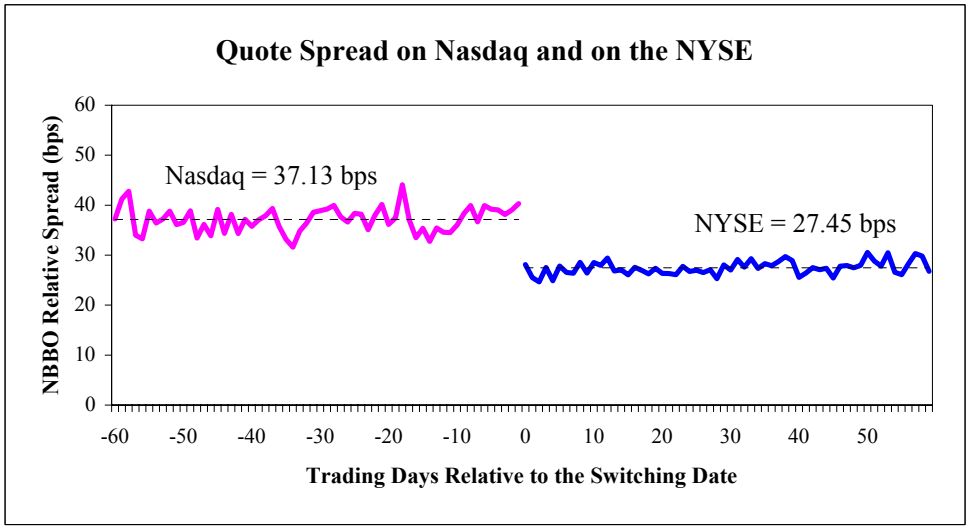
Figure 2: Intraday 5-Minute Price Range and Relative Price Range



The figure is the average of the 5-minute interval price range and the relative price range across the sample stocks and sample period. We divide a trading day into 78 5-minute intervals. Interval #1 is from 9:30-9:35AM, and Interval #78 is between 3:55-4:00PM. For each stock, we compute its interval price range and relative price range in each of the 78 intervals. Interval Price range is defined as the difference between the interval high price and the interval low price, and the interval relative price range is the ratio between the price range and the interval close price. Our sample includes the 39 stocks that have transferred their listings from the Nasdaq to the NYSE during January 2002 to March 2003. Our investigation window is (-60, -1) relative to each stock's transfer date, and our sample period is from October 2001 to January 2003.

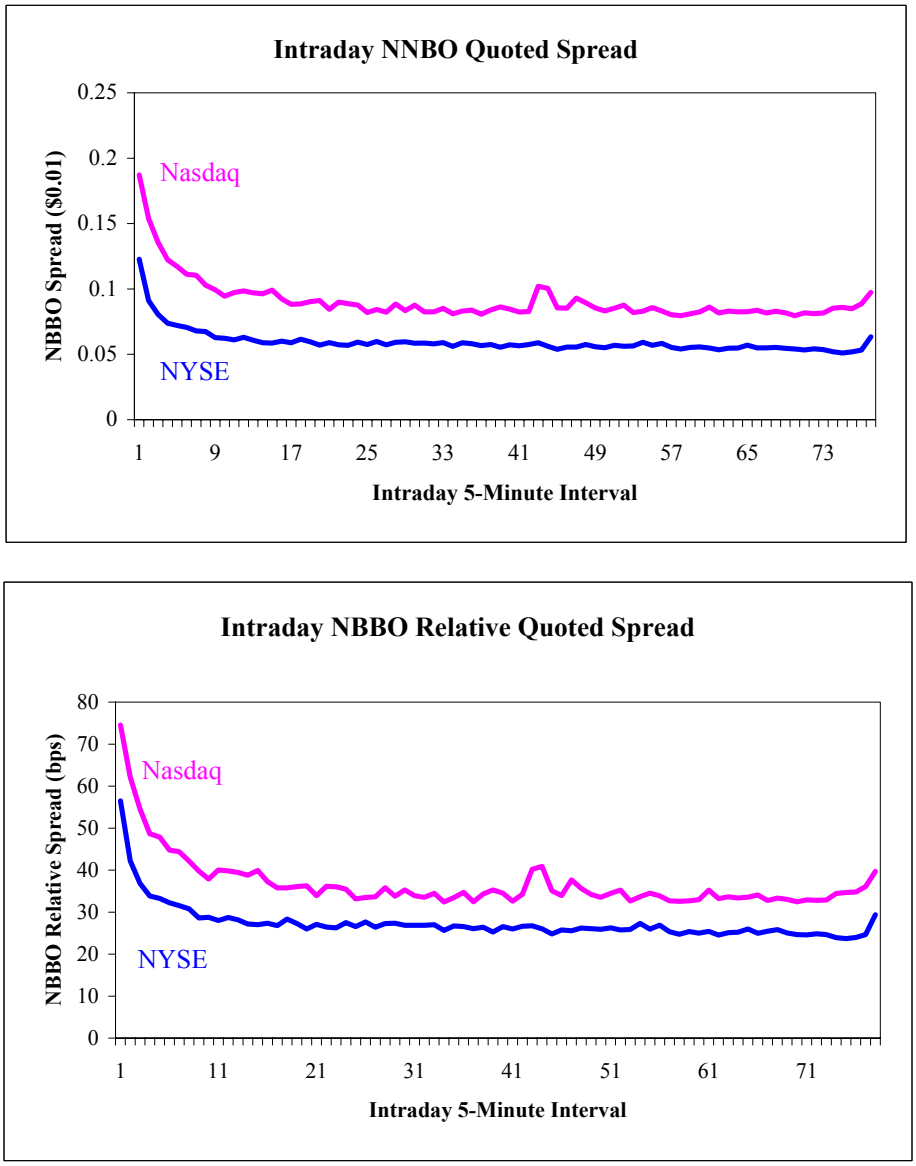
Figure 3: Daily Average of NBBO Quoted Spread and Relative Quoted Spread





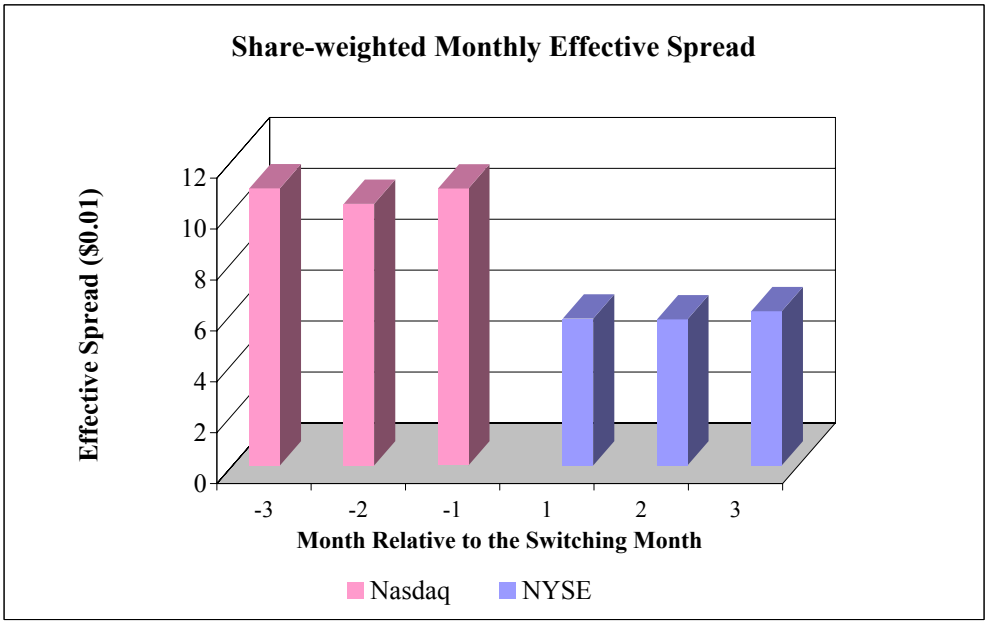
The figure is the daily average of NBBO quoted spread across sample stocks. For each stock, we compute its time-weighted daily average of the NBBO quoted spread. Our sample includes the 39 stocks that have transferred their listings from the Nasdaq to the NYSE during January 2002 to March 2003. Our investigation window is (-60, -1) relative to each stock's transfer date, and our sample period is from October 2001 to January 2003.

Figure 4: Intraday NBBO Quoted Spread and Relative Quoted Spread



The figure is the average of intraday NBBO quoted spread and relative NBBO quoted spread across sample stocks and sample period. We divide a trading day into 78 5-minute intervals. Interval #1 is from 9:30-9:35AM, and Interval #78 is between 3:55-4:00PM. For each stock, we compute its time-weighted NBBO quoted spread for each interval. The relative NBBO quoted spread is the ratio between the NBBO quoted spread to the interval closing quote midpoint. Our sample includes 39 stocks that have transferred their listings from the Nasdaq to the NYSE during January 2002 to March 2003. Our investigation window is (-60, -1) relative to each stock's transfer date, and our sample period is from October 2001 to January 2003.

Figure 5: Monthly Average of Effective Spreads



The figure shows the monthly average effective spread, weighted by shares that executed in all market centers in the Dash-5 report, across the 39 stocks around the transfer event. We compute the share-weighted effective spread for each stock in each month, and average them across stocks to obtain the monthly average share-weighted effective spread. Our sample includes the 39 stocks that have transferred their listings from the Nasdaq to the NYSE during January 2002 to March 2003. Our investigation window is (-3, -1) and (+1, +3) relative to each stock's transfer date, and our sample period is from October 2001 to June 2003.

Appendix 1: Information for the 39 Transferred Nasdaq Stocks

We report sample statistics for the 39 firms that swtich from Nasdaq to NYSE. Our sample window is 60 days prior to the swtiches. Our investigation period is October 2001 to Janaury 2003.

Company Name	Transfer Date	Market Cap ($ 000)	Volatility * (%)	Closing Price ($)	Daily Volume (share)	Medium Trade Size (share)	Mean Trade Size (share)
RailAmerica, Inc.	1/2/2002	345,507	2.628	12.65	195,527	309	1,019
Network Associates, Inc.	2/12/2002	4,152,265	4.108	25.99	3,870,573	227	799
Old National Bancorp	2/15/2002	1,474,259	0.846	24.46	49,445	170	545
Action Performance Group	2/20/2002	696,643	3.867	34.66	424,148	117	461
The Bisys Group Inc.	3/6/2002	3,741,776	6.652	58.81	539,655	112	487
Clark/Bardes, Inc.	3/7/2002	420,218	2.883	24.83	45,150	148	439
Regions Financial Corporation	5/3/2002	8,054,141	0.972	33.66	562,085	103	340
Tom Brown, Inc.	5/16/2002	1,135,582	1.461	27.66	150,718	126	380
Astoria Financial Corporation	5/17/2002	2,890,475	1.174	30.86	555,388	128	517
The Nautilus Group, Inc.	5/21/2002	1,567,853	2.974	37.37	966,672	162	356
Cantel Medical Corp	5/29/2002	159,748	4.804	24.52	36,053	194	414
Province Healthcare Company	6/5/2002	1,214,086	4.955	29.38	552,492	158	461
The CATO Corporation	6/13/2002	523,859	2.466	24.97	105,593	148	505
Remington Oil & Gas Co.	6/20/2002	503,502	2.662	19.62	153,780	148	438
Emulex Corporation	6/24/2002	2,458,602	5.819	29.11	8,521,118	202	422
Oshkosh Truck Corporation	7/12/2002	973,246	3.328	58.32	82,577	103	287
Christopher & Banks Co.	7/17/2002	1,077,889	3.107	39.92	357,183	100	289
CACI International Inc.	8/16/2002	973,895	4.054	33.91	518,490	102	288
Select Medical Corporation	8/28/2002	674,228	2.819	14.45	142,488	112	313
Valmont Industries, Inc.	8/30/2002	523,109	3.527	20.30	59,138	108	274
Genesse & Wyoming Inc.	9/27/2002	289,238	3.645	20.68	61,750	109	326
BearingPoint, Inc.	10/3/2002	1,224,357	5.263	9.78	1,399,358	177	551
Greif Bros. Corporation	10/7/2002	259,259	3.276	26.15	16,042	106	276
Webster Financial Corp.	10/17/2002	1,610,396	2.378	35.39	278,221	100	294
Stewart & Stevenson Services	10/18/2002	1,124,613	2.218	24.94	330,586	102	280
Waste Connections, Inc.	10/24/2002	967,440	2.409	33.79	265,037	105	297
Banknorth Group, Inc.	11/4/2002	3,428,326	2.306	24.43	824,466	123	363
Getty Images, Inc.	11/5/2002	1,532,737	4.792	20.17	439,202	115	316
Concord EFS, Inc	11/7/2002	7,326,140	5.581	16.74	9,869,623	222	644
Right Management Consultants	11/15/2002	298,646	5.873	19.79	171,485	107	263
St Mary Land & Exploration Co.	11/20/2002	705,896	2.170	24.34	124,143	100	284
H.B. Fuller Company	12/2/2002	821,386	2.565	28.20	88,341	100	198
Interactive Data Corporation	12/10/2002	1,430,755	2.060	13.91	210,244	114	336
Alliance Gaming Corporation	12/12/2002	845,261	3.464	16.33	588,430	152	391
New York Community Bancorp	12/20/2002	2,988,178	2.351	28.23	887,826	107	357
CPB Inc.	12/31/2002	412,946	6.846	36.59	18,008	102	193
AMERIGROUP Corporation	1/3/2003	619,203	3.534	30.41	331,506	100	298
Offshore Logistics, Inc	3/12/2003	493,222	2.871	20.27	109,989	100	251
Regis Corporation	3/27/2003	279,012	3.301	11.88	222,738	107	382

* Volatility is measured as the standard deviation of daily return.

Appendix 2: the 39 Matching Nasdaq-Nasdaq Pairs

We report the 39 matched Nasdaq stocks for each of the 39 transferred stocks. We use 4 variables, price, market cap, volatility, daily trading volume, to select a matched Nasdaq stock for each of our 39 transferred stocks. Price is measured as the daily closing price; volatility is the standard deviation of the daily close-to-close return; daily volume is the trading volume reported during the regular market hour between 9:30AM – 4:00PM. Our punishment score is the sum of the absolute value of the relative difference: Punishment Score = |mcap/mcap39-1| + |price/price39-1| + |volume/volume39-1| + |volatility/volatility39-1|. Our match sample selection criterion is to minimize the Punishment Score. Our investigation period for selecting the matched sample is January 1, 2001 to December 31, 2001.

Transferred Firm Symbol	Transfer Firm Name	Transfer Date	Matched Nasdaq Firm Symbol	Match Nasdaq Firm Name
RAIL	RailAmerica, Inc.	1/2/2002	NTBK	NET BANK INC
NETA	Network Associates, Inc.	2/12/2002	ELNK	EARTHLINK INC
OLDB	Old National Bancorp	2/15/2002	CFFN	CAPITOL FEDERAL FINANCIAL
ACTN	Action Performance Group	2/20/2002	SHFL	SHUFFLE MASTER INC
BSYS	The Bisys Group Inc.	3/6/2002	ICOS	I C O S CORP
CLKB	Clark/Bardes, Inc.	3/7/2002	SPSS	SPSS INC
RGBK	Regions Financial Corporation	5/3/2002	CINF	CINCINNATI FINANCIAL CORP
TMBR	Tom Brown, Inc.	5/16/2002	RESP	RESPIRONICS INC
ASFC	Astoria Financial Corporation	5/17/2002	SIAL	SIGMA ALDRICH CORP
DFXI	The Nautilus Group, Inc.	5/21/2002	FEIC	F E I COMPANY
CNTL	Cantel Medical Corp	5/29/2002	NEOG	NEOGEN CORP
PRHC	Province Healthcare Company	6/5/2002	PHCC	PRIORITY HEALTHCARE CORP
CACOA	The CATO Corporation	6/13/2002	ASTE	ASTEC INDUSTRIES INC
ROIL	Remington Oil & Gas Corporation	6/20/2002	PDFS	P D F SOLUTIONS INC
EMLX	Emulex Corporation	6/24/2002	EXTR	EXTREME NETWORKS INC
OTRKB	Oshkosh Truck Corporation	7/12/2002	SRCP	SOURCECORP INC
CHBS	Christopher & Banks Corporation	7/17/2002	MDCC	MOLECULAR DEVICES CORP
CACI	CACI International Inc.	8/16/2002	PNRA	PANERA BREAD CO
SLMC	Select Medical Corporation	8/28/2002	NAUT	NAUTICA ENTERPRISES INC
VALM	Valmont Industries, Inc.	8/30/2002	UFPI	UNIVERSAL FOREST PRODUCTS INC
GNWR	Genesse & Wyoming Inc.	9/27/2002	EMBX	EMBREX INC
KCIN	BearingPoint, Inc.	10/3/2002	LSCC	LATTICE SEMICONDUCTOR CORP
GBCOB	Greif Bros. Corporation	10/7/2002	AEPI	A E P INDUSTRIES INC
WBST	Webster Financial Corp.	10/17/2002	WFSL	WASHINGTON FEDERAL INC
SSSS	Stewart & Stevenson Services, Inc.	10/18/2002	AMSY	AMERICAN MANAGEMENT SYSTEMS INC
WCNX	Waste Connections, Inc.	10/24/2002	INSU	INSITUFORM TECHNOLOGIES INC
BKNG	Banknorth Group, Inc.	11/4/2002	CBSS	COMPASS BANCSHARES INC
GETY	Getty Images, Inc.	11/5/2002	SBAC	S B A COMMUNICATIONS CORP
CEFT	Concord EFS, Inc	11/7/2002	PAYX	PAYCHEX INC
RMCI	Right Management Consultants, Inc	11/15/2002	EPIQ	EPIQ SYSTEMS INC
MARY	St Mary Land and Exploration Company	11/20/2002	MNTR	MENTOR CORP MN
FULL	H.B. Fuller Company	12/2/2002	STRA	STRAYER EDUCATION INC
IDCO	Interactive Data Corporation	12/10/2002	ENTG	ENTEGRIS INC
ALLY	Alliance Gaming Corporation	12/12/2002	MAPS	MAPINFO CORP
NYCB	New York Community Bancorp, Inc.	12/20/2002	WFMI	WHOLE FOODS MARKET INC
CPBI	CPB Inc.	12/31/2002	BWINB	BALDWIN & LYONS INC
AMGP	AMERIGROUP Corporation	1/3/2003	ROIA	RADIO ONE INC
OLOG	Offshore Logistics, Inc	3/12/2003	ASGN	ON ASSIGNMENT INC
RGIS	Regis Corporation	3/27/2003	PLCE	CHILDRENS PLACE RTL STORES INC

Appendix 3: Comparison of the 39 Transferred Stocks and the 39 Matching Nasdaq Stocks

We report the mean, median, max and min of mcap, price, volume, return volatility, share outstanding, number of trade, daily return, and the matching punishment score. Return Volatility is measured as the standard deviation of daily return. Daily volume is the trading volume reported during the regular market hour between 9:30AM – 4:00PM. Our punishment score (PSCORE) is the sum of the absolute value of the relative difference: Punishment Score (PSCORE) = |mcap/mcap39-1| + |price/price39-1| + |volume/volume39-1| + |volatility/volatility39-1|. Our match sample selection criterion is to minimize the Punishment Score. Our sample period is January 1, 2001 to December 31, 2001.

Pabel A: The 39 Transferred Stocks

TYPE	SAMPLE SIZE	MCAP ($M)	PRICE ($)	RETURN STD (%)	VOLUME (Shares)	RETURN (%)	SHARE OUTSTANDING (Million Shares)	PSCORE
mean	39	1,393.010	26.306	4.844	681,333.079	0.240	51.415	
median	39	699.974	24.723	4.481	273,298.117	0.151	27.521	
max	39	12,328.378	53.329	11.071	7,000,596.125	1.181	307.072	
min	39	92.638	9.647	1.765	4,735.411	-0.111	4.771	

Panel B: The 39 Matching Nasdaq Stocks

Mean	39	1,401.969	25.277	5.152	597,908.181	0.118	50.328	0.456
Median		610.350	23.222	4.875	259,844.129	0.107	26.997	0.461
Max		14,105.517	55.458	11.495	6,415,571.302	0.498	373.748	1.040
Min		83.640	9.276	2.289	4,658.770	-0.267	5.843	0.155

Appendix 4: Summary Statistics for the 39 Non-Switching and Matching Nasdaq Stocks

We report the following evidence for the 39 Nasdaq match stocks during the 60-day pre-switch period and the 60-day post-switch period: the daily and 5-minute quote midpoint return volatility and autocorrelation, the 5-minute quote midpoint price range, and the NBBO quoted spread. The tick-by-tick trade and quote data is from the TAQ database. We also report the effective spread data from the 11Ac1-5 data, which has a monthly frequency. All the above studies are using the exact same methodology as used for the 39 transferred stocks. Our investigation window is (-60, -1) and (0, 59) relative to the stock's switching date. Our sample period is from October 2001 to June 2003.

PANEL A: Quote Return Volatility

		Quote Midpoint Open-to-Open Return			Quote Midpoint Close-to-Close Return		
	Sample	Pre-Switch (%)	Post-Switch (%)	Post-Switch - Pre-Switch (%)	Pre-Switch (%)	Post-Switch (%)	Post-Switch - Pre-Switch (%)
				Daily Return Volatility			
Mean	39	3.764	4.002	0.238 (0.397)	3.716	3.688	0.028 (0.916)
Median	39	3.152	3.283	0.566 (0.307)	3.128	3.374	0.144 (0.967)
				5-Minute Return Volatility			
Mean	39	0.408	0.436	0.028 (0.087)	0.403	0.420	0.017 (0.288)
Median	39	0.362	0.393	0.022 (0.145)	0.341	0.353	-0.013 (0.546)

PANEL B: Quote Return Autocorrelation

		Quote Midpoint Open-to-Open Return			Quote Midpoint Close-to-Close Return		
	Sample	Pre-Switch	Post-Switch	Post-Switch - Pre-Switch	Pre-Switch	Post-Switch	Post-Switch - Pre-Switch
				Daily Return Autocorrelation			
Mean	39	-0.078	-0.088	-0.011 (0.797)	-0.046	-0.025	0.021 (0.576)
Median	39	-0.092	-0.114	-0.018 (0.837)	-0.025	-0.042	-0.013 (0.593)
				5-Minute Return Autocorrelation			
Mean	39	-0.0277	-0.0525	-0.025 (0.012)	-0.045	-0.060	-0.015 (0.062)
Median	39	-0.0278	-0.0532	-0.037 (0.004)	-0.041	-0.059	-0.019 (0.058)

PANEL C: 5-Minute Price Range

		5-Minute Interval High-Low Range			Relative to Interval Close Quote Midpoint		
	Sample	Pre-Switch ($0.01)	Post-Switch ($0.01)	Post-Switch - Pre-Switch ($0.01)	Pre-Switch (%)	Post-Switch (%)	Post-Switch - Pre-Switch (%)
Mean	39	7.357	6.823	-0.535 (0.092)	38.930	39.287	0.350 (0.817)
Median	39	6.788	5.676	-0.656 (0.005)	31.956	34.772	1.665 (0.794)

PANEL D: NBBO Spread

		NBBO Quoted Spread			Relative to Quote Midpoint		
	Sample	Pre-Switch ($0.01)	Post-Switch ($0.01)	Post-Switch - Pre-Switch ($0.01)	Pre-Switch (%)	Post-Switch (%)	Post-Switch - Pre-Switch (%)
Mean	39	9.095	8.334	-0.761 (0.194)	54.299	55.293	0.994 (0.776)
Median	39	6.662	6.175	-0.577 (0.078)	37.352	31.426	0.261 (0.826)

PANEL E: Effective Spread from the 11Ac1-5 Data

					Relative Effective Spread		
	Sample	Pre-Switch ($0.01)	Post-Switch ($0.01)	Post-Switch - Pre-Switch ($0.01)	Pre-Switch (bps)	Post-Switch (bps)	Post-Switch - Pre-Switch (bps)
Mean	39	7.626	7.141	-0.485 (0.504)	46.232	159.129	112.9 (0.307)
Median	39	6.019	4.528	-0.875 (0.001)	29.582	28.502	0.262 (0.870)

Note: 1. We also conduct the above studies for returns based on trade prices. The results are consistent with the theory and comparable to the above results based on quote midpoints. Using trade prices generates a higher return volatility and a more negative autocorrelation, revealing the bid-ask spread bounds. Overall, the evidence reaches a similar conclusion. 2. We also examine the volatility and autocorrelation for the bid-to-bid and ask-to-ask return. The results are similar to the results using the quote midpoint return.

Appendix 5: The Regression Results in the First Stage Probit Model

The first stage regression equation is: Prob (transfer = 1) = a + b1 ln(mcap) + b2 ln(shareout) + b3 ln(volume) + b4 ln (price) + b5 ln(mmcnt) + b6 (volatility) + b7 (return) + b8 (close_spread) + b9 ln(distance) + b10 ln(hsicmg_num) + b11 (ex_cindex) + error. In the equation, mcap (market capitalization) is the product of the number of share outstanding and the price; price is the daily average close price; volatility is measured as the standard deviation of daily close-to-close return; volume is the daily trading volume in shares; mmcnt is the the number of registered Nasdaq market maker; close_spread is the ratio of the quote spread between the closing ask and the closing bid to the quote midpoint; distance is the geographic distance between the firm to the New York Stock Exchange, measured between the New York City and the capital city of the US state in which the firm is located until December 31, 2001; hsicmg_num is the total number of listed companies in the major group of the Standard Industry Classification (SIC) in which a firm belongs to; ex_cindex is the Exchange Industry Concentration Index (EICI), which is the defined as the ratio between the total market cap of all Nasdaq NYSE-eligible firms to the total market cap of the NYSE firms and the Nasdaq NYSE-eligible firms in the SIC major group. All the above variables are estimated during January 1, 2001 to December 31, 2001. Our sample size is 660 Nasdaq NYSE-eligible companies.

Dependent Variable	Estimate	Standard Error	Wald Chi Square Test	Pr > ChiSq
Intercept	-2.5738	2.9677	0.75	0.3858
ln (mcap)	0.2716	0.1845	2.17	0.1411
ln (volume)	-0.687	0.2272	9.14	0.0025
ln (price)	-0.1764	0.226	0.61	0.4352
ln (mmcnt)	1.3347	0.5998	4.95	0.0261
return	-1.6589	0.4796	11.97	0.0005
volatility	17.4189	9.4567	3.39	0.0655
close_spread	-0.921	1.4386	0.41	0.5221
ln (distance)	0.0167	0.0416	0.16	0.6883
ex_cindex	1.437	0.5798	6.14	0.0132
ln (hsicmg_num)	-0.0769	0.111	0.48	0.4885

Appendix 6: Exchange Industry Concentration Summary

We report the top 15 major groups of the Standard Industry Classification (SIC) that have the highest Exchange Industry Concentration Index by Firm Mcap, for the NYSE and Nasdaq, respectively. The Exchange Industry Concentration Index by Firm Number (EICIFN) is computed as the ratio between the number of Nasdaq firms, who are eligble for the NYSE listing standards, in a particule SIC major group to the total number of the sum of the NYSE firms and the Nasdaq NYSE-eligible firms in the SIC major group. The Exchange Industry Concentration Index by Firm Mcap (EICIFM) is computed as the ratio between the total market cap of all Nasdaq NYSE-eligible firms to the total market cap of the NYSE firms and the Nasdaq NYSE-eligible firms in the SIC major group. The sample estimation period is January 1 , 2001 to December 31, 2001.

CRSP SIC Major Group Code	Standard Industrial Classification (SIC) Code Descriptions by the US Census Bureau	Industry Market Cap ($M)	Nasdaq Market Cap ($M)	Industry Firm Number	Nasdaq Firm Number	Exchange Industry Concentration Index by Firm Number (EICIFN)	Exchange Industry Concentration Index by Firm Mcap (EICIFM)
41	LOCAL AND INTERURBAN TRANSIT	309.28	309.28	1	1	1.00	1.00
47	TRANSPORTATION SERVICES	7,293.73	7,159.75	7	6	0.86	0.98
82	EDUCATIONAL SERVICES	13,821.52	10,915.41	11	8	0.73	0.79
42	TRUCKING AND WAREHOUSING	13,871.72	9,455.44	15	11	0.73	0.68
73	BUSINESS SERVICES	1,279,835.49	691,960.57	187	104	0.56	0.54
87	ENGINEERING & MANAGEMENT SERVICES	57,403.27	30,933.67	41	16	0.39	0.54
36	ELECTRONIC EQUIPMENT	1,297,002.23	607,098.60	163	88	0.54	0.47
78	MOTION PICTURES	9,638.43	3,567.92	5	2	0.40	0.37
23	APPAREL AND OTHER TEXTILE PRODUCTS	24,903.18	8,569.05	15	2	0.13	0.34
83	SOCIAL SERVICES	1,027.17	343.55	3	1	0.33	0.33
57	FURNITURE AND HOMEFURNISHINGS STORES	40,147.49	13,223.17	15	7	0.47	0.33
16	HEAVY CONSTRUCTION, EX. BUILDING	6,184.42	1,683.22	8	3	0.38	0.27
35	INDUSTRIAL MACHINERY AND EQUIPMENT	696,221.84	187,318.44	122	30	0.25	0.27
58	EATING AND DRINKING PLACES	78,815.81	18,005.91	35	14	0.40	0.23
59	MISCELLANEOUS RETAIL	88,005.06	18,485.56	29	8	0.28	0.21
20	FOOD AND KINDRED PRODUCTS	460,721.95	5,305.17	53	8	0.15	0.01
49	ELECTRIC, GAS, AND SANITARY SERVICES	435,958.63	3,707.05	112	6	0.05	0.01
29	PETROLEUM AND COAL PRODUCTS	426,471.59	419.04	19	1	0.05	0.00
1	RICE CORN SOYBEANS	1,498.64	0.00	1	0	0.00	0.00
2	AGRICULTURAL PRODUCTION^LIVESTOCK	342.34	0.00	1	0	0.00	0.00
10	METAL MINING	30,303.31	0.00	21	0	0.00	0.00
12	COAL MINING	6,954.37	0.00	6	0	0.00	0.00
14	NONMETALLIC MINERALS, EXCEPT FUELS	1,654.78	0.00	3	0	0.00	0.00
17	SPECIAL TRADE CONTRACTORS	3,392.44	0.00	7	0	0.00	0.00
21	TOBACCO PRODUCTS	110,531.03	0.00	3	0	0.00	0.00
40	RAILROAD TRANSPORTATION	35,519.38	0.00	8	0	0.00	0.00
43	U.S. POSTAL SERVICE	2,914.58	0.00	1	0	0.00	0.00
46	PIPELINES, EXCEPT NATURAL GAS	6,799.41	0.00	3	0	0.00	0.00
70	HOTELS AND OTHER LODGING PLACES	32,090.29	0.00	19	0	0.00	0.00
75	AUTO REPAIR, SERVICES, AND PARKING	2,483.67	0.00	5	0	0.00	0.00