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DOES MARKET STRUCTURE MATTER? TRADING COSTS AND RETURN VOLATILITY AROUND EXCHANGE LISTINGS

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Abstract

We document that bid-ask spreads decrease substantially for stocks that moved from Nasdaq to the NYSE between 1996 and 2000, and that spread reductions continued to be observed after the 1997 market reforms. Somewhat surprising in light of these reforms, the largest spread reductions are for stocks where Nasdaq liquidity providers round quotations most often. We extend the analysis to document that average return volatility also decreases substantially after exchange listing. However, spreads, volatility, and trading activity are determined jointly in equilibrium, implying that simple before versus after comparisons may not reveal structural effects. The results of simultaneous equation estimation indicate that decreases in average bid-ask spreads are attributable to market structure, while reductions in volatility and trading volume can be attributed to changes in other endogenous and exogenous variables, including the spread reduction.

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Introduction

A well functioning financial market provides price discovery and low-cost liquidity, without excessive volatility in prices. Does the structure of a financial market affect its functionality? We provide some empirical evidence on this issue by examining changes in bid-ask spreads, return volatility, and trading activity for 320 stocks that moved from the Nasdaq's dealer-based Stock Market to the New York Stock Exchange's specialist-assisted auction market between 1996 and 2000.

Christie and Huang (1994), Kadlec and McConnell (1994), and Barclay (1997) have all documented decreases in average bid-ask spreads for stocks that moved from Nasdaq to the NYSE during earlier sample periods. We confirm this finding, and extend this literature in several dimensions. First, we provide updated evidence, verifying that average bid-ask spreads continue to decrease after Exchange listing in the more recent data, and even after the 1997 reforms of the Nasdaq Stock market. Second, we extend the analysis to volatility, documenting that return volatility decreases on average after stocks move to the NYSE. The reduction in return volatility is observed even after allowing for decreases in "bid-ask" bounce attributable to smaller spreads, and after controlling for changes in market-wide return volatility.

Third, and most important, we use simultaneous equation methods to examine the extent to which changes in endogenous spreads and volatility can be attributed to market structure, as opposed to changes in other endogenous and exogenous variables. For example, microstructure theory implies that volatility affects equilibrium bid-ask spreads, both because volatility increases inventory-related costs of market making (as in Ho and Stoll (1980)), and because volatility is likely to be associated with informed trading and adverse selection costs (as in Glosten and Milgrom (1985)). Reductions in average spreads after Exchange listing could, in principle, be attributable to reductions in volatility rather than market structure, *per se*. Likewise, volatility reductions might be attributable to changes in trading activity or in spreads

rather than market structure.

The results of implementing simultaneous equation estimation methods indicate that the reduction in bid-ask spreads after Exchange listing is indeed structural: trading costs are significantly affected by market structure. In contrast, the observed reduction in average return volatility is attributable to changes in other economic variables rather than market structure. The absence of a structural listing effect on return volatility is consistent with the reasoning that volatility is determined by the rate of information flow for the stock, and not by the structure of the market where the stock is traded.

Finally, we contribute to the recurring debate as to whether return volatility can be decreased by imposing a "transactions tax". Several authors have argued in favor of taxes on financial market trades, reasoning that higher trading costs will curb "excessive" speculation by dissuading those traders who have short investment horizons.[1] The results of the simultaneous equation system reported here indicate that an increase in trading costs is associated with an increase in return volatility. This finding, and also the result that both average spreads and average return volatility decrease after listing, is at odds with reasoning that volatility can be decreased by increasing transactions costs, as the proponents of transactions taxes presume.

This paper is organized as follows. Section I describes the sample as well as the measures of trading costs and volatility that are employed. Section II presents average bid-ask spreads and return standard deviations before and after Exchange listing. Section III reports on cross-sectional analysis and simultaneous equation analysis of the changes in spreads and volatility, while Section IV concludes.

I: Sample Selection and Empirical Measures.

We use various issues of the annual NYSE Fact Book to identify all 320 firms that moved from the Nasdaq stock market to the NYSE during calendar years 1996 to 2000. The number of Nasdaq to NYSE transfers appears to have increased in recent years. The current sample includes an average of 64 firms per

[1] These include Summers and Summers (1989), Stiglitz (1989), and Eichengreen, Tobin, and Wyploz (1995). Hau

year. By comparison, the 1983 to 1992 sample used by Barclay (1997) contains an average of 29 Nasdaq to NYSE transfers per year. The increase in transfers likely reflects in part the increase in the number of Nasdaq listed stocks that meet Exchange listing requirements.

Cursory examination of the data indicates that a subset of these stocks was not actively quoted while listed on Nasdaq. In particular, we observed many stock/dates on which a Nasdaq quote is entered before the market opens, but no quote update occurs during the trading day. In general the Nasdaq stocks that are not frequently quoted are smaller and have wider spreads than those that are frequently quoted. While we report some summary statistics for the full sample of 320 stocks, most of our empirical analysis focuses on a restricted sample of 154 stocks. Stocks are excluded if there are trading dates during which no quote update is entered during normal trading hours. The main reason for this exclusion is that quote-based volatility measures will be biased downward during intervals when quotes are not updated. For rest of the paper, we refer to the original sample of 320 firms as the 'full sample' and the sample of 154 firms with regular quote updates as the 'restricted sample'.

We focus on the 180 calendar days around Exchange listing. A longer interval could improve the precision of point estimates due to the use of more data, but more elapsed calendar time also allows the possibility of significant changes in firm characteristics, thereby diluting the extent to which observed changes can be associated with the change in market structure.

To assess whether volatility changes after Exchange listing, we focus on quotation midpoints, rather than trade prices, as the volatility of trade-price returns will be affected by the movement of prices between the bid and ask quotes. Raw quotation data is obtained from the Trade and Quote (TAQ) database made available by the NYSE. We use only Nasdaq quotes before listing and NYSE quotes after listing. Blume and Goldstein (1997) document that market makers off the NYSE occasionally post quotes that improve on those of the NYSE, implying that our exclusive use of NYSE quotations introduces a slight bias *against*

(2001) describes recent proposals to impose transactions taxes in European financial markets.

finding lower spreads after listing. The average quoted spread is measured for each firm before and after Exchange listing as the time-weighted average of individual quotation spreads. Most of reported results are reported on an absolute (dollar) basis. We also examine spreads as a percentage of the bid-ask midpoint, and find very similar results.[2]

We record the midpoints of the quotations in effect at 9.30 a.m. and at 4 p.m., and examine the volatility of daily (4 p.m. to 4 p.m.) and intraday (9:30 a.m. to 4 p.m.) quote mid-point returns.[3] Also, the possibility that changes in volatility after Exchange listing could simply reflect changes in overall market volatility around the time of transfers is investigated. To do so, we examine standardized volatility measures where each firm's pre and post-listing return volatilities are divided by the volatilities of the S&P 500 Index over the same 90-day intervals.

Statistical significance of the changes in average bid-ask spreads and volatility after Exchange listing is assessed using simple non-parametric sign tests. If changes in spreads and volatility after Exchange listing are random then we would expect to observe increases for 50% of firms and decreases for the other 50%. The percentage of firms that actually show a decrease in each measure is recorded and a simple binomial sign test used to assess whether this percentage differs from the benchmark of 50. We also report the mean spread before and after listing, as well as the median volatility before, median volatility after, and median change in volatility.

We consider results for several subsamples. To assess whether changes in bid-ask spreads and volatility after Exchange listing depend on firm size, we divide the sample into three equal subsamples based on market capitalization at the listing date. To determine whether improvements in spreads and

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[2] Earlier studies of Exchange listings, including Barclay (1997) and Christie and Huang (1994), examined effective bid-ask spreads as well as quoted spreads. Effective spreads measure how close trade execution prices are to the mid-point of the bid and ask quotes, and thereby capture any benefits due to trading within the quotes. However, Schultz (2000) documents significant problems with the time stamps for Nasdaq trades during the early years of our sample interval. As a consequence, no comparisons of effective spreads are provided here.

[3] All prices in the volatility analyses are adjusted for stock splits. Splits after Exchange listing are identified based on data in the TAQ Master file, while splits before Exchange listing are identified based on data on shares outstanding kindly provided by Tim McCormick of the Nasdaq Stock Market.

volatility occur primarily for firms with relatively poor liquidity while listed on the Nasdaq market, we examine three subsets of firms based on average pre-listing bid-ask spreads. Barclay (1997) documents that decreases in bid-ask spreads upon Exchange listing are largest for firms whose Nasdaq market-makers avoided odd-eighth quotes. To determine whether this regularity continues to hold for the more recent data we separate the sample based on Nasdaq quote rounding frequencies.

Finally, we consider separately the experience of firms that listed on the NYSE after the 1997 reforms of the Nasdaq market. New order-handling rules mandated by the SEC were implemented during 1997, with stocks phased in on various dates.[4] Information provided on NASD web sites is used to determine the dates at which sample stocks became subject to the new order handling rules, and to identify a subsample of stocks that were subject to the new order handling rules for all of their last 90 days before Exchange listing.

Tables 1 and 2 provide some summary data regarding the full and restricted samples. Average share prices are little altered after Exchange listing for either the full or the restricted sample. For the full sample, the time weighted number of quotes reported per day declines from an average of 125.34 before listing to 113.78 after listing. However, the median number of quotes per day increases from 29.17 to 64.20. The difference in the direction of change in mean and median estimates indicates that some firms are much more heavily quoted on the Nasdaq than they are on the NYSE. The time weighted percentage of quotes rounded to even eighths of a dollar in the full sample averages 59.85% on Nasdaq, compared to 41.13% on the NYSE.

Comparing the full and restricted samples, it is apparent that those stocks excluded from the main study are quoted much less frequently, and are smaller. The mean market capitalization of stocks in the restricted sample is $1.63 billion, compared to $466 million for the stocks excluded from the restricted sample. The average number of quote updates per day prior to listing is 214 for stocks in the restricted

[4]For a description of the order handling rules, see Barclay, Christie, Harris, Kandel, and Schultz (1999).

sample, compared to 42 for the stocks eliminated from the final sample.

Table 2 indicates that that average pre-listing bid-ask spread for the full sample of stocks is 44.7 cents. By comparison, the average pre-listing spread for the restricted sample is 30.8 cents, and the average pre-listing spreads for stocks excluded from the restricted sample is 57.7 cents. Since the restricted sample excludes stocks with relatively wide Nasdaq spreads, our results are biased away from finding narrower spreads after listing. Indeed, the average reduction in bid-ask spreads after Exchange listing is larger for the full sample (24.8 cents) than for the restricted sample (13.1 cents).

Table 2 also provides some summary evidence regarding volatility for the full and restricted samples. The median decrease in full sample close-to-close return volatility after Exchange listing is 0.24 percent, and 63.1% of full sample firms show a decrease in close-to-close return volatility. Corresponding figures for the restricted sample are almost identical: the median decrease in close-to-close return volatility after exchange listing is 0.29 percent, and 64.2% of restricted sample firms show a decrease in close to close return volatility. The similarity in close-to-close volatility declines across the full and restricted samples indicates that our overall conclusions regarding volatility changes are unlikely to be affected by omitting stocks whose quotes are sometimes not updated during regular trading hours.

The infrequently-quoted stocks that are excluded from our restricted sample have relatively wide spreads, but similar close-to-close volatility as compared to the more-actively quoted stocks included in the restricted sample. Apparently, Nasdaq market makers post wide spreads for some stocks on some days and, protected from informed traders by the wide spreads, do not update quotations until the following day. If so, intraday volatility estimates will be affected. Indeed, the evidence reported on Table 2 indicates that inference regarding intraday price movements *is* sensitive to including stocks whose quotes are not updated frequently. In particular, the median standard deviation of half-hour returns prior to Exchange listing is 0.72 percent for the restricted sample, compared to 0.47 for the full sample. The absence of timely quote updates reduces the intraday volatility that can be observed, even if stocks are not truly less volatile. For

the rest of the paper, we therefore focus on the restricted sample of 154 firms to examine the volatility changes. It should be noted though that our most important conclusion: that both trading costs and return volatility decline after Exchange listing, holds in the full as well as the restricted sample. Section II.B. below provides a more complete investigation of volatility changes after Exchange listing.

II. Average Bid-Ask Spreads and Return Volatility Around Exchange Listings

This section reports on cross-sectional average bid-ask spreads and return volatility during the last 90 days before and first 90 days after Exchange listing. Section III below provides cross-sectional analysis of the firm-by-firm changes in spreads and volatility, and reports on results of estimating a simultaneous system to ascertain whether the structural effects of Exchange listing are responsible for the observed changes in mean spreads and volatility.

A. Bid-Ask Spreads

Table 3 reports average bid-ask spreads in cents per share before and after Exchange listing for the restricted sample and for each subsample described above. Bid-ask spreads decline markedly after Exchange listing. For all the firms in the restricted sample, the decline is from a median of 24.9 cents on Nasdaq to a median of 16.7 cents on the NYSE. Eighty two percent of the firms in the sample saw a reduction in average spreads.

Every subsample, with two exceptions, saw significant reductions in average spreads after listing. By market capitalization, the smallest firms have the largest decreases in spreads. As might be expected, firms that had the widest spreads while listed on Nasdaq show the greatest decline in spreads after Exchange listing. For this group the median Nasdaq spread was 44.6 cents, while the average NYSE spread is 18.8 cents, and all of the 51 firms in this group saw a spread reduction after listing. In contrast, those stocks with relatively narrow Nasdaq spreads saw minimal reductions after listing. This group had post-listing bid-ask spreads averaging 13.5 cents, compared to 13.7 cents before listing.

Firms whose Nasdaq market makers avoided odd-eighth quotations also saw large spread reductions upon Exchange listing. For the "high avoidance" subsample the median reduction in spreads is from 42.3 cents on Nasdaq to 18.8 cents on the NYSE, with ninety eight percent of firms showing a reduction in spreads. In contrast, the "low avoidance" subsample shows a much smaller and statistically insignificant spread reduction, from 14.4 cents on Nasdaq to 13.9 cents on the NYSE, with only 25 of the 51 firms experiencing spread reductions. These results, obtained for firms transferring to the NYSE during the 1996-2000 period, are quite similar to those reported by Barclay (1997) for the 1983-1992 period, and indicate that the extent to which spreads on the Nasdaq dealer market exceed spreads on the NYSE specialist-auction market continues in the more recent data to be related to whether Nasdaq dealers use odd-eighths in their quotations.

Firms that moved to the NYSE after the introduction of Nasdaq reforms also experienced decreases in average bid-ask spreads. For the 113 firms in this group, the reduction is from a mean (median) spread of 29.0 cents (23.3 cents) on Nasdaq to 17.5 cents (16.5 cents) on the NYSE, and 86 of the individual firms showed spread reductions. Demsetz (1997) conjectures that NYSE spreads are narrower than Nasdaq spreads because the public is able to compete with the NYSE specialist by posting limit orders, while in the past this capability did not exist on Nasdaq. Among the 1997 reforms of the Nasdaq market was the requirement that limit orders be displayed as Nasdaq quotes when they improve on dealer quotes. The observation that spreads decline after Exchange listing even with the new order-handling rules in place indicates that the Demsetz explanation does not fully explain cross-exchange differences in spreads.[5] However, it should be noted that while the reduction in average spreads for the post-reform sample of 11.6

[5] A possible explanation for the continued observation of lower trading costs on the NYSE is the widespread use of preferencing agreements on the Nasdaq market. Huang and Stoll (1996), Godek (1996), and Dutta and Madhavan (1997) have all conjectured that preferencing arrangements, under which order flow is directed by preexisting agreement to market makers, are responsible for wider Nasdaq spreads. Bloomfield and O'Hara (1998) provide experimental evidence indicating that incentives to compete for order flow by improving quotations are reduced if a large proportion of order flow is subject to preferencing agreements. More recently, Chung, Chuwonganant, and McCormick (2001) provide the first direct empirical evidence on the issue. They study Nasdaq-listed stocks, and find that quotes are less competitive and spreads are wider for those stocks with more preferenced order flow.

cents is substantial, it is less than the reduction of 17.4 cents observed for sample firms that moved before the Nasdaq reforms were completed.[6] The key result of this analysis is that companies that transferred from Nasdaq to the NYSE in the recent data continue to experience substantive decreases in trading costs. We now examine return volatility before and after Exchange listing.

B. Return Volatility

We examine volatility by focusing on returns that are constructed from the midpoints of the last quote reported before 4 p.m. each day. Since these returns are based on midpoints they should be unaffected by "bid-ask bounce", whose impact would be reduced after Exchange listing. The standard deviation of these returns is computed for the last 90 days before and the first 90 days after Exchange listing for each firm. Table 4 reports the cross-sectional median standard deviation for the full sample and several subsamples, and the percentage of firms experiencing a reduction in return volatility after Exchange listing.

Results reported on Table 4 indicate that volatility is on average lower after Exchange listing. For all stocks in the restricted sample, the cross sectional median volatility of daily quote midpoint returns is 3.06% before listing as compared to 2.83% after Exchange listing. Ninety nine of the 154 firms have lower quote-based return volatility after Exchange listing, and this proportion (64.3%) of firms with volatility reductions exceeds significantly (p-value = .0004) the benchmark of fifty.

The strength of the evidence regarding volatility reductions varies somewhat across subsamples. Evidence of volatility reductions is generally strongest for small firms, firms with a high degree of odd-eighth avoidance by Nasdaq market makers, and firms with wide Nasdaq spreads. Although point estimates indicate volatility reductions after Exchange listing for all subsamples, the evidence is statistically weak for firms with a low degree of odd-eighth avoidance and those that had narrower Nasdaq spreads.

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[6] Tse (2001) also examines recent evidence, and finds that stocks that move from the Nasdaq to AMEX continue to experience reductions in spreads.

The determinants of cross-sectional variation in volatility reductions are examined more formally and in a multivariate setting in section III below.

It is possible that changes in volatility after Exchange listing could reflect changes in overall market volatility rather than the structural shift in trading costs. For example, the overall market was unusually turbulent during the last half of October 1997. If an unusually large number of firms listed just before (after) this period then the tests would be biased toward finding higher (lower) volatility after Exchange listing. To investigate this possibility we construct a standardized volatility measure. We measure the volatility of S&P 500 Index returns over firm-specific 90-day pre and post-listing periods, and standardize each stock's volatility measures by dividing by the matched S&P 500 volatilities. Each standardized volatility measure can be interpreted as the firm's volatility relative to that of the S&P 500 during the relevant 90 day interval.

Table 5 reports average standardized volatility measures. These results indicate that the evidence of lower return volatility after Exchange listing is strengthened by allowing for changes in overall market volatility. For the full sample, the cross-sectional median ratio of firm volatility to S&P volatility is 2.84 times prior to Exchange listing, compared to 2.33 times after Exchange listing. Seventy four percent of sample firms experience a decrease in return volatility relative to that of the overall market after Exchange listing. The proportion of firms experiencing a decrease in standardized volatility exceeds significantly the benchmark of fifty for the full sample (p-value < .0001) and for all subsamples (each p-value < .015). Notably, significant decreases in standardized volatility continue to be observed for stocks that moved to the NYSE after the 1997 reforms of the Nasdaq market.

To assess whether the observed volatility changes reflect differences in the evolution of prices within the trading day, as opposed to overnight volatility, we also examine intraday returns by comparing

quotes in effect at 4 p.m. to those in effect at 9:30 a.m.[7] The results reported in Table 6 indicate that the majority of the volatility reduction reflects intraday price changes. The median reduction in intraday return volatility is 0.17%, compared to a median reduction of 0.29% in daily (4 p.m. to 4 p.m.) volatility. Of the 154 firms, 90 (58.4%) experienced a decline in intraday volatility, and this percentage again exceeds significantly (p-value = .006) the benchmark of fifty. The results in Table 6 show decreases in median intraday volatility for every subsample, though the statistical significance varies. The strongest evidence of decreases in intraday volatility is for small stocks, stocks with wide Nasdaq spreads, stocks that transferred to the NYSE before the Nasdaq reforms, and stocks with high odd-eighth avoidance on Nasdaq.

To summarize, the evidence indicates that return volatility decreases after stocks move from Nasdaq to the NYSE. This result is not attributable to reductions in "bid-ask bounce", since we measure returns from quotation midpoints. Nor is it attributable to contemporaneous shifts in market-wide volatility, as controlling for overall stock market volatility strengthens rather than weakens the evidence.

III: Cross-sectional Variation in Spread and Volatility Changes After Exchange listing

The results reported in Tables 2 through 6 demonstrate that bid-ask spreads and return volatility both decrease on average after Exchange listing. However, there is cross-sectional variation in the results, with some firms experiencing increases. Also, other variables, including trading activity, average share price, and quotation characteristics change after Exchange listing. As Barclay (1997) points out, reductions in spreads might be attributable to changes in other economic variables. In this section we report the results of multivariate analysis of the firm-by-firm changes in spreads and volatility. The purpose is to explain cross-sectional variation in changes in spreads and volatility, and to ascertain whether the observed reductions in mean spreads and volatility can be attributed to changes in other economic variables.

A. Multivariate Analysis of Spread and Volatility Changes

[7] We also examined changes in the volatility of quote returns measured over half-hour intervals. Results, which are

We begin by estimating a series of multiple regressions, where the dependent variable for each regression is the change from the time of Nasdaq listing to the time of NYSE listing in a spread or volatility measure, while the independent variables include firm size and changes in variables known from prior research (e.g. Harris (1994)) to be related to spreads and volatility. Explanatory variables include market capitalization at the listing date, the change in average share price, the change in the number of quote updates per day, the change in the percentage of quotations rounded to even eighths of a dollar, an indicator variable to distinguish between firms listed before and after Nasdaq market reform (0=before and 1=after), and trading activity. The interpretation of reported share volume differs across dealer and auction markets.[8] As a consequence, we follow Barclay (1997) in using both average pre-listing (Nasdaq) volume and average post-listing (NYSE) volume as explanatory variables, as opposed to using the change in reported volume. Results of the cross-sectional regressions analyses analysis are reported in Table 7. Results are reported both with odd eighth variables included and excluded.

A.1. Changes in Bid-Ask Spreads

Panel A of Table 7 reports on the determinants of cross-sectional variation in bid-ask spread changes after Exchange listing. The most important variable in this analysis is the change in the proportion of quotations that are rounded to even eighths of a dollar. The coefficient on this variable is very significant in a statistical sense, with a t-statistic of 6.1 (3.8 when explaining the change in percentage spreads), and is large in an economic sense. The point estimate of 0.99 implies that a reduction in the proportion of quotes rounded to quarters from 47.9% (the pre-listing Nasdaq restricted-sample mean) to 35.9% (the post-listing restricted-sample NYSE average) is associated with a decrease in quoted spreads of 11.9 cents, ceteris paribus. By comparison, the average quoted spread before moving to the NYSE is 30.8 cents. The coefficient estimate on the product of the change in odd-eighth avoidance and the post reform indicator is

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available from the authors on request, support similar conclusions to those reported.

[8] A customer buy order and a customer sell order would lead to two reported trades on a dealer market, but could cross and be reported as a single trade on an auction market. Dealer market volume may also reflect interdealer trades undertaken to rebalance inventory. See Dyl and Anderson (2002) for additional discussion and analysis of reported

positive and statistically significant as well, indicating that odd-eighth avoidance has become *more* rather than less important in terms of explaining spread changes after the adoption of market reforms.

The estimated intercept when explaining changes in absolute spreads is negative (-0.213) and significant (t-statistic = -5.98) when avoidance variables are excluded from the regression, but does not differ significantly from zero when avoidance measures are included. This indicates that the reduction in average spreads after listing cannot be explained by changes in the variables other than odd eighth avoidance, i.e. by changes in share price, trading activity, or return volatility. However, the reduction in average quoted spreads can be fully explained when the reduction in avoidance is included as an explanatory power.

Share price changes have significant explanatory power for spread changes, with spreads widening in absolute terms and falling in percentage terms for stocks with share price increases. The estimated coefficient on the post-reform indicator is positive and marginally significant, which indicates a smaller decline in spreads at Exchange listing after the Nasdaq reforms. The other variables included in the multiple regression, including trading activity, market capitalization, and the change in return volatility have relatively little explanatory power for spread changes.

To summarize, changes in odd-eighth avoidance dominate cross-sectional variation in spread reductions after Exchange listing, and this effect became stronger rather than weaker after the 1997 reforms of the Nasdaq market. Cross-sectional variation in other variables (trading activity, market capitalization, and change in return volatility) do not explain the average reduction in bid-ask spreads, but when the change in odd-eight avoidance is included the reduction in average spreads can be fully explained.

A.2. Changes in Volatility

Panel B of Table 7 reports the results of estimating cross-sectional regressions to explain post-listing changes in the volatility of daily and intraday quote-midpoint returns. The coefficient estimates

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volume on Nasdaq and the NYSE.

reveal relatively little systematic cross-sectional variation in volatility changes – adjusted R^2 statistics range from just .011 to .027. The change in volatility is negatively but insignificantly related to pre-listing volume, and positively and marginally significantly related to post-listing volume. The change in the average share price is significantly related to the change in the volatility of daily returns, while the relation between average share price changes and intraday volatility is marginally significant. The coefficient estimate on the Nasdaq reform indicator is positive and marginally significant when explaining the change in daily volatility, though this effect disappears when avoidance variables are included in the regression. The intercept estimate in the daily volatility regression is negative and statistically significant when avoidance variables are excluded, indicating that the other explanatory variables do not explain the reduction in mean volatility. However, the intercept estimate becomes statistically insignificant when avoidance variables are included. The change in the quoted spread is marginally significant when explaining the change in intraday volatility, but this effect is also subsumed when avoidance variables are included in the regression.

The overall conclusion from this Table is that changes in spreads have weak power in explaining changes in volatility following exchange listing. However, similar to our cross sectional analysis of spread changes, odd-eighth avoidance can explain volatility changes. The continued dominance of odd-eighth avoidance as an explanatory variable for spread and volatility changes in the wake of the 1997 market reforms is puzzling.

B. Endogeneity of Spreads, Volume, and Volatility

The preceding analysis provides information regarding cross-sectional variation in spread and volatility reductions after Exchange listing, in a multivariate setting. However, it can be argued that this analysis is incomplete, as it does not take into account the endogenous nature of bid-ask spreads, trading activity, and return volatility. It is possible that the reductions in average spreads documented here and in prior studies and the reduction in average volatility documented here are not attributable to Exchange listing

per se, but result from changes in other endogenous or exogenous variables that occur around the time of listing.

Both inventory-based (e.g. Ho and Stoll, 1980) and information-based (e.g. Glosten and Milgrom 1985) theories of bid-ask spreads imply that spreads should vary positively with volatility. This raises the possibility that the observed spread reductions might be attributable to volatility reductions. Further, Demsetz (1968) argues that spreads should vary inversely with typical trading activity, ceteris paribus, and volume is not held constant in the analysis.

It is also well-documented that trading activity and return volatility are positively correlated (Karpoff [1987] reviews eighteen such studies, and more recent evidence is presented by Lamoureux and Lastrapes [1990]). Clark [1973] and Tauchen and Pitts [1983] develop the "mixture of distributions" hypothesis, in which the sequential arrival of new information endogenously generates both trading volume and price movements, with both increasing during periods characterized by numerous information shocks.

It could also be argued that spreads are determinants of trading activity if the demand for liquidity is downward sloping in the price of liquidity. Further, spreads could affect volatility by changing informed traders' incentives to act on the information they acquire. In short, spreads, trading activity, and volatility are jointly determined in equilibrium. To provide more definitive evidence on whether Exchange listing has a structural effect on these endogenous variables we estimate a system of simultaneous equations by two stage least squares.

As noted in Section III.A. above, reported trading volumes are not directly comparable across dealer and auction markets, which precludes focusing on changes in this endogenous variable from the pre-listing to post-listing periods. Instead, we use as the basic unit of observation firm level averages computed from the 90 days before and 90 days after Exchange listing. Each regression therefore includes 308 observations, corresponding to the pre and post listing observations on each of the 154 firms in the restricted sample. The set of variables employed includes:

Endogenous Variables:

- The average bid-ask spread for the firm during the 90 days before and after listing.
- The volatility of close-to-close midpoint returns, computed from the 90 days before and after listing.
- Average reported volume during the 90 days before and 90 days after listing.

Market Structure Variables

- An NYSE indicator that equals one for observations computed from the 90 days after listing and that equals zero for observations from the 90 days before listing.
- Odd eighth avoidance, measured as the time-weighted percentage of quotes at even-eighths of a dollar, before and after listing.
- The product of spread and the NYSE indicator,
- The product of volatility and the NYSE indicator,
- The product of the avoidance measure and the NYSE indicator,

Exogenous Variables:

- Overall market volatility, measured as the volatility of S&P 500 index returns during the firm-specific 90 days before and after Exchange listing,
- Overall market trading activity, proxied by total NYSE volume during the firm-specific 90 day intervals before and after Exchange listing,
- Market capitalization at the listing date,
- Average share price during the pre and post listing periods,
- An indicator variable that equals one for stocks that transferred after Nasdaq reforms were implemented.

To assess whether market structure has a structural effect on the endogenous variables we test

whether the coefficients associated with the NYSE indicator variable are non zero. The NYSE indicator itself measures shifts in estimated intercepts after Exchange listing, while the product of the NYSE indicator and other variables measure shifts in estimated slope coefficients after Exchange listing. Regression intercepts in general measure the mean of the dependent variable, conditional on all explanatory variables equaling zero. Estimates of shifts in average spreads and volatility conditional on zero market capitalization, zero share price, zero market volume, etc., are of no practical interest. To obtain meaningful estimates, we deduct from each firm-specific explanatory variable the cross-sectional mean of that explanatory variable, computed from the pre-listing observations.[9] The NYSE indicator coefficients therefore measure shifts in intercepts and slope coefficients for stocks with avoidance equal to the pre-listing mean, share price equal to the pre-listing mean, market volatility and volume equal to the mean observed during the last 90 days on Nasdaq, etc.

To estimate the simultaneous system requires the imposition of a sufficient number of exclusion restrictions. Market volume and market volatility are excluded from the spread equation, under the reasoning that these exogenous variables will affect firm specific volume and volatility, which in turn affect spreads. Avoidance and market volume are excluded from the volatility regression. The reasoning with respect to quote rounding is that avoidance directly affects spreads but not volatility, so that the impact of spreads on volatility can be identified. The reasoning with respect to market volume is that overall volume should not affect volatility except through effects on firm-specific volume. The volume regression excludes avoidance and market volatility, again under the reasoning that avoidance should not affect directly volume, except through a possible affect on spreads, and that market volatility should not affect trading activity with firm-specific volatility included in the specification.

Table 8 reports the results of estimating this simultaneous system by two stage least squares. Focusing first on spreads as the endogenous variable, avoidance is highly significant in explaining spreads

[9] As a sensitivity test we also estimated the system after deducting the full sample (computed across the pre and post-

(t-statistic = 17.65), but less so after NYSE listing (t-statistic for the change in slope = -6.48).[10] Higher volatility is associated with wider bid-ask spreads (t-statistic = 3.45), as predicted by inventory and information based theories of the spread, but the sensitivity is less on the NYSE (t-statistic for the change in slope = -2.16). Surprisingly, spreads are not significantly affected by trading activity. Spreads are positively related to share price, and after controlling for variation in other exogenous and endogenous variables, are actually higher on average post-reform. Most importantly, note the negative and statistically significant coefficient estimate on the NYSE indicator. This indicates that the market structure of the NYSE is associated with lower average spreads, even after allowing for changes in other endogenous and exogenous variables.

Consider next results obtained when return volatility is the dependent variable. Higher firm specific volume and higher market-wide volume are both associated with greater volatility (t-statistics of 5.01 and 2.40, respectively), as would be expected if increased trading activity signifies larger information flows. Larger stocks have returns that are less volatile (t-statistic = -2.29), while volatility has been greater post-reform (t-statistic = 2.16). Wider spreads are associated with greater volatility (t-statistic = 3.25). This result is potentially important, because it is at odds with the reasoning of those who favor transactions taxes (e.g. Summers and Summers (1989)), who have argued that volatility can be decreased by increasing transactions costs.

Finally, note that the coefficient estimate on the NYSE indicator does not differ significantly from zero, and that a joint test of the hypothesis that all coefficient estimates that involve the NYSE indicator are zero cannot be rejected (p-value = .740). This indicates that Exchange listing does not have a significant structural effect on return volatility. The observed reduction in average volatility after Exchange listing can be attributed to changes in other endogenous and exogenous variables, including the structural reduction in bid-ask spreads.

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listing observations) cross-sectional mean from each firm-specific explanatory variable. All inference was unaffected.

Finally, consider the specification where trading volume is the dependent variable. Trading volume is positively related to same stock volatility, strongly related to market capitalization (t-statistic = 20.70), and has decreased post reform (t-statistic = -3.47). The interpretation of the NYSE-listing variables in this specification is clouded by differences in reporting conventions across dealer and auction markets. Coefficient estimates on the NYSE indicators will reflect effects of both reporting differences and actual changes in customer trading proclivity. The joint hypothesis that all coefficients involving the NYSE indicator are zero is rejected (p-value = .003), indicating that reported volume is structurally related to NYSE listing. Surprisingly, however, in light of differences in reporting conventions, the coefficient estimate on the NYSE indicator is insignificant.

To summarize, the analysis of trading volume, return volatility, and bid-ask spreads as a simultaneous system of endogenous variables provides several results consistent with microstructure theory (e.g. spreads widen with volatility and share price, greater volume is associated with higher volatility), one result (volatility increases when spreads increase) that is at odds with the reasoning of those who support transactions taxes, and one result that is puzzling in light of recent market reforms (spreads remain in the recent data significantly related to the avoidance of odd eighth quotes). The results indicate that Exchange listing is associated with a structural reduction in bid-ask spreads even after allowing for changes in other endogenous and exogenous variables, but that the observed reduction in average volatility can be attributed to changes in other variables, including the reduction in spreads.

IV. Conclusions

This study examines changes in trading costs and volatility for 320 firms that moved from the Nasdaq stock market to the New York Stock Exchange from 1996 to 2000. Consistent with results reported by Christie and Huang (1994), Kadlec and McDonnell (1994), and Barclay (1997) for earlier samples, we

[10] This result is consistent with that reported by Bessembinder (1997), who examined a matched sample of NYSE and

find that bid-ask spreads in the recent data continue to decrease substantially upon Exchange listing, even after the implementation during 1997 of several reforms of the Nasdaq market.[11] Further, the magnitude of the reduction in bid-ask spreads remains, as documented by Barclay (1997) for an earlier sample, closely related to whether Nasdaq market makers made use of odd-eighth quotations. We extend the analysis to return volatility, documenting that returns are significantly less volatile after Exchange listing. The reduction in average volatility is not attributable to reductions in "bid-ask" bounce, and cannot be explained by changes in contemporaneous market-wide volatility.

The results of this analysis are also relevant to the recurring argument that return volatility can be decreased by imposing a "transactions tax". Summers and Summers (1989), Stiglitz (1989), and Eichengreen, Tobin, and Wyploz (1995) have argued for taxes on financial market transactions, reasoning that higher trading costs will curb "excessive" speculation. The results reported here indicate that trading costs and return volatility both decrease substantially after Exchange listing. Further, simultaneous equation methods indicate that an increase in trading costs is associated with an increase in return volatility, rather than a decrease as the proponents of transactions taxes presume.

Finally, we use simultaneous equation methods to examine the extent to which changes in endogenous spreads and volatility can be attributed to market structure, as opposed to changes in other variables. For example, microstructure theory implies that volatility affects equilibrium bid-ask spreads, which raises the possibility that the decrease in average spreads after Exchange listing as documented here and by earlier authors could be attributable to reductions in volatility or changes in other variables rather than market structure, *per se*. The results of the simultaneous equation estimation indicates that Exchange listing is indeed associated with a structural reduction in bid-ask spreads, even after allowing for changes in

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Nasdaq stocks rather than stocks that changed listing.

11 One caveat that should be kept in mind when interpreting the results of this study, as well as other studies of Exchange listings, is that the decision to list is also endogenous. To the extent that managers can ascertain cross-sectional variation in the costs and benefits of Exchange listing, firms that choose to list are likely to be those with the best cost-benefit tradeoffs. As a consequence care must be exercised in extrapolating from the trading costs reductions observed for firms that do list in order to project possible trading cost savings for broader populations of companies.

other endogenous and exogenous variables, but that the observed reduction in average volatility can be attributed to changes in other variables, including the reduction in spreads.

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Table1
Descriptive Statistics

Descriptive statistics for 320 (full sample) and 154 (restricted sample) firms that moved from Nasdaq to be listed on the NYSE between 1996 and 2000. Results pertain to 90 calendar days before and after the listing date. The restricted sample is a subset of the full sample containing firms that have at least 1 quote update between 9:30 a.m. and 4 p.m. on each sample date.

	Full Sample				Restricted sample			
	Mean	Median	Min	Max	mean	Median	min	max
Market Capitalization (in Million $)	1025.97	466.49	18.89	19781.28	1629	877.49	18.89	19781.28
Share Price (in 100 shares)								
Before listing	29.43	26.16	3.10	113.04	32.18	28.34	3.16	95.74
After listing	30.11	26.6	2.65	137.52	31.48	28.66	2.83	106.18
Number of quotes per day per firm								
Before listing	125.36	29.17	1.83	4809.81	214.32	96.06	9.90	4809.81
After listing	113.78	64.2	7.34	1686.85	177.03	123.04	9.90	1686.80
Quote size (in 100 shares)								
Before listing	14.96	14.91	3.41	41.03	14.79	14.93	3.41	33.08
After listing	51.38	34.16	4.85	424.19	53.04	35	11.12	335.87
Proportion of quotes occurring at even multiples of eighths of dollar								
Before listing	59.85	52.42	3.73	100	47.59	45.3	18.63	96.13
After listing	41.13	40.67	0	85.89	35.87	34.29	0	64.24
Number of days with at least 1 quote update								
Before listing	54.23	60	1	63	61.76	62	60	63
After listing	62.14	63	41	64	62.78	63	60	64

Table 2
Changes in Spreads and Volatility

Measures of volatility and spreads for 320 (full sample) and 154 (restricted sample) firms that moved from Nasdaq to be listed on the NYSE between 1996 and 2000. All return measures are based on quotation midpoints. The restricted sample is a subset of the full sample containing firms that have at least 1 quote update between 9:30 a.m. and 4 p.m. on each sample date.

Full Sample (N=320)	Median Nasdaq	Median NYSE	Median Change	% decline	Binomial p-value	Mean Nasdaq	Mean NYSE	Mean Change
Market capitalization on listing date (in million $)	466	466				1026	1026	
Time-weighted quoted spreads (in cents)	33.88	19.19	-14.11	89.39	0.0000	44.74	20.00	-24.75
Time-weighted quoted spreads (in percent of share price)	1.41	0.74	-0.63	85.31	0.0000	1.66	0.82	-0.91
Close-to-close volatility (in %)	2.59	2.29	-0.24	63.12	0.0000	3.15	2.63	-0.51
Half-hourly volatility (in %)	0.47	0.53	0.04	41.56	0.0029	0.54	0.69	0.14
Restricted Sample (N=154)								
Market capitalization on listing date (in million $)	877	877				1629	1629	
Time-weighted quoted spreads (in cents)	24.95	16.73	-6.28	81.8	0.0000	30.81	17.68	-13.13
Time-weighted quoted spreads (in percent of share price)	0.87	0.62	-0.24	74.6	0.0000	1.08	0.69	-0.39
Close-to-close volatility (in %)	3.06	2.83	-0.29	64.29	0.0000	3.64	3.26	-0.39
Half-hourly volatility (in %)	0.72	0.64	-0.08	61.69	0.0013	0.78	0.77	-0.01

Table-3

Time Weighted Means and Medians of Quoted Bid-Ask Spreads in Cents per Share.

Reported are average spreads between primary market bid and ask quotes, for 154 firms that moved from Nasdaq to the NYSE between 1996 and 2000. The sample covers the last 90 days on Nasdaq and the first 90 days on the NYSE for each stock. The mean spread before and after Exchange listing is computed for each company by time weighting each individual observation. Reported are cross-sectional means and medians of the firm-by-firm spread measures while The 154 firms are divided into three subsamples of approximately equal number of firms according to the following categories: by stock market capitalization on the date of listing (market capitalization), by time-weighted average spread on the Nasdaq (mean Nasdaq spread), and by frequency of Nasdaq quotes occurring on the even multiple of eights of a dollar (odd-eighth avoidance). Post-reform refers to companies that were subject to new Nasdaq order-handling rules and a tick size of one-sixteenth dollars for 90 days before exchange listing. The binomial p-value is obtained from a sign test of the hypothesis that the probability of a decline in spreads is 0.5. The t-stat is obtained from the univariate test that the mean change is zero.

Sample Firms	Number	Median Nasdaq Spread	Median NYSE Spread	Median Change	% of firms With Decline	Binomial P-value	Mean Nasdaq Spread	Mean NYSE Spread	Mean Change	t-stat
All firms	154	24.95	16.73	-6.28	81.8	0.0000	30.81	17.68	-13.13	-7.56
By market capitalization										
Smallest third	51	33.05	17.98	-14.68	92.1	0.0000	37.61	18.98	-18.63	-4.95
Middle third	52	25.64	17.72	-9.38	84.6	0.0000	31.69	18.53	-13.15	-6.01
Largest third	51	17.42	14.56	-2.5	68.6	0.0000	23.12	15.51	-7.60	-2.78
By Nasdaq reform										
Pre	41	26.57	17.3	-11.34	97.5	0.0000	35.68	18.31	-17.37	-5.37
Post	113	23.25	16.46	-4.95	76.1	0.0000	29.05	17.45	-11.59	-5.67
By Mean Nasdaq spread										
Smallest third	51	14.28	13.67	-0.18	63.7	0.5294	13.72	13.51	-0.21	-0.66
Middle third	52	24.95	17.26	-6.35	92.3	0.0000	25.19	18.25	-6.94	-8.57
Largest third	51	44.57	18.85	-24.16	100.0	0.0000	53.63	21.27	-32.37	-8.25
By odd-eighth avoidance										
Lowest Third	51	14.39	13.9	-0.05	49.0	0.7534	14.98	14.3	-0.67	-1.26
Medium Third	52	26.93	17.2	-8.46	98.1	0.0000	28.04	18.16	-9.88	-9.82
Highest Third	51	42.25	18.77	-22.55	98.0	0.0000	49.48	20.57	-28.89	-6.77

Table 4

Average Volatility of Daily Returns, Based on Last Daily Quote.

Daily returns are computed for 90 days before and after Exchange listing for 154 firms that moved from Nasdaq to the NYSE between 1996 and 2000. Returns are based on the midpoint of the last daily quotation. Reported are cross-sectional medians of standard deviations of these daily returns, before and after Exchange listing, in percent. The binomial p-value is obtained from a sign test of the hypothesis that the probability of a decline in volatility is 0.5. The 154 firms are divided into three subsamples of approximately equal number of firms according to the following categories: by stock market capitalization on the date of listing (market capitalization), by time-weighted average spread on the Nasdaq (mean Nasdaq spread), and by frequency of Nasdaq quotes occurring on the even multiple of eights of a dollar (odd-eighth avoidance). Post-reform refers to companies that were subject to new Nasdaq order-handling rules and a tick size of one-sixteenth dollars for 90 days before exchange listing.

Sample Firms	Number Firms	Median Nasdaq Volatility	Median NYSE Volatility	Median Change	% of Firms with Decline	Binomial P-value
All Firms	154	3.06	2.83	-0.29	64.3	0.0004
By Market Capitalization						
Smallest Third	51	3.06	2.86	-0.37	70.6	0.0025
Medium Third	52	3.33	2.95	-0.24	59.6	0.2154
Largest Third	51	2.89	2.70	-0.19	62.7	0.0575
By Nasdaq Reform						
Pre-Reform	41	2.98	2.45	-0.50	75.6	0.0003
Post-Reform	113	3.12	2.93	-0.21	60.2	0.0407
By Mean Nasdaq Spread						
Smallest Third of Sample	51	3.82	3.09	-0.15	56.9	0.1890
Middle Third	52	2.97	2.79	-0.20	61.5	0.1742
Largest Third	51	2.97	2.43	-0.68	74.5	0.0009
By Odd-Eighth Avoidance						
Low Avoidance	51	3.43	3.09	-0.06	50.9	0.9999
Medium	52	3.42	3.02	-0.59	67.3	0.0019
High Avoidance	51	2.77	2.31	-0.40	74.5	0.0040

Table 5
Average Volatility of Daily Returns, Relative to Overall Market

Daily returns are computed for each firm, based on closing quotation midpoints, for 90 days before and after Exchange listing, for 154 firms that moved from Nasdaq to the NYSE between 1996 and 2000. Standard deviations of these daily returns are then computed for each firm, and each standard deviation is divided by the standard deviation of S&P 500 Index returns over the same 90-day interval. Reported are cross-sectional medians of the firm-by-firm volatility measures. The binomial p-value is obtained from a sign test of the hypothesis that the probability of a decline in volatility is 0.5. The 154 firms are divided into three subsamples of approximately equal number of firms according to the following categories: by stock market capitalization on the date of listing (market capitalization), by time-weighted average spread on the Nasdaq (mean Nasdaq spread), and by frequency of Nasdaq quotes occurring on the even multiple of eights of a dollar (odd-eighth avoidance). Post-reform refers to companies that were subject to new Nasdaq order-handling rules and a tick size of one-sixteenth dollars for 90 days before exchange listing.

Sample Firms	Number Firms	Median Nasdaq Volatility	Median NYSE Volatility	Median Change	% of Firms with Decline	Binomial P-value
All Firms	154	2.84	2.33	-0.54	74.2	0.0000
By Market Capitalization						
Small Firms	51	2.83	2.35	-0.67	76.5	0.0002
Medium Firms	52	2.84	2.35	-0.58	78.8	0.0000
Large Firms	51	2.88	2.32	-0.37	66.7	0.0118
By Nasdaq Reform						
Pre-Reform	41	3.40	2.22	-0.82	92.7	0.0000
Post-Reform	113	2.74	2.38	-0.37	67.3	0.0002
By Mean Nasdaq Spread						
Smallest Third of Sample	51	3.13	2.67	-0.33	70.6	0.0003
Middle Third	52	2.81	2.31	-0.55	71.2	0.0047
Largest Third	51	3.04	2.23	-0.69	80.4	0.0000
By Odd-Eighth Avoidance						
Low Avoidance	51	2.75	2.60	-0.30	62.7	0.0140
Medium	52	3.00	2.47	-0.56	75.0	0.0002
High Avoidance	51	2.56	2.23	-0.71	84.3	0.0000

Table 6

Average Volatility of Daily Returns, Based on Opening and Closing Quotes.

Intraday returns are computed for each firm for 90 days before and after Exchange listing, based on the midpoint of the quote in effect at 9:30 am and the last quote of the day. Standard deviations of these intraday returns in percent are then computed for each firm, before and after Exchange listing. Reported are cross-sectional medians of the firm-by-firm volatility measures. The binomial p-value is obtained from a sign test of the hypothesis that the probability of a decline in volatility is 0.5. The 154 firms are divided into three subsamples of approximately equal number of firms according to the following categories: by stock market capitalization on the date of listing (market capitalization), by time-weighted average spread on the Nasdaq (mean Nasdaq spread), and by frequency of Nasdaq quotes occurring on the even multiple of eights of a dollar (odd-eighth avoidance). Post-reform refers to companies that were subject to new Nasdaq order-handling rules and a tick size of one-sixteenth dollars for 90 days before exchange listing.

Sample Firms	Number Firms	Median Nasdaq Volatility	Median NYSE Volatility	Median Change	% of Firms with Decline	Binomial P-value
All Firms	154	2.86	2.64	-0.17	58.4	0.0056
By Market Capitalization						
Small Firms	51	2.93	2.73	-0.24	64.7	0.0122
Medium Firms	52	2.87	2.74	-0.11	53.8	0.6795
Large Firms	51	2.67	2.55	-0.13	56.9	0.0614
By Nasdaq Reform						
Pre-Reform	41	2.74	2.36	-0.31	70.7	0.0026
Post-Reform	113	2.88	2.73	-0.11	53.9	0.1093
By Mean Nasdaq Spread						
Smallest Third of Sample	51	3.44	2.97	-0.09	52.9	0.4532
Middle Third	52	2.68	2.61	-0.17	55.8	0.4606
Largest Third	51	2.71	2.36	-0.49	66.7	0.0004
By Odd-Eighth Avoidance						
Low Avoidance	51	3.16	3.02	0.15	47.1	0.7394
Medium	52	3.03	2.88	-0.24	57.7	0.0460
High Avoidance	51	2.56	2.22	-0.31	70.6	0.0007

Table 7

Cross sectional relations among Change in Spreads, Change in Volatilities, and Firm Characteristics.

Reported are coefficients obtained in cross sectional regressions of average change in time-weighted spreads and return volatilities on several characteristics of 154 firms that moved from Nasdaq to the NYSE between 1996 and 2000. Nasdaq reform is an indicator variable that is 1 if the firm was subject to new Nasdaq order-handling rules and a tick size of one-sixteenth dollars for 90 days before exchange listing, and 0 otherwise. Market capitalization refers to the stock market value of the firm (in millions dollars) on the day of listing. Change in share price is the change in average closing share prices (in dollars) before and after listing. Change in odd-eighth avoidance refers to the change in frequency of quotes occurring on the even multiple of eighths of a dollar on the Nasdaq and the NYSE. Volumes are averages of reported daily volumes on the two exchanges. The t-statistic is for the hypothesis that the associated coefficient estimate equals zero.

Panel A: Dependent Variables are Changes in spread

	Change in quoted spreads in cents				**Change in quoted spreads in percent of share price**			
	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat	Coef.	t-stat
Intercept	-0.2133	-5.98	-0.0113	-0.25	-0.6148	-6.68	-0.2955	-2.46
Nasdaq Reform Indicator	0.0079	1.98	0.0371	0.76	0.0165	1.64	0.2791	2.13
Market capitalization[a]	0.0055	0.48	0.0072	0.85	0.0468	1.59	0.0438	1.91
Change in share price	0.0054	2.64	0.0046	3.01	-0.0089	1.69	-0.0122	2.97
Average volume on Nasdaq	0.0409	0.77	-0.0069	-0.16	0.0780	0.57	0.0177	0.15
Average volume on NYSE	-0.0134	-0.20	0.0059	0.12	-0.0461	-0.26	-0.0107	-0.08
Change in quotes per day[a]			0.0045	0.06			0.2216	1.15
Change in odd-eighth avoidance			0.9990	6.11			1.6761	3.82
Reform indicator*avoidance			0.5497	2.37			2.4894	4.00
Change in close-to-close return standard deviation	0.0016	0.22	-0.0010	-0.19	0.0357	1.90	0.0316	2.20
Adj R-sq.	0.0753		0.5047		0.0270		0.0154	

Panel B: Dependent Variables are Changes in volatility

	Change in close-to-close daily return standard deviation				**Change in open-to-close daily return standard deviation**			
	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat	Coef.	t-stat
Intercept	-1.03	-2.32	-0.4402	-0.63	0.0735	0.14	-0.3583	-0.44
Nasdaq Reform Indicator	0.8173	1.81	0.2341	0.31	0.2651	0.51	1.1432	1.29
Market capitalization[a]	0.0094	0.07	0.0264	0.20	-0.0512	-0.34	-0.0765	-0.49
Change in share price	0.0510	2.16	0.0561	2.32	-0.0487	-1.77	-0.0490	-1.75
Average volume on Nasdaq	-0.6968	-1.15	-0.9551	-1.44	-0.6609	-0.94	-0.5694	-0.74
Average volume on NYSE	1.2699	1.64	1.3560	1.72	1.0194	1.13	1.0506	1.15
Change in quotes per day[a]			-0.9572	-0.86			0.5994	0.46
Change in odd-eighth avoidance			2.6986	0.94			-0.8274	-0.25
Reform indicator*avoidance			-2.1336	-0.58			6.6034	1.54
Change in quoted spread in cents	0.2078	0.22	-0.2494	-0.19	2.0332	1.84	0.8932	0.59
Adj R-sq.	0.0270		0.0154		0.0119		0.0108	

a. The estimates are multiplied by 1000.

Table 8

Simultaneous equation estimation of Spread, Volatility and Volume.

Reported are coefficients obtained from a system of equations with spread, volatility and volume as endogenous variables for 154 firms that moved from Nasdaq to the NYSE between 1996 and 2000. The coefficients are estimated by using two stage least squares method. For each exchange, endogenous variables are calculated as follows: spread is the time weighted average quoted spread in cents; volatility is the standard deviation of returns based on daily close-to-close returns; volume is the average reported daily trading volume. The NYSE indicator is 1 if the firm is on the NYSE or 0 otherwise. Nasdaq reform is an indicator variable that is 1 if the firm was subject to new Nasdaq order-handling rules and a tick size of one-sixteenth dollars for 90 days before exchange listing, or 0 otherwise. Market capitalization refers to the stock market value of the firm (in millions dollars) on the day of listing. Share price (in dollars) is the average closing stock price. Avoidance refers to the frequency of quotes occurring on the even multiple of eighths of a dollar on each exchange. Market volatility and market volume are contemporaneous standard deviation of daily S&P500 returns and contemporaneous NYSE trading daily trading volume on each exchange, respectively. All independent variables, except indicator variables, are adjusted by subtracting the mean of its average on the Nasdaq. The t-statistic is for the hypothesis that the associated coefficient estimate equals zero.

Dependent Variable	**Spread**		**Volatility**		**Volume**	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
Intercept	0.2364	15.84	3.2241	12.90	0.9159	8.36
NYSE indicator	-0.0810	-4.70	0.2909	0.64	0.1089	0.67
Spread			2.3152	3.25	-0.3338	-1.30
Volatility	0.0144	3.45			0.0985	3.74
Volume	-0.0024	-0.27	0.7912	5.01		
Avoidance	1.1406	17.65				
Market volatility			0.8981	2.40		
Market volume					0.0003	1.13
Spread*NYSE indicator			2.35	0.77	2.35	0.77
Volatility*NYSE indicator	-0.0131	-2.16			-0.0090	-0.23
Avoidance*NYSE Indicator	-0.7199	-6.48				
market cap	-0.0072	-1.75	-0.1700	-2.29	0.3470	20.70
Share Price	0.0025	6.01	-0.0065	-0.77	-0.0126	-4.28
Nasdaq Reform Indicator	0.9885	5.92	0.5824	2.16	-0.4518	-3.47
Adj r-sq.	0.6700		0.1264		0.6514	
	F-stat	p-value	F-stat	p-value	F-stat	p-value
F-test*	15.73	0.0001	0.3000	0.7403	4.77	0.0029

*The null hypothesis being tested is that all coefficient estimates involving the NYSE listing indicator are jointly equal to zero.