Electronic Limit Order Books, Dealer/Specialists, and Inter-Market Competition on NASDAQ

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Current version: February 2004

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Abstract

This study analyzes execution costs and competition for order flow between the NASDAQ Stock Market and five other trading venues that trade NASDAQ-100 securities (QQQ). We find that NASDAQ controls the most market share, although it has both the inside bid and ask only 50.24% of the time. These shares are much smaller than similar proportions reported for the NYSE, indicating a greater level of quote and order flow competition on NASDAQ. In addition, the dealer/specialist trading venues (NASDAQ, AMEX, and the Chicago Stock Exchange) show a decreasing percentage of trades from large to small trades, while trades through electronic limit order book systems (Archipelago and Island) exhibit an increasing percentage of trading from large to small trades. We find that both effective and realized spreads are smallest for the electronic limit order book systems and larger for the dealer/specialist systems. We also find evidence that order flow fragmentation and competition has hurt the markets as the NBBO spreads appear crossed 2.24% of the time and locked 12.43% of the time. Using a multinomial logistic regression, we find that all non-NASDAQ market centers have a lower likelihood of executing a trade as compared to NASDAQ itself, although the likelihood increases if the quotes are more competitive. Our findings suggest that extant findings on inter-market competition for NYSE-listed securities are not a result of the NYSE being the primary market, but instead due to differences in market structure.

Traders seeking to trade NASDAQ-listed stocks have a variety of choices in locations on which they can trade. Currently, NASDAQ stocks quote and trade on six different venues: NASDAQ, the American Stock Exchange (AMEX), the Cincinnati Stock Exchange (CSE), the NASD Alternative Display Facility (ADF), the Chicago Stock Exchange (CHX), and the Pacific Stock Exchange (PSE). These markets all compete for order flow, not only on the basis of price and quotes, but also cost to brokers.[1] While competition and diversity of market types provides greater choice for traders and may lead to better prices, it may also lead to fragmentation and the worsening of markets. However, increased competition and fragmentation may lead to frequent locked or crossed markets.[2]

A recent study by Barclay, Hendershott, and McCormick (2003) examines competition between ECNs and market makers (they do not examine competition across different market centers), the effects of competition across markets centers have been mostly studied for NYSE-listed stocks. Studies of competition in NYSE-listed securities include Blume and Goldstein (1992), Lee (1993), Battalio, Greene, and Jennings (1997), Bessembinder and Kaufman (1997), Bessembinder (2003), and Lipson (2004). These studies examine regional and third market execution for NYSE listed securities. Until recently, it has been difficult to examine the different markets for competing prices for NASDAQ stocks. Increased fragmentation, acquisitions and reporting arrangements now

[1] In addition, there is competition within the NASDAQ stock market itself, with multiple dealers, ECNs and limit order traders competing for order flow.

[2] According to Dean Furbish, Executive Vice President, NASDAQ Transaction Services, the issues associated with locked and crossed markets "refers to the relationships between SuperMontage and entities that are outside of it" (Schmerken, 2003).

allow an examination of the effects of competition and fragmentation within the NASDAQ market system on prices, quotes, and order flow.

The purpose of this study, therefore, is to examine the competitive nature of the NASDAQ market. Although most market makers and electronic crossing networks (ECNs) post quotes and report trades through NASDAQ, some, such as Instinet, use the ADF. On the other hand, the largest ECN, Island, posts trades and quotes through the Cincinnati Stock Exchange. Archipelago, another electronic limit order book system, posts trades and quotes through the Pacific Stock Exchange. While AMEX is a specialist system, Chicago is a competing specialist system. These different reporting venues, i.e., ADF, AMEX, Island (Cincinnati), Archipelago (Pacific) and Chicago, allow us a glimpse into the inter-competitive nature of NASDAQ. Additionally, we examine issues of locked and crossed markets, and determinates of order routing.

Overall, we find that there is substantial fragmentation of order flow for NASDAQ-listed stocks. Examining the NASDAQ-listed common stocks that comprise the NASDAQ-100 (QQQ) index from April to June 2003, we find that a little less than half (48%) of all trades occur away from the NASDAQ. Almost 27% of all trades occur on one of the two electronic limit order book systems (Island and Archipelago). However, these results are most prominent for smaller size trades. Over 87% of all block trades are still done on NASDAQ itself. While these results are consistent with those in Bessembinder (2003) for NYSE-listed securities, we find that NASDAQ's market share in terms of volume (62%) is much smaller than that the 85% reported in Bessembinder (2003) for the NYSE, indicating that the market for NASDAQ-listed securities is less centered on the primary market. This may be because costs on NASDAQ are higher:

with the exception of AMEX, we find that NASDAQ has higher effective and realized spreads than its competitors. NASDAQ is also not particularly competitive in terms of quote behavior. While it matches the best quote on at least one side of the market about 90% of the time, it only matches both sides about half the time. Notably, NASDAQ is alone at quoting the best bid or the best ask only 11% of the time, and is alone at quoting both sides of the market less than 1% of the time. About 10% of the time, NASDAQ quotes neither the best bid or the best ask. Only 2.9% of all of NASDAQ's volume comes during this time. There is significant evidence of preferencing, however. Chicago quotes neither the best bid or the best ask almost all the time (96%); even so, it receives 61% of its volume during these periods. Strikingly, we find significant instances of locked or crossed markets, indicating that the competition across these markets creates significant instances of market failure.

These results contrast with those found in Bessembinder (2003) for the NYSE. While the NYSE matches at least one side of the quote over 99% of the time, it matches both sides of the quote almost 90% of the time, much more than NASDAQ does for NASDAQ-listed securities. Even more important, the NYSE is three to four times as likely to be alone at the best quote than NASDAQ, and is almost never at neither the best bid or the best ask. In addition, the NYSE has lower effective and realized spreads than its competitors.

Collectively, these results indicate that the primary market is a much less effective competitor for NASDAQ-listed stocks than for NYSE-listed stocks. Overall, there is substantial competition for order flow from one or more of the other trading venues on NASDAQ.

Section I of the paper gives a brief history of the trading venues, while section II describes our sample and provides market share information. Section III describes our trading cost results, while section IV examines quote competition for NASDAQ-listed stocks. Section V examines trading activity. Section VI examines the results of fragmentation by examining locked and crossed markets. Section VII examines the determinates of the order routing mechanism. Section VIII concludes.

I. History of Trading Venues

Each of the six NASDAQ trading venues have recently had significant changes that affect their order flow and quoting characteristics. Most of these changes have occurred as a result of competitive pressures in the market. As a result of these changes, the disseminated data in TAQ is now more informative about the competitive landscape for trading NASDAQ-listed securities. In particular, these changes now allow for the identification of trading on certain electronic limit order books.

For example, beginning in March of 2002, Island[3], the largest ECN on NASDAQ, began reporting trades to the Cincinnati Stock Exchange. In October of 2002, Island also began routing quotes through the Cincinnati Stock Exchange. Island states that these moves were for cost savings, as the Cincinnati Stock Exchange charges less than NASDAQ to report trades and quotes.

Also in October 2002, NASDAQ introduced the Alternative Display Facility (ADF). The ADF is a quotation collection, trade comparison, and trade reporting facility operated by the National Association of Securities Dealers Inc. (NASD) for its members.

[3] Island and Instinet merged in 2002. However, Instinet trades and quotes are reported on the ADF.

The ADF was approved in July 2002 by the SEC as a pilot project (as outlined in rule SR-NASD-2001-90) proposed by NASD for a period of nine months (July 24, 2002 through April 24, 2003). Currently, Instinet trades and quotes are reported through the ADF.

In early 2003 the Pacific Stock Exchange began disseminating trades and quotes in NASDAQ stocks.[4] The Archipelago Stock Exchange uses the Pacific Exchange as the market center in which it reports the trades and quotes for the NASDAQ stocks in which they are making a market.

Additionally, two other venues (markets) trade NASDAQ-listed securities[5], the Chicago Stock Exchange (CHX) and the American Stock Exchange (AMEX). The Chicago Stock Exchange employs a competing specialist system, in some ways similar to the competing dealer system on NASDAQ. Chicago specialists handle a number of NASDAQ stocks and have traded some NASDAQ stocks since 1987. Also, AMEX specialists post quotes and execute trades for Nasdaq stocks.

II. Sample

The study considers a sample of 100 NASDAQ-listed common stocks comprising NASDAQ-100 market index (QQQ).[6] The time period for the study is the second quarter

[4] The phase-in of NASDAQ stocks on the Pacific Exchange, by Archipelago, began in February 2003 and was completed in early April 2003.

[5] SuperMontage was launched by NASDAQ in October 2002. Currently SuperMontage disseminates trades and quotes through NASDAQ (shown as a "T" in the TAQ database).

[6] We begin with 100 stocks, but 99 have trades and quotes in all three months of our sample. An analysis of the results does not change if this stock is removed from the sample. The stock of issue is USAI (USA Networks) which joined with Vivendi Universal (May 7, 2003), a joint venture was spun off and USA Networks was renamed USA Interactive (and the ticker of that company become IACI).

of 2003 (April, May and June 2003).[7] The data for the study was extracted from Trade and Quote (TAQ) database provided by the NYSE. The sample is restricted to include only quotes and trades that occurred during regular trading hours (9:30 a.m. to 4:00 p.m. EST). Additionally, certain filters are applied to the data to remove observations that could be subject to errors. In particular, trades and quotes were omitted if the TAQ database indicates that they were out of time sequence or involved either an error or a correction. Quotes were also omitted if either ask or bid price was equal to or less than zero. Finally, certain trades were omitted, in case the price or volume was equal to or less than zero.

Descriptive statistics for the sample are provided in Table I. Panel A of Table I shows the market share as a percentage of trades, panel B shows the market share as a percentage of volume, while panel C shows the percentage of dollar volume. NASDAQ executes a majority (51.59%) of trades in our sample. The two electronic limit order book systems, Island, which reports through the Cincinnati Stock Exchange, and Archipelago, which reports through the Pacific Stock Exchange, completed 17.12% and 19.31% of the trades, respectively, while the two specialist systems (AMEX and Chicago Stock Exchange) executes only 0.68% together. The ADF executes the remaining 11.30% of the trades. Since the AMEX and CHX execute an infinitesimally small number of trades in NASDAQ-listed securities one would expect that, they do not have substantial influence on the markets in those securities.

[7] The move by Archipelago to disseminate trades and quotes through the Pacific Stock ended at the beginning of our sample (they finished the switch on April 11th, 2003). An analysis of only May and June yields quantitative similar results as those reported here with all three months.

However, these results vary across the size of the trade. We divide our sample into four categories: large trades (those exceeding 10,000 shares), trades from 5,001 to 9,999 shares, trades from 501 to 5000 shares, and small trades (less than 500 shares). NASDAQ market share of large trades is 91.47%, while its market share for small trades is only 48.34% (Table 1, Panel B). NASDAQ shows a decreasing amount of the percentage of trades from large to small – and this is also seen for AMEX and Chicago, the two specialist systems. Conversely, the two electronic limit order book systems – Island (CSE) and the Archipelago (PSE) – show an increasing percentage of trades from large to small. Somewhat surprisingly, the ADF also does not repeat the NASDAQ's pattern and executes more small trades (12.09%) than large ones (1.73). Panel C reports the market shares as a percentage of dollar volume, and the results are similar to those presented in panels A and B. The differences in the trade size categories is statistically different for all markets for each panel.

One very clear pattern emerges from Table I, which is consistent in panel A through panel C. The dealer/specialist markets (NASDAQ, AMEX, and the Chicago Stock Exchange) all execute a larger percentage of large trades than small trades, in contrast to the electronic limit order book markets (CSE and PSE), which do the reverse. These differences support the arguments of Blume (2001) and Harris (1993), different markets develop to serve different types of traders needs. In particular, it appears that small traders prefer the advantages of an electronic limit order book system, while larger orders still require the human intervention that comes with dealer/specialist systems.

To verify that some markets do not specialize in trading only some of the stocks of our sample, we examine the location of trades and quotes for each of the stocks in our

sample. An analysis of the data indicates that the Cincinnati Stock Exchange, ADF, Pacific, and NASDAQ all have trades and quotes for the 100 stocks, while AMEX only shows trades for 98 of the stocks, and quotes for all 100. The Chicago Stock Exchange is making a market in only 80 of the 100 stocks in the sample.

III. Trading Costs

With NASDAQ garnering around 50% of the total order flow in NASDAQ stocks, and the remaining 50% of trading occurring on other venues, the question remains at to how much these other venues compete on price or execution quality. We use three measures of trade based execution costs: the effective half-spread, price impact, and realized half-spread.[8] To compute these trade based measures, we use the trade from the particular trading venue, and calculate the National Best Bid and Offer (NBBO) at the time the trade occurred. The NBBO is not given the TAQ database and must be reproduced from the data. There are instances in which the NBBO indicates that the market is crossed (bid price is greater than the ask price) or locked (bid and ask are the same price).[9] In the analysis of trade based execution cost measures, we only use NBBO quotes in which the NBBO is greater than zero.[10] The effective half-spread, that can be defined for security i at time t as:

[8] We use trade base execution costs so that we can compute the current NBBO for each stock, and see the execution cost for each market is at the time of a trade. Computing quoted spread might be misleading, as some of the trading venues might only be competitive for prices when they trades to make, and hence are not competitive all the time.

[9] An analysis of locked and crossed markets is undertaken in section VI.

[10] An analysis of BBO quotes in which the market is crossed or locked does not indicate evidence of stale quotes. The quotes that lock or cross the market are not outstanding for more than 5 minutes. Additionally, an examination of different lags (possible lags in quote reporting) do not change the findings regarding the locked and crossed BBOs. See section VI for more details on locked and crossed markets.

$$\textit{Effective Half-Spread}_{i,t} = I_{i,t}\left(P_{i,t} - M_{i,t}\right), \text{ where}$$

I_{it} is an indicator variable that equals one for the customer-initiated buys and negative one for the customer-initiated sells,

P_{it} is the trade price, and

M_{it} is the midpoint of the NBBO quotes in effect for stock i at time t.[11]

The effective spread, which is considered to be a better measure of execution costs than the quoted spread, reflects the real price that market participants actually pay for immediate execution of their trades. The effective half-spread measures how close the trade price comes to the quotation midpoint; which, in turn, is usually perceived as a proxy for the real value of the stock.

In order to assess the "cream skimming" argument asserted by many previous microstructure studies (Bessembinder and Kaufmann (1997); Easley, Kiefer, and O'Hara (1996); and Battalio (1997)), we measure trades' information content by assessing each trade's price impact:

$$\textit{Price Impact}_{i,t} = I_{i,t}\left(M_{i,t+10} - M_{i,t}\right), \text{ where}$$

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[11] Following Bessembinder (2003), trades are designed as customer buys and sells using the algorithm described by Ellis, Michaely, and O'Hara (2000) instead of using the Lee and Ready (1991) algorithm. Bessembinder (2003) finds that although there is a difference between the results delivered by the two algorithms (results in case of using Lee and Ready are higher than if using Ellis et all), the overall inferences remains identical.

$M_{i,t+10}$ is the midpoint of the NBBO quotes in effect ten minutes after the trade time.[12]

A measure of trade execution cost that considers the possible effect of trades' differing price impact is the realized half-spread, defined for each trade as:

$$\textit{Realized Half-Spread}_{i,t} = \textit{Effective Half-Spread}_{i,t} - \textit{Price Impact}_{i,t}$$

The realized half-spread measures revenue to the liquidity supplier, net of the trade's price impact.

Table II reports the effective half-spread, price impact, realized half-spread and percent of orders which are price improved (panels A through D) for each of the market centers. The effective half-spread is the lowest for the electronic limit order book markets and highest on the dealer/specialist markets. Specifically, the effective half-spread on the Cincinnati Stock Exchange averaged 0.71 cents, followed by ADF with 0.84, the Pacific Stock Exchange with 0.93 cents. The effective half-spreads were higher for the Chicago Stock Exchange with 1.04 cents, and then NASDAQ with a 1.10-cent effective half-spread.[13] The results for AMEX are notably higher, 1.90 cents.

Panel B of table II indicates that the price impact varies across the trading venues from 0.25 to 0.46 cents (with a notable exception – that AMEX has a negative price impact). Consistent with the "cream skimming" hypothesis, the average price impact of

[12] For trades executed in the last 10 minutes of the trading day, the closing quote midpoint is used. We realize that the measured price impact for any trade can potentially contain a lot of noise due to the arrival of new information. Nonetheless, it is assumed that averaging across a large number of trades is supposed to mitigate the noise and provide reliable estimates.

[13] Using all BBO quotes (including locked and crossed market BBOs) does not change any of the results regarding trade execution costs, other than they are slightly smaller for each of the trading venues, but the magnitudes of the differences between the exchanges does not substantially change.

trades completed on NASDAQ is in the middle of the other trading venues (0.31 cents) with only ADF and the Pacific Stock Exchange exceeding the NASDAQ result (0.42 and 0.46 cents respectively). Unlike the other results in this paper, these results do not seem to indicate a reliable difference across market structures.

According to the results from Table II, the average realized half-spread is the lowest on ADF (0.42 cents) followed by Island at 0.46 cents per share and Archipelago (0.47 cents). Again, the costs are higher for the specialist/dealer markets: the results for NASDAQ (0.79 cents) are not very different from those of the Chicago Stock Exchange (0.75 cents). The revenues to the liquidity suppliers on AMEX on the other hand, are markedly higher at 2.47 cents per share than the ones for NASDAQ, CSE, ADF, CHX, and the PSE.

Table II also reports on the percentage of trades that receive price improvement, (i.e. trades executed at prices within the best quotes), as well as the percentage of trades that are executed at prices outside the quotes (panel E). Cincinnati provides substantial impact to price improvement (54.27%), while the rates for NASDAQ, AMEX, ADF, CHX, and PSE are, correspondingly, 15.91%, 22.98%, 9.11%, and 10.67%. A sizeable number of trades are executed at prices outside the NBBO quotations, ranging from 7.46% on NASDAQ to 34.50% on AMEX.

IV. Time at Quotes

In order to measure the competition for prices between each of the trading venues for NASDAQ stocks, we examine the amount of time in which a trading venue is at the NBBO quote. Table III presents the results, with time weighted averages in panel A, and

trade weighted averages in panel B. NASDAQ is at either the bid or ask 89.92% of the time on a time weighted average and 86.52% of the time on a trade weighted basis. Interestingly, the electronic limit order book systems (Cincinnati Stock Exchange/Island and the Pacific Stock Exchange/Archipelago) as well as the ADF are at either the bid or ask more than half the time as well (which supports the findings of Huang (2002)). These results indicate a greater level of competition among trading venues than has been seen for NYSE listed stocks, between the NYSE and regional stock exchanges as indicated in Blume and Goldstein (1997) and Bessembinder (2003).

On a time weighted average (trade weighted average) NASDAQ, is at both the inside bid and ask the most often of the five trading venues, but they are alone only 50.24% (50.31%) of the time.[14] Two other markets (NASDAQ's ADF and Archipelago, the Pacific Stock Exchanges) are at both the inside bid and ask frequent (34.18% and 33.64% of the time), although Island is not.

Table IV examines a percentage of a market volume conditional on its quotes. We examine each trading venues executed trades, and determine where their quotes are relative to the NBBO at the time they executed a trade. While no real clear patterns emerge, it is evident that a trade will execute on a particular market regardless of how competitive the particular exchange is with their quotes.

V. Trading Activity when not at the NBBO

While table IV shows that market volume is not necessarily conditional on whether an exchange is at the NBBO quote, table V (panel A) examines trading relative

[14] The implication of this is that researchers using the TAQ database who are only using quotes identified with the letter "T" are most likely over-estimating the costs of trading for NASDAQ stocks.

to where the NBBO is. We find that NASDAQ gets very few trades (as a percentage) when they are not at the NBBO (2.93%), while AMEX and the Chicago Stock Exchange get a substantial amount of volume when not at the NBBO (43.06 and 61.16%).

Panel B and C of table V examines the number of times a market matches the NBBO and improves the NBBO. Interestingly, AMEX matches or betters the NBBO a large percentage of the time (when compared to the other market venues). Additionally, the two ECN (Island (CSE), and Archipelago (PSE)), match and improve the NBBO is similar percentages to those of NASDAQ. So, it appears that the ECNs provide similar quote matching and improvements as those that originate from NASDAQ.

VI. Locked and Crossed Markets

Since the National Best Bid and Offer (NBBO) quotes are not provided by the TAQ database, we reconstruct it using the TAQ data. An unexpected result was the number of negative and zero NBBO spreads that are observed, and seem to be somewhat inconsistent with a logical perception of markets' behavior.[15] The Security Traders Association (STA) acknowledges that locked and crossed markets are an issue on NASDAQ. Currently they are proposing to bar access fees for exchanges and their members who lock and cross NASDAQ stocks (Clary, 2003). Table VI presents the number and percentage of quotes that result in negative (crossed) and zero (locked) spreads. The average percentage of time the market is crossed (negative spreads) is 2.24% or locked (zero spreads) is 12.43% during June 2003. The total percentage of negative and zero spreads during June 2003 is 14.67% of the NBBO quotes.

[15] A discussion with Tim McCormick at NASDAQ confirmed that NASDAQ is having issues with locked and crossed markets.

Even though we find that the market is crossed or locked for our sample of NASDAQ stocks over 10% of the time, there is no evidence that the markets are locked for extended periods of time.[16] This is consistent with the statements by Chris Nagy, head of trading at Ameritrade "Though locked markets don't last long, they occur frequently", (Schmerken, 2003).

Table VII examines where the NBBO quotes are occurring for locked (panel A) and crossed (panel B) markets. As would be expected, locked and crossed markets do not occur with quotes from the same trading/quoting venue (there is not an instance in which both the ask and bid prices occur from the same exchange lock or cross the market). Zero locked markets (zero spreads) occur most frequently when NASDAQ has one side of the market and one of the other trading venues (other than the AMEX) has the other. A little different pattern emerges for crossed markets (negative spreads). This occurs most often when the Chicago Stock Exchange has one side of the market and NASDAQ has the other. This is an indication that ECNs (in this case Island on the CSE) seems to be a detriment to the quote setting process.

It is possible that the existence of non-positive spreads maybe attributable to the interexchange miscommunication problems or TAQ reporting delays. Although, we did extensively examine whether the locked and crossed markets were a result of stale quotes or reporting delays, we find no evidence that stale quotes lead to the locked or crossed

[16] An examination of BBO quotes, we find that markets will lock/cross, then unlock/uncross, and repeat themselves periodically during the trading day.

markets, and no systematic lag from any of the different market centers that would substantially change our findings regarding locked and crossed markets.[17]

VII. Determinates of Trade Routing

Previously we show that 48.41% of our sample trades are not executed on NASDAQ (NASDAQ captures 51.59% of the trades). Although quoting activity of the various market centers provides us with insights into the reasons for trade routing, we use a multiple regression specification to include additional variables into the analysis to examine the determinants of trade routing.

To determine the influences trade routing, we use a multinomial logistic regression specification for an unordered dependent variable, where the dependent variable is the exchange where the trade occurred.[18] Numerical values are assigned to the dependent variable as follows: 0 = AMEX, 1 = CSE, 2 = ADF, 3 = CHX, 4 = PSE, 5 = NASDAQ. A vector of regressors include the following: dummy variables capturing whether an exchange is at the best bid or ask (6 variables for best bids and 6 for best asks), relative order imbalance, relative number of trades in the preceding 10 minutes, relative volume, inverse of price, a dummy variable indicating if inter-exchange market NBBO quote was crossed or locked, and the relative cumulative return. All regressors, except the dummies, are scaled to avoid a non-convergence problem often encountered

[17] An examination of quotes which lead to the BBO being locked and crossed, there is no evidence that any of those quotes were outstanding for as long as 5 minutes before they were updated (from initiation of the quote to the next quote update from the particular trading/quoting venue).

[18] Trades were divided into customer buys and sells. Further (to facilitate the reporting of results), only the results for customer buy orders are reported. Sell order results show similar results.

when using iterative routines.[19] We employ a fixed effects model by allowing for clustering across stocks and account for the possibility of non-spherical errors by using the Huber-White estimator.

The following relations between the dependent variable and the specified regressors are expected. If an exchange posts an ask quote at the NBBO, a customer buy order is more likely to be routed to that specific exchange. NBBO ask quotes for all other exchanges should have a negative sign indicating competition among exchanges through posting of the best quotes.

Signs for NBBO bid quotes for customer buy orders could follow two hypotheses. On one hand, a bid quote should not affect the customer buy trade routing, so the relation between an exchange having a bid quote at NBBO and the probability of getting a trade by that exchange should be zero. Another possibility of positive relations is a positive correlation between the decisions to post best bid and best ask quotes by market makers.

The order imbalance variable (see Bessembinder (2003)) is constructed for each market based on the accumulated difference since the open between customer buy and customer sell trades on that market. Variables correspond to every trade in the sample and are scaled by the mean order imbalance for each day of observations to facilitate iterative computations. We expect a relation between the probability of a customer buy and order imbalance to be negative, since when the order imbalance is positive, a market has sold too much from the beginning of the day and is trying to discourage further customer buys.

[19] Due to the size of our data and computing limitations, we limit our sample to trades that occur between 11 a.m. and 1 p.m. Additionally, we were only able to examine five days at a time in this framework – again, due to data size and computing limitations. An analysis of other days (not reported) show similar results as those reported here.

The number of trades during the immediately preceding ten minutes (see Bessembinder (2003)) is scaled by the average number of trades per ten minutes in the stock. We expect the relationship between this and dependent variables to be positive if regional markets are more likely to receive a trade when the inter-exchange market overall is liquid. The relationship could be negative if a market is trying to avoid informed traders, the presence of which might be indicated by the increased trading.

The cumulative return is computed from the beginning of the trading day and is scaled by the average cumulative return for each stock for that day. If this variable is positively related to the probability of trade on a particular exchange, we conjecture that exchanges try to trade those stocks that are experiencing price appreciation.

The results of multiple logistic regression are provided in Table VIII. Probabilities (marginal effects) are "relative to NASDAQ," which means that, for instance, CSE, ceteris paribus, has a 10.24% more chances of getting a customer buy trade than does the NASDAQ if CSE has an ask quote at the NBBO. By the same token, if the inter-exchange market is crossed or locked, CSE has an 8.78% more chances of getting a customer buy than does the NASDAQ.

Negative coefficients for all exchanges in Table VIII indicate that, assuming all other variables are zero, all exchanges (other than NASDAQ) have a lower probability of getting a trade than NASDAQ. Nonetheless, it is obvious that exchanges are perfectly capable of competing for order flow by posting competitive quotes, more so for the exchanges with a heavy ECN participation. In addition to the CSE (mentioned previously), the PSE, everything else constant, has an 8.03% higher probability than

NASDAQ of getting a customer buy trade, if it posts an ask quote that would be at the NBBO.

Surprisingly, in some cases an exchange can get a trade if another exchange posts the best quote. As an example we can see that there is a 1.03% chance of PSE getting a trade instead of NASDAQ if the ADF ask quote is at the NBBO. The same surprising results are observed for CHX, but mostly, the exchanges compete against each other by posting quotes, as indicated by most of the signs.

Table VIII also shows that posting a bid at the NBBO can attract additional customer buys. This result is a little surprising, but could be explained by the correlation between best bids and asks as posted by the market makers. Order imbalance has a negative sign as expected, but is insignificant for all exchanges.

While interpreting the coefficients for volume, we should remember that although the coefficients seem economically insignificant, they represent probabilities for 100-share trades. However, if we assume that a certain trade is for 10,000 shares, the probabilities still remain economically insignificant. We can see from the signs of the coefficients that ECNs are less likely to get a trade if it is large. This can be explained by the fact that large trades can quickly work through the limit order book and execute at a worse price that expected.

CSE trade routing seems not to depend on the price of a security being traded, but for ADF, for instance, when the price is low (inverse of the price goes up), the probability of getting a trade is lower than that of NASDAQ by 13.05% (or 21.34% for PSE). This indicates that ADF and PSE tend to trade stocks with higher prices as compared to NASDAQ.

VIII. Conclusion

This study adds to the empirical evidence pertinent to the continuing discussion on the subject of market fragmentation and competition among exchanges, as well as differences across market structures. The analysis concentrates on effective and realized half-spreads as indicators of execution costs' magnitude, and on the measure of price impact as an indicator of ongoing "cream skimming" practices employed by regional exchanges.

We find that the American and Chicago Stock Exchanges' market shares are relatively small. The Chicago Stock Exchange, ADF, Cincinnati Stock Exchange, the Pacific Stock Exchange and NASDAQ Stock Market execute 99.32% of sample trades. The two electronic limit order book markets (Cincinnati/Island and Pacific/Archipelago) have a larger market share in smaller orders, while the dealer/specialist markets (NASDAQ, AMEX, and Chicago) find their market share increasing as order sizes get larger. We conjecture (following Blume and Goldstein (1997)) that AMEX and Chicago are customarily used by large institutional investors for either "clean crossing" or short selling. We also find that the cost of trading on the two electronic limit order book markets (Island and Archipelago) is less than those for the dealer/specialist markets (NASDAQ, AMEX, and Chicago). Overall, we find substantial differences in cost, quoting behavior, and order flow between the electronic limit order book markets and the dealer/specialist markets, indicating competition across types of market structure as well as across markets in general.

Interestingly, the results for NASDAQ are noticeably different than those published previously for the NYSE. Thus, the previous results are not due to the NYSE's position as a primary market – if so, we should see similar results for NASDAQ. In addition, previous results were not due to the NYSE's significant market share – again, we would expect similar results for NASDAQ, which has over 50% of the trades and almost 2/3rds of the overall volume. Instead, the results in this paper indicate that there are significant differences in the level of competition, fragmentation, and market structure between the two markets. The much larger percentage of locked or crossed markets for NASDAQ-listed securities indicates that competition and fragmentation is having some adverse affects on overall market quality.

Using a multinomial logistic regression specification for an unordered dependent variable to determine trade routing, we find that all the market centers have a lower probability of executing a trade than NASDAQ. Also, we find that if they are competitive with their quotes, they are more likely to execute additional trades.

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Table I
Descriptive Statistics on Trade Market Shares

Reported are percentages of trades and trading volume trades completed between 9:30 a.m. and 4 p.m. EST in the 100 largest NASDAQ-listed common stocks in April-June 2003. Large trades are those exceeding 5,000 shares, medium trades are from 500 to 5,000 shares, and small trades are less than 500 shares. AMEX denotes American Stock Exchange, CSE denotes Cincinnati Stock Exchange, CHX denotes Chicago Stock Exchange, NASD ADE denotes NASD Alternative Display Facility, PSE denotes Pacific Stock Exchange NASDAQ denotes Nasdaq Stock Market.

	AMEX	CSE	ADF	CHX	PSE	NASDAQ
Panel A: Market Shares, Percent of Sample Trades						
All Trades	0.02	17.12	11.30	0.66	19.31	51.59
100 to 500	0.01	17.69	12.09	0.54	19.54	50.14
501 to 5,000	0.04	15.42	8.76	1.09	18.91	55.78
5,001 to 9,999	0.06	10.55	3.83	1.21	10.79	73.56
10,000 or more	0.25	4.33	1.73	1.10	5.17	87.43
F-Stat	178.73**	3,061.40***	2,854.87***	528.61***	501.47***	2,715.83***
Panel B: Market Shares, Percent of Sample Trading Volume						
All Trades	0.08	13.23	7.72	1.05	15.62	62.30
100 to 500	0.01	18.62	12.25	0.67	20.11	48.34
501 to 5,000	0.05	14.15	7.82	1.20	17.99	58.79
5,001 to 9,999	0.06	10.39	3.74	1.22	10.77	73.81
10,000 or more	0.29	2.67	1.12	1.23	3.22	91.47
F-Stat	83.04***	1,479.76***	1,654.69***	285.68***	287.89***	561.55***
Panel C: Market Shares, Percent of Sample Dollar Volume						
All Trades	0.09	12.88	8.58	1.05	16.49	60.91
100 to 500	0.02	18.03	12.70	0.68	20.59	47.99
501 to 5,000	0.08	13.01	8.20	1.20	18.68	58.83
5,001 to 9,999	0.09	7.49	3.57	1.28	10.10	77.47
10,000 or more	0.32	1.41	0.92	1.49	2.00	93.86
F-Stat	69.93***	1,730.28***	1,368.34***	246.94***	299.73***	524.07***

*** Significant at 0.01 percent level

Table II
Trade Execution Cost Statistics

Reported are averages of trade execution cost statistics (in cents) computed across trades completed between 9:30 a.m. and 4 p.m. EST in the 100 largest NASDAQ-listed common stocks in April, May and June 2003. In Panel A, results are weighted according to the amount of time between two consecutive trades. In Panel B, results are weighted according to the elapsed time between successive trades AND in relation to the trade volume for a particular stock for a certain day. The results for individual stock are then equally weighted to obtain a final value. The Effective Half Spread is the amount by which the trade price exceeds (for customer buys) or is below (for customer sells) the midpoint of the contemporaneous NBBO quotes. Price impact is the increase (after customer buys) or decrease (after customer sells) in the NBBO midpoint in the 10 minutes after the trade time. The Realized Half Spread is the difference between the trade's Effective Half-Spread and its Price Impact. A trade is recorded as price improved when a customer buy (sell) is executed at a price below (above) the best contemporaneous ask (bid) quote. Trades are designed as customer buys and sells using the algorithm described by Ellis, Michaely, and O'Hara (2000). Buy (sell) orders are recorded as outside the NBBO, if the trade price exceeds (is less than) the best ask (bid) quote. AMEX denotes American Stock Exchange, CSE denotes Cincinnati Stock Exchange, CHX denotes Chicago Stock Exchange, NASD ADF denotes NASD Alternative Display Facility, NASDAQ denotes Nasdaq Stock Market

	AMEX	CSE	ADF	CHX	PSE	Nasdaq	*F* Stat
Panel A: Effective Half Spread (Cents)							
Overall	1.90	0.71	0.84	1.04	0.93	1.10	227.72***
100 to 500 shares	2.37	0.64	0.84	0.95	0.92	1.00	187.39***
501 to 5000 shares	1.36	1.01	0.82	1.21	0.97	1.44	26.70***
5001 to 9999 shares	1.84	0.51	0.60	0.67	0.56	0.74	2.93**
10,000 or more shares	2.02	0.52	0.45	1.01	0.58	0.68	18.02***
Panel B: Price Impact (Cents)							
Overall	-0.57	0.25	0.42	0.28	0.46	0.31	9.09***
100 to 500 shares	-0.63	0.28	0.44	0.20	0.49	0.39	7.01***
501 to 5000 shares	-0.55	0.11	0.33	0.44	0.34	0.07	4.86***
5001 to 9999 shares	0.27	0.20	0.49	0.13	0.11	0.13	0.35
10,000 or more shares	-0.38	0.67	0.70	0.08	0.38	-0.08	4.22***
Panel C: Realized Half Spread (Cents)							
Overall	2.47	0.46	0.42	0.75	0.47	0.79	59.75***
100 to 500 shares	3.00	0.36	0.41	0.74	0.43	0.61	37.96***
501 to 5000 shares	1.92	0.90	0.49	0.76	0.63	1.37	10.27***
5001 to 9999 shares	1.57	0.31	0.12	0.54	0.45	0.61	1.82
10,000 or more shares	2.40	-0.14	-0.25	0.94	0.19	0.76	13.32***

Table II Continued.

Panel D: Percent Price Improved							
Overall	15.91	54.27	22.98	9.11	10.67	24.14	1,941.60***
100 to 500 shares	14.26	55.41	22.96	10.58	11.32	25.66	1,673.94***
501 to 5000 shares	16.05	49.97	22.98	6.19	8.26	19.31	747.03***
5001 to 9999 shares	33.59	31.19	32.19	12.99	7.76	18.37	93.76***
10,000 or more shares	24.27	21.98	23.92	18.72	5.85	23.22	36.35***
Panel E: Percent Outside the NBBO							
Overall	34.50	8.39	6.07	10.62	5.13	7.46	1,869.91***
100 to 500 shares	37.26	8.81	6.35	9.25	5.43	7.53	1,261.43***
501 to 5000 shares	30.89	6.73	4.68	12.55	4.05	6.79	545.30***
5001 to 9999 shares	53.02	3.07	3.23	19.54	2.86	9.83	143.64***
10,000 or more shares	34.20	2.48	4.36	28.03	2.21	20.36	211.18***

*** Significant at 0.01 percent level

Table III
Quote-based Competition Statistics

Reported are the means for various features of quotations placed between 9:30 a.m. and 4 p.m. EST in the 100 largest NASDAQ-listed common stocks in April, May and June 2003. In Panel A the results are weighted by the amount of time between two consecutive quotations. In Panel B the results are weighted by the number of trades executed while a quotation is in effect. A quotation is considered to be at the inside, if it matches one (or both) of the NBBO quotes; and alone at the inside, if a quotation from no other exchange is matching the NBBO. A quotation has time priority, if it is alone at the inside, or has been places earlier that all other inside quotes coming from the other exchanges.

Panel A: Time-weighted Averages (percent of time)							
	AMEX	CSE	ADF	CHX	PSE	Nasdaq	*F* Stat
At Either Inside Bid or Ask	30.90	52.51	85.25	4.21	81.86	89.92	7,4433.40***
At Both Inside Bid and Ask	22.72	13.09	34.18	0.54	33.64	50.24	1,506.60***
Alone at Inside Ask	1.90	2.83	7.48	0.65	6.58	11.18	577.53***
Alone at Inside Bid	2.00	2.80	7.01	0.63	5.57	11.91	659.66***
Alone at Both Bid and Ask	0.05	0.08	0.43	0.00	0.38	0.97	101.41***
Time Priority at Bid	14.20	21.65	37.74	1.45	37.09	50.38	3,285.25***
Time Priority at Ask	14.44	21.85	36.96	1.29	36.37	52.56	3,424.42***
Panel B: Trade-weighted Averages (percent of trades)							
	AMEX	CSE	ADF	CHX	PSE	Nasdaq	*F* Stat
At Either Inside Bid or Ask	30.74	54.17	80.92	3.08	71.85	86.52	1,051.73***
At Both Inside Bid and Ask	15.24	13.40	31.93	0.07	28.98	50.31	1,128.06***
Alone at Inside Ask	5.21	5.50	12.70	0.35	9.99	18.20	776.18***
Alone at Inside Bid	5.10	5.65	12.43	0.28	8.68	18.81	933.09***
Alone at Both Bid and Ask	0.34	0.23	1.16	0.00	1.02	3.57	299.60***
Time Priority at Bid	12.98	21.90	34.65	0.83	30.31	47.82	3,285.25***
Time Priority at Ask	12.91	21.68	34.98	0.98	30.91	46.34	3,424.42***

*** Significant at 0.01 percent level

Table IV
Percentage of a Market's volume conditional on its quotes

Reported are the percentages of the time in which an exchange executes a quote, relative to the placement of that market centers quote. This is done when each of the trading venues (AMEX, CSE, ADF, CHX, PSE, and NASDAQ) have: both the best bid and ask, the best bid only, the best ask only, and neither the best bid or best ask.

	AMEX	CSE	ADF	CHX	PSE	Nasdaq
Both Best Bid and Ask						
100 to 500 shares	9.24	31.44	39.92	12.44	33.89	20.57
501 to 5000 shares	45.77	57.60	53.68	65.71	58.13	44.78
5001 to 9999 shares	6.30	5.88	3.32	8.19	3.99	6.41
10,000 or more shares	38.70	5.08	3.08	13.65	3.99	28.24
F-Statistic	38.40***	751.92***	1,334.71***	38.35***	183.76***	468.67***
Best Bid Only						
100 to 500 shares	15.10	56.31	60.44	33.82	50.54	33.41
501 to 5000 shares	60.36	40.53	36.57	62.00	44.33	41.63
5001 to 9999 shares	3.74	1.98	1.67	2.30	3.09	5.06
10,000 or more shares	20.80	1.17	1.32	1.89	2.03	19.90
F-Statistic	17.67***	1,036.04***	785.22***	74.63***	216.83***	203.89***
Best Ask Only						
100 to 500 shares	14.30	55.65	57.75	33.12	49.86	32.72
501 to 5000 shares	61.55	40.86	37.71	55.53	44.75	42.46
5001 to 9999 shares	7.08	2.17	2.30	3.71	3.24	5.31
10,000 or more shares	17.07	1.32	2.24	7.64	2.16	19.51
F-Statistic	18.80***	1,182.18***	752.76***	55.39***	216.72***	204.88***
Neither Best Bid nor Ask						
100 to 500 shares	2.40	57.57	64.53	18.93	51.77	36.79
501 to 5000 shares	23.45	39.55	32.43	52.18	44.58	38.38
5001 to 9999 shares	2.68	1.77	1.39	5.94	2.18	4.53
10,000 or more shares	71.47	1.12	1.65	22.95	1.47	20.30
F-Statistic	66.99***	1,480.63***	1,041.73***	288.63***	334.83***	183.03***

*** Significant at 0.01 percent level

Table V
Trading relative to the quote

Reported are statistics regarding trading relative to where the NBBO during the regular trading hours of 9:30 a.m. and 4 p.m. EST for the 100 largest NASDAQ-listed common stocks in April, May and June 2003. Panel A shows the trading activity when an exchange is not at the NBBO. Panel B presents the number and percentage of time in which a quote (ask and bid) from a particular exchange matches the current NBBO quote. Panel C shows the number of quotes (ask and bid) that better the current NBBO quote.

	AMEX	CSE	ADF	CHX	PSE	Nasdaq
Panel A: Trading relative to NBBO						
Volume when not at NBBO	17,606,700	1,083,953,231	266,761,000	316,578,561	525,887,600	901,163,700
Total volume	40,889,100	6,521,604,142	3,802,843,200	517,644,512	7,699,390,500	30,704,567,500
% of volume when not at NBBO	43.06	16.62	7.01	61.16	6.83	2.93
Panel B: Matching the quote						
# of times an ask quote matches the NBBO	5,767,890	5,976,304	15,578,717	118,355	12,946,312	15,760,377
# of times a bid quote matches the NBBO	6,681,905	5,984,908	15,566,040	110,881	12,581,675	15,416,924
Total # of times a quote matches the NBBO	12,449,795	11,961,212	31,144,757	229,236	25,527,987	31,177,301
Total # of quotes	40,650,458	49,432,562	110,044,748	17,459,959	155,362,009	153,471,680
% of times a quote matches the NBBO	30.63	24.20	28.30	1.31	16.43	20.31
Panel C: Improving the quote						
# of times an ask quote betters the NBBO	1,101,852	1,378,640	4,569,868	6,139	3,412,420	3,783,888
# of times a bid quote betters the NBBO	1,465,179	1,396,498	4,504,216	5,409	3,165,491	3,744,288
Total # of times a quote betters the NBBO	2,567,031	2,775,138	9,074,084	11,548	6,577,911	7,528,176
Total # of quotes	40,650,458	49,432,562	110,044,748	17,459,959	155,362,009	153,471,680
% of times a quote betters the NBBO	6.31	5.61	8.25	0.07	4.23	4.91

Table VI
Locked and Crossed Markets

The table examines the frequency of occurrence of zero and negative NBBO spreads using quotations placed between 9:30 a.m. and 4:00 p.m. for the 100 largest NASDAQ-listed stocks in June 2003. A zero NBBO spread occurs when an inside ask quotation equals to the inside bid quotation. While a zero NBBO spread is in effect, the market is considered to be locked. A negative NBBO spread occurs when an inside ask quotation is lower that a contemporaneous inside bid quotation. While a negative NBBO spread is in effect, the market is considered to be crossed.

Date	Spreads Total	Negative Spreads		Zero Spreads		Total Non-positive Spreads	
		#	%	#	%	#	%
2-Jun	9,246,454	240,701	2.60%	1,270,329	13.74%	1,511,030	16.34%
3-Jun	9,520,969	133,136	1.40%	1,244,161	13.07%	1,377,297	14.47%
4-Jun	9,904,306	125,970	1.27%	1,343,275	13.56%	1,469,245	14.83%
5-Jun	10,189,718	220,082	2.16%	1,272,629	12.49%	1,492,711	14.65%
6-Jun	11,139,199	752,424	6.75%	1,447,360	12.99%	2,199,784	19.75%
9-Jun	8,418,496	140,809	1.67%	1,154,828	13.72%	1,295,637	15.39%
10-Jun	7,784,829	127,704	1.64%	1,060,900	13.63%	1,188,604	15.27%
11-Jun	9,171,043	164,922	1.80%	1,236,570	13.48%	1,401,492	15.28%
12-Jun	8,203,653	142,862	1.74%	995,425	12.13%	1,138,287	13.88%
13-Jun	8,014,581	257,471	3.21%	987,810	12.33%	1,245,281	15.54%
16-Jun	7,997,657	96,342	1.20%	967,839	12.10%	1,064,181	13.31%
17-Jun	8,338,436	166,783	2.00%	1,091,694	13.09%	1,258,477	15.09%
18-Jun	9,171,971	343,729	3.75%	1,204,897	13.14%	1,548,626	16.88%
19-Jun	9,351,963	347,871	3.72%	1,175,406	12.57%	1,523,277	16.29%
20-Jun	8,695,121	176,733	2.03%	944,944	10.87%	1,121,677	12.90%
23-Jun	8,258,597	186,125	2.25%	936,095	11.33%	1,122,220	13.59%
24-Jun	9,934,676	161,775	1.63%	1,102,252	11.09%	1,264,027	12.72%
25-Jun	8,867,710	178,717	2.02%	937,778	10.58%	1,116,495	12.59%
26-Jun	9,265,658	123,582	1.33%	1,066,335	11.51%	1,189,917	12.84%
27-Jun	9,429,501	150,121	1.59%	1,119,165	11.87%	1,269,286	13.46%
30-Jun	7,310,889	94,293	1.29%	863,635	11.81%	957,928	13.10%
Mean	8,962,639	206,293	2.24%	1,115,397	12.43%	1,321,689	14.67%

Table VII
Quote-based competition statistics for Locked and Crossed Markets

Reported are the means for various features of quotations placed between 9:30 a.m. and 4 p.m. EST in the 100 largest NASDAQ-listed common stocks in June 2003. Quotations used are the ones that either lock or cross the market. In Panel A the results are for zero NBBO spreads weighted by the amount of time between two consecutive quotations. In Panel B the results are for the negative NBBO spreads weighted in the same manner. A quotation is considered to be at the inside, if it matches one (or both) of the NBBO quotes; and alone at the inside, if a quotation from no other exchange is matching the NBBO. A quotation has time priority, if it is alone at the inside, or has been places earlier that all other inside quotes coming from the other exchanges.

Panel A: Time-weighted Averages for Zero-Spreads (percent of time)						
	AMEX	CSE	ADF	CHX	PSE	Nasdaq
At Either Inside Bid or Ask	3.45	4.41	7.42	0.11	5.74	7.53
At Both Inside Bid and Ask	0.00	0.00	0.28	0.00	0.01	0.00
Alone at Inside Ask	0.49	0.92	1.99	0.06	1.66	1.80
Alone at Inside Bid	0.52	0.96	2.15	0.08	0.88	2.05
Alone at Both Bid and Ask	0.00	0.00	0.02	0.00	0.00	0.00
Time Priority at Bid	1.08	1.38	2.58	0.05	2.29	2.41
Time Priority at Ask	1.21	1.45	2.81	0.06	1.40	2.75
Panel B: Time-weighted Averages for Negative Spreads (percent of time)						
	AMEX	CSE	ADF	CHX	PSE	Nasdaq
At Either Inside Bid or Ask	1.01	0.49	1.02	2.57	0.87	0.98
At Both Inside Bid and Ask	0.00	0.00	0.06	0.00	0.00	0.00
Alone at Inside Ask	0.40	0.10	0.29	1.12	0.17	0.17
Alone at Inside Bid	0.39	0.10	0.23	1.59	0.15	0.23
Alone at Both Bid and Ask	0.00	0.00	0.03	0.00	0.00	0.00
Time Priority at Bid	0.44	0.17	0.40	2.82	0.29	0.30
Time Priority at Ask	0.43	0.19	0.37	2.34	0.31	0.42

Table VIII
Multiple Logistic Regression of Trade Routing.

Analysis considers trades that occurred from 11 a.m. to 1 p.m. EST on five randomly chosen consecutive dates (June 2 through June 6, 2003). The dependent variable is the exchange an order is routed to; the regressors are dummy variables for each exchange indicating that the exchange is an the NBBO (6 dummies for best ask and 6 dummies for best bid), relative order imbalance, number of trades in the preceding 10 minutes, volume, inverse of a price, a dummy variable indicating that the inter-exchange market is crossed or locked, and relative cumulative return. All regressors except the dummies were scaled to avoid possible nonconvergence. Newton-Raphson maximum likelihood algorithm is used to model the probabilities. The model was adjusted for fixed effects and existence of non-spherical errors by allowing clustering across stocks and using the Huber-White sandwich estimator. Regression coefficients are presented in a regular font, marginal effects are boldfaced, and p-values are in cursive.

	AMEX	CSE	ADF	CHX	PSE
Intercept	-8.5683***	-1.2789***	-1.4507***	-5.0370***	-0.9627***
	0.00	*0.00*	*0.00*	*0.00*	*0.00*
At Best Ask:					
AMEX	0.5685	0.0476	-0.1128	0.0889	-0.0052
	0.0001*	**0.0078**	**-0.0106*****	**0.0007**	**-0.0002**
	0.08	*0.25*	*0.01*	*0.46*	*0.87*
CSE	-0.0580	0.7191	-0.1654	0.2031	-0.0187
	0.0000	**0.1024*****	**-0.0256*****	**0.0007****	**-0.0271**
	0.74	*0.00*	*0.00*	*0.04*	*0.59*
ADF	0.6056	-0.0317	0.4489	0.1686	0.1113
	0.0001**	**-0.0147***	**0.0378*****	**0.0007****	**0.0103*****
	0.01	*0.05*	*0.00*	*0.03*	*0.00*
CHX	-0.3281	-0.0441	-0.1117	1.6276	-0.0436
	0.0000	**-0.0063**	**-0.0107**	**0.0266*****	**-0.0098**
	0.54	*0.56*	*0.16*	*0.00*	*0.49*
PSE	0.5953	0.0766	-0.0495	0.2462	0.4680
	0.0001***	**-0.0056*****	**-0.0167**	**0.0009****	**0.0803*****
	0.00	*0.00*	*0.13*	*0.01*	*0.00*
At Best Bid:					
AMEX	0.6839	-0.1478	0.0587	0.2433	-0.0837
	0.0001***	**-0.0166*****	**0.0095**	**0.0020***	**-0.0118*****
	0.01	*0.00*	*0.18*	*0.09*	*0.00*
CSE	0.1594	0.3058	-0.0479	0.1205	0.0064
	0.0000	**0.0398*****	**-0.0092**	**0.0005**	**-0.0087**
	0.39	*0.00*	*0.14*	*0.28*	*0.79*
ADF	-0.2549	-0.2133	-0.0305	0.0518	-0.0621
	0.0000	**-0.025*****	**0.0019**	**0.0007**	**-0.0029*****
	0.24	*0.00*	*0.28*	*0.46*	*0.00*
CHX	0.5355	-0.0973	-0.0041	0.6952	0.0150
	0.0001*	**-0.0133**	**0.0000**	**0.0068*****	**0.0044**
	0.09	*0.17*	*0.95*	*0.00*	*0.77*
PSE	-0.0937	-0.1756	0.0139	-0.0397	0.0726
	0.0000	**-0.0255*****	**0.0023**	**-0.0002**	**0.0187*****
	0.65	*0.00*	*0.61*	*0.65*	*0.00*
Order Imbalance	-0.0342	-0.0374	-0.0361	-0.0354	-0.0310
	0.0000	**-0.0031**	**-0.0020**	**-0.0001**	**-0.0033**
	0.53	*0.52*	*0.54*	*0.53*	*0.56*
Number of Trades	-0.1102	0.1055	0.0623	0.2749	0.0682
	0.0000	**0.0098*****	**0.0023**	**0.0016*****	**0.0066****
	0.67	*0.01*	*0.17*	*0.01*	*0.02*

Volume	0.0000	-0.0003	-0.0003	0.0000	-0.0001
	0.0000* **	**-0.0000*** **	**-0.0000*** **	**0.0000**	**-0.00000*** **
	0.00	*0.00*	*0.00*	*0.45*	*0.00*
Inv. Price	-6.2122	0.3639	-1.7178	0.8743	-1.3443
	-0.0007* **	**0.1173**	**-0.1305*** **	**0.0089**	**-0.2134*** **
	0.01	*0.43*	*0.00*	*0.60*	*0.00*
Crossed and Locked Markets	-0.0662	0.5993	0.1205	0.0432	-0.0312
	0.0000	**0.0878*** **	**0.0006***	**-0.0005**	**-0.0320**
	0.88	*0.00*	*0.06*	*0.78*	*0.58*
Cumulative Return	-0.0020	0.0045	0.0042	0.0022	0.0036
	0.0000	**0.0004** **	**0.0002** **	**0.0000**	**0.0004**
	0.86	*0.03*	*0.01*	*0.27*	*0.10*

*** Significant at 0.01 level
** Significant at 0.05 level
* Significant at 0.10 level