Exchange Entrances, Mergers and the Evolution of Trading of NASDAQ Listed Securities 1993-2010

Jared F. Egginton
Louisiana Tech University

Bonnie F. Van Ness
University of Mississippi

Robert A. Van Ness
University of Mississippi

We examine the changes in reported trades on NASDAQ from 1993 through 2010. We find that while volume and the number of trades are increasing for NASDAQ-listed securities, the percentage of volume that executes on NASDAQ declines from almost 100% in the 1990's to less than 40% in 2010. We examine the entrants of new exchanges on NASDAQ and the merger of NASDAQ and several exchanges. We do not find that either entrants of new trading venues or the merging of trading venues leads to a change in total volume of securities executed. We also document a large increase in the number of cancelled orders for NASDAQ-listed securities, and this is increasing.

INTRODUCTION

The structure of stock exchanges are continually evolving as is how they compete for order flow. The purpose of this study is to trace the evolution of the NASDAQ stock market from 1993 through 2010. NASDAQ experiences many changes during this time period, ranging from trading and quoting rule changes (such as the limit order rule, quote rule, and minimum tick size changes) to competition from other venues in trading NASDAQ-listed securities. NASDAQ has seen a dramatic decline in its market share of executions of NASDAQ-listed stocks, with volume executing on NASDAQ going from 100% (1993) to 37% (2010) during our sample time period.

We look at market competition and fragmentation as we trace the evolution of the NASDAQ market from 1993 through 2010. Many studies examine specific events, perhaps a small point in time, a single event, or the effect of particular trading or quoting rules. However, we target the structural changes such as the entrance of another venue trading NASDAQ-listed securities and whether the change results in the consolidation of (exchange mergers) or fragmentation of trading.

This paper builds on the work of Arnold, Hersch, Hulherin, and Netter (1999), who examine the evolution of regional stock exchanges' trading in the United States from 1938 to 1995. Arnold, Hersch, Hulherin, and Netter document the consolidation of regional stock exchanges (mergers) during this time period, which leads to a consolidation of trading on the regional stock exchanges and to decreases in bid-ask spreads. Although our study time period (1993 – 2010) contains a few NASDAQ-venue mergers, our

study differs significantly from Arnold, Hersch, Hulherin, and Netter as a number of exchanges, as well as alternative trading systems, begin trading NASDAQ-listed securities, leading to an increase in fragmentation rather than consolidation. Like Arnold, Hersch, Hulherin, and Netter, we find a narrowing of spreads during our time period, but our period is one when NASDAQ trading is fragmenting, not consolidating.

The issue of whether markets are more efficient when trading is consolidated in one venue (see, for example, Mendleson, 1987, and Chowdry and Nanda, 1991) or if trading is fragmented across multiple venues (see for example Battalio, 1997; Boehmer and Boehmer, 2003; and Foucault and Menkveld, 2008) is pondered both theoretically and empirically. A recent paper by O'Hara and Ye (2011) uses a matched sample of NYSE and NASDAQ stocks from April through June of 2008 to determine how market fragmentation affects the quality of trading in US markets. They use the volume of trade reporting facilities (TRF) as a proxy for fragmentation and conclude that fragmentation does not appear to harm market quality. We add to this work by looking at NASDAQ over time (as opposed to a point in time) to see how changes in fragmentation and the number of venues that trade NASDAQ stocks impacts market quality measures.

Several microstructure studies examine trading and trading costs over time – but most of these studies use only the activity of the primary exchange, and do not consider the activity of exchanges other than the primary listing exchange. For example, Chordia, Roll and Subrahmanyam (2001) look at trading volume and spreads for NYSE listed stocks from 1988 through 1998; Jones (2002) examines trading and trading costs from 1990 through 2000 for the Dow Jones stocks; Chorida, Sarkar, and Subrahmanyam (2005) investigate spreads of NYSE listed stocks from 1991 through 1998; Chordia, Huh, and Subrahmanyam (2007) look at trading from July 1963 to December 2002 for NYSE/AMEX stocks, and NASDAQ stocks from 1983 through 2002; Hameed, Kang, and Viswanathan (2010) study spreads of NYSE listed stocks from 1988 through 2003; and Angel, Harris and Spatt document provide an overview of changes in trading and trading costs in the U.S. markets from a 8th tick sizes to decimalization. Our study adds to this line of research, by showing the increase in participation of trading venues other than the primary exchange. We document where trades occur for NASDAQ stocks (different reporting venues) , show that the number of reporting venues are increasing, and thereby, changing the NASDAQ marketplace, and examine changes in spreads and speeds of execution for these NASDAQ stocks (see Boehmer, 2005).

We verify that, from 1993 to 2010, the average volume and number of trades per stock for NASDAQ-listed securities dramatically increases while the average trade size per stock declines. The number of stocks listed on NASDAQ increases from 1993 to 1997, and declines steadily thereafter. From 1993 through 2010, trading evolves, volume migrates to other venues, and fragmentation increases due to competition from other trading venues. During this time period, nine trading venues enter the market to trade NASDAQ-listed securities, and four exchanges that trade NASDAQ-listed securities participate in mergers.

THE EVOLUTION OF TRADING ON NASDAQ

The primary objective of our paper is to show how the landscape of NASDAQ has changed over time. While there are many events that have shaped NASDAQ as we know it today. NASDAQ has seen regulatory changes during this time period (such as the minimum tick size change from eights to sixteenths, the tick size change from sixteenths to decimals, and the inclusion of inter-market sweep orders). The number of venues trading in NASDAQ stocks (such as Archipelago, the ISE, BATS) has increased. Also, some venues that trade NASDAQ-listed stocks have consolidated (such as the merger of Instinet and Island and NASDAQ and BRUT; the NASDAQ purchase of the Philadelphia stock exchange and the NASDAQ purchase of the Boston Stock Exchange).

The effects of many of these events are documented in the finance literature. See Barclay, Christie, Harris, Kandel, and Schultz (1999) and Bessembinder (1999) for tick size changes and order handling rule changes and O'Hara and Ye (2011) for the effects of fragmentation. These papers typically study the market over a short time period revolving around the event.

We use data from CRSP, TAQ, and SEC Rule 605 to investigate, not just at one point in time, but rather the evolution of trading on NASDAQ from 1993 through 2010. We match trade data, obtained from the NYSE trade and Quote (TAQ) data set, to stocks with NASDAQ as their primary listing exchange in the CRSP data set. Order-flow statistics such as the percentage of volume, percentage of dollar volume, and percentage of trade executions are computed for the various exchanges that make markets in NASDAQ securities. Figure 1 shows that volume and number of trades for NASDAQ-listed securities from 1993 through 2010 is steadily increasing.

Although volume and number of trades are increasing for NASDAQ- listed stocks, the number of NASDAQ-listed stocks fluctuates over time (see table 1). The number of NASDAQ listings increases from 1993 to 1997, and subsequently declines. As trading activity increases, the percentage of volume of NASDAQ-listed stocks executing on NASDAQ changes dramatically. Volume on NASDAQ goes from 100% in 1993 to 37% in 2010 (table 2 panel a). The loss in volume goes predominantly to NASD ADF/TRF and Arca. Although volume is increasing over the time period, trading is fragmenting. Table 2 panel b shows that not all venues that trade NASDAQ stocks trade all NASDAQ-listed stocks. For example, in 1993 the Chicago Stock Exchange is the only venue, other than NASDAQ, that trades NASDAQ-listed stocks and it trades only 97 NASDAQ-listed securities (and execute only a few trades in 1993 for these stocks), while in 2010 Archipelago (now part of the NYSE) executes trades all NASDAQ-listed securities.

CHANGING OF VENUES ON NASDAQ

For the majority of NASDAQ's history, only NASDAQ, via its members, traded NASDAQ-listed stocks. NASDAQ-only trading changed in May of 1987 when the Chicago Stock Exchange began trading a small number NASDAQ-listed securities. Beginning in 2002, trading in NASDAQ-listed securities began fragmenting as several exchanges and ECNs began making markets in NASDAQ stocks. The number of venues that trade NASDAQ-listed securities changes as well as the percentage of volume reported on these exchanges. There are new entrants as well as several mergers that occur on NASDAQ over our time period. Table 3 lists the dates of the first trades when various exchanges begin trading NASDAQ-listed securities (panel A) and dates that NASDAQ merges with other exchanges and trading platforms (panel B).

New Entrants
Prior to 2002 NASDAQ stocks were primarily traded on NASDAQ by its members with a small fraction of trading occurring on the Chicago stock Exchange. Between 2002 and 2008, eight additional trading venues began trading NASDAQ-listed stocks –the National Stock Exchange and Amex in 2002, ARCHA/Pacific and the Boston Stock Exchanges in 2003, the International Stock Exchange and the Philadelphia Stock Exchange in 2006, the Chicago Board Options Exchange in 2007, BATS in 2008, and Direct Edge in 2010 (the exact dates of when these venues began trading is shown in panel A of table 3). While there are a number of new entrants in the market for NASDAQ stocks, there were also several mergers, which will be discussed and analyzed later in the paper. NASDAQ underwent mergers with BRUT in 2004, Instinet in 2005, the Philadelphia Stock Exchange and Boston Stock Exchange in 2008. Panel B of table 3 shows the exact dates of mergers between NASDAQ and other trading venues/platforms.

Table 4 shows the changes in the NASDAQ marketplace surrounding an exchange entrance. When the National Stock Exchange, Archa/Pacific, the Boston Stock Exchange, BATS and Direct Edge begin trading NASDAQ-listed stocks, theses venues trade a large number of NASDAQ-listed securities and execute between 3.56% (BATS) to 11.98% (Direct Edge) of volume in those securities. The exchanges/venues that make a market in the most securities execute large volumes. When AMEX, ISE, the Philadelphia Stock Exchange and the CBOE start trading NASDAQ-listed stocks, they trade only a few stocks (less than 400 in each case) and do not execute many trades. Total volume tends to drop when an exchange enters (change in volume and the percentage volume of entrant in table 4), with the

exceptions of the entrance of ARCH/Pacific and the Boston Stock Exchange. We test if these differences are statistically different from zero. We do not find that new entrants increase (or decrease) the total volume of trading in securities on NASDAQ.

When trading fragments, it likely results in an increase in price volatility (Madhaven, 1995). We examine the effect of each new entrant in the trading of NASDAQ-listed securities on price volatility and find that price volatility is not significantly lower for most entrants (see Table 5). The decrease is significant for the National Stock Exchange and AMEX, which is in contrast to the theoretical prediction of Madhaven.

Mergers

There are four mergers that involve NASDAQ from 2004 through 2008 (mergers of NASDAQ with BRUT, Instinet, the Philadelphia Stock Exchange and the Boston Stock Exchange). Table 6 shows that the NASDAQ-BRUT merger results in an increase in the number of trades (panel a) and volume (panel B) on NASDAQ (that is, NASDAQ and the merged exchange). All other mergers result in NASDAQ losing market share. We test for changes in the overall volume when exchanges merge (in panel D of table 6), but we do not find any significant changes in overall volume (we also examine dollar volume of trading and find the same results).

We expect a merger to result in a decrease in volatility as trades are concentrated in one trading venue (and, as Madhaven (1995) theorizes that fragmentation leads to an increase in volatility, it seems that consolidation if trading should lead to a decrease in volatility). Table 7 shows the results of our merger-volatility investigation. We find mixed evidence regarding changes in the volatility of prices when trading exchanges/venues merge. The merger of NASDAQ and Brut results in a decline in price volatility, but the NASDAQ and Boston merger results in an increase in price volatility.

TRADING COSTS AND SPEED OF EXECUTION ON NASDAQ

We use the SEC Rule 605 data to examine trading costs and speed of execution for NASDAQ-listed securities from 2002 through 2010 (the trends can be seen in figure 2). Rule 605 data begins in 2001, but we begin our analysis in 2002 as not all exchanges report in the early part of 2001. We show, in table 8, effective spread and speed of execution statistics for the three largest venues that report trades in NASDAQ securities – NASDAQ, NASD, and ARCA—for 2002 through 2010. Effective spread, for the most part, declines from 2002 through 2010. The time of execution (speed) also generally declines. We now examine the relation between fragmented trading, trading costs, and speed of execution.

Trading Costs Regressions

Trading on NASDAQ is fragmenting. Not only are more trading venues trading NASDAQ-listed securities, but a larger proportion of trades are executing on these exchanges. We seek to determine whether it is the number of venues on which trades execute or the percentage of trades that executes off NASDAQ that affects trading costs. We control for the determinants of spread: price, volume, trade size, volatility and firm size in the regression (see McInish and Wood, 1992). The results of this regression are in table 9.

We find that as trading fragments for NASDAQ-listed stocks, that is, the percentage of volume executing off NASDAQ, spreads decline. We find a positive relation between the number of reporting venues and spread indicating that more reporting venues leads to an increase in spreads. We conclude that it is fragmentation of trading that reduces trading costs and not the number of venues that trade NASDAQ stocks.

Speed of Execution Regressions

The time for execution is declining (speed is increasing) on NASDAQ during the 2002 to 2010 time period. As there is a relation between speed and trading costs (Boehmer, 2005), we use the same control variables in our speed regressions that we use for our spread regressions. We find that, as trading

fragments on NASDAQ, speed of execution declines. This indicates that as there is now more fragmentation, the speed of execution increases. Also, the speed of execution and the number of reporting venues are positively related, indicating that speed of execution is increasing with more trading venues.

Characteristics of Stocks That Have Greater Fragmentation

We also examine the characteristics of stocks that relate to fragmentation (table 10). Firm size is negatively related to fragmentation, but this relation is not significant. Price and trade size are significantly negatively related to the amount of fragmentation, indicating that as prices increase the amount of fragmentation decreases (higher priced stocks trade more on NASDAQ) and larger trades execute on NASDAQ. We see a positive relation with execution speed and fragmentation indicating that as execution speed increases there is more trading off-NASDAQ.

ORDER CANCELLATION RATES

The number (as well as the percentage) of cancelled orders is increasing during our time period. In an orderly competitive market, we do not expect to find a large number of cancelled orders. It appears, from the statistics in table 11, that cancelling orders is a practice that is becoming more and more common for NASDAQ-listed securities (panel A shows the number of cancelled orders and panel B shows the percentage of cancelled orders). We see that order cancellations are increasing through time. Some of the venues reporting cancelled trades report an alarming percentage of cancelled orders. In 2010 NASD reports 82.8% of orders cancelled, ARCA reports 92.1% of orders cancelled, AMEX cancels 52.8% of orders, the International Stock Exchange (ISE) cancels 97% of its orders and BATS cancels 40.8% of its orders. We believe the number of cancelled orders is an important characteristic of today's NASDAQ market, which affects underlying market quality. We also feel that false liquidity (orders which are posted and subsequently cancelled) is an important issue to point out, and while orders are cancelling at such high rates is outside of the scope of this paper, we hope that this points researchers to an issue with the NASDAQ stock market that researchers should explore.

Table 12 reports the differences in the percentage of orders cancelled by trading venues with the most cancelled orders. Arca is cancelling a significantly higher proportion of orders than NASD (and larger than NASDAQ, not tabulated). NASD is cancelling a larger proportion of orders than is NASDAQ. BATS has a high order cancellation rate, but not relative to the NASD. Initially, we believe the increasing number of cancelled orders may be related to the increase in high frequency trading. However, we leave this phenomenon to future researchers.

CONCLUSION

Arnold, Hersch, Hulherin, and Netter (1999) show that as regional stock exchanges merge and trades are consolidated that trading costs decline. We examine NASDAQ listed securities from 1993 through 2010, a time period in which trading of NASDAQ listed securities becomes very fragment. We find that even in times of increased fragmentation that trading costs are declining and speeds of execution are increasing. We find that fragmentation of trades and not the number of exchanges/venues reduces trading costs and increases the speed of trading. We also document a large increase in the number of orders in NASDAQ-listed securities being cancelled.

REFERENCES

Angel, J., Harris, L. and Spatt, C. (2011). Equity trading in the 21st Century. *Quarterly Journal of Finance*, 1, 1-53.

Arnold, T., Hersch, P., Mulherin, H. and Netter, J., (1999). Merging Markets. *The Journal of Finance*, 54, 1083-1107.

Barclay, M., Christie, W., Harris, J., Kandel, E., and Schultz, P., (1999). The effects of market reform on the trading costs and depths of Nasdaq stocks. *The Journal of Finance*, 54, 1-34.

Battalio, R. (1997). Third market broker-dealers: Cost competition or cream skimmers?. *The Journal of Finance*, 52, 341-352.

Bennett, P., and Wei, L. (2006). Market structure, fragmentation, and market quality. *Journal of Financial Markets*, 9, 49-78.

Bessembinder, H. (1999). Trade execution costs on NASDAQ and the NYSE: A post-reform comparison. *The Journal of Financial and Quantitative Analysis*, 34, 387-407.

Boehmer, E., and Boehmer, B. (2003). Trading our neighbor's ETF: Competition or fragmentation? *Journal of Banking and Finance*, 27, 1667-1703.

Boehmer, E. (2005). Dimensions of execution quality: recent evidence from for US equity markets. *Journal of Financial Economics*, 78, 553-582.

Chordia, T., Roll, R., and Subrahmanyam, A. (2001). Market liquidity and trading activity. *The Journal of Finance*, 56, 501-530.

Chordia, T., Sarkar, A., and Subrahmanyam, A. (2005). An empirical analysis of stock and bond market liquidity. *The Review of Financial Studies*, 18, 85-129.

Chordia, T., Hun, A., and Subrahmanyam, A. (2006). The cross-section of expected trading activity. *The Review of Financial Studies*, 20, 709-740.

Chowdry, B., and Nanda, V. (1991). Multimarket trading and market liquidity. *The Review of Financial Studies*, 4, 483-511.

Foucault, T. and Menkveld, A. (2008). Competition for order flow and smart order routing systems. *The Journal of Finance*, 63, 119-158.

Jones, C. (2002). A century of stock market liquidity and trading costs, working paper, Columbia University.

Hameed, A., Kang, W., and Viswanathan, S. (2010). Stock market declines and liquidity. *The Journal of Finance*, 65, 257-293.

Madhavan, A, (1995). Consolidation, fragmentation, and the disclosure of trading information. *The Review of Financial Studies*, 8, 597-603.

McInish, T., and Wood, R. (1992). An analysis of intraday patterns in bid/ask spreads for NYSE stocks. The Journal of Finance, 47, 753-

Mendelson, H. (1987). Consolidation, fragmentation, and market performance. *Journal of Financial and Quantitative Analysis*, 22, 189-208.

O'Hara, M. and Ye, M. (2011). Is Market Fragmentation Harming Market Quality? forthcoming, *Journal of Financial Economics*.

TABLE 1
TRADING STATISTICS

Mean trading statistics reported by year and tick size regime.   # of stocks is the number NASDAQ-listed of stocks. Volume is the average daily volume of a sample stock. # of trades is the average daily trades for a sample stock. Trade Size is the average number of shares per trades for a stock in the sample. Data source is the NYSE TAQ database.

Panel A: by year				
Year	# of stocks	Volume	# of trades	Trade Size
1993	3571	55053	30	1839
1994	4038	57934	32	1841
1995	4123	79939	49	1813
1996	4339	106355	68	1709
1997	4824	116883	81	1617
1998	4658	149434	123	1404
1999	4357	208189	253	1088
2000	4329	357422	540	878
2001	4327	414543	562	871
2002	3793	433425	622	744
2003	3324	470704	844	555
2004	2977	549951	1217	392
2005	2929	569786	1403	373
2006	2850	633516	1741	318
2007	2841	712784	2240	296
2008	2834	758178	2998	321
2009	2765	777261	2859	369
2010	2639	819388	2905	294
Panel B: by tick size				
Year	# of stocks	Volume	# of trades	Trade Size
8ths	4179	83233	52	1763
16ths	4418	238348	305	1124
Decimals	2994	613954	1739	453

TABLE 2 (a)

SUMMARY STATISTICS BY VENUE – PERCENTAGE OF VOLUME BY EXCHANGE

This table reports percentage of order-flow, over time, by exchange. Order-flow data is compiled from the NYSE TAQ database.

Year	NASDAQ	AMEX	Boston	National	NASD ADF, TRF	Chicago	ARCA	CBOE	ISE	Philadelphia	BATS	Direct Edge
1993	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1994	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1995	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1996	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1997	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1998	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1999	99.9%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2000	99.7%	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2001	99.7%	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2002	94.8%	0.0%	0.0%	5.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2003	76.1%	0.0%	0.1%	11.7%	3.2%	0.1%	8.7%	0.0%	0.0%	0.0%	0.0%	0.0%
2004	56.8%	0.0%	5.9%	19.0%	0.6%	0.1%	17.6%	0.0%	0.0%	0.0%	0.0%	0.0%
2005	63.4%	0.0%	0.0%	20.1%	0.1%	0.1%	16.4%	0.0%	0.0%	0.0%	0.0%	0.0%
2006	71.9%	0.0%	0.0%	1.5%	6.7%	0.1%	19.8%	0.0%	0.0%	0.0%	0.0%	0.0%
2007	51.8%	0.0%	0.0%	0.5%	31.0%	0.1%	16.4%	0.0%	0.1%	0.0%	0.0%	0.0%
2008	46.3%	0.0%	0.0%	3.0%	33.6%	0.1%	15.2%	0.3%	0.8%	0.0%	0.7%	0.0%
2009	39.0%	0.0%	0.4%	0.7%	37.9%	0.3%	12.7%	0.3%	3.4%	0.0%	5.3%	0.0%
2010	37.0%	0.2%	0.9%	1.0%	35.3%	0.3%	16.7%	0.2%	1.7%	0.0%	6.7%	4.6%

TABLE 2 (b)
SUMMARY STATISTICS BY VENUE– NUMBER OF FIRMS TRADING ON EACH EXCHANGE

This table reports the number of NASDAQ-listed firms that trade on an exchange during the year. Order-flow data is compiled from the NYSE TAQ database.

Year	NASDAQ	AMEX	Boston	National	NASD ADF, TRF	Chicago	ARCA	CBOE	ISE	Philadelphia	BATS	Direct Edge
1993	3571	0	0	0	0	97	0	0	0	0	0	0
1994	4038	0	0	0	0	110	0	0	0	0	0	0
1995	4123	0	0	0	0	100	0	0	0	0	0	0
1996	4339	0	0	0	0	105	0	0	0	0	0	0
1997	4824	0	0	0	0	181	0	0	0	0	0	0
1998	4658	0	0	0	0	369	0	0	0	0	0	0
1999	4357	0	0	0	0	636	0	0	0	0	0	0
2000	4329	0	0	0	0	932	0	0	0	0	0	0
2001	4327	0	0	3	0	777	0	0	0	0	0	0
2002	3793	130	0	3659	0	472	0	0	0	0	0	0
2003	3324	138	2184	3323	3238	247	3217	0	0	0	0	0
2004	2977	140	2954	2977	2868	321	2977	0	0	0	0	0
2005	2929	135	138	2929	1504	715	2929	0	0	0	0	0
2006	2850	130	1663	2843	2829	1177	2850	0	194	100	0	0
2007	2841	119	2343	2819	2841	1919	2841	1079	2534	623	0	0
2008	2834	28	0	2834	2834	2371	2834	2440	2793	466	2577	0
2009	2765	0	2585	2699	2765	2649	2764	2552	2762	0	2764	0
2010	2639	768	2589	2629	2639	2556	2639	2593	2638	1569	2639	2506

TABLE 3
INCEPTION DATE OF EXCHANGES TRADING NASDAQ STOCKS AND EXCHANGE MERGER DATES

This table reports the first date when an exchange trades NASDAQ-listed stocks and the dates of NASDAQ and various exchange and ECN mergers.

Panel A: Date of 1st Trade in NASDAQ-listed Stocks	
Exchange	Date
National Stock Exchange(NSX)	March 18, 2002
AMEX	August 27, 2002
ARCA/Pacific	February 14, 2003
Boston Stock Exchange	December 23, 2003
International Stock Exchange (ISE)	November 11, 2006
Philadelphia Stock Exchange	November 16, 2006
Chicago Board Options Exchange (CBOE)	April 4, 2007
BATS	October 24, 2008
Direct Edge	July 21, 2010
Panel B: Dates of Mergers	
Exchange	Date
NASDAQ-BRUT	September 7, 2004
NASDAQ-Instinet	December, 8 2005
NASDAQ-Philadelphia	July 24, 2008
NASDAQ-Boston	August 29, 2008

TABLE 4

CHANGES AROUND EXCHANGE ENTRANCE

This table reports NASDAQ-listed stock order-flow when an entering exchange begins trading NASDAQ stocks. # of Firms that trade on NASDAQ is the number of NASDAQ-listed firms traded during the 60-day window surrounding an exchange entrance. # of firms trading on entering exchange is the number of stocks the entering exchange makes a market in during its first 30 days of trading NASDAQ securities. Avg. Volume of the previous 30 days is the average daily volume for the 30 days prior to the entering exchange making a market in those securities. Avg. 30 days after entrance is the average daily volume for the 30 days after the entering exchange begins making a market in NASDAQ securities. Change in volume is the average change in volume for a stock (volume from all exchanges), which the entering exchange trades, from the 30 days prior to the exchange entering to the 30 days after the exchange begins trading NASDAQ stocks (volume from all exchanges). Percentage Volume of Entrant is the average daily percentage of order-flow (per stock) the entering exchange captures in the first 30 days of trading. Order-Flow data is obtained from the NYSE TAQ database.

Exchange	Date	# of Firms that trade on NASDAQ	# of firms trading on entering exchange	Avg. Volume the previous 30 days	Avg. Volume 30 days after entrance	Change in volume	Percentage Volume of Entrant
National (NSX)	March 18, 2002	3,705	2,662	610,296	565,703	-44,593	5.59%
AMEX	August 27, 2002	3,420	50	4,218,900	3,657,907	-560,992	0.98%
ARCA/Pacific	February 14, 2003	3,249	2,992	396,171	451,534	56,162	5.04%
Boston	December 23, 2003	2,323	2,831	532,111	635,521	85,911	7.21%
ISE	November 11, 2006	2,626	215	4,869,141	4,306,876	-650,394	0.02%
Philadelphia	November 16, 2006	2,626	100	6,183,555	5,583,201	-600,355	0.21%
CBOE	April 4, 2007	2,789	384	2,849,074	2,782,719	-66,355	0.02%
BATS	October 24, 2008	2,604	2,536	992,776	824,717	-168,060	3.56%
Direct Edge	July 21, 2010	2,502	2,500	787,435	70,0396	-87,038	11.98%

*Statistically significant at the 10% level
**Statistically significant at the 5% level
***Statistically significant at the 1% level

TABLE 5
CHANGES IN VOLATILITY AROUND EXCHANGE ENTRANCE

This table reports percentage changes in price volatility from the 30-day period before an exchange entrance to the 30-day period after. Overall Change is the percentage change in volatility for all NASDAQ securities over the period. Percentage Change is the change in volatility for the stocks in which the entering exchange makes a market. All Other is the change in volatility in stocks which were not traded by the entering exchange. N is the number of stocks that the entering exchange trades in the first 30 days. Net change is the difference between Percentage Change and All Other. Data source: NYSE TAQ

Panel A: Changes in Price Volatility

Exchange	Date	Overall Change	Percentage Change	All Other	N	Net Change
National (NSX)	March 18, 2002	12.2%	0.9%	41.3%	2,662	-40.3%**
AMEX	August 27, 2002	-12.4%	-23.7%	-12.3%	50	-11.4%***
ARCA/Pacific	February 14, 2003	14.3%	14.1%	16.5%	2,992	-2.4%
Boston	December 23, 2003	9.7%	9.8%	5.9%	2,831	3.9%
ISE	November 11, 2006	-2.0%	-3.3%	-1.9%	215	-1.4%
Philadelphia	November 16, 2006	-3.7%	-7.6%	-3.6%	100	-4.0%
CBOE	April 4, 2007	-1.5%	-2.8%	-1.3%	384	-1.6%
BATS	October 24, 2008	-13.3%	-13.5%	-8.6%	2,536	-4.9%
Direct Edge	July 21, 2010	-3.1%	-3.1%	-32.6%	2,500	29.4%

*Statistically significant at the 10% level
**Statistically significant at the 5% level
***Statistically significant at the 1% level

TABLE 6
CHANGES IN TRADING AROUND EXCHANGE MERGERS

This table reports the change in volume, dollar volume, and number of trades (average per stock) in NASDAQ-listed stocks surrounding an exchange or ECN merger. Change for merging is the change in order-flow for the merging exchange 30 days before to 30 days after the completion of the merger. Change for others is the change in order-flow for the non-merging exchanges 30 days before to 30 days after. Difference in merging and other is the difference between Change for Merging and Change for others. Data source: NYSE TAQ.

Exchange/Venue	Date	# of firms that merging venues Trade	Change for merging	Change for others	Difference in merging and other
Panel A: Changes in Number of Trades around exchange Merger					
NASDAQ-BRUT	September 7, 2004	2,787	55%	4%	50.5%***
NASDAQ-Instinet	December, 8 2005	2,640	42%	51%	-8.9%***
NASDAQ-Philadelphia	July 24, 2008	2,681	-2%	8%	-9.9%***
NASDAQ-Boston	August 29, 2008	2,648	15%	23%	-7.8%***
Panel B: Changes in Volume around exchange Merger					
NASDAQ-BRUT	September 7, 2004	2,787	60%	23%	37.6%***
NASDAQ-Instinet	December, 8 2005	2,640	60%	79%	-18.8%**
NASDAQ-Philadelphia	July 24, 2008	2,681	6%	19%	-13.7%***
NASDAQ-Boston	August 29, 2008	2,648	34%	44%	-9.7%***
Panel C: Changes in Dollar Trading Volume around exchange Merger					
NASDAQ-BRUT	September 7, 2004	2,787	78%	40%	37.0%***
NASDAQ-Instinet	December, 8 2005	2,640	84%	133%	-49.3%
NASDAQ-Philadelphia	July 24, 2008	2,681	6%	21%	-14.9%***
NASDAQ-Boston	August 29, 2008	2,648	19%	27%	-7.8%***

Panel D: Changes in overall Volume around exchange Merger

	Date	Avg. Volume the previous 30 days	Avg. Volume 30 days after merger	Change in volume
NASDAQ-BRUT	September 7, 2004	463,458	513,108	49,649
NASDAQ-Instinet	December, 8 2005	602,633	572,042	-30,591
NASDAQ-Philadelphia	July 24, 2008	789,429	691,709	-97,720
NASDAQ-Boston	August 29, 2008	708,331	911,006	202,675

*Statistically significant at the 10% level
**Statistically significant at the 5% level
***Statistically significant at the 1% level

TABLE 7

CHANGES IN VOLATILITY AROUND EXCHANGE MERGERS

This table reports percentage changes in price volatility from the 30 day period before an exchange merger to the 30 period after the merger. Overall Change is the percentage change in volatility for all NASDAQ securities over the period. Data source: NYSE TAQ

Exchange/Venue	Date	N	Pre Volatility	Post Volatility	Overall Change
NASDAQ-BRUT	September 7, 2004	2,787	0.123	0.110	-5.4%***
NASDAQ-Instinet	December, 8 2005	2,640	0.123	0.115	-0.3%
NASDAQ-Philadelphia	July 24, 2008	2,681	0.153	0.146	0.1%
NASDAQ-Boston	August 29, 2008	2,648	0.149	0.217	46.3%***

*Statistically significant at the 10% level
**Statistically significant at the 5% level
***Statistically significant at the 1% level

TABLE 8
EFFECTIVE SPREAD AND SPEED OF EXECUTION BY EXCHANGE

This table reports the average Effective Spread and Speed of execution for NASDAQ-listed
stocks for 2002 through 2010. Data source: DASH 5

	NASDAQ		NASD		ARCA	
	Eff Sprd	Speed	Eff Sprd	Speed	Eff Sprd	Speed
2002	-	-	0.14	59.60	-	-
2003	-	-	0.10	57.55	0.102	16.86
2004	-	-	0.09	47.61	0.021	4.39
2005	-	-	0.07	41.31	0.005	1.41
2006	0.05	10.18	0.06	46.28	0.003	0.66
2007	0.05	6.74	0.05	64.61	0.002	0.60
2008	0.07	3.99	0.04	44.99	0.003	1.39
2009	0.07	2.74	0.04	53.46	0.004	1.53
2010	0.05	4.48	0.02	48.26	0.002	0.72

TABLE 9
REGRESSIONS OF TRADING COSTS

The dependent variable is Effective Spread. The sample is made up of annual firm observations for NASDAQ listed stocks. Size is firm market value at the end of the year. Price is average stock price for the year. Volatility is average daily price volatility for the year. Volume is the average daily number of shares. Trade size is the average number of shares per trade. Fragmentation is the percent of volume that is executed off of NASDAQ. # of reporting venues is the average number of market center that trade a stock per month. Data sources are NYSE TAQ, and DASH 5.

	Effective Spread	Effective Spread	Effective Spread	Execution Speed	Execution Speed	Execution Speed
Intercept	0.17**	0.16**	0.16**	147.95***	149.94***	148.40***
	(2.481)	(2.309)	(2.377)	(9.747)	(9.875)	(9.776)
Ln (size)	-0.01*	-0.01	-0.01	0.25	0.19	0.20
	(-1.777)	(-1.621)	(-1.636)	(0.349)	(0.261)	(0.280)
Log(price)	0.04***	0.04***	0.04***	-12.08***	-12.21***	-12.09***
	(3.246)	(3.268)	(3.246)	(-10.077)	(-10.142)	(-10.081)
Log (volume)	-0.03***	-0.02***	-0.02***	-13.46***	-13.95***	-14.05***
	(-8.924)	(-4.433)	(-4.342)	(-23.864)	(-19.666)	(-19.880)
Log (trade size)	0.04***	0.03***	0.03***	11.24***	11.65***	11.81***
	(3.344)	(3.027)	(2.976)	(5.844)	(5.979)	(6.066)
Volatility	0.13	0.13	0.13	0.09	-0.20	0.07
	(1.101)	(1.104)	(1.102)	(0.101)	(-0.195)	(0.076)
Fragmentation	-0.06***		-0.06***	19.56***		19.50***
	(-2.782)		(-2.761)	(3.952)		(3.935)
# of reporting venues		-0.00*	-0.00*		0.18*	0.17*
		(-1.664)	(-1.652)		(1.775)	(1.729)
N	26,952	26,952	26,952	26,952	26,952	26,952
R²	0.41	0.41	0.41	0.68	0.68	0.68
F-value	77.96	79.40	74.23	114.2	112.7	106.8

*Statistically significant at the 10% level
**Statistically significant at the 5% level
***Statistically significant at the 1% level

TABLE 10

REGRESSIONS OF WHO IS TRADING ON/OFF NASDAQ

This table reports marginal effects regression results based on tobit regression models for dependent variables that are constrained (two-way). The dependent variable is the percent of volume that is executed off of NASDAQ (Fragmentation). The sample is made up of annual firm observations for NASDAQ listed stocks. Size is firm market value at the end of the year. Price is average stock price for the year. Volatility is average daily price volatility for the year. Volume is the average daily number of shares. Trade size is the average number of shares per trade. Execution speed is the average number of second from order receipt to execution. Data sources are NYSE TAQ, and DASH 5.

	(1)	(2)	(3)	(4)
Intercept	1.833***	1.833***	1.767***	1.766***
	(70.83)	(70.80)	(67.52)	(67.47)
Ln (size)	-0.00134	-0.00132	-0.0017	-0.00166
	(-0.738)	(-0.725)	(-0.935)	(-0.920)
Log(price)	-0.0932***	-0.0935***	-0.086***	-0.0863***
	(-30.67)	(-30.32)	(-27.88)	(-27.57)
Log (volume)	0.0324***	0.0327***	0.0365***	0.0368***
	(30.09)	(29.47)	(32.40)	(31.56)
Log (trade size)	-0.276***	-0.276***	-0.277***	-0.278***
	(-79.88)	(-79.35)	(-81.68)	(-80.98)
Volatility	-0.00212	-0.00450	-0.0033	-0.00627
	(-0.190)	(-0.408)	(-0.300)	(-0.569)
Effective Spread		0.00781		0.0098
		(0.973)		(1.138)
Execution Speed			0.000351***	0.000352***
			(9.965)	(9.984)
N	26,952	26,952	26,952	26,952
F-value	2270	1896	1919	1649

*Statistically significant at the 10% level
**Statistically significant at the 5% level
***Statistically significant at the 1% level

TABLE 11
CANCELED ORDERS

Panel A reports the average number of canceled orders per stock by exchange. Panel B reports the average percentage of orders canceled per stock by exchange. Data is compiled from the DASH 5 reports.

Percentage of Orders Canceled

Year	NASD	NASDAQ	ARCA	AMEX	ISE	BATS
2002	20.2%	-	-	55.7%	-	-
2003	32.5%	-	4.1%	65.8%	-	-
2004	40.2%	-	62.5%	74.2%	-	-
2005	41.5%	-	53.4%	64.8%	-	-
2006	35.0%	15.2%	56.6%	63.4%	-	-
2007	36.6%	18.7%	67.2%	80.8%	85.9%	-
2008	65.4%	17.6%	75.8%	77.5%	96.2%	33.2%
2009	62.8%	16.3%	79.1%	-	96.5%	38.3%
2010	82.8%	16.3%	92.1%	52.8%	97.0%	40.8%

TABLE 12
DIFFERENCES IN THE PERCENTAGE OF ORDERS CANCELED

Table reports the difference in percentage of orders canceled between exchanges. Difference is reported only if both exchanges trade NASDAQ stocks for the entire year. Data is compiled from the DASH 5 reports.

Year	NASD – ARCA	NASD-NASDAQ	NASD-BATS
2002	-	-	-
2003	-	-	-
2004	-22.3%***	-	-
2005	-11.9%***	-	-
2006	-21.6%***	19.7%***	-
2007	-30.6%***	17.9%***	-
2008	-10.4%***	47.7%***	-
2009	-16.2%***	46.5%***	24.6%***
2010	-9.31%***	66.5%***	42.1%***

*Statistically significant at the 10% level
**Statistically significant at the 5% level
***Statistically significant at the 1% level

FIGURE 1
Nasdaq Mean Daily Volume and NTS

FIGURE 2
Trading Stats