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Cubes to quads: The move of QQQ from AMEX to NASDAQ

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Abstract

We examine the microstructure effects of the QQQ ETF listing change from AMEX to NASDAQ. We find that even though the stock traded on both venues before and after the listing change, NASDAQ reaped a substantial increase in order flow for QQQ at the expense of the AMEX. The change results in a decline in trading costs, consolidation of order flow, and a less fragmented market for QQQ. We hypothesize that the avoidance of the explicit and implicit costs imposed by the Intermarket Trading System for NASDAQ traders was partly responsible for the improvement in QQQ market quality.

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1. Introduction

On November 9, 2004, the NASDAQ Stock Market and the American Stock Exchange (AMEX) announced that the exchange-traded fund (ETF) QQQ will change its listing from AMEX to NASDAQ effective December 1, 2004. QQQ is an ETF designed to correspond to the price and yield performance of the NASDAQ-100 index, a value-weighted index comprising the 100 largest NASDAQ listed non-financial companies. As of September 30, 2004, QQQ was the most actively

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traded ETF in the world and the most heavily traded listed equity in the United States.² As a result of the listing change, the ticker symbol for the ETF changed from QQQ to QQQQ (in this paper we use the label QQQ). QQQ continues to trade on AMEX with unlisted trading privileges.

The NASDAQ-100 Trust, the body that manages the QQQ ETF, made the decision to change listing. According to our conversations with NASDAQ personnel, the original 10-year listing agreement for the ETF was coming to an end and the NASDAQ Trust was considering alternative listing venues. The NASDAQ market argued that a listing change to NASDAQ would result in greater liquidity for the ETF.³

From NASDAQ's point of view, the change made a great deal of sense. From the late 1990s and early part of the 2000s, NASDAQ experienced unprecedented competition for trading volume from other emerging market places, notably ECNs. As a response to this decline in market share, the acquisition of the QQQ listing was promoted as a means of increasing trading volume on NASDAQ. In their pitch for the ETF listing, NASDAQ argued that the move would improve market quality for QQQ. But from NASDAQ's point of view, significant cost savings are associated with having the QQQ listing. First, NASDAQ market makers can avoid the fees for trades in QQQ routed via the Intermarket Trading System (ITS), as well as surcharges for orders executed on AMEX. Second, the ITS imposes indirect costs on NASDAQ dealers due to the lack of time priority and to delays inherent in the system.

Although market quality concerns motivated the listing change, it is not at all clear that the change would result in greater liquidity. In fact, after the listing change fewer exchanges could trade the QQQ, thereby resulting in a consolidation of trading and potentially less competition. Offsetting this consolidation is the benefit that NASDAQ would reap by avoiding the Intermarket Trading System after the listing change. Prior to the change, all QQQ trades made by NASDAQ market makers had to be routed through ITS; after the change, the NASDAQ market makers could trade directly with each other. Direct trade, coupled with the relatively large volume NASDAQ handles, could result in a reduction in spreads.

In addition, by listing the QQQ on NASDAQ, NASDAQ traders could reap cost savings in terms of the fees they pay to NASDAQ. First, they would not have to pay routing execution fees for trading non-NASDAQ ETFs on AMEX. These fees amounted to 0.003 cents per share for orders that do not use the AMEX specialist and an additional US\$ 0.01 per share for specialist-handled orders.⁴ Second, with QQQ listed on NASDAQ, NASDAQ dealers would be able to count QQQ trading volume towards the NASDAQ market center's trading volume pricing thresholds.⁵ These pricing thresholds determine in part the fees paid by market makers.

The ITS imposes an indirect cost on dealers utilizing it.⁶ Specifically, when an order is submitted by a NASDAQ dealer to, say AMEX, the AMEX market maker has a short period of time in which to decide whether to trade with the order or pass on it. In effect, the NASDAQ market maker has written a short-term option contract to the AMEX market maker, in that the NASDAQ market

² Morgan Stanley Exchange Funds Strategies: ETFs end of third quarter 2004 Review, October 12, 2004.

³ In particular, we would like to thank Frank Hathaway, Chief Economist at NASDAQ for providing much of this information.

⁴ Full details of the NASDAQ market maker fee structure can be found in the NASDAQ fee schedule. This pricing schedule is updated periodically on the NASDAQ website. We are referring to the schedule in place close to when the listing change occurred, a copy of which is available from the authors.

⁵ NASDAQ (2004).

⁶ Several authors examine the ITS, see, for example, Battalio (1997), Blume and Goldstein (1997), and Hendershott and Jones (2005).

maker is bound by his/her price. The options can last for up to a couple of minutes (see Stoll, 1992 for a discussion of the costs of the ITS). To compensate for writing this option, rational NASDAQ market makers should submit quotes at slightly wider spreads. Avoiding the ITS, should therefore result in lower trading costs for NASDAQ dealers.

For aesthetic reasons, NASDAQ argued that listing QQQ on NASDAQ made sense given that this ETF tracks the NASDAQ-100 and, by definition, these stocks are all listed on NASDAQ (as opposed to other ETFs, such as DIA and SPY, that are listed on AMEX where few of their component stocks trade). As stated by John Jacobs, CEO of NASDAQ Financial Products Services, Inc., the sponsor of QQQ, “This is a homecoming of sorts for QQQ and we are delighted it will trade alongside the component stocks on the NASDAQ-100 index.”⁷

The listing change will mean that Boston, Philadelphia and the NYSE will no longer trade QQQ since these exchanges follow NYSE listing requirements that prohibit trading of NASDAQ-listed stocks. Prior to the change, these exchanges had unlisted trading privileges to trade QQQ. Boehmer and Boehmer (2003) show the effects of the NYSE obtaining unlisted trading privileges in some ETFs. They find that liquidity improved dramatically after NYSE began unlisted trading privileges in ETFs, which they attributed to the elimination of market maker rents. Therefore, the listing change will mechanically benefit NASDAQ by forcing some trading volume to find a new trading venue. However, the listing change will also result in a constraint on the choice of venues available to market participants. If one assumes that investors were optimally selecting the venue most suitable for their trading needs prior to the listing change, the net reduction in ETF trading venues available to investors may have a negative impact on QQQ market quality and liquidity. Thus, the listing change that was engineered to benefit the NASDAQ market may result in higher trading costs for QQQ investors due to forced consolidation.

In this paper, we examine the changes in trading across markets that result from the QQQ listing change from the AMEX to NASDAQ. Previous studies examine stocks that change listings from AMEX to the NYSE or NASDAQ to the NYSE; however, QQQ moving from AMEX to NASDAQ is fairly unique given the volume of the trading activity of the security in question and also the direction of the move. Our null hypothesis is:

H₀. There will be no change in the trading characteristics and market quality of the QQQ following its listing change from AMEX to NASDAQ.

We have two alternative hypotheses:

H_{A1}. Market quality will decline following the listing change. Because the listing change results in a forced consolidation of trading volume onto fewer exchanges, a decline in inter-exchange competition may have adverse effects on market quality. Furthermore, previous work suggests that dealer markets (such as NASDAQ) represent higher-cost trading venues than specialist markets (such as AMEX).

H_{A2}. Market quality will improve following the listing change. If the listing change enables NASDAQ market makers to avoid various explicit and implicit costs when trading the QQQ ETF, we may observe these cost savings being passed on to investors in the form of narrower spreads.

The benefit to NASDAQ dealers could outweigh the losses to other markets if the volume garnered by NASDAQ is large enough. Thus, our paper also represents an indirect test of the costs associated with trading using the ITS.

⁷ American Stock Exchange News Release, November 9, 2004.

Our paper proceeds as follows. Section 2 discusses previous work on listing changes. Section 3 looks at the change in QQQ trading venues. Sections 4 and 5 examine changes in quoting behavior and trading costs. Section 6 looks at a measure of market quality, specifically locked and crossed markets, and Section 7 concludes.

2. Previous work on exchange listing changes

Our paper is closely related to previous research that examines changes in trading costs for firms that switch listings from one stock exchange to another. In most cases, these papers examine the effect of a move to the NYSE, either from NASDAQ or AMEX. Christie and Huang (1994), examining stocks in 1990, find that stocks that move from dealer markets (NASDAQ) to specialist markets (AMEX or the NYSE) experience a substantial reduction in trading costs. Bennett and Wei (2005) examine stocks that move their listing from NASDAQ to the NYSE (in 2002 and 2003) after the change to decimalization and find results similar to those of Christie and Huang, that trading costs decline when a stock moves from NASDAQ to the NYSE. However, Jones and Lipson (1999) examine execution costs, including the costs of commissions, for institutional orders on firms that move their listing. They find no differences in trading costs across these exchanges.

Our study differs from previous studies that examine exchange-listing changes in several key ways. First, we are examining the move of a very heavily traded security. Second, the listing change is to, as opposed to from, NASDAQ. Third, we examine the impact of the listing change on the trading behavior of QQQ on all of its trading venues, rather than just the NASDAQ and AMEX. Fourth, the bulk of the trading venues can still trade QQQ after the listing change.

3. Changes in QQQ trading venues

The QQQ listing change from AMEX to NASDAQ alters the mix of exchanges that can trade this security (Table 1 summarizes these changes). Following the listing change, the NYSE, Boston, and Philadelphia exchanges are no longer able to trade the QQQ. Previously, these exchanges were trading QQQ with unlisted trading privileges. The Chicago Stock Exchange can still trade QQQ

Table 1
QQQ trading venues before and after listing change

| | AMEX-listed (before December 1, 2004) | NASDAQ-listed (December 1, 2004 and later) |
|--------------|---------------------------------------|--|
| NASDAQ | Yes | Yes |
| AMEX | Yes | Yes |
| NYSE | Yes | No |
| Boston | Yes | No |
| Cincinnati | Yes | Yes |
| Chicago | Yes | Yes |
| Pacific | Yes | Yes |
| Philadelphia | Yes | No |

This table shows the trading venues that are able to trade QQQ for the time period before the listing change, when the security was listed on AMEX, and after the listing change when the security was listed on NASDAQ. After the change, the ticker symbol for the ETF on NASDAQ was QQQQ. AMEX: American Stock Exchange; NYSE: New York Stock Exchange, The Pacific Stock Exchange is actually the ECN Archipelago, as Archipelago purchased the Pacific Stock Exchange and, as a result, all trades and quotes are disseminated with an identifier as the Pacific Stock Exchange.

due to a special trading privilege granted to them by the SEC. Van Ness, Van Ness, and Pruitt (1999) examine this last case and find that reported trading volume declines substantially and attribute this decline to differences in reported trading volume between a dealer and specialist market.⁸ The trades and quotes from the Cincinnati Stock Exchange are from the ECN Island. Similarly, the trades and quotes from the Pacific Stock Exchange are from the ECN Archipelago. The NASDAQ ADF, which is essentially an internal NASDAQ ECN, will now trade the ETF.

As the listing change occurred on December 1, 2004, we extract data from the NYSE trade and quote (TAQ) database for November and December of 2004. Our basic approach is to examine changes in trading activity and market quality around the listing date using November 2004 as the pre-listing period and December 2004 as the post-listing period. We use an 11 trading day window that spans the listing day change with 5 days on either side. Our results are also robust using a 26 trading day window, with 13 days on either side of the listing day.⁹ We precondition the data to minimize errors, and omit trades and quotes if the TAQ database indicates that they are out of time sequence or involve either an error or a correction. We also omit quotes if either the ask price or the bid price is equal to or less than zero and we omit trades if the price or volume is equal to or less than zero.

The shift in QQQ volume associated with the listing change (by each exchange) is presented in Table 2. Panel A presents the share volume around the change. Consistent with the expectations of NASDAQ personnel, NASDAQ shows a large jump in daily volume from 10.23 million shares the day before the listing switch to 33.98 million shares on the day of the listing switch. To control for the effects of changes in market-wide volume for all stocks, Panel B presents the results from Panel A scaled by the total market volume for all stocks across all exchanges. These data are collected from CRSP and are listed in the last column of Panel B. The key result here is that the volume gains shown in Panel A for NASDAQ are robust to overall changes in market-wide volume. Indeed, the QQQ volume goes from being 0.24% of total market volume immediately before the change to 0.71% immediately after the change.

Panel C presents the relative market shares of QQQ volume for the different exchanges and shows that NASDAQ's shares move from 12.35% to 36.21%. Despite an initial decrease in overall QQQ volume on day 0, Cincinnati increases overall volume and becomes the largest single venue for trading of the QQQ after the listing change (recall that Cincinnati's volume consists of trades conducted on the Island ECN, but reported through Cincinnati). Due to the change in listing, the NYSE, Boston, and Philadelphia exchanges lose their entire market share in QQQ volume (although collectively they were less than 10% immediately prior to the listing change). AMEX sees a decline in volume from about 8% to less than 2%; Chicago also sees a decline, as does the Pacific exchange. The data in Panel C of Table 2 is also presented graphically in Fig. 1.

Table 3 examines the statistical significance of these volume changes using the full 26-day sample period (13 trading days before the listing change and 13 trading days after). The changes can be summarized as follows: for NASDAQ, the listing change resulted in a highly significant increase in volume of QQQ. The average trade size declined, but the percentage of trades on NASDAQ increased by 19.97% (statistically significant). Cincinnati was the other market to have

⁸ The issue of inconsistent counting of volume by different exchanges is discussed at length in Atkins and Dyl (1997) and Anderson and Dyl (2005). While we acknowledge that our results may be impacted by different counting methods a clear and unbiased approach to correcting the problem is not obvious given that we do not know the extent of the issue vis-a-vis the regional markets.

⁹ On Monday, December 20, 2004, the composition of the NASDAQ-100 (the index underlying QQQ) changed, restricting the post-listing window to 13 trading days.

Table 2
Time series of volume for QQQ

| Day | NASDAQ | NYSE | AMEX | Boston | Cincinnati | NASDAQ ADF | Chicago | Pacific | Philadelphia | Total market volume (billions) | Herfindahl |
|--|--------|--------|--------|--------|------------|------------|---------|---------|--------------|--------------------------------|------------|
| Panel A: Total volume (in millions of shares) | | | | | | | | | | | |
| -5 | 9.07 | 1.61 | 6.14 | 2.69 | 27.61 | 0.00 | 4.67 | 26.68 | 2.47 | | |
| -4 | 6.64 | 2.26 | 4.81 | 1.58 | 23.40 | 0.00 | 3.53 | 23.31 | 2.36 | | |
| -3 | 2.48 | 2.41 | 2.49 | 1.03 | 9.04 | 0.00 | 1.27 | 10.63 | 0.77 | | |
| -2 | 10.00 | 2.65 | 8.53 | 3.13 | 31.60 | 0.00 | 3.13 | 27.22 | 3.46 | | |
| -1 | 10.23 | 1.70 | 6.70 | 2.10 | 28.61 | 0.00 | 2.96 | 28.84 | 1.69 | | |
| 0 | 33.98 | 0.00 | 2.76 | 0.00 | 31.13 | 0.15 | 1.63 | 24.20 | 0.00 | | |
| 1 | 37.54 | 0.00 | 1.67 | 0.00 | 40.73 | 0.01 | 2.42 | 23.52 | 0.00 | | |
| 2 | 32.15 | 0.00 | 1.24 | 0.00 | 39.15 | 0.00 | 1.64 | 24.91 | 0.00 | | |
| 3 | 22.76 | 0.00 | 1.23 | 0.00 | 28.56 | 0.01 | 1.54 | 12.22 | 0.00 | | |
| 4 | 37.34 | 0.00 | 1.43 | 0.00 | 30.85 | 0.00 | 3.60 | 24.80 | 0.00 | | |
| 5 | 25.32 | 0.00 | 1.16 | 0.00 | 37.49 | 0.00 | 1.87 | 16.85 | 0.00 | | |
| Panel B: QQQ volume as a percentage of total market wide volume for all stocks across all exchanges (and market wide volume) | | | | | | | | | | | |
| -5 | 0.221% | 0.039% | 0.149% | 0.065% | 0.672% | 0.000% | 0.114% | 0.649% | 0.060% | 4.11 | |
| -4 | 0.202% | 0.069% | 0.147% | 0.048% | 0.713% | 0.000% | 0.108% | 0.711% | 0.072% | 3.28 | |
| -3 | 0.175% | 0.170% | 0.175% | 0.073% | 0.637% | 0.000% | 0.089% | 0.749% | 0.054% | 1.42 | |
| -2 | 0.258% | 0.068% | 0.220% | 0.081% | 0.817% | 0.000% | 0.081% | 0.703% | 0.089% | 3.87 | |
| -1 | 0.244% | 0.041% | 0.160% | 0.050% | 0.683% | 0.000% | 0.071% | 0.688% | 0.040% | 4.19 | |
| 0 | 0.712% | 0.000% | 0.058% | 0.000% | 0.653% | 0.003% | 0.034% | 0.507% | 0.000% | 4.77 | |
| 1 | 0.772% | 0.000% | 0.034% | 0.000% | 0.838% | 0.000% | 0.050% | 0.484% | 0.000% | 4.86 | |
| 2 | 0.697% | 0.000% | 0.027% | 0.000% | 0.849% | 0.000% | 0.036% | 0.540% | 0.000% | 4.61 | |
| 3 | 0.561% | 0.000% | 0.030% | 0.000% | 0.703% | 0.000% | 0.038% | 0.301% | 0.000% | 4.06 | |
| 4 | 0.773% | 0.000% | 0.030% | 0.000% | 0.639% | 0.000% | 0.075% | 0.513% | 0.000% | 4.83 | |
| 5 | 0.560% | 0.000% | 0.026% | 0.000% | 0.829% | 0.000% | 0.041% | 0.373% | 0.000% | 4.52 | |
| Panel C: Percent of total volume | | | | | | | | | | | |
| -5 | 11.20% | 1.99% | 7.59% | 3.33% | 34.10% | 0.00% | 5.77% | 32.96% | 3.06% | | 0.2490 |
| -4 | 9.78% | 3.33% | 7.08% | 2.33% | 34.46% | 0.00% | 5.21% | 34.34% | 3.47% | | 0.2568 |
| -3 | 8.25% | 8.01% | 8.25% | 3.42% | 30.01% | 0.00% | 4.22% | 35.29% | 2.55% | | 0.2382 |
| -2 | 11.14% | 2.96% | 9.50% | 3.49% | 35.22% | 0.00% | 3.49% | 30.34% | 3.86% | | 0.2423 |
| -1 | 12.35% | 2.05% | 8.09% | 2.53% | 34.54% | 0.00% | 3.58% | 34.82% | 2.04% | | 0.2651 |
| 0 | 36.21% | 0.00% | 2.94% | 0.00% | 33.17% | 0.16% | 1.74% | 25.79% | 0.00% | | 0.3088 |
| 1 | 35.46% | 0.00% | 1.57% | 0.00% | 38.47% | 0.01% | 2.28% | 22.21% | 0.00% | | 0.3238 |
| 2 | 32.44% | 0.00% | 1.25% | 0.00% | 39.51% | 0.00% | 1.65% | 25.13% | 0.00% | | 0.3249 |
| 3 | 34.32% | 0.00% | 1.86% | 0.00% | 43.06% | 0.02% | 2.33% | 18.42% | 0.00% | | 0.3380 |
| 4 | 38.10% | 0.00% | 1.46% | 0.00% | 31.47% | 0.00% | 3.67% | 25.30% | 0.00% | | 0.3098 |
| 5 | 30.62% | 0.00% | 1.40% | 0.00% | 45.34% | 0.00% | 2.26% | 20.38% | 0.00% | | 0.3416 |

Panel A presents the time series of total daily volume of QQQ, broken down by trading venue (in millions of shares). The time period covers the 11 trading days surrounding QQQ's listing change from AMEX to NASDAQ (5 days before switching, the day of the switch, and 5 days after switching). Panel B presents the volume numbers in Panel A expressed as a percentage of the marketwide volume for all stocks that is shown in the last column of Panel B. Panel C presents the time series of the percentage of total daily volume of QQQ, broken down by trading venue. The time period also covers the 11 trading days surrounding QQQ's listing change from AMEX to NASDAQ. In all panels, the listing day of December 1, 2004 is day 0.

Table 3
Post – pre trading differences for QQQ

| Variable | NASDAQ | AMEX | Cincinnati | Boston | Philadelphia | NASDAQ ADF | Chicago | NYSE | Pacific |
|--------------------------|----------|-----------|------------|--------|--------------|------------|----------|---------|-----------|
| Volume (mill) | | | | | | | | | |
| Pre | 10.56 | 6.73 | 28.15 | 2.57 | 2.19 | 0 | 3.34 | 2.68 | 28.31 |
| Post | 27.34 | 1.34 | 37.24 | 0 | 0 | 0.02 | 2.02 | 0.00 | 20.21 |
| Difference (post – pre) | 16.78 | –5.39 | 9.09 | –2.57 | –2.19 | –0.02 | –1.32 | –2.68 | –8.10 |
| <i>t</i> -statistic | 8.30*** | –9.98*** | 3.19*** | N/A | N/A | N/A | –3.30*** | N/A | –3.40*** |
| %Volume | | | | | | | | | |
| Pre | 12.49% | 7.96% | 33.3% | 3.04% | 2.59% | 0.00% | 3.95% | 3.17% | 33.49% |
| Post | 31.01% | 1.52% | 42.24% | 0.00% | 0.00% | 0.02% | 2.29% | 0.00% | 22.92% |
| Difference (post – pre) | 18.79% | –6.45% | 8.87% | –3.04% | –2.59% | 0.02% | –1.66% | –3.17% | –10.57% |
| <i>t</i> -statistic | 13.68*** | –20.04*** | 5.59*** | N/A | N/A | N/A | –4.56*** | N/A | –12.58*** |
| No. of trades | | | | | | | | | |
| Pre | 6264 | 1779 | 27,251 | 1509 | 925 | 0 | 6841 | 11,174 | 151,170 |
| Post | 17,085 | 398 | 35,543 | 0 | 0 | 32 | 1147 | 0 | 19,540 |
| Difference (post – pre) | 10,821 | –1381 | 8292 | –1509 | –925 | 32 | –5694 | –11,174 | –131,630 |
| <i>t</i> -statistic | 7.25*** | –11.42*** | 2.82*** | N/A | N/A | N/A | –8.70*** | N/A | –14.86*** |
| Percent of trades | | | | | | | | | |
| Pre | 3.19% | 0.91% | 13.86% | 0.77% | 0.47% | 0.00% | 3.48% | 0.44% | 76.88% |
| Post | 23.16% | 0.54% | 48.2% | 0.00% | 0.00% | 0.04% | 1.56% | 0.00% | 26.50% |
| Difference (post – pre) | 19.97% | –0.37% | 34.34% | –0.77% | –0.47% | 0.04% | –1.92% | –0.44% | –50.38% |
| <i>t</i> -statistic | 13.93*** | –6.04*** | 20.17*** | N/A | N/A | N/A | –7.49*** | N/A | –47.69*** |
| Trade size | | | | | | | | | |
| Pre | 1702 | 3776 | 1045 | 1715 | 2357 | 0 | 519 | 3247 | 187 |
| Post | 1632 | 3563 | 1050 | 0 | 0 | 735 | 1782 | 0 | 1032 |
| Difference (post – pre) | –70 | –213 | 5 | –1715 | –2357 | 735 | 1263 | –3247 | 845 |
| <i>t</i> -statistic | 0.75 | –0.33 | 0.17 | N/A | N/A | N/A | 8.35*** | N/A | 21.96*** |

This table presents results of *t*-tests for differences in trading characteristics of QQQ between the pre- and post-switch periods, broken down by trading venue. Tests for differences (post – pre) in the mean daily amounts of total volume (in millions of shares), percent of total volume, number of trades, percent of total trades, and trade size, for each trading venue. The tests compare the 13 trading days before the switch with the 13 trading days after the switch.

*** Statistically significant at the 1% level.

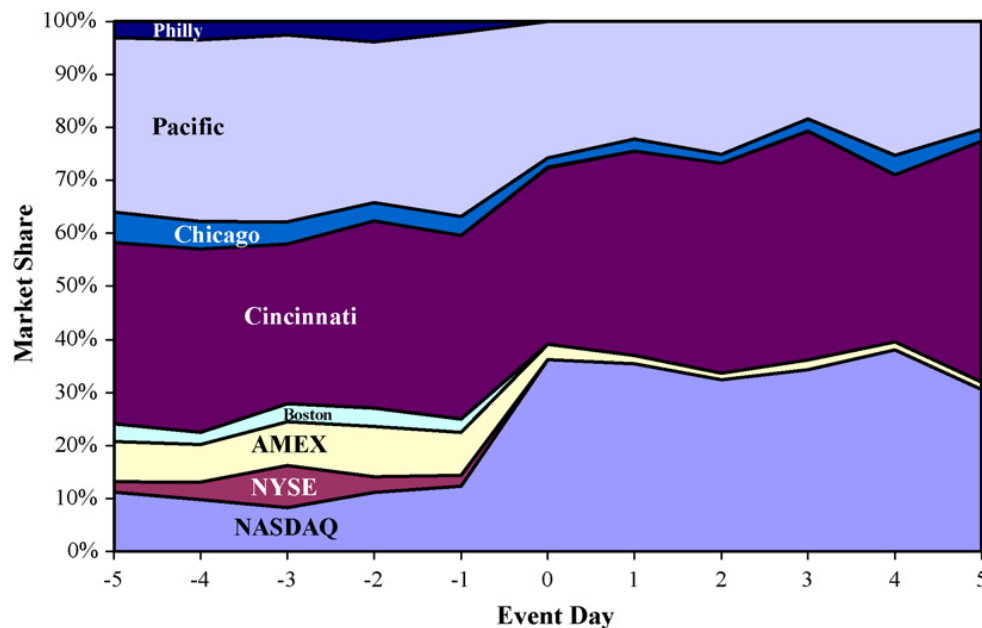


Fig. 1. Percentage of share volume in QQQ.

a significant increase in volume (an 8.87% increase in market share). Very noticeably, Cincinnati gained 34% in trades, consistent with much of the small-trade volume moving to the Island ECN. Both AMEX and Pacific lose volume, with Pacific losing a far greater percentage of the total trades (>50%). Given that trades reported through the Pacific Stock Exchange originate from an ECN (Archipelago), it seems likely that most of these small trades will have migrated to the Island ECN (Cincinnati). Given that both ECNs were available to traders before the listing change, it appears that some other factor must be driving this shift in volume.

A possible explanation for this shift may be that Island has preferencing arrangements with retail brokers for NASDAQ-listed stocks, but no such arrangements for AMEX-listed securities. In this case, traders appear to have just moved to a new venue, but did not change their trading behavior. This is speculation on our part, as hard data on preferencing is virtually impossible to obtain. However, Chung, Chuwonganant, and McCormick (2004), using proprietary data from NASDAQ, find that purchased and internalized order flow make up more than 70% of NASDAQ volume. These arrangements are the dominant order flow type for large-volume securities with high levels of institutional ownership. The QQQ ETF is likely to be such a stock.

A possible explanation for the observed movements in trading volume (documented in Tables 2 and 3) is that changes are being driven by the underlying securities of QQQ (the stocks of the NASDAQ-100 index). Table 4 examines the trading volume of the NASDAQ-100 stocks before and after the QQQ listing change. Since all of these stocks are listed on NASDAQ, they do not trade on the NYSE, Philadelphia, or Boston Stock Exchange. Examining the 11-day window surrounding the QQQ listing change (5 days prior, the event day, and 5 days after), the underlying stocks appear unaffected. Table 5 examines the changes in the trading characteristics of the underlying securities using the full 26-day sample period (13 trading days before the listing change and 13 trading days after). While a small increase in volume does occur over the event period, the NASDAQ percentage of the underlying stocks volume is unchanged around the listing day change. Chicago does see a significant increase in the percentage of volume, but in absolute terms these numbers are small and not economically significant.

Table 4
Time series of volume for the underlying stocks of QQQ

| Day | NASDAQ | AMEX | Cincinnati | Chicago | NASDAQ ADF | Pacific |
|---|--------|-------|------------|---------|------------|---------|
| Panel A: Total volume (in millions of shares) | | | | | | |
| –5 | 294.08 | 0.22 | 152.43 | 3.02 | 2.63 | 144.45 |
| –4 | 263.65 | 0.30 | 126.96 | 2.63 | 2.71 | 108.57 |
| –3 | 105.78 | 0.15 | 54.20 | 0.92 | 1.89 | 40.72 |
| –2 | 298.22 | 0.39 | 162.19 | 3.07 | 3.48 | 136.80 |
| –1 | 316.71 | 0.36 | 166.67 | 3.15 | 3.39 | 154.69 |
| 0 | 408.88 | 0.43 | 190.21 | 3.73 | 4.67 | 183.47 |
| 1 | 398.45 | 0.55 | 214.07 | 3.48 | 3.68 | 167.51 |
| 2 | 433.67 | 0.64 | 250.51 | 3.35 | 3.68 | 196.03 |
| 3 | 327.02 | 0.61 | 179.05 | 2.48 | 5.76 | 142.97 |
| 4 | 386.71 | 0.38 | 169.70 | 4.01 | 3.45 | 193.29 |
| 5 | 302.64 | 0.49 | 181.65 | 3.01 | 2.44 | 165.76 |
| Panel B: %Volume | | | | | | |
| –5 | 49.27% | 0.04% | 25.54% | 0.51% | 0.51% | 24.20% |
| –4 | 52.23% | 0.06% | 25.15% | 0.52% | 0.52% | 21.51% |
| –3 | 51.94% | 0.07% | 26.61% | 0.45% | 0.45% | 20.00% |
| –2 | 49.36% | 0.06% | 26.85% | 0.51% | 0.51% | 22.64% |
| –1 | 49.11% | 0.06% | 25.84% | 0.49% | 0.49% | 23.98% |
| 0 | 51.67% | 0.05% | 24.03% | 0.47% | 0.47% | 23.18% |
| 1 | 50.58% | 0.07% | 27.18% | 0.44% | 0.44% | 21.26% |
| 2 | 48.84% | 0.07% | 28.21% | 0.38% | 0.38% | 22.08% |
| 3 | 49.71% | 0.09% | 27.22% | 0.38% | 0.38% | 21.73% |
| 4 | 51.05% | 0.05% | 22.40% | 0.53% | 0.53% | 25.52% |
| 5 | 46.14% | 0.07% | 27.69% | 0.46% | 0.46% | 25.27% |

Panel A presents the time series of total daily volume of the 100 underlying stocks of QQQ, broken down by trading venue (in millions of shares). The time period covers the 11 trading days surrounding QQQ's listing change from AMEX to NASDAQ (5 days before switching, the day of the switch, and 5 days after switching). Panel B presents the time series of the percent of total daily volume of the 100 underlying stocks of QQQ, broken down by trading venue. The time period also covers the 11 trading days surrounding QQQ's listing change from AMEX to NASDAQ. In both panels, the listing day of December 1, 2004 is day 0.

4. Changes in quoting behavior

The TAQ database provides the most competitive bid and offer quotes for a security for each exchange. However, the database does not provide the most competitive national bid and offer (NBBO) for a security. Therefore, we take the inside quotes for each exchange and compute the NBBO for both QQQ and the underlying stocks. When calculating the NBBO for a security, it is possible that a quote can become “stale.” Since QQQ, as well as the underlying stocks (the NASDAQ-100), are some of the most active stocks in the United States, we deem a quote as stale if it is older than 10 min and omit the observation from the computation of the NBBO.¹⁰

In Table 6, we examine the quoting behavior of the exchanges prior to and after the listing change (Panels A and B, respectively). Panel C displays the results of *t*-tests for statistical differences in quoting behavior between the periods immediately before and after the listing change. As seen in Table 2, several of the exchanges that quoted and traded the NASDAQ-100 index prior to the listing change are no longer able to compete in this security (the NYSE, Boston,

¹⁰ As a robustness check, we use differing values to deem a quote “stale” and find that 10 min appears to be appropriate.

Table 5
Post – pre trading differences for the underlying stocks of QQQ

| Variable | NASDAQ | AMEX | Cincinnati | NASDAQ ADF | Chicago | Pacific |
|-------------------------|---------|---------|------------|------------|----------|---------|
| Volume (mill) | | | | | | |
| Pre | 323.436 | 0.421 | 169.155 | 3.18 | 4.079 | 146.240 |
| Post | 396.675 | 0.562 | 209.011 | 4.08 | 3.301 | 181.266 |
| Difference (post – pre) | 73.239 | 0.141 | 39.856 | 0.90 | –0.778 | 35.026 |
| <i>t</i> -statistic | 2.60** | 1.77* | 2.72** | 1.94* | –1.33 | 2.81*** |
| %Volume | | | | | | |
| Pre | 50.03% | 0.07% | 26.16% | 0.49% | 0.63% | 22.62% |
| Post | 49.90% | 0.07% | 26.29% | 0.51% | 0.42% | 22.8% |
| Difference (post – pre) | –0.13% | 0.00% | 0.13% | 0.02% | –0.21% | 0.18% |
| <i>t</i> -statistic | –0.61 | 0.42 | 0.32 | 0.04 | –3.66*** | 0.72 |
| No. of trades | | | | | | |
| Pre | 562,830 | 251.67 | 471,353 | 3535 | 4829 | 373,973 |
| Post | 681,342 | 277.77 | 558,047 | 4044 | 4835 | 439,687 |
| Difference (post – pre) | 118,512 | 26.10 | 86,694 | 509 | 6 | 65,714 |
| <i>t</i> -statistic | 2.83*** | 0.9 | 2.39** | 1.32 | 0.01 | 2.23** |
| Percent of trades | | | | | | |
| Pre | 39.73% | 0.02% | 33.27% | 0.25% | 0.34% | 26.40% |
| Post | 40.36% | 0.02% | 33.06% | 0.24% | 0.29% | 26.04% |
| Difference (post – pre) | 0.63% | 0.00% | –0.21% | –0.01% | –0.05% | –0.36% |
| <i>t</i> -statistic | 1.25 | –1.25 | –0.49 | –0.66 | –1.84* | –0.57 |
| Trade size | | | | | | |
| Pre | 421.00 | 1767.00 | 276.00 | 472.00 | 5390.00 | 296.00 |
| Post | 424.00 | 2016.00 | 280.00 | 530.00 | 5071.00 | 303.00 |
| Difference (post – pre) | 3.00 | 249.00 | 4.00 | 58.00 | –319.00 | 7.00 |
| <i>t</i> -statistic | 0.24 | 0.87 | 0.87 | 1.87* | –0.24 | 1.56 |

This table presents the results of *t*-tests for differences in trading characteristics of the 100 underlying stocks of QQQ between the pre- and post-switch periods, broken down by trading venue. Tests for differences (post – pre) in the mean daily amounts of total volume (in millions of shares), percent of total volume, number of trades, percent of total trades, and trade size, for each trading venue. The tests compare the 13 trading days before the switch with the 13 trading days after the switch.

* Statistically significant at the 10% level.

** Statistically significant at the 5% level.

*** Statistically significant at the 1% level.

and Philadelphia Stock Exchanges). We find that NASDAQ is now quoting at the NBBO much more frequently (from 80.28% to 92.95%), while AMEX has become less competitive, quoting the NBBO (from 95.72% to 49.62%).

The NASDAQ ADF (NASDAQ's internal ECN), a new participant in the competition for QQQ order flow, is also frequently at the inside bid and/or ask once the listing change occurs (60.7%). The ECNs, Island and Archipelago, are at the inside bid and/or ask in similar manners than they were previously. Similarly, Chicago shows very little change in its quoting behavior when comparing the pre and post-change periods.

We also examine the quoting behavior of the various exchanges for the underlying NASDAQ-100 index stocks (not reported). All of the exchanges show similar quoting behavior before and after the change. Therefore, the listing change appears to have had no impact on quoting behavior in the underlying stocks.

Table 6
Quoting statistics for QQQ

| Variable (percent of time) | NASDAQ | AMEX | Cincinnati | Boston | Philadelphia | NASDAQ ADF | Chicago | NYSE | Pacific |
|---|----------|-----------|------------|--------|--------------|------------|----------|--------|----------|
| Panel A: Pre time period | | | | | | | | | |
| At inside bid and/or ask | 80.82% | 95.72% | 96.31% | 31.82% | 30.39% | N/A | 21.58% | 81.07% | 91.54% |
| At both inside bid and ask | 44.76% | 49.29% | 52.42% | 3.78% | 2.11% | N/A | 1.19% | 26.25% | 60.04% |
| Alone at inside ask | 0.27% | 7.98% | 3.13% | 1.10% | 0.78% | N/A | 0.29% | 0.91% | 2.11% |
| Alone at inside bid | 0.31% | 8.99% | 3.40% | 0.79% | 0.66% | N/A | 0.27% | 0.84% | 1.96% |
| Alone at both inside bid and ask | 0.00% | 0.01% | 0.02% | 0.00% | 0.00% | N/A | 0.00% | 0.00% | 0.01% |
| Panel B: Post-time period | | | | | | | | | |
| At inside bid and/or ask | 92.95% | 49.62% | 93.60% | N/A | N/A | 60.70% | 15.47% | N/A | 95.26% |
| At both inside bid and ask | 49.99% | 2.55% | 49.85% | N/A | N/A | 2.17% | 0.67% | N/A | 52.03% |
| Alone at inside ask | 2.05% | 5.19% | 2.75% | N/A | N/A | 16.92% | 0.12% | N/A | 2.90% |
| Alone at inside bid | 2.24% | 5.49% | 3.09% | N/A | N/A | 7.76% | 0.10% | N/A | 3.20% |
| Alone at both inside bid and ask | 0.00% | 0.00% | 0.00% | N/A | N/A | 0.00% | 0.00% | N/A | 0.00% |
| <i>t</i> -tests | NASDAQ | AMEX | Cincinnati | Boston | Philadelphia | NASDAQ ADF | Chicago | NYSE | Pacific |
| Panel C: Post – pre quoting differences | | | | | | | | | |
| At inside bid and/or ask | 6.94*** | –15.43*** | –1.98* | N/A | N/A | N/A | –2.82*** | N/A | 2.06* |
| At both inside bid and ask | 1.40 | –30.18*** | –0.67 | N/A | N/A | N/A | –1.87* | N/A | –1.44 |
| Alone at inside ask | 9.38*** | –4.32*** | –0.08 | N/A | N/A | N/A | –2.70** | N/A | 1.68 |
| Alone at inside bid | 13.41*** | –4.79*** | –0.18 | N/A | N/A | N/A | –4.21*** | N/A | 5.20*** |
| Alone at both inside bid and ask | 0.00 | 0.00 | –681.38*** | N/A | N/A | N/A | 0.00 | N/A | –3.16*** |

This table presents time-weighted averages of market quoting behavior in competition for QQQ order flow. Statistics show the percent of time each market displays quotes at either the inside bid or ask, at both the inside bid and ask, alone at the inside ask, alone at the inside bid, and alone on both the inside bid and ask. Panel A shows market quoting behaviors before QQQ's listing change, while Panel B shows market quoting behaviors after the listing change. The tests compare the 13 days before the switch with the 13 days after the switch.

* Statistically significant at the 10% level.

** Statistically significant at the 5% level.

*** Statistically significant at the 1% level.

Table 7
Daily mean effective and percent effective spreads for QQQ

| Day | Effective spread | %Effective spread |
|-----|------------------|-------------------|
| -5 | 0.0053 | 0.0137 |
| -4 | 0.0053 | 0.0135 |
| -3 | 0.0052 | 0.0133 |
| -2 | 0.0057 | 0.0145 |
| -1 | 0.0056 | 0.0144 |
| 0 | 0.0042 | 0.0105 |
| 1 | 0.0043 | 0.0107 |
| 2 | 0.0044 | 0.0108 |
| 3 | 0.0039 | 0.0098 |
| 4 | 0.0042 | 0.0106 |
| 5 | 0.0041 | 0.0103 |

This table shows the mean effective and mean percent effective spreads for the 11 trading days surrounding the listing change, 5 days before, the listing day and 5 days after. The listing day of December 1, 2004 is day 0.

5. Changes in trading costs

The consolidation of some QQQ volume onto NASDAQ, coupled with the reduction in the number of venues available to traders, may have an adverse impact on the trading costs borne by market participants. However, now that NASDAQ market makers are able to earn rebates on trades of QQQ, and can avoid using the ITS, these market makers may pass on some of these rents to market participants. In other words, the cost savings may result in lower spreads.

Table 7 shows the mean daily effective and percent effective spreads for each day during the 26 trading day period surrounding the listing change. The results show a clear change in the patterns for both effective spreads and percent effective spreads. Immediately after the listing change, both effective spreads and percent effective spreads appear to drop. Coupled with evidence of more aggressive quoting behavior of NASDAQ market makers, the reduction in trading costs is consistent with a portion of the market makers' rebate being passed on to traders. These results are presented graphically in Fig. 2 (for effective spreads) and Fig. 3 (for percentage effective spreads).

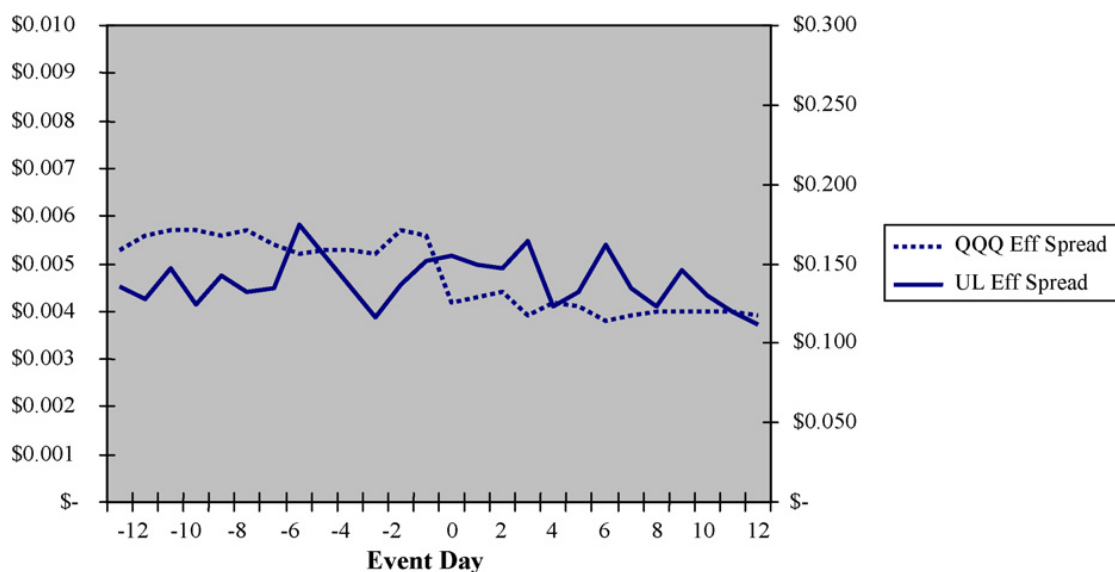


Fig. 2. Effective spreads (US\$).

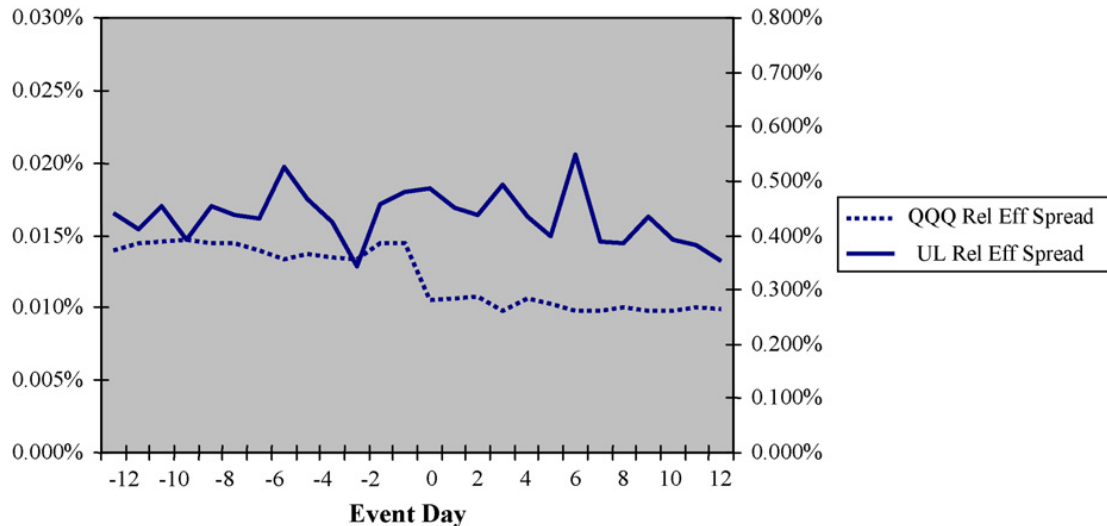


Fig. 3. Relative effective spreads.

Table 8 examines this issue more closely using the full 26-day sample period (Panel A for QQQ and Panel B for the underlying securities). Quoted spreads and percentage quoted spreads both declined significantly for QQQ immediately following the listing change. Additionally, effective spreads and percentage effective spreads also decrease significantly. To compute the average quoted and effective spreads in the underlying stocks, we compute a daily market value-weighted average, as the NASDAQ-100 is a value-weighted index. The underlying Nasdaq-100 securities do not show any pattern of significant changes in trading costs (quoted spreads, percentage quoted spreads, effective spreads, percentage effective spreads). Though we do see a minor decrease in the percent quoted spread, the decrease is not found when analyzing the effective spreads that occur during actual trades.

Table 8
Post – pre differences in quoted and effective spreads for QQQ and the underlying stocks

| | Pre | Post | Difference (post – pre) | t-statistics |
|----------------------------|---------|---------|-------------------------|--------------|
| Panel A: QQQ | | | | |
| Quoted spread | 0.0101 | 0.0100 | –0.0001 | 3.77*** |
| Quoted spread (%) | 0.0300% | 0.0300% | –0.000008% | 9.20*** |
| Effective spread | 0.0054 | 0.0040 | –0.0014 | 20.90*** |
| Effective spread (%) | 0.0141% | 0.0101% | –0.0040% | 22.79*** |
| Panel B: Underlying stocks | | | | |
| Quoted spread | 0.0201 | 0.0200 | –0.0001 | 0.23 |
| Quoted spread (%) | 0.0688% | 0.0684% | –0.0003% | 2.37* |
| Effective spread | 0.0100 | 0.0101 | 0.0001 | –0.76 |
| Effective spread (%) | 0.0298% | 0.0297% | –0.0001% | 0.57 |

This table presents the results of *t*-tests for differences in quoting behavior for order flow. Tests for differences (post – pre) in the mean daily quoted spread (of NBBO), percent quoted spread, effective spread, and percent effective spread. The tests compare the 13 trading days before the switch with the 13 trading days after the switch. Panel A provides test results for QQQ; Panel B provides test results for the underlying stocks of QQQ where the reported numbers are a value-weighted average of the stocks of the NASDAQ-100.

* Statistically significant at the 10% level.

*** Statistically significant at the 1% level.

6. Locked and crossed markets

Tables 6–8 show that trading costs are very low for QQQ when listed on either the AMEX or NASDAQ, implying that based upon trading costs, market quality has not deteriorated and likely has improved. As an additional measure of market quality, we investigate instances of locked and crossed markets around the change in listing of QQQ. Shkilko, Van Ness, and Van Ness (2005) show that the fragmented nature of NASDAQ results in a large frequency of time that the NASDAQ stock market is locked and crossed during the day for the most active stocks. The impact of locked and crossed markets is a market quality issue, since when the markets lock or cross, trading stops across exchanges until this issue is resolved (until spreads are positive again). We examine whether the listing change results in QQQ becoming significantly more or less locked and crossed.

Table 9 displays the daily time-series of quote updates and the daily instances of zero and negative spreads (locked and crossed markets, respectively). We find that the total number of non-positive spreads increases dramatically once the listing moves to NASDAQ. Of particular note, a dramatic rise in the number of negative spread instances (where the bid price is greater than the ask price) occurs. However, the amount of negative spreads subsides quickly by the third day after the listing change. Also, the number of zero-spread instances increases. This indicates that a number of trades are crossing (buys and sells) at the same price, so investors are transacting without incurring bid-ask spread costs.

Table 10 further examines the differences in locked and crossed markets using the full 26-day sample period. QQQ shows a statistically significant increase in the instances of locked and crossed markets (Panel A). An examination of the underlying stocks (Panel B of Table 10) does not show a similar pattern when compared to the locking and crossing problems seen with QQQ. The Nasdaq-100 stocks were locking and crossing around 15% of the time (similar in magnitudes to those found by Shkilko, Van Ness, and Van Ness), and it appears fairly stable. We do not find similar increases in the instances of locked and crossed markets for the underlying stocks around the QQQ listing change.

Table 9
Locked and crossed markets for QQQ

| Day | No. of quote updates | Negative spread (%) | Zero spread (%) | Total non-positive spread (%) | Percent of time non-positive |
|-----|----------------------|---------------------|-----------------|-------------------------------|------------------------------|
| –5 | 329,712 | 4.42 | 14.54 | 18.97 | 12.58 |
| –4 | 265,652 | 3.24 | 14.38 | 17.62 | 11.43 |
| –3 | 120,500 | 1.14 | 11.51 | 12.66 | 8.91 |
| –2 | 344,581 | 4.07 | 17.90 | 21.97 | 14.03 |
| –1 | 362,369 | 7.13 | 16.76 | 23.89 | 14.86 |
| 0 | 321,076 | 60.30 | 21.86 | 82.16 | 72.23 |
| 1 | 359,311 | 67.68 | 14.83 | 82.51 | 72.37 |
| 2 | 452,945 | 71.19 | 17.07 | 88.26 | 76.45 |
| 3 | 349,830 | 2.15 | 25.24 | 27.39 | 16.71 |
| 4 | 404,474 | 3.86 | 27.71 | 31.57 | 17.17 |
| 5 | 405,721 | 4.36 | 26.34 | 30.70 | 17.08 |

This table presents the number of quote updates, the percent of NBBOs for QQQ that are locked (zero-spread) or crossed (negative spread), and the total percent of NBBOs that have non-positive spreads for the 11 trading days surrounding the listing change: 5 days before, the listing day, and 5 days after. The quotes in this table are computed on a time-weighted basis. The listing day of December 1, 2004 is day 0.

Table 10
Post – pre differences in locked and crossed markets for QQQ and the underlying stocks

| | Pre | Post | Difference (post – pre) | <i>t</i> -statistics |
|-------------------------------|--------|--------|-------------------------|----------------------|
| Panel A: QQQ | | | | |
| Negative spread (%) | 14.84% | 21.22% | 6.40% | 4.69 ^{***} |
| Zero spread (%) | 4.15% | 24.96% | 20.80% | 2.65 ^{**} |
| Total non-positive spread (%) | 18.99% | 46.18% | 27.20% | 3.89 ^{***} |
| Panel B: Underlying stocks | | | | |
| Negative spread (%) | 10.34% | 11.11% | 0.77% | 2.89 ^{**} |
| Zero spread (%) | 5.83% | 6.59% | 0.76% | 1.52 |
| Total non-positive spread (%) | 16.17% | 17.70% | 1.53% | 2.69 ^{**} |

This table presents the results of *t*-tests for the difference (post – pre) percent of NBBOs for QQQ that are locked (zero-spread) or crossed (negative spread) or have a non-positive spread for the 13 trading days before the switch with the 13 trading days after the switch. Panel A provides test results for QQQ. Panel B provides test results for the underlying stocks of QQQ where the reported numbers are a value-weighted average of the stocks of the NASDAQ-100.

^{**} Statistically significant at the 5% level.

^{***} Statistically significant at the 1% level.

7. Conclusion

We examine the change of the listing venue of the QQQ ETF from AMEX to NASDAQ. The QQQ ETF is one of the most heavily traded equity securities in the world. The listing change had a dramatic impact on where QQQ is traded and also on the cost of trading QQQ. Specifically, we find that NASDAQ is able to significantly increase its share of QQQ volume immediately after the change by quoting more aggressively. This aggressive quoting may have been made possible in part due to the rebates that NASDAQ market makers are able to earn from trading QQQ now that it is listed on NASDAQ. Furthermore, NASDAQ market makers are now able to avoid the Intermarket Trading System when trading QQQ. The opposite is true for AMEX; the AMEX quoting behavior became much less aggressive after the switch, thereby coinciding with a drop in its overall market share in QQQ trading volume. The NYSE, Boston, and Philadelphia Stock Exchanges lost their QQQ market share due to restrictions that prevent them from trading NASDAQ-listed stocks.

A substantial proportion of smaller trades shifted from the Archipelago ECN to the Island ECN following the listing change, a somewhat unintuitive result given that one would expect that these two markets are substitutes for one another in terms of execution costs and speed. Furthermore, both ECNs traded QQQ before and after the listing change. A possible explanation for the shift in small trade volume could be that Island has preferencing or purchased order flow agreements with retail brokers for NASDAQ securities, whereas Archipelago does not.

Trading costs declined significantly as a result of the listing change, even as order flow consolidated from eight exchanges to six. Furthermore, trading costs declined as the dominant exchanges (NASDAQ, Island, and Archipelago) increased their combined market shares from 79% of total QQQ volume to over 96% of total volume. This shift in order flow is the equivalent of a 32% increase in the Herfindahl Index, thereby resulting in a less fragmented market for trading in QQQ.

Because our study examines only a single event, it is hard to draw conclusions about the causes of the liquidity changes that we observe in the QQQ ETF. We speculate that avoiding charges such as those imposed by the Intermarket Trading System is one such cause. NASDAQ market

makers use ITS when they trade QQQ on AMEX. The ITS imposes implicit costs on market makers because of its lack of time priority and the presence of time delay, which amounts to the market makers on NASDAQ writing short-term options to AMEX market makers.

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References

- American Stock Exchange News Release (2004, November 9). QQQ to list on NASDAQ. On the Internet at www.amex.com.
- Anderson, A., & Dyl, E. (2005). Market structure and trading volume. *The Journal of Financial Research*, 28, 115–131.
- Atkins, A., & Dyl, E. (1997). Market structure and reported trading volume: NASDAQ versus the NYSE. *The Journal of Financial Research*, 20, 203–291.
- Battalio, R. H. (1997). Third market broker-dealers: Cost competitors or cream skimmers. *Journal of Finance*, 52, 341–352.
- Bennett, P., & Wei, L. (2005). *Market structure, fragmentation and market quality*. Working paper. New York Stock Exchange.
- Blume, M. E., & Goldstein, M. A. (1997). Quotes, order flow and price discovery. *Journal of Finance*, 52, 221–244.
- Boehmer, B., & Boehmer, E. (2003). Trading your neighbor's ETFs: Competition or fragmentation? *Journal of Banking & Finance*, 27, 1667–1703.
- Christie, W., & Huang, R. (1994). Market structures and liquidity: A transaction data study of exchange listings. *Journal of Financial Intermediation*, 3, 300–326.
- Chung, K., Chuwonganant, C., & McCormick, D. (2004). Order preferencing, spreads, and dealer market share on NASDAQ: Evidence before and after decimalization. *Journal of Financial Economics*, 71, 581–612.
- Hendershott, T., & Jones, C. M. (2005). Trade-through prohibitions and market quality. *Journal of Financial Markets*, 8, 1–23.
- Jones, C. M., & Lipson, M. L. (1999). Execution costs and institutional equity orders. *Journal of Financial Intermediation*, 8, 123–140.
- Morgan Stanley Exchange Funds Strategies (2004, October 12). ETFs end of third quarter 2004 review, p. 15.
- NASDAQ (2004). QQQ moves to NASDAQ. www.nasdaqtrader.com/trader/hottopics/qqqfaqs.pdf.
- Shkilko, A., Van Ness, B., & Van Ness, R. (2005). *Locked and crossed markets on NASDAQ and the NYSE*. Working paper. University of Mississippi.
- Stoll, H. R. (1992). Principles of market trading structure. *Journal of Financial Services Research*, 6, 75–107.
- Van Ness, B., Van Ness, R., & Pruitt, S. (1999). An empirical examination of the NASDAQ/CHX dual-trading experiment. *The Financial Review*, 34, 65–78.