Equity Trading and the Allocation of Market Data Revenue*

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Abstract

Revenues generated from the sales of consolidated trade and quote data represent a substantial source of income for U.S. stock exchanges. Prior to 2007, Consolidated Tape Association data revenue was allocated in proportion to the number of reported trades. This allocation rule engendered synergies between exchanges and Electronic Communication Networks, and has encouraged market participants to break up large trades and execute them in multiple pieces, a practice known as "tape shredding." We provide evidence that data revenue allocation has influenced the trading process, by examining trading activity surrounding various events that changed the marginal data revenue per trade. When the Nasdaq 100 Tracking Stock (QQQ) migrated from Network B to Network C on December 1, 2004, this increased the revenue allocated to the securities remaining in Network B, increasing the incentive for tape shredding, and we find a significant decline in average trade size, and a significant increase in the proportion of 100-share trades on these securities. Likewise, we examine changes in trading patterns when 40 Exchange-Traded Funds migrated from Network B to Network A on November 30, 2005. We find a significant increase in average trade size for the ETFs leaving Network B and a significant decrease in trade size for the securities remaining in Network B. However, we find no significant effects in a sample of 150 stocks migrating from AMEX to NYSE between 1993 and 2005. We find significant changes in trading patterns when exchanges implemented new rules prohibiting tape shredding in April and May 2006, and surrounding the implementation of the new allocation formula on April 1, 2007.

In 1975, the United States Congress established a framework for the creation of a "National Market System" in an effort to promote economic efficiency and create an environment where brokers can achieve best execution for their customers. A central component of the National Market System is a technology for collecting, consolidating, and distributing real-time trade reports and market quotes.

Data revenue constitutes an important source of income for securities exchanges. For example, in 2004, sales of consolidated market data generated approximately $400 Million, representing about 10–15% of total revenues reported by the largest exchanges, and more for some of the smaller exchanges.[1] The process of collecting and disseminating market trade and quote data is managed by a set of industry "Plans."[2] These Plans oversee the collection of fees charged for access to the consolidated data networks, and the allocation of the resulting revenue across the exchanges.

The formula used under the CTA plan until April 1, 2007 allocated revenue in proportion to the number of (round-lot) trades reported by each exchange. This created incentives that influenced how and where trades are executed and reported. By linking revenue to trade reports, the allocation rule created an incentive for exchanges to pay for directed order flow, to enter into arrangements with brokers or Electronic Communications Networks (ECNs) to print trades that were executed off-exchange, and eventually to merge with ECNs.

In addition, this allocation formula assigned twice as much revenue for two trades of 100 shares than one of 200 shares. This created a situation where exchanges received more revenue when large orders were broken up and executed in multiple small pieces. Beginning in 1997, some of the exchanges implemented revenue-sharing or rebate programs, that created an incentive for brokers to split their customers' orders, and for proprietary traders to engage

[1] See Securities and Exchange Commission, Regulation NMS Adopting Release, No. 34-51808, June 9, 2005, and the Exchanges' public financial statements.

[2] For securities listed on the New York Stock Exchange (NYSE), The American Stock Exchange (AMEX), or a regional exchange, data distribution is governed by The Consolidated Tape Association Plan (CTA) and the Consolidated Quotation Plan (CQ), which were created in the 1970s. For Nasdaq securities, data distribution is governed by the Nasdaq UTP Plan (UTP), created in 1990.

in algorithmic trading designed solely to capture the rebates.[3]

Market data revenues are collected and allocated separately for stocks with their primary listing on NYSE ("Network A"), Nasdaq (Network C), and AMEX or any other exchange ("Network B"). For many years, revenue per trade has been significantly higher on Network B than on Networks A or C. [4] Consequently, when a security moves from AMEX to Nasdaq or NYSE, the revenue per trade suddenly decreases for that security.

In this paper, we show that the allocation of market data revenue has had a significant impact on the trading process. In particular, we examine a series of natural experiments to demonstrate that average trade size is sensitive to changes in the marginal revenue per trade. We also find indirect evidence that rebate programs are a key institutional mechanism through which the allocation rule influences the trading process.

Our analysis has five prongs. First, On December 1, 2004 the Nasdaq 100 Index Tracking Stock (QQQ) moved its listing from AMEX to Nasdaq. Prior to the move, QQQ accounted for more than 45% of the trades on Network B. When these trades were removed, this increased the revenue per trade for those securities remaining in Network B. This event allows us to examine the effects of a change in incentives without contamination from endogeneity, differences in trade reporting conventions, or other factors associated with a security changing its primary listing venue. We find that when QQQ left, average trade size decreased for those securities remaining in Network B, and the number of 100-share trades as a percentage of all trades increased, particularly on those exchanges that have rebate programs.

Second, we examine trading activity for a sample of 40 Exchange Traded Funds (ETFs) that switched primary listing from AMEX to NYSE on November 30, 2005. The effect of this move was immediate and striking. Comparing the three-month periods before and after the switch, we find that average trade size increased by more than a factor of five. Average trade size increased on all the exchanges but the extreme magnitude of the result was largely

[3]For example, see the case involving MarketXT, Inc. SEC Administrative Proceeding File no. 3–11813.

[4]The total amount of revenue generated by each network is determined by the number of subscribers to that network, not by the number of trades printed in the network. The subscription rates are regulated, and tend to change slowly over time.

driven by changes in trading activity on exchanges with aggressive rebate programs. As for the QQQ migration, we again find evidence that average trade size decreased and the proportion of 100-share trades increased for the stocks remaining in Network B.

Third, we examine a sample of stocks that moved from AMEX to NYSE between 1993 and 2005. In this sample, we test for changes in average trade size in the sample as a whole, and separately for Nasdaq and each regional exchange. For those exchanges that implemented rebate programs, we look separately before and after the initiation of the rebate program. Contrary to our results for the QQQ and the 40 ETFs, we find no statistically significant change in average trade size for any subsample. We conclude that the effects of the allocation rule are not robust across all securities, but the effect is concentrated in certain securities.

Fourth, between August 2005 and May 2006, six exchanges and the National Association of Securities Dealers (NASD) adopted "Tape Shredding" rules prohibiting brokers from breaking up customer orders into smaller pieces for any reason other than best execution. For the exchanges most involved in trading Network B securities, these rule changes went into effect in April and May of 2006. We examine whether these rules had any observable effect on average trade size. When we aggregate across securities, we find a sudden, economically large increase in average size of Network B trades on Nasdaq and NYSE Arca, both of which had rebate programs, but a decrease in average trade size on AMEX, which did not have a rebate program. This result disappears when securities are equally weighted in a paired t-test, confirming that tape shredding activity was concentrated in a relatively small number of securities. For Network A securities, where revenue per trade is lower, we find no significant increases in average trade size when these tape-shredding rules went into effect.

Fifth, the Securities and Exchange Commission (SEC) established a new allocation formula at the same time it adopted Regulation NMS, under which only one fourth of the revenue is allocated in proportion to the number of trades.[5] When the new formula went into effect on April 1, 2007, there was an immediate decrease in the marginal revenue

[5]See SEC Release No. 34-51818, June 9, 2005.

allocated to an exchange as a result of splitting trades. However, there was no immediate change in the terms of the exchanges' rebate programs. Consistent with our earlier results for Network B securities, we find a statistically significant increase in average trade size on NYSE Arca, and a decrease on AMEX. Again, no significant increases in trade size were observed on Network A securities.

It has long been understood by industry participants and regulators that allocation formulas influence how trades are executed and reported. To the best of our knowledge, this paper provides the first comprehensive academic study of this topic. It confirms that the incentives created by allocation formulas are large enough to have a significant impact on average trade size, that revenue-sharing/rebate programs are a key mechanism used by the exchanges to align the incentives of order-flow providers with the exchange, and that distortive impact of the old allocation formula was significantly larger in Network B than in Network A.

Our results should be of interest to exchanges and regulators around the world, as they consider approaches to market data, and broader questions such as the extent to which market data should be considered a public good, whether and to what extent the distribution of market data should be consolidated across exchanges, and how property rights to market data should be assigned. Among the prior authors who have focused on these issues are Mulherin, Netter, and Overdahl (1991), and Boulatov and Dierkir (2007).

Our research also contributes directly or indirectly to several other areas of academic research. For example, we introduce a new dimension to the analysis of competition between exchanges, other aspects of which have been considered by authors such as Arnold, Hersh, Mulherin, and Netter (1998), Santos and Scheinkman (2001), Bessembinder (2003), Foucault and Parlour (2004) and Caglio and Pescatori (2007). Our results have immediate implications for the "Stealth Trading" literature, which implicitly assumes the main motivation to break up larger trades into smaller trades is to camouflage informed trading (see Barclay and Warner (1993), Chakravarty (2001), Choe and Hansch (2006)). Market data rebate programs

have a direct influence on the large investor's tradeoff between block trading and "working" an order, a topic addressed by authors such as Seppi (1990), Cheng and Madhavan (1997), and Back and Baruch (2007).

In addition, we would argue that market data revenue is an impetus contributing to the practices of payment for order flow, internalization, and order preferencing, but has largely been ignored in the literature investigating those practices. Among the many authors who have studied these topics are Chordia and Subrahmanyam (1995), Battalio, Green, and Jennings (1998), Bloomfield and O'Hara (1998), Battalio and Holden (2001), Parlour and Rajan (2003), Peterson and Sirri (2003), Chung, Chuwonganant, and McCormick (2004).

This paper is organized as follows. In section I we provide an overview of the regulatory history of the Plans that administer the dissemination of consolidated market data. We discuss the formulas used to allocate revenues, describe the revenue-sharing or rebate plans used by the exchanges to compete for trade prints, and give several examples of how revenue allocation has been influenced by trade reporting arrangements or mergers between ECNs and Exchanges. Section II investigates how the migration of the Nasdaq 100 tracking stock from Network B to Network C affected the trading patterns for those stocks remaining in Network B. Section III contains our analysis of 40 ETFs that switched from AMEX to NYSE on November 30, 2005, and of 163 stocks that switched from AMEX to NYSE between 1993 and 2005. Section IV reports our analysis of the tape shredding rules implemented by the exchanges in 2005 and 2006. In section V we report our results on the impact of the new Revenue Allocation rule that went into effect on April 1, 2007. Section VI provides additional commentary and concludes the paper.

I Institutional Background

A Consolidated Data Plans and Revenue Allocation

The regulatory framework for the dissemination of real-time consolidated last sale and quote data from U.S. Equity markets is set forth in three plans, the CTA Plan, the CQ Plan, and the UTP Plan.[6] These Plans are administered by their participants, who are registered National Securities Exchanges or National Securities Associations, and overseen by the SEC. As of September 2007, the parties to the CTA, CQ, and UTP Plans included eleven participants.[7]

Under these Plans, eligible securities are assigned to one of three Networks based on where the security is listed. Securities listed on NYSE are assigned to Network A, those listed on another National Securities Exchange but not NYSE or Nasdaq are assigned to Network B. Networks A and B are administered by the CTA Plan and CQ Plan. The UTP Plan administers the dissemination of market data for Nasdaq Global Market and Nasdaq Capital Market securities that are not part of Networks A and B. We will refer to this distribution channel as "Network C."

Market data revenues amount to hundreds of millions of dollars annually, and represent a nontrivial portion of the exchanges' total revenues. For example, in 2004, Networks A, B, and C generated net income of approximately $155 Million, $100 Million, and $138 Million, respectively, for a total of approximately $394 Million.[8] For most of the exchanges, market data revenues constitute somewhere between 10% and 20% of total revenues.

Tape Revenue is allocated across market centers according to formulas established under the regulatory jurisdiction of the SEC. Prior to April 1, 2007, revenue on Networks A and B was allocated in proportion to the number of round-lot transactions reported by the

[6] A separate plan governs dissemination of options data, under the Options Price Reporting Authority.

[7] American Stock Exchange, Boston Stock Exchange, Chicago Board Options Exchange, Chicago Stock Exchange, International Securities Exchange, Nasdaq Stock Market, National Association of Securities Dealers (NASD), National Stock Exchange (formerly Cincinnati Stock Exchange), New York Stock Exchange, NYSE Arca (formerly Pacific Exchange), and Philadelphia Stock Exchange.

[8] Regulation NMS Adopting Release, Securities and Exchange Commission Release No. 34-51808, June 9, 2005.

Participant. Revenue on Network C was allocated half in proportion to the number of transactions and half in proportion to share volume.

In conjunction with the adoption of Regulation NMS, the SEC in June 2005 adopted a new allocation formula for the various plans. The new formula was originally scheduled to go into effect on September 1, 2006, but was delayed to April 1, 2007. The new algorithm (1) associates revenues with individual securities in proportion to the square root of dollar trading volume, and (2) allocates revenues across exchanges one fourth in proportion to the number of trades, one fourth in proportion to dollar volume, and one half in proportion to the degree to which the exchange's quotes contribute to the National Best Bid and Offer (NBBO). The main effect of the square root transformation is to spread the revenue more evenly across securities. The effect of the weighted allocation function is to reduce the incentive for tape shredding and to create an additional incentive for exchanges to provide liquidity at the NBBO.

B Revenue Sharing/Rebate Programs

In the late 1990s, exchanges began to introduce programs to share data revenue with the specialists or member firms that generated the order flow. When an exchange shares data revenue with member firms in proportion to how much revenue they generate, this creates an incentive to execute large orders in smaller pieces.

Between 1997 and 1999, revenue sharing or rebate programs were initiated by three regional exchanges and Nasdaq. Specifically, programs were introduced by the Chicago Stock Exchange (CHX), effective January 17, 1997[9], Cincinnati Stock Exchange (CSE), effective November 13, 1997[10], Boston Stock Exchange (BSE), effective October 1, 1998,[11] and Nasdaq, effective March 4, 1999.[12]

The specifics of these programs differed across exchanges. For example, on CHX, rebates

[9]Securities Exchange Act Release No. 38237 (February 4, 1997), 62 FR 6592.
[10]Securities Exchange Act Release No. 39395 (December 3, 1997), 62 FR 65113.
[11]Securities Exchange Act Release No. 40591 (October 22, 1998), 63 FR 58078.
[12]Securities Exchange Act Release No. 41174 (March 16, 1999), 64 FR 14034.

were computed on a stock-by-stock basis, according to the specialist's monthly market share in that particular stock. Specialists received a rebate of 18% for all trades up to a market share of 7%, 36% for trades in excess of 7% and up to 12% market share, and 54% for trades above 12% of market share. Under the CSE program, Members were credited on a pro rata basis, based upon the percentage of Network B transaction market share captured by the Exchange in a given quarter, rebating 10% of revenues for stocks in which the CSE market share was below 3%, 25% when the market share was between 3% and 5%, 30% when the market share was between 5% and 7%, and 40% when the market share was at least 7%. The BSE revenue sharing program rebated 50% of consolidated Tape A and Tape B market data revenue, and the Nasdaq program offered rebates from pools made of 40% of Tape A and B revenues. These descriptions apply to the revenue-sharing programs as initially designed, but the programs have been modified numerous times over the years.

On May 28, 2002, the Pacific Exchange (PCX), after its equity trading business had been taken over by Archipelago, implemented a revenue-sharing program targeted to trades executed on the Archipelago Exchange. In June, 2002, PCX, Nasdaq and CSE expanded their revenue sharing programs, but the Securities and Exchange Commission abrogated these fee changes on July 2, 2002. The PCX reinstated its revenue-sharing programs through rule filings on July 9, 2002 for Network B securities, and on August 6, 2002 for Network A securities.[13] This program has evolved over the years, as PCX completed its merger with Archipelago, and then was taken over by the NYSE. Today, NYSE Arca continues to have a rebate program. While this program has some limitations on who is eligible to receive rebates, the amount of the pool for calculation purposes is based on 50% of the gross revenues derived from market data fees. The rebate program establishes a 50% transaction credit on revenues generated by Network A non-ETF securities and Network B securities, while the Network C program is based on a pro rata contribution of the operating revenues generated by each participant.

[13]Securities Exchange Act Release No. 46293.

C Reporting Arrangements and Platform Mergers

Trading platforms that are not National Securities Exchanges are not eligible to participate directly in the consolidated revenue plans. However, trades executed on these platforms are reported through a participant exchange, or a trade-reporting facility connected to a participant. For example, trades executed on Electronic Communications Networks (ECNs) generates market data revenue for the exchange on which the ECN chooses to report. In cases where an ECN is able to attract a significant market share, the data revenue attached to those trades make the ECN particularly attractive to the exchanges, and vice versa. This synergy created an impetus for revenue sharing arrangements between exchanges and ECNs, and increased the attractiveness of mergers between exchanges and ECNs.

For example, arrangements between Island (later iNet) and the Cincinnati Stock Exchange in 2002 generated substantial Network B and Network C revenues for that exchange, until iNet was acquired by Nasdaq in December 2005. Archipelago ECN was able to access data revenue by aligning with the Pacific Exchange. Archipelago aligned with the Pacific Exchange in 2000, registered as a stock exchange and became Arca Ex in 2001, migrated all PCX equity trading to Arca Ex in 2002, and began to report trades via the Pacific Exchange in stages between 2002 and 2003. Arca Ex took over the Pacific Exchange completely in 2005, only to be acquired by NYSE in March 2006.

Figures 1 and 2 illustrate the extent to which these reporting arrangements and acquisitions influenced the distribution of trade prints across exchanges. Figure 1 graphs the market share of Network B trades (computed from TAQ data) for AMEX, Cincinnati/National Stock Exchange, PCX/Arca, and Nasdaq, from 2001 to 2006. For clarity, daily fluctuations are smoothed using a 5-day moving average. The impact of the trade-reporting arrangement between the Cincinnati Stock Exchange and Island ECN may be easily observed in July 2002. Likewise, market share immediately transferred from Cincinnati (National) to Nasdaq in January 2006 following Nasdaq's acquisition of iNet. Particularly striking in this figure is the experience of Arca Ex and the Pacific Exchange, which went

from almost zero to in excess of 50% market share of Network B in two years.

Figure 2 shows a similar graph for Network C. This figure graphs the market share of Network C trades, computed from TAQ), for Nasdaq, Cincinnati/National, PCX/Arca, and The Boston Stock Exchange, from 2001 to 2006. Cincinnati's Network C market share went from zero to nearly 20% overnight on March 18, 2002 when Island began reporting trades there, and jumped up again in February 2004 when Instinet moved its trade reporting from NASD's Alternative Display Facility to Cincinnati. Likewise, the market share of trades reported by the Pacific Exchange increased from essentially zero to nearly 20% when Arca Ex began reporting its Network C trades there in April 2003. The graphs also shows the impact of an arrangement between the BRUT ECN and the Boston Stock Exchange in December 2003, and the acquisition of the BRUT ECN by Nasdaq in September 2004.

II Migration of the Nasdaq-100 Tracking Stock

On December 1, 2004 primary listing of the Nasdaq 100 Index Tracking Stock (QQQ) moved from AMEX to Nasdaq. Before this change, QQQ accounted for a substantial proportion of the trades on Network B. For example, based on the TAQ data, we estimate that in the three months from September through November, 2004, QQQ accounted for approximately 45.7% of trades reported on Network B.

Evidence that tape shredding was occurring on the QQQ prior to its departure from AMEX has been provided by Kugele and Wood (2006). Analysis of this event is somewhat complicated by differences in market microstructure between AMEX and Nasdaq, and by the fact that the CTA allocation formula was different from the UTP formula. For these reasons, we do not conduct of formal analysis of changes in the QQQ itself. We merely note that average trade size in the QQQ more than doubled when it migrated to Nasdaq, as illustrated by Figure 3. Casual examination of trading patterns on the individual exchanges surrounding December 1, 2004 indicates a particularly dramatic increase in the average trade

size on Arca Ex and on the Chicago Stock Exchange.

Tests involving direct examination of securities that switch exchanges may be influenced by other confounding effects. For example, there may be differences between the two exchanges that affect trading patterns, or the choice of the issuer to move its listing may have been influenced by endogenous factors that are also related to trading activity. Such concerns should not arise when we examine those securities that do not migrate.

Our analysis focuses on how the departure of the QQQ affected trading in those stocks remaining in Network B. After the migration, QQQ trades no longer claimed Network B revenue, and this increased the revenue allocated to trades on the remaining securities. In the absence of any equilibrating response by market participants, this would have raised the marginal revenue per trade on the remaining Network B securities by more than 80%. If the market responded to this change in incentives, we would expect to see more tape shredding in other Network B securities after the departure of the QQQ.

In order to explore this hypothesis, we extract trade data for all AMEX listed stocks from the NYSE Trades and Quotes (TAQ) database from September 2004 to February 2005. We eliminated from consideration the QQQ and three stocks that moved from AMEX to NYSE during this period. We merged TAQ data with CRSP and use "exchcd" code to identify the primary exchange on which each security is listed. We examine trading activity of Network B stocks on each exchange, only considering those stocks that continue to trade on the same exchange before and after the QQQ migration. Table 1 reports the number of trades, total volume, and average trade size for Network B stocks before and after December 1, 2004.

As indicated in the table, average trade size declined by more than 20% on Nasdaq, Arca Ex, Chicago, and National, statistically significant at the 1% level. Amex and Boston, which did not have rebate programs, experienced much smaller declines in trade size or no significant change.

Table 2 shows the distribution of trade sizes on Network B stocks on each exchange before and after the migration. We find an economically important increase in the proportion of

100-shares trades on ARCA and the regional exchanges. For example, the proportion of 100-share trades on the remaining Network B stocks increased from approximately 24% to 35% on Nasdaq, 74% to 84% on Arca, 23% to 39% on Chicago, and 25% to 58% on National. This confirms that the changes in mean are largely driven by the changes in the number of small trades, not by changes in the number of block trades.

The results in Tables 1 and 2 provide evidence of tape shredding in Network B securities, and in particular that the amount of tape shredding is sensitive to the marginal revenue to per trade. To further explore whether tape shredding is confined to a certain type of securities, we partitioned our sample in various ways and repeated our analysis. In the interest of space, we do not include numeric results here, but we find that among the securities remaining on Network B, the significant changes in average trade size are observed for both ETFs and non-ETFs.[14] The evidence of tape shredding appears to be stronger for higher-volume securities, but is not confined to only the top decile or even the top half of securities. There appears to be no obvious relation between tape shredding and price level.

Inasmuch as a relatively small number of very large block trades can have a big impact on average trade size, as a robustness check we repeated our analysis throwing out all block trades of over 10,000 shares. We found that our results were qualitatively unchanged (results not reported).

III Securities Switching from AMEX to NYSE

In the previous section, we examined changes in trading patterns surrounding the migration of the QQQ from AMEX to Nasdaq. However, we did not formally examine changes in trading patterns on the QQQ itself, in part because we believed it would be hard to disentangle the effects of tape shredding from the effects of changing the primary listing from a specialist structure to a dealership structure. It is well-known that trades are reported differently on the Specialist exchanges and Nasdaq, making direct comparisons difficult.

[14] We obtain the list of ETFs from the archived issues of ETFR on www.indexuniverse.com.

Furthermore, the analysis of the change in marginal incentive to split large trades into small trades is complicated by the fact that CTA and UTP plans used different allocation formulas.

However, securities migrating from AMEX to NYSE remained within CTA, within a specialist market structure, and the primary listing remained with an exchange that did not have a rebate program. Although there are some differences between NYSE and AMEX, we believe for the purposes of isolating the effects of a change in marginal revenue per trade, a move from AMEX to NYSE is a cleaner natural experiment than is a move from AMEX to Nasdaq.

As mentioned above, market data revenues are collected and allocated separately for NYSE-listed ("Network A") and AMEX-listed ("Network B") securities. Based on numbers for calendar year 2004, the aggregate data revenue was almost 50% higher for Network A than for Network B. But because the number of trades for Network A was more than ten times higher than for Network B, revenue per trade was substantially higher for stocks with their primary listing on AMEX than those with their primary listing on NYSE. For 2004, we estimate that market data revenue amounted to approximately $0.15 per trade on Network A and $1.03 per trade on Network B. Thus, when a security moves its primary listing from AMEX to NYSE, the marginal benefit of splitting a large trade into multiple small trades declines significantly. If market participants respond to these incentives, we would expect the average trade size to increase when the stock migrates.

We test this hypothesis using two samples. First, we examine a sample of 40 Exchange Traded Funds (ETFs) that switched from AMEX to NYSE on November 30, 2005. Second, we examine a sample of 164 stocks that switch from the American Stock Exchange (AMEX) to the New York Stock Exchange (NYSE) between 1993 and 2005. This sample spans a period of time before and after the introduction of rebate programs, allowing us to test whether rebate programs facilitate tape shredding.

A Exchange-Traded Funds

In 2005, Barclays Global Investors (BGI) announced that the primary listing for 81 iShares ETFs would move off of the American Stock Exchange, some to NYSE and some to ARCA. As a result of this move, those ETFs moving to the NYSE would change from trading in Network B to Network A, while those moving to ARCA would remain in Network B. As the first phase of this migration, BGI moved 40 iShares ETFs from AMEX to NYSE on November 30, 2005. These included ETFs tracking large-cap, mid-cap, and small-cap indexes, value and growth component indexes, sector indexes, and international equity indexes.

Analysis of this event is somewhat contaminated by a confounding event. Having been purchased by Nasdaq, iNet ECN stopped reporting its trades on NSX and began reporting them on Nasdaq during the first week of January 2006. This caused a sudden change in the composition of trades reported on those two exchanges. Accordingly, we exclude these two exchanges from our examination of three-month event windows before and after the migration. To compensate, we perform additional analysis based on one-month event windows, which are short enough to exclude the confounding event in January.

Our results are reported in Table 3, with Panel A reporting events based on three-month windows and Panel B reporting results based on one-month windows. Not surprisingly, NYSE gained and AMEX lost market share when the primary listing switched. Consistent with the sudden decrease in the benefit of tape shredding, we find a large increase in average trade size on all of the exchanges not directly involved with the listing change. Based on three-month windows, we observe significant increases in average trade size on the Chicago and Boston exchanges, and a huge increase in trade size on Arca. As indicated in Panel B, the results based on one-month windows are essentially the same for these exchanges, but also reveal a huge increase in average trade size on the National Exchange, and a very large increase on Nasdaq. Across all exchanges, average trade size increased by more than 500%. As shown in Figure 4, this change did not occur gradually over the six-month period surrounding the switch, but quite suddenly, and exactly at the time of the listing switch.

We recognize that average trade size on particular exchanges may change for reasons other than a change in the amount of tape shredding. In particular, changes in average trade size on NYSE and AMEX are likely to be affected if the mix of large and small traders responds to the change of primary listing. Also, the other exchanges experienced changes in market share of trading volume, that may be associated with a change in the mix of traders transacting on those exchanges. We interpret our results as consistent with the hypothesis that market data revenue affects average trade size, and we find the economic magnitude of the results to be compelling.

Table 4 provides additional information on how the distribution of reported trade sizes changed on each exchange when the ETFs migrated. As before, Panel A reports results for all exchanges other than Nasdaq and National based on three-month windows, and Panel B reports results for all exchanges based on one-month windows. Each panel shows the percentage of reported trades in each of six size buckets, including trades of 100 shares, trades between 101 and 499 shares, trades between 500 and 999 shares, trades between 1000 and 2499 shares, 2500-4900 shares, and trades above 5000 shares. This table confirms that the change in the average trade size is largely due to changes in the number of 100-share trades relative the number of larger trades. Based on one-month windows, when the ETFs were trading in Network B, we find that trades of 100 shares account for approximately 94% on Arca, and 95% on the National Exchange, and 80% on Nasdaq. After they migrated to Network A, these numbers drop to approximately 43%, 35%, and 32%. On these three exchanges, the huge decrease in the proportion of 100 share trades is offset by increases in the each of the other five trade-size buckets.

In the three months prior to November 30, 2005, we estimate that these 40 ETFs accounted for approximately 21% of all trades printed on Network B. While this was not quite as large an event as the departure of the QQQs, it was large enough that it had an economically significant effect on the marginal revenue per trade for the the securities remaining in Network B.

Table 5 reports what happened to the number of trades, trading volume, and average trade size for these securities, and table 6 reports what happened to the distribution of trade sizes. As before, panel A of each table shows results based on three-month windows for all exchanges except Nasdaq and NSX and panel B shows results based on one-month windows surrounding the event.

We find that when the 40 ETFs left Network B, average trade size declined significantly on ARCA, Nasdaq, and NSX. No significant change is observed on Chicago, and the results for Boston are inconsistent across the two window sizes. We also find a statistically significant increase in average trade size on AMEX. This confirms our prior results that AMEX, which did not have a rebate program, does not show evidence of tape shredding. Interestingly, we also find that the average trade size for Network B securities on NYSE declines significantly on the NYSE in the three-month samples. In the one-month samples, the change on NYSE is negative but not statistically significant. It should be noted that the NYSE trades only a small number of Network B securities.

The results in table 6 indicate a modest increase in the percentage of 100-share trades on Nasdaq from 54.77% to to 57.27%, on ARCA from 73.84% to 78.36%, and on National from 69.64% to 72.2%, for the one-month window.

In results not shown, we found that the decrease in average trade size of non-migrating Network B securities on ARCAholds for ETFs and non-ETFs, holds across all deciles of trading volume, and does not appear to be confined to high-priced or low-priced stocks.

B Stocks Migrating from AMEX to NYSE (1993-2005)

Given the large, immediate response we observed in connection with the Exchange-Traded Funds, we now wish to test whether a similar effect is observed when individual stocks switch from Amex to NYSE. Using the annual NYSE Fact Books and press releases issued by the NYSE, we identified 164 stocks that switched from AMEX to NYSE between 1993 and 2005.

Conceptually, our approach is similar to the approach we used in the previous section,

but we cannot examine changes in trading activity within NYSE or AMEX, because the two exchanges historically have not traded each other's primary individual stock listings. Our focus is on aggregate trading activity, and also on trading activity on Nasdaq and the other exchanges that trade the stock.

Table 7 reports aggregate results across all stocks and exchanges. As indicated in the table, we find a statistically significant increase in the number of trades, but no statistical evidence that moving from AMEX to NYSE is associated with a change in trade size.

Table 8 reports the results of the same tests applied separately to trading activity reported on Nasdaq, the Pacific Exchange/ARCA, Chicago, Cincinnati/National, Boston, and the Philadelphia Stock Exchange. Contrary to the results on ETFs reported in the previous section, we find that only one exchange (Cincinnati/National) experienced a significant increase in average trade size when the stock migrated from AMEX to NYSE, and three other exchanges experienced significant declines.

We also explored the possibility that the results in table 8 are not significant because many of the events occurred before the exchanges implemented rebate programs. For those exchanges that initiated rebate programs, we identified the group of stocks that move from AMEX to NYSE before and after the introduction of the rebate program. The event date and the composition of the two groups change for each exchange, given that they established rebate program at different points in time. For each exchange, we only consider the stocks that continue to trade on that exchange before and after the primary listing moves from AMEX to NYSE.

Table 9 reports our results. We observe no statistically significant change in average trade size on any exchange, either before or after the initiation of rebate programs. After exchanges began rebating market data revenue, we register a small statistically significant decrease in the number of trades on some exchanges.

In summary, the experience of the 164 individual stocks switching from AMEX to NYSE between 1993 and 2005 is markedly different from that of 40 ETFs that made the same

switch on November 30, 2005.

IV Tape Shredding Rules

In 2005 and 2006, the exchanges and NASD proposed (and the SEC approved) rules designed to reduce tape shredding. Specifically, these rules prohibit the unbundling of customer orders for reasons other than best execution.

In this section, we investigate whether the implementation of these rules had an appreciable effect on trading. Because these rules apply specifically to brokers who are handling customer orders on an agency basis, they would not affect order splitting by proprietary trading operations. Thus, looking at how trading activity changed when these rules became effective helps shed light on the extent to which our other results are driven by the behavior of brokers, as opposed to the activities of proprietary trading desks.

If the practice of order splitting by brokers was prevalent prior to these rules, and if these rules were effective at reducing the practice, we would expect to see an increase in average trade size surrounding the implementation of these rules. If the response of the market to revenue allocation incentives is confined exclusively to proprietary trading operations, we would expect these tape shredding rules to have little or no effect.

In the appendix, we provide a table summarizing the date of the original proposal, the approval date and effective date for the tape shredding rules implemented by each of the Self-Regulatory Organizations. In some cases, the adopted rules reflect amendments filed after the original proposal date. In addition, we attempted to identify the date that these rules became effective, or the date that exchange members were informed of the rule. In the absence of any documentation of the effective date, we assume the effective date is the approval date.

To analyze the impact of these rules, we conduct two tests. First, we aggregate across all securities and examine whether total volume, number of trades, and average trade size were

affected. Second, we perform a paired t-test, which examines stock-by-stock whether trading was affected, and then aggregates these individual comparisons into a single aggregate test statistic. If the tape shredding rules had an equal impact across all stocks, we would expect to see thus reflected in both tests. On the other hand, if the impact on the highest-volume stocks is disproportionately large, we would expect to see a more significant effect in the first test. Essentially, the first test is a value-weighted test, while the second places equal weights on all stocks.

In table 10, we report our results for trading activity on Network B securities. Panel A reports the results from the test based on aggregate trading activity. We find that when the tape shredding rule went into effect on NYSE/Arca, average trade size for Network B securities on that exchange increased by 87.4%. Likewise, trade size increased on Nasdaq by 35.7% when NASD's rule became effective. These results suggest that tape shredding by brokers was most prevalent on those exchanges prior to the rule.

In contrast, we find a significant decline in average trade size of Network B securities traded on AMEX and the National Stock Exchange. It is not obvious why the implementation of a tape shredding rule should decrease average trade size. But since all of these exchanges implemented their rules at roughly the same time, it is possible that these rule changes induced a change in the equilibrium mix of large and small traders across exchanges.

Figure 5 shows a graph of average trade size on Network B securities on AMEX, Nasdaq, and NYSE/Arca surrounding the introduction of these tape shredding rules. The graph confirms that the increase in trade size on NYSE/Arca occurred rather suddenly on May 2, 2006, the second trading day after the rule adoption notice was circulated to members. The graph also indicates a sudden increase in average trade size on Nasdaq on May 25, 2006, the effective date of the rule. The decrease of average trade size on AMEX also occurred at this time.

Panel B of Table 10 reports the results of our paired t-test. These results give quite a

different picture. Based on this test, we observe no significant increases in average trade size, and even find a significant decrease on NYSE/ARCA. This suggests that the impact of the tape shredding rule was not uniform across all securities, but that the results of Panel A are driven by a relatively small number of securities. This is consistent with our earlier findings that switching from AMEX to NYSE had a significant impact on average trade size for ETFs but not for individual securities.

When we repeated both tests on Network A (NYSE-listed) securities (results not reported), we found no statistically significant increases in average trade size on any exchange. Indeed, these tests indicated a statistically significant decrease in average trade size on both NYSE/Arca and Nasdaq. That we find a different reaction in Network A and Network B reinforces our prior findings that tape shredding is more prevalent in Network B, where the revenue per trade is greater. We have no explanation for why trade size decreased on Network A.

V New Allocation Rule

In this section, we examine changes in trading activity surrounding April 1, 2007, when the new allocation formula went into effect. One of the aims of the formula change was to reduce the incentive for tape shredding. As mentioned above, the new formula allocates only 25% of the data revenue in proportion to the number of trades, with another 25% allocated in proportion to share volume and 50% in proportion to a measure of the aggressiveness with which the exchange quotes at the inside of the market. Thus, the immediate effect of the new formula was to reduce by about 75% the additional revenue allocated to the exchange when a large trade is split into multiple smaller trades.

Table 11 reports statistics summarizing the changes in trading activity surrounding the implementation of the new allocation formula. Based on a comparison of three months before and three months after April 1, 2007, we observe no increases in average trade size on any

exchange, consistent with our prior results that trade splitting is not rampant on Network A. No changes are observed on NYSE, NYSE Arca or Nasdaq surrounding the implementation of the new formula, while there appears to have been a small but statistically significant decline in average trade size reported on National. We also observe significant decreases in the average size of Network A trades on some of the smaller exchanges. Given that these exchanges also experienced significant changes in total volume, it is somewhat difficult to know to extent to which these changes in average change size may be influenced by other changes in the market.

The second panel of 11 reports the same statistics for Network B. We find that average trade size on Network B stocks increased by about 5% on NYSE/Arca, and decreased by 13% on AMEX. Both of these changes are statistically significant at the 1% confidence level. Again, the allocation formula appears to be associated with trade splitting on NYSE/Arca, but not on AMEX. In Table 11, we find no significant change in the average size of Network B trades reported on Nasdaq or the National Stock Exchange. Interestingly, we do find an statistically significant increase in average trade size for Network B securities trading on NYSE.

We note that formula change on April 1 did not only decrease the incentive for tape shredding, it also increased the incentive for exchanges to quote aggressively. If some exchanges responded more than others to this incentive, those that are quoting most aggressively may have attracted more order flow, or a different kind of order flow as a result. Thus, the change in the allocation formula may have caused a change in average trade size for reasons other than changes in tape shredding.

Finally, we should note that although the changes in Network B activity reported for NYSE Arca and AMEX are statistically significant, the economic magnitude of these changes is smaller than for some of the other tests considered in this paper. Unlike some of the other events studied in this paper, where a simple visual examination of a graph reveals a sudden regime change on the event date, the effects documented in Table 11 for Network B stocks

appear to have occurred gradually over time.

In this respect, our evidence in this section is somewhat weaker than in other sections. One possible reason for this is that when the new formula went into effect, the exchanges did not immediately alter their rebate programs, but continued to share revenue in proportion to the number of trades. To the extent that rebate programs are the key mechanism through which the allocation formula affects markets, we might expect the main impact of the new formula to occur only after the terms of these programs are modified to align the incentives of order flow providers with those of the exchange.

VI Conclusion

In this paper, we have explored several facets of how the trading process is affected by the formulas used for allocating data revenue in proportion to the number of trades. Our results indicate that the old, proportional allocation rule had a strong influence under certain circumstances, but in other cases appears to have a minimal impact. The effect has been most severe where the revenue per trade is greatest (Network B), and on those exchanges that have developed mechanisms to exploit the formula.

Our analysis of securities that remained in Network B when the QQQs migrated in December 2004 and when 40 other ETFs in migrated in November 2005 indicate that the distortive effect of the allocation rule is not confined only to ETFs, nor is it confined only to low- or high-volume stocks or low- or high-priced stocks. On the other hand, our analysis of 164 stocks that migrated from AMEX to NYSE between 1993 and 2005 shows no evidence of tape shredding, even after rebate programs were implemented in 1997.

We hope that by demonstrating that data revenue allocation has had an important influence on the trading process, this paper will stimulate further research on the nature of competition between exchanges. Three significant sources of revenues for the exchanges are listing fees, transaction fees, and data revenues. We would suggest that in the distant

past, it was largely the case that these three revenue sources were closely tied to listing. That is, whichever exchange obtained the primary listing would also attract the dominant market share of transaction volume, and trades were reported where they were executed, so transaction fees and market data revenue were determined mostly by listing. But this has changed significantly since the mid 1990s, partially as a result of the economic forces and institutional developments explored in this paper. Today, there is vigorous competition for transaction volume, to the point that it is becoming less and less relevant where the stock is listed. This has especially been true of AMEX-listed securities, where the primary listing exchange is no longer one of the two largest trading venues. For Network A securities, the New York Stock Exchange has also faced intense competition in the past few years. Apparently, primary listing no longer gives the listing exchange a significant advantage in the competition for order flow.

Similarly, we should note that a significant portion of all trading volume is either executed on ECNs or internalized, but this trading activity can only generate data revenue through a reporting channel. The research community must appreciate that there is an important distinction between competition among trading venues to execute trades and competition among plan participants to report trades that are executed off of the exchanges. The examples depicted in figures 1 and 2 illustrate that this becomes particularly important when an ECN that is unaffiliated with an exchange gains significant market share.

Along these lines, a notable development was the creation of trade reporting facilities. In the aftermath of the separation of Nasdaq and NASD in 2002, NASD created the Alternative Display Facility (ADF), giving Nasdaq's competitors a place to display quotes and report trades. ADF is a trade reporting facility–a channel for reporting trades executed on other venues–and is not associated with a platform for executing trades. More recently, four exchanges developed trade reporting facilities in 2007: NYSE, Nasdaq, Boston and National. Prior to 2007, trades were reported to the tape using a single letter to designate the reporting channel. An observer could not distinguish by looking at the one-letter designation whether

the trade was executed on the exchange or only reported there. Now, there is a two-letter designation that enables observers to make this distinction.[15] This new information might create new opportunities for researchers to study off-exchange trading activity.

Another interesting topic that we do not address here is the extent to which the new allocation formula has led to greater depth at the NBBO. By assigning 50% of the revenue on the basis of quoting activity, the new formula should encourage more aggressive quoting. Further research in this area could shed light on whether the new formula succeeded in this regard, and perhaps reveal other ways that the exchanges have responded in the face of this new incentive.

This paper has argued that market data revenue was an important part of the dynamics surrounding the emergence of Island and Archipelago a few years ago. These economic forces are still in place today, and are likely to shape the structure of markets going forward. For example, the BATS ECN was founded in June 2005 and by 2007 it had achieved a significant market share, larger than all exchanges except for NYSE, Nasdaq, and NYSE Arca.

Other interesting research questions relating to equity markets are likely to emerge in the coming months and years. The equity trading industry is currently going through a period of rapid structural change, as a result of a confluence of many inter-related forces and trends. Among these are the demutualization of exchanges, the separation of the regulatory function from the exchanges, national and international consolidation, a blurring of the boundary between the securities industry and the commodities and futures industry, the movement by large brokerage firms to acquire ownership stakes in ECNs and Exchanges, the Reg NMS order protection rule, new trading technologies that have significantly decreased the role of a physical trading floor, the entry of two large option exchanges (ISE and CBOE) into the equity trading business, the increasing prevalence of algorithmic trading, and the emergence of new "dark" trading platforms for institutional trading. As the industry moves towards

[15]For example, Nasdaq trades executed on Nasdaq are designated Q and trades reported on Nasdaq's trade reporting facility are designated DQ. Users of transaction-level databases such as NYSE's TAQ should note this change in February 2007.

a new equilibrium, new issues will arise and undoubtedly, a new generation of research will emerge. To the extent that market data revenue continues to be a major revenue source for exchanges, it is likely that data revenue will continue to play a significant role in shaping the industry.

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Appendix

Implementation Dates of Tape Shredding Rules

Exchange	Proposed	Approved	Effective
Boston Stock Exchange	June 23, 2005	August 26, 2005	August 26, 2005
New York Stock Exchange	September 9, 2005	October 26, 2005	November 10, 2005
American Stock Exchange	November 1, 2005	May 12, 2006	May 12, 2006
NASD	December 8, 2005	February 24, 2006	May 25, 2006
Chicago Stock Exchange	January 24, 2006	April 17, 2006	April 17, 2006
NYSE Arca	February 3, 2006	April 24, 2006	April 28, 2006
National Stock Exchange	April 4, 2006	May 24, 2006	May 24, 2006

Table 1: **Impact of the QQQ Migration on Other Network B Stocks**

This table reports changes in trading volume, number of trades and average trade size for other Network B stocks surrounding the departure of the QQQ on December 1st 2004. Averages are computed for three-month windows before and after the switching date, based on data reported in TAQ. A test is performed to verify the significance of difference between the two periods. * denotes significance at the 5% level, ** denotes significance at the 1% level.

		Mean Before	Mean After	Diff	% Change
AMEX	*Trades*	38,869	46,387	7,518**	19.34%
	Volume	50,688,409	58,273,926	7,585,517**	14.96%
	Trade Size	1,300.89	1,254.78	-46.11*	-3.54%
Nasdaq	*Trades*	25,080	40,333	15,253**	60.82%
	Volume	68,093,685	76,412,513	8,318,829**	12.22%
	Trade Size	2,759.87	1,945.09	-814.78**	-29.52%
PCX/Arca	*Trades*	122,418	214,989	92,571**	75.62%
	Volume	38,628,046	49,208,490	10,580,444**	27.39%
	Trade Size	316.74	229.84	-86.90**	-27.44%
Chicago	*Trades*	7,059	10,560	3,502**	49.61%
	Volume	7,417,266	8,077,599	660,333 *	8.90%
	Trade Size	1,056.31	811.81	-244.50**	-23.15%
Cincinnati/	*Trades*	33,078	65,157	32,079**	96.98%
National	*Volume*	27,531,074	33,283,341	5,752,267**	20.89%
	Trade Size	837.16	593.24	-243.92**	-29.14%
Boston	*Trades*	1,994	2,109	115	5.77%
	Volume	1,865,148	1,965,893	100,746	5.40%
	Trade Size	942.35	938.45	-3.90	-0.41%

Table 2: **Trade Distribution across Sizes Categories for Other Network B Stocks after the QQQ Migration**

This table reports the distribution of trades across different size categories for other Network B stocks surrounding the departure of the QQQ on December 1st 2004. Frequencies are computed for three-month windows before and after the switching date, based on data reported in TAQ. A test was performed to verify the significance of difference between the distributions for the two periods (numbers are not reported).

Share size		100	101-499	500-999	1000-2499	2500-4900	¿5000
AMEX	*before*	27.41%	28.53%	17.01%	16.46%	5.29%	5.3%
	after	28.24%	28.49%	16.79%	16.28%	5.16%	5.05%
NASDAQ	*before*	24.18%	25.49%	17.25%	21%	4.87%	7.21%
	after	34.95%	23.28%	15.83%	16.69%	4.05%	5.19%
Arca-EX	*before*	73.75%	13.96%	6.55%	4%	1%	0.74%
	after	84.37%	8.53%	3.44%	2.58%	0.65%	0.42%
Chicago	*before*	22.79%	31.38%	18.34%	18.67%	5.17%	3.66%
	after	38.9%	29.16%	13.01%	12.66%	3.69%	4.73%
National	*before*	25.04%	27.36%	26.31%	16.28%	3.07%	1.94%
Cincinnati	*after*	58.45%	17.49%	12.15%	9.21%	1.6%	1.1%
Boston	*before*	18.79%	29.17%	20.83%	24.41%	4.61%	2.19%
	after	22.44%	28.15%	19.12%	23.43%	4.76%	2.10%

Table 3: **Changes in Trading Activity for ETFs moving from AMEX to NYSE**

This table reports the change in the mean number of trades, trading volume, and trade size, for 40 Exchange-Traded Funds that switched primary listing from AMEX to NYSE on November 30, 2005. Averages are computed for three-month windows (Panel A) and one-month window (Panel B) before and after the switching date, based on data reported in TAQ. A test is performed to verify the significance of difference between the two periods. * denotes significance at the 5% level, ** denotes significance at the 1% level.

Panel A: Three-months window

		Mean before	Mean after	change	%change
NYSE	*Trades*	420	7,440	7,020	1671 %
	Volume	1,393,634	14,371,598	12,977,964 **	931.23 %
	Trade Size	3,324.03	1,929.76	-1,394.27 **	-41.95 %
AMEX	*Trades*	4,422	774	-3,648 **	-82.50%
	Volume	7,791,952	2,668,449	-5,123,503 **	-65.75%
	Trade Size	1,751.41	3,486.00	1,734.59 **	99.04%
Arca Ex	*Trades*	86,215	6,652	-79,563 **	-92.28 %
	Volume	15,829,969	10,643,374	-5,186,595 **	-32.76 %
	Trade Size	185.43	1,589.57	1,404.14 **	757.25 %
Chicago	*Trades*	925	1,115	190 **	20.50 %
	Volume	500,307	748,239	247,933 **	49.56 %
	Trade Size	541.80	686.03	144.22 **	26.62 %
Boston	*Trades*	177	379	202 **	114.49 %
	Volume	116,929	344,741	227,812 **	194.83 %
	Trade Size	665.91	894.39	228.48 **	34.31 %

Panel B: One-month window

		Mean before	Mean after	change	%change
NYSE	*Trades*	459	6,097	5,638 **	1227.21 %
	Volume	1,522,320	12,735,475	11,213,155 **	736.58 %
	Trade Size	3,282.19	2,076.60	-1,205.58 *	-36.73 %
AMEX	*Trades*	4,347	842	-3,505 **	-80.63 %
	Volume	7,758,355	2,454,860	-5,303,495 **	-68.36 %
	Trade Size	1,777.07	2,932.85	1,155.78 **	65.04 %
Nasdaq	*Trades*	13,929	4,099	-9,830	-70.57 %
	Volume	9,738,975	11,290,020	1,551,045 **	15.93 %
	Trade Size	714.53	2,788.66	2,074.12 **	290.28 %
Arca Ex	*Trades*	94,176	5,333	-88,843 **	-94.34 %
	Volume	16,777,725	7,945,020	-8,832,705 **	-52.65 %
	Trade Size	179.88	1,540.04	1,360.16 **	756.13 %
National	*Trades*	24,295	1,227	-23,068 **	-94.95 %
	Volume	3,713,590	1,505,940	-2,207,650 **	-59.45 %
	Trade Size	153.35	1,400.52	1,247.17 **	813.28 %
Chicago	*Trades*	865	791	-73	-8.46 %
	Volume	474,850	630,780	155,930	32.84 %
	Trade Size	568.32	788.53	220.21	38.75 %
Boston	*Trades*	134	192	58	43.10 %
	Volume	98,710	181,505	82,795 *	83.88 %
	Trade Size	739.09	931.92	192.83 **	26.09 %

Table 4: **Trade Distribution across Sizes Categories for ETFs moving from AMEX to NYSE**

This table reports the distribution of trades across different size categories for 40 Exchange-Traded Funds that switched primary listing from AMEX to NYSE on November 30, 2005. Frequencies are computed for three-month (Panel A) and one-month (Panel B) windows before and after the switching date, based on data reported in TAQ. A test was performed to verify the significance of difference between the distributions for the two periods (numbers are not reported).

Panel A: Three-months window

Share size		100	101-499	500-999	1,000-2,499	2,500-4,900	>5,000
NYSE	*before*	11.67%	19.52%	15.41%	22.41%	11.64%	19.34%
	after	25.31%	29.28%	15.08%	15.51%	6.20%	8.62%
AMEX	*before*	30.21%	31.01%	14.38 %	12.96 %	4.34 %	7.10 %
	after	19.65%	21.88%	18.22%	17.69 %	7.03 %	15.52 %
ARCA	*before*	95.41%	2.23 %	0.73 %	0.86 %	0.32 %	0.45 %
	after	32.22%	15.43%	12.34 %	24.64 %	8.55 %	6.82 %
Chicago	*before*	35.38%	34.55 %	17.09 %	10.33 %	1.71 %	0.94 %
	after	31.42%	35.20 %	16.91 %	13.00 %	2.35 %	1.12 %
Boston	*before*	21.41%	35.72 %	19.21 %	19.42 %	2.96 %	1.28 %
	after	14.63%	31.79 %	22.72 %	23.01 %	5.08 %	2.77 %

Panel B: One-month window

Share size		100	101-499	500-999	1000-2499	2500-4900	>5000
NYSE	before	12.9%	19.8%	17.93%	21.19%	9.53%	18.65%
	after	25.9%	28.19%	14.81%	15.74%	6.2%	9.14%
AMEX	before	29.47%	31.5%	15.12%	12.56%	4.19%	7.16%
	after	23.04%	23.34%	16.2%	17.5%	6.72%	13.2%
NASDAQ	before	79.58%	10.12%	4.11%	4.12%	0.87%	1.21%
	after	31.14%	26.5%	14.28%	17.56%	5.07%	5.45%
ARCA	before	94.48%	3.24%	0.72%	0.86%	0.32%	0.39%
	after	43.15%	15.84%	11.1%	17.22%	5.83%	6.85%
National	before	95.31%	3.33%	0.39%	0.56%	0.18%	0.24%
Cincinnati	after	34.71%	19.51%	12.23%	17.51%	10.66%	5.38%
Chicago	before	37.12%	34.02%	16.16%	10.32%	1.6%	0.79%
	after	31.99%	34.44%	17.33%	12.62%	2.27%	1.36%
Boston	before	21.88%	35.24%	17.01%	19.87%	4.39%	1.6%
	after	12.72%	31.11%	23.2%	24.66%	5.75%	2.57%

Table 5: **Impact of the ETF Migration from AMEX to NYSE on Other Network B Stocks**

This table reports changes in number of trades, trading volume and average trade size for other Network B stocks when 40 Exchange-Traded Funds switched primary listing from AMEX to NYSE on November 30, 2005. Averages are computed for three-month (Panel 1) and one-month (Panel B) windows before and after the switching date, based on data reported in TAQ. A test is performed to verify the significance of difference between the two periods. * denotes significance at the 5% level, ** denotes significance at the 1% level.

Panel A: Three-month window

		Mean before	Mean after	change	%change
NYSE	*Trades*	2,929	3,781	852**	29.08%
	Volume	5,248,523	5,145,867	-102,656	-1.96%
	Trade Size	1,779.06	1,372.37	-406.69**	-22.86%
AMEX	*Trades*	52,273	63,017	10,745**	20.55%
	Volume	55,182,144	67,194,872	12,012,728**	21.77%
	Trade Size	1,052.86	1,066.23	13.38	1.27%
Arca Ex	*Trades*	237,620	293,828	56,208**	23.65%
	Volume	76,862,241	81,547,338	4,685,097	6.10%
	Trade Size	322.14	280.71	-41.44**	-12.86%
Chicago	*Trades*	6,503	6,888	384	5.91%
	Volume	6,947,860	7,501,587	553,727*	7.97%
	Trade Size	1078.78	1,091.26	12.48	1.16%
Boston	*Trades*	1,537	1,163	-374 **	-24.35%
	Volume	1,069,172	732,992	-336,180 **	-31.44%
	Trade Size	700.42	632.17	-68.24 **	-9.74%

Panel B: One-month window

		Mean before	Mean after	change	%change
NYSE	*Trades*	2,893	3,290	398*	13.74%
	Volume	4,591,530	4,900,700	309,170	6.73%
	Trade Size	1,594.71	1,503.96	-89.75	-5.63%
AMEX	*Trades*	51,276	56,461	5,184*	10.11%
	Volume	53,058,798	61,092,028	8,033,230**	15.14%
	Trade Size	1,035.20	1,081.56	46.35*	4.48%
Nasdaq	*Trades*	78,895	83,123	4,228	5.36%
	Volume	90,169,724	86,515,230	-3,654,494	-4.05%
	Trade Size	1,138.93	1,055.94	-82.99*	-7.29%
Arca Ex	*Trades*	214,337	232,102	17,765	8.29%
	Volume	70,037,935	68,024,040	-2,013,895	-2.88%
	Trade Size	326.64	297.89	-28.75*	-8.80%
National	*Trades*	83,585	84,824	1,239	1.48%
	Volume	31,207,780	29,639,545	-1,568,235	-5.03%
	Trade Size	374.16	354.18	-19.98**	-5.34%
Chicago	*Trades*	5,862	5,885	23	0.39%
	Volume	6,852,157	6,762,733	-89,424	-1.31%
	Trade Size	1,169.23	1,142.84	-26.39	-2.26%
Boston	*Trades*	1,224	1,018	-206	-16.85%
	Volume	838,505	722,925	-115,580*	-13.78%
	Trade Size	687	707.53	20.53	2.99%

Table 6: **Trade Distribution across Sizes Categories for Other Network B Stocks after the ETF Migration from AMEX to NYSE**

This table reports the distribution of trades across different size categories for other Network B stocks when 40 Exchange-Traded Funds switched primary listing from AMEX to NYSE on November 30, 2005. Frequencies are computed for three-month (Panel A) and one-month (Panel B) windows before and after the switching date, based on data reported in TAQ. A test was performed to verify the significance of difference between the distributions for the two periods (numbers are not reported).

Panel A: Three-months window

Share size		100	101-499	500-999	1,000-2,499	2,500-4,900	>5,000
NYSE	*before*	26.98%	23.75%	15.80%	19.29%	5.99%	8.19%
	after	29.88%	24.51%	16.35%	18.98%	4.61%	5.67%
AMEX	*before*	32.04%	29.02%	16.39%	14.19%	4.36%	3.99%
	after	31.55%	29.06%	16.59%	14.30%	4.45%	4.05%
ARCA	*before*	75.18%	10.72%	7.22%	5.06%	1.12%	0.70%
	after	78.78%	9.11%	6.39%	4.39%	0.79%	0.53%
Chicago	*before*	22.92%	27.64%	21.34%	19.91%	5.02%	3.17%
	after	22.89%	27.84%	21.14%	19.90%	4.88%	3.35%
Boston	*before*	27.40%	29.33%	18.48%	19.71%	3.28%	1.79%
	after	29.38%	29.59%	17.77%	19.06%	2.91%	1.29%

Panel B: One-month window

Share size		100	101-499	500-999	1000-2499	2500-4900	>5000
NYSE	before	28.66%	24.33%	14.87%	19.08%	5.43%	7.63%
	after	28.43%	25.44%	14.98%	19.84%	4.77%	6.54%
AMEX	before	31.41%	29.86%	16.55%	13.96%	4.32%	3.90%
	after	31.27%	28.77%	16.61%	14.6%	4.6%	4.14%
NASDAQ	before	54.77%	18.01%	11.82%	10.37%	2.55%	2.49%
	after	57.27%	16.65%	11.05%	10.16%	2.45%	2.42%
ARCA	before	73.84%	11.76%	7.44%	5.20%	1.04%	0.72%
	after	78.36%	9.38%	6.33%	4.36%	0.93%	0.64%
National	before	69.64%	13.26%	8.12%	6.69%	1.33%	0.96%
Cincinnati	after	72.20%	11.98%	7.54%	6.24%	1.16%	0.88%
Chicago	before	21.98%	27.25%	21.98%	20.40%	5.20%	3.20%
	after	22.39%	27.22%	21.72%	20.29%	5.10%	3.27%
Boston	before	27.06%	28.95%	18.09%	20.76%	3.54%	1.61%
	after	25.93%	28.49%	17.89%	22.36%	3.74%	1.59%

Table 7: **Changes in Trading Activity on Stocks moving from AMEX to NYSE**

This table reports the change in the mean number of trades, trading volume, and trade size, aggregate results across exchanges and all stocks that switched primary listing from AMEX to NYSE. Averages are computed for three-month windows before and after the switching date, based on data reported in TAQ. A test is performed to verify the significance of difference between the two periods. * denotes significance at the 5% level, ** denotes significance at the 1% level.

	Mean before	Mean after	change	%change
Volume	6,397,930	7,536,538	1,138,608	17.79
Trades	5283.82	7208.31	1924	36.42***
Size	1278.67	1354.90	76.23	5.96

Table 8: **Changes in Trading Activity on Stocks moving from AMEX to NYSE, By Exchange**

This table shows the average distribution across exchanges of number of trades and trading volume around the change of listing venue. Averages are computed for three-month windows before and after the switching date, based on data reported in TAQ. A test is performed to verify the significance of difference between the two periods. * denotes significance at the 5% level, ** denotes significance at the 1% level.

		Mean Before	Mean After	Diff	% Change
Nasdaq	*Trades*	1,987.2	2,681.3	-694.10**	-34.93%
	Volume	2,351,815	2,420,000	68,185	2.90%
	Trade Size	1,188.5	902.27	286.23**	24.08%
PCX/Arca	*Trades*	302.24	276.37	25.87	8.56%
	Volume	158,246	158,313	-67	-0.04%
	Trade Size	526.66	560.85	-34.19	-6.49%
Chicago	*Trades*	1,837.2	1624.2	213**	11.59%
	Volume	1,219,252	994,957	224,295**	18.40%
	Trade Size	663.74	615.36	48.38*	7.29%
Cincinnati/	*Trades*	70.905	27.317	43.59**	61.47%
National	*Volume*	26,458	12,997	13,461**	50.88%
	Trade Size	381.37	462.7	-81.33*	-21.33%
Boston	*Trades*	123.98	113	10.98	8.86%
	Volume	104,619	78,038	26,581	25.41%
	Trade Size	849.43	689.51	159.92**	18.83%

Table 9: **Changes in Trading Activity on Stocks moving from AMEX to NYSE, By Exchange, Before and After the Introduction of Rebate Programs**

This table shows the average distribution across exchanges of number of trades and trading volume around the change of listing venue. Averages are computed for three-month windows before and after the switching date, based on data reported in TAQ. A paired test is performed to verify the significance of difference between the two periods. * denotes significance at the 5% level, ** denotes significance at the 1% level.

		Before	Rebate	Program	After	Rebate	Program
		Before Switch	After Switch	Change	Before Switch	After Switch	Change
Nasdaq	*Trades*	168.77	406.8	238	2,147.92	2,483.84	335.9
	Volume	211,002	418,497	207,495	2,516,101	2,170,568	-345,533
100/51	*Trade Size*	2,444.34	2,011.55	-432.78	1,391.35	1,739.26	347.9
PCX/ARCA	*Trades*	255.3	234.4	-20.9	277.3	208.80	-68.5*
	Volume	137,287	140,893	3,606	140,229	110,576	-29,653
54/21	*Trade Size*	889.60	687.95	-201.64	516.27	502.87	-13.4
Chicago	*Trades*	347.86	582.6	234.7	1,329.47	986.55	-342.92
	Volume	323,578	390,066	66,488	830,903	580,711	-250,192**
50/73	*Trade Size*	1,301.94	1,710.42	408.5	1,790.45	1236.60	-553.84
Cincinnati/	*Trades*	131.5	335.5	204	42.5	23.25	-19.25*
National	*Volume*	138,950	169,000	30,050	19,450	11400	-8050
2/4	*Trade Size*	600.32	457.57	-142.75	364.60	697.60	333
Boston	*Trades*	124.35	77.03	-47.323	271.26	309.0	37.74
	Volume	124,677	69,094	-55,584	193,900	184,460	-9440
31/15	*Trade Size*	2,272.31	1,298.74	-973.56	852.70	954.25	101.5

Table 10: **Impact of Tape-Shredding Rules on Network B Activity**

This table reports changes in trading activity for Network B stocks surrounding the implementation of Tape-Shredding Rules. Averages are computed for three-month windows before and after the switching date, based on data reported in TAQ. In Panel A, we perform a t-test on aggregate total volume, number of trades, and average trade size across all securities. A test is performed to verify the significance of difference between the two periods. In Panel B, we perform a paired t-test, which examines stock-by-stock the change in aggregate total volume, number of trades, and average trade size. * denotes significance at the 5% level, ** denotes significance at the 1% level.

Panel A: Aggregate Trading Activity

		Mean Before	Mean After	Diff	% Change
AMEX	*Trades*	71,618	69,424	-2,194	-3.16%
	Volume	77,379,446	66,055,214	-11,324,232**	-17.14%
	Trade Size	1,077.47	935.80	-141.68 **	-15.14%
Nasdaq	*Trades*	272,319	198,083	-74,237 **	-37.48%
	Volume	172,830,000	172,970,000	140,000	0.08%
	Trade Size	636.0211	863	227 **	26.32%
NYSE Arca	*Trades*	297,615	206,111	-91,505 **	-44.40%
	Volume	94,047,502	124,290,000	30,242,498 **	24.33%
	Trade Size	319.10	598.10	279.01 **	46.65%
National	*Trades*	5,892	4,563	-1,329 **	-29.13%
	Volume	7,784,495	5,222,880	-2,561,615 **	-49.05%
	Trade Size	1,313.95	1,141.92	-172.03 **	-15.16%
Chicago	*Trades*	7,870	8,242	372.23	4.52%
	Volume	8,515,021	8,657,447	142,426.00	1.65%
	Trade Size	1,082.51	1,047.10	-35.41	-3.38%
NYSE	*Trades*	3,746	4,366	620**	14.20%
	Volume	6,279,232	5,725,477	-553,755	-9.67%
	Trade Size	1,655.38	1,329.90	-325.48**	-24.47%

Table 10: Panel B: Paired Test (cont'd)

		Mean Before	Mean After	Diff	% Change
AMEX	*Trades*	4,771.3	4,606.0	-165.2	-3.5%
	Volume	5,137,897	4,357,173	-780,724**	-15.2%
830	*Trade Size*	1,035.4	953.3	-82.1	-7.9%
Nasdaq	*Trades*	18,880.0	13,851.3	-5,028.7	-26.6%
	Volume	12,050,496	12,145,774	95,278	0.8%
832	*Trade Size*	1,039.5	1,136.4	96.9	9.3%
NYSE Arca	*Trades*	21,255.6	14,793.6	-6,462.0	-30.4%
	Volume	6,746,393	8,961,243	2,214,850	32.8%
816	*Trade Size*	589.0	427.5	-161.5**	-27.4%
National	*Trades*	5,311.3	4,088.2	1,223.1*	-23.0%
	Volume	7,186,970	4,741,854	-2,445,116**	-34.0%
57	*Trade Size*	2,430.5	1,745.2	-685.3	-28.2%
Chicago	*Trades*	2,579.5	2576.2	-3.2	-0.1%
	Volume	2,767,431	2,713,497	53,933	-1.9%
179	*Trade Size*	2,345.3	1,699.0	-646.3	-27.6%
NYSE	*Trades*	4253.1	4606.0	-165.2	-3.5%
	Volume	6,415,171	6,375,579	-39,592	-0.6%
48	*Trade Size*	1648.3	1382.2	-266.1*	-16.1%

Table 11: **Impact of New Allocation Formula**

This table reports changes in trading activity for Network B stocks (Panel A) and Network A stocks (Panel B) surrounding the implementation of the the new allocation formula that went into effect on april 1, 2007. Averages are computed for three-month windows before and after the event date, based on data reported in TAQ. A test is performed to verify the significance of difference between the two periods. * denotes significance at the 5% level, ** denotes significance at the 1% level.

Panel A:**Impact on Network A Activity**

		Before	After	change	change (%)
NYSE	*Trades*	4,095,760	4,002,172	-93,588	-2.28%
	Volume	1,556,900,000	1,515,400,000	-41,500,000	-2.67%
	Trade Size	381.86	379.35	-2.50	-0.66%
Nasdaq	*Trades*	2,615,671	2,777,408	161,737**	6.18%
	Volume	959,040,000	1,029,700,000	70,660,000*	7.37%
	Trade Size	369.84	371.66	1.82	0.49%
NYSE Arca	*Trades*	1,545,748	1,620,392	74,644.00	4.83%
	Volume	311,630,000	327,770,000	16,140,000	5.18%
	Trade Size	202.45	202.10	-0.35	-0.17%
National	*Trades*	34,778	68,921	34,143 **	98.17%
	Volume	7,156,666	10,655,736	3,499,070 **	48.89%
	Trade Size	236.55	153.83	-82.72 **	-34.97%
Boston	*Trades*	15,348	18,679	3,331 **	21.70%
	Volume	3,211,427	3,837,059	625,632 *	19.48%
	Trade Size	210.97	202.95	-8 *	-3.80%
Chicago	*Trades*	9,087.54	6,969.07	-2,118.47	-23.31%
	Volume	20,439,811.00	16,566,329.00	-3,873,482.00**	-18.95%
	Trade Size	8,570.39	3,694.48	-4,875.91**	-56.89%
AMEX	*Trades*	744.37	792.3898	48.02	6.45%
	Volume	1,008,793.00	1,000,218.00	-8,575.00	-0.85%
	Trade Size	1,341.36	1,322.71	-18.65	-1.39%

Panel B:**Impact on Network B Activity**

		Before	After	change	change (%)
AMEX	*Trades*	64,788	68,006	3,218	4.97%
	Volume	40,391,182	36,955,128	-3,436,054 *	-8.51%
	Trade Size	626.65	544.60	-82.05 **	-13.09%
Nasdaq	*Trades*	293,107	336,729	43,623 **	14.88%
	Volume	164,170,000	204,050,000	39,880,000 **	24.29%
	Trade Size	532.98	604.61	71.63 **	13.44%
NYSE Arca	*Trades*	214,281	222,196	-11,815	-5.51%
	Volume	100,620,000	108,800,000	8,180,000	8.13%
	Trade Size	463.02	487.18	24.16 **	5.22%
National	*Trades*	4,569	3,626	-943 *	-20.65%
	Volume	2,200,066	1,727,573	-472,493 *	-21.48%
	Trade Size	457.67	472.76	15.09	3.30%
NYSE	*Trades*	6,769	4,254	-2,515 **	-37.15%
	Volume	3,402,256	2,623,261	-778,995 **	-22.90%
	Trade Size	510.03	620.80	110.77 **	21.72%

Figure 1:
Market Share of Network B Trades
2001-2006

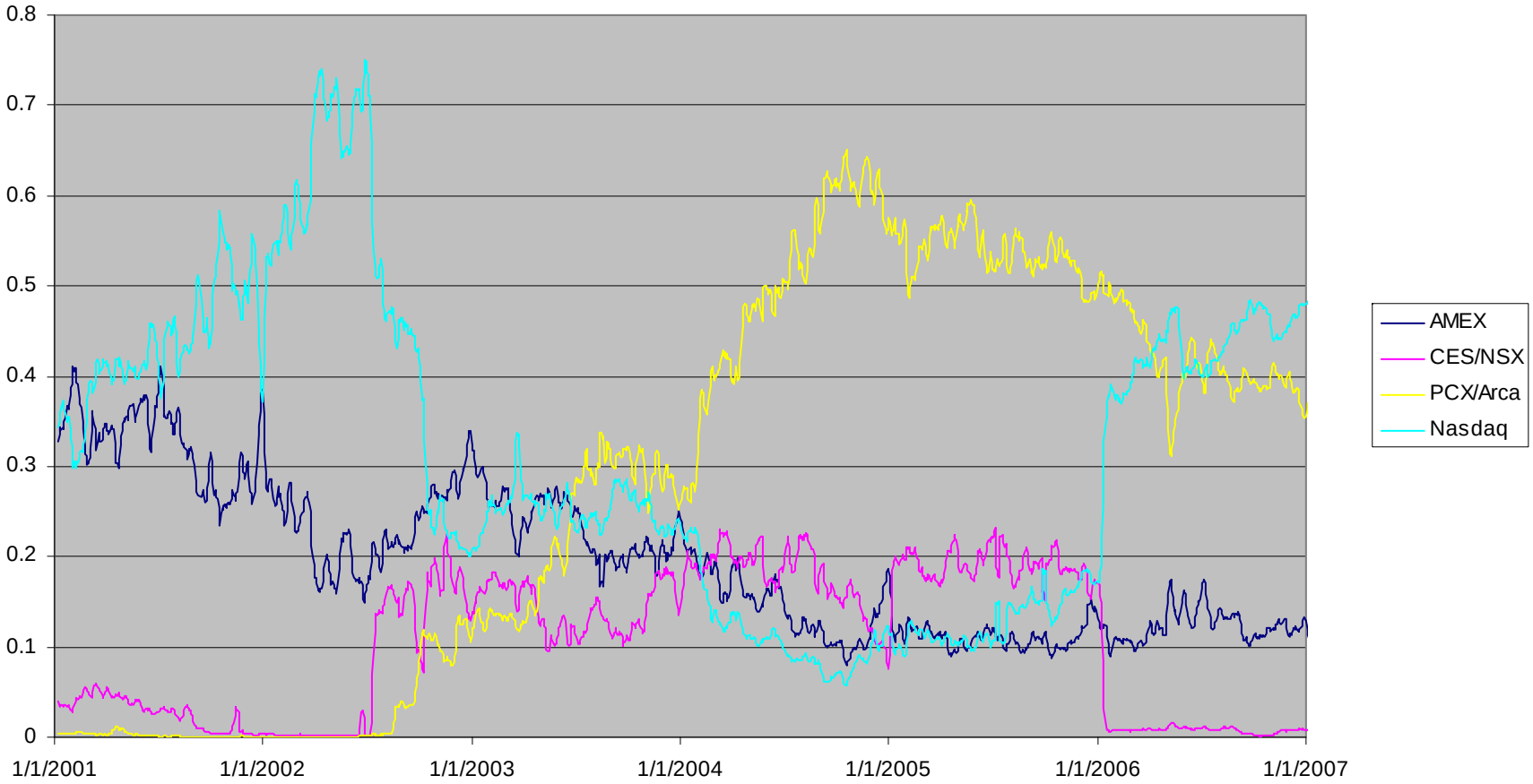

Figure 2:
Market Share of Network C Trades
2001-2006

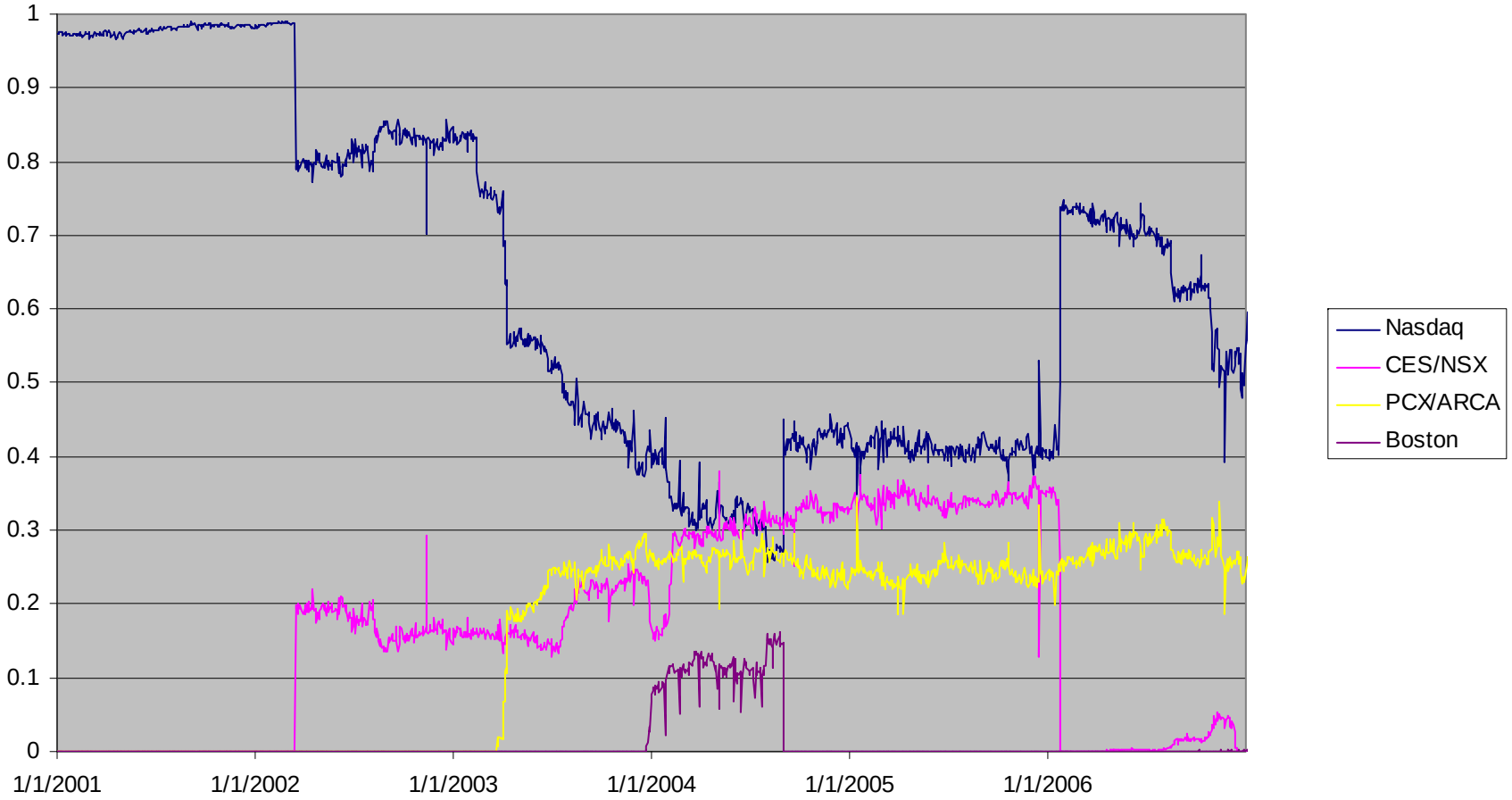

Figure 3:
Average Trade Size
Nasdaq 100 Tracking Stock (QQQ/QQQQ)
Surrounding Move from Network B to Network C

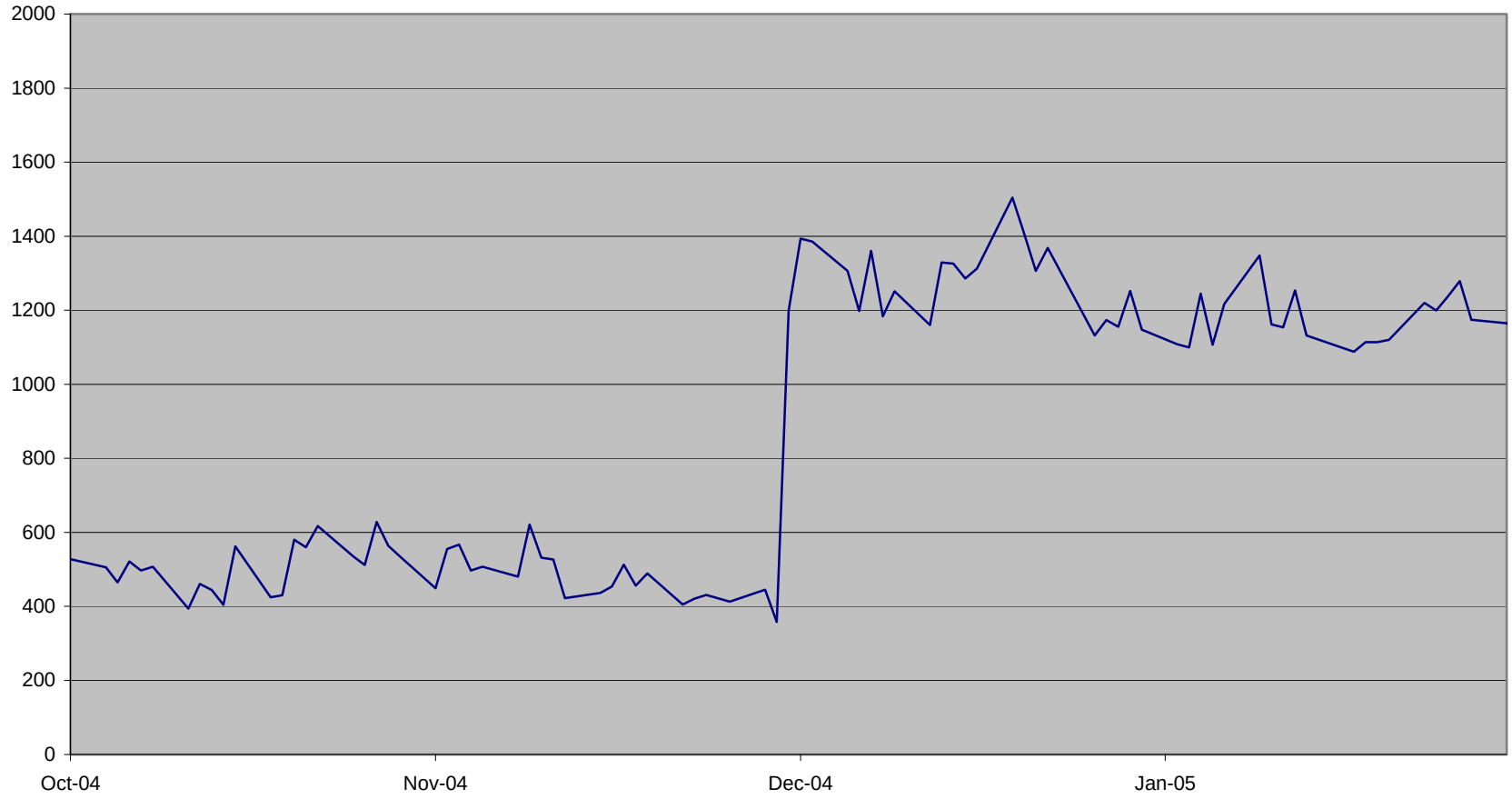

Figure 4:
Average Trade Size
40 iShares Exchange Traded Funds
Surrounding Move from Network B to Network A

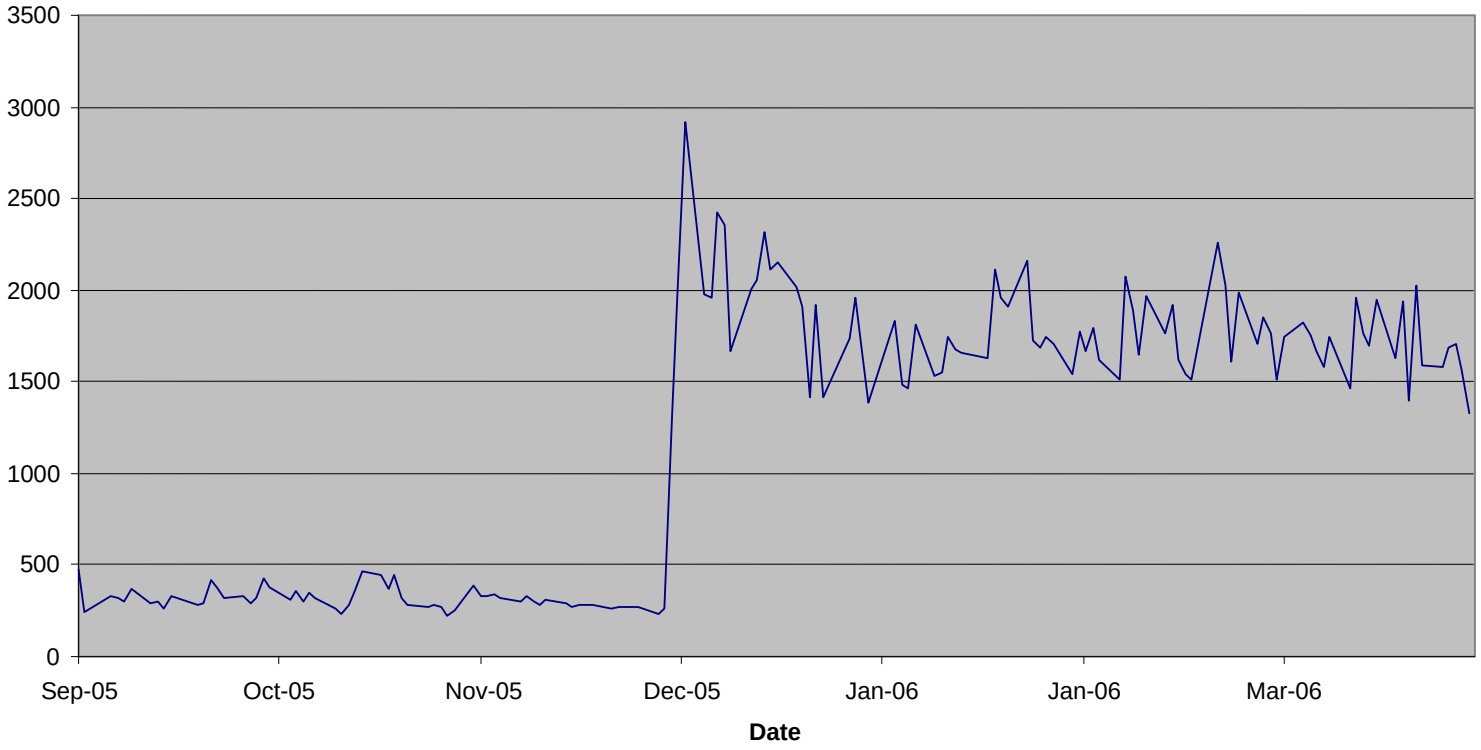

Figure 5:
Average Trade Size on Network B
Surrounding Introduction of Tape Shredding Rules