Preferenced Trading, Quote Competition, and Market Quality: Evidence from Decimalization on the NYSE

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We examine the impact of decimalization on preferenced trading in NYSE-listed stocks and show a significant decline in preferenced trading around decimalization. For the largest NYSE stocks, the total decline is nearly 22%. We also find a negative correlation between the changes in preferenced trading and the changes in quote competition intensity, and a positive correlation between the changes in preferenced trading and the changes in spreads. Consistent with the cream skimming hypothesis, we find that abnormal changes in information asymmetry cost for NYSE trades are positively correlated with the changes in preferenced trading.

1. Introduction

Decimalization has attracted much attention because of its broad-based impact on trading behavior and market quality. Recent studies have reported improvements in market quality (Bessembinder, 2003a; Smith, Alasdair, Turnbull, and White, 2006) and quote competition (Bacidore, Battalio, and Jennings, 2001 and 2003) after decimalization. Chung, Chuwonganant, and McCormick (2004) found that decimalization significantly reduces preferenced trading on Nasdaq. No study, however, has examined whether and to what extent preferenced trading has declined in NYSE-listed stocks after decimalization and whether the changes in preferenced trading are associated with the documented improvement in quote competition and market quality.

The issue of how decimalization affects preferenced trading has remained unsettled. Theoretical predictions are mixed (Chordia and Subrahmanyam, 1995; Kandel and Marx, 1999; Battalio and Holden, 2001), and the only empirical study examines Nasdaq only (Chung, Chuwonganant, and McCormick, 2004). Due to their structural differences, decimalization could have a very different impact on preferenced trading on the auction-based NYSE and the dealer-based Nasdaq. On Nasdaq, dealers maintain their own limit order books and compete for order flow. For NYSE-listed stocks, the competition for order flow occurs among NYSE, Nasdaq, Electronic Communication Networks (ECNs), and regional markets. Therefore, Nasdaq is inherently more segmented than the NYSE, and the impact on preferenced trading from decimalization on the two markets can be very different.

Preferenced trading in NYSE-listed stocks takes place on Nasdaq, regional stock exchanges, and ECNs in one of two forms: payment-for-order-flow and internalization. Payment for order flow occurs when a market maker or specialist pays brokers for routing orders to her in the form of rebates. Rebate per share is typically dependent on stocks, spreads, and size of orders. Internalization occurs when broker-dealers take the opposite side of customer orders, or cross customer orders against each other and then route the trade to affiliated market makers or specialists for execution and reporting. Two regional exchanges, the Boston Stock Exchange (BSE) and the Cincinnati Stock Exchange (CSE), officially adopt preferencing programs to internalize order flow in the 1990s. While both programs lead to increased internalization of order flows, time priority is maintained on the BSE but not on the CSE. The Securities and Exchange Commission (SEC) notes that both programs "increase internalization" (SEC, 1997).

The practice of preferenced trading is considered by many to be detrimental to quote competition (Dutta and Madhavan, 1997; Kandel and Marx, 1999) and results in higher spreads (Bloomfield and O'Hara, 1998; Ackert and Church, 1999; Bessembinder, 1999; Kluger and Wyatt, 2002). Parlour and Rajan (2003) demonstrate that consumer and social welfare are lower with payment for order flow. At the same time, decline in spreads after decimalization is expected to reduce preferenced trading. Therefore, the changes in preferenced trading around decimalization should be negatively correlated to changes in quote competition intensity and positively correlated to changes in spreads. However, these correlations have not been confirmed by the literature.

We construct a proxy for preferenced trading activity and examine its change in NYSE-listed stocks around decimalization. Our findings suggest that decimalization significantly reduces preferencing activity in NYSE-listed stocks. Specifically, we find a declining trend of preferencing activity that starts several months before decimalization and lasts until the end of our study period, with the largest change occurring immediately after decimalization. Our estimate of the total decline in preferenced trading activity during our study period reaches up to 22% for the largest NYSE stocks.

Consistent with Bacidore, Battalio, and Jennings (2001, 2003) and Bessembinder (2003a), we find more aggressive quote competition and smaller spreads after decimalization. The changes in preferencing activity is negatively correlated with the changes in quote competition intensity and positively correlated with the changes in spreads. Additionally, we find that the decline in preferenced trading leads to a decline in information asymmetry cost on the NYSE. This evidence is consistent with the cream skimming hypothesis (Easley, Kiefer, and O'Hara, 1996; Bessembinder and Kaufman, 1997; Lipson, 2004) as well as the sorting hypothesis (Battalio and Holden, 2001).

2. Data and sample selection

We apply the following sample selection rules to all NYSE-listed common stocks. A stock is excluded if it is first listed on the exchange after June 2000, de-listed between June 2000 and August 2001, decimalized before January 2001, or if it is not traded on Nasdaq and any of the five regional exchanges in June 2000.[1] These screening rules result in a sample of 1,291 NYSE-listed common stocks.[2] Next, we rank the stocks into three groups based on market capitalization as of June 2000. The top 100 stocks in each of the three groups are selected and labeled "large-cap stocks," "medium-cap stocks," and "small-cap stocks," respectively. The 300 stocks in our sample are a representative sample of NYSE-listed stocks.

We obtain intraday tick-by-tick quote and trade data for each trading day between 9:30 A.M. market open and 4:00 P.M. market close in the months of June, August, October, and December 2000 and February, April, June, and August 2001 from the NYSE's Trade and Quote (TAQ) database. Given the enormous size of transaction data, we use data from every other month. The Center for Research in Security Prices (CRSP) data are the source of market capitalization. We filter the trade and quote data following Bessembinder (2003b). Our study period ends in August 2001, as this is the furthest we can go without complicating our analysis with the September 11 event.

[1] The five regional exchanges are Boston, Chicago, Cincinnati, Pacific, and Philadelphia Stock Exchanges.

[2] The two classes of Berkshire Hathaway, Inc. stocks (BRKA and BRKB) are excluded. Allied Products Corp. (ADP) are also excluded because it was traded for approximately $1 in June 2000 and over $60 in December 2000 with almost no trades between August 2000 and October 2000.

Table 1 presents descriptive statistics of the three portfolios as of December 2000. The mean market capitalization is $66 billion, $2 billion, and $0.5 billion for large-, medium-, and small-cap stocks. The large-cap stocks are more heavily traded, have a smaller percent of trading volume from small-sized trades, have a higher average trading price and larger average trading size, and display smaller trade-to-trade return volatility.[3]

[Insert Table 1]

3. Quote competition and preferenced trading around decimalization

Changes in quoting behavior and competition strategy can start well ahead of decimalization in anticipation of the impact and can also last until long after the completion of decimalization. We believe that our study period from June 2000 to August 2001 is long enough to capture a fuller impact of decimalization without interfering with other significant confounding events. The entire study period is divided into three sub-periods: the pre-decimalization period (from June 2000 to December 2000), the decimalization period (from December 2000 to February 2001), and the post-decimalization period (from February 2001 to August 2001).

3.1. Measuring quote competition intensity and preferencing activity

We use two variables to capture the intensity of quote competition: (i) the frequency of quote revisions (FRQ), and (ii) the duration of NBBO quotes (DUR) or the length of time a quote stays on the NBBO. When quote competition intensifies, there are more frequent quote revisions and the NBBO quotes are more frequently revised, which leads to a decrease in the length of time quotes remain on NBBO.

[3] Following Bessembinder (2003b), trades of less than 500 shares are considered small, trades of 500 shares or higher but under 5,000 shares are considered medium, and trades of 5,000 shares or more are considered large.

We construct a proxy to estimate the level of preferenced trading following Chung, Chuwonganant, and McCormick (2004). Using Nasdaq proprietary data, they consider a trade to be internalized if the reporting market maker is also a contra-party in the trade; they consider the trade preferenced if the reporting market maker is posting quotes that are poorer than the prevailing inside market quote. The TAQ data include a quote file and trade file. The quote file contains a quoted price from each market with a time stamp, and the trade file contains price, venue, and time for each trades. The two data files can be matched to determine when a reporting market is quoting prices that are inferior to the best prevailing price across markets.[4] Therefore, preferenced trades can be similarly defined for NYSE-listed stocks. A complication for the NYSE is that orders executed off the NYSE may not be preferenced even when the reporting market is not posting the best prices at the time of the trades. Institutional investors may prefer their orders to be routed to regional markets or the Nasdaq for faster execution, anonymity, or for a negotiated price. We minimize this complication by focusing on small-sized trades. This approach is justified because: (i) orders from institutional investors are usually large in size, and (ii) a preferencing agreement usually restricts order size to small retail orders. By identifying small-sized trades executed off the NYSE when the reporting market is not quoting the best prices, we can isolate the bulk of preferenced trades. We define our proxy as the non-NYSE market share of small-sized trade volume when NYSE is on the NBBO alone, i.e., the percentage of small-sized trade volume executed off the NYSE when the NYSE is on both sides of the NBBO alone. This proxy is shown in equation (1).

$$\text{PREF} = \frac{\text{Non-NYSE small-sized trade volume when NYSE on NBBO alone}}{\text{Total small-sized trade volume when NYSE on NBBO alone}} \times 100\% \qquad (1)$$

[4] When matching quotes with trading prices, we follow Ellis, Michaely, and O'Hara (2000) and Bessembinder (2003c) using no adjustment to time stamps.

It is possible for small-sized orders to be executed on the NYSE while the NYSE is not quoting the best price. However, we find that this rarely happens, especially for large-cap stocks, partly because the NYSE almost always posts competitive quotes. On the other hand, trades executed off the NYSE when NYSE is not on the NBBO could also be preferenced. In this sense, PREF can be considered a lower bound of preferencing activity.

3.2. Changes in quote competition intensity and preferencing activity

In Table 2, we present the changes in quote competition and preferencing activity in the three sub-periods. We observe that FRQ increases significantly, DUR declines significantly, and PREF declines significantly in the months leading up to decimalization, which implies that market participants adjust their trading behavior and strategy in anticipation of the impact from decimalization. The subsequent decimalization and post-decimalization period quote competition continues to show significant improvement, and preferencing activity continues to decline significantly across all three portfolios. PREF shows that the decline in preferenced trading from June 2000 to August 2001 is 21.64%, 14.48%, and 17.72% for large-, medium-, and small-cap stocks, respectively. These changes are significantly higher than the 3% decline for Nasdaq-listed stocks reported by Chung, Chuwonganant, and McCormick (2004).[5]

[Insert Table 2]

[5] A number of reasons may explain the large difference: (i) the 7-month study period in Chung, Chuwonganant, and McCormick (2004) between November 2000 and June 2001 is about half of our study period; (ii) decimalization could have a differential impact on the two markets due to the market micro-structural differences between Nasdaq and NYSE; (iii) more dealers may have given up preferencing of NYSE than Nasdaq order flow because of lower spreads of NYSE-listed stocks before decimalization; and (iv) our sample stocks are much larger in terms of market capitalization than the sample used by Chung, Chuwonganant, and McCormick (2004). Since preferenced trading is the most prevalent in very liquid stocks, the decline in preferenced trading may also be higher in larger and more liquid stocks.

We present the time series of PREF in Figure 1. The preferenced trading proxy shows downward trends throughout the study period. The largest decline occurs in the decimalization period, and it is also apparent that the decline starts ahead of decimalization. This downward trend is in sharp contrast to the decade long upward trend of preferenced trading discussed in Peterson and Sirri (2003).

[Insert Figures 1]

We decompose PREF for each non-NYSE market center. Our results indicate that decimalization significantly reduces preferenced trading on all market centers. However, the impact is different on the Boston Stock Exchange (BOS) and the Cincinnati Stock Exchange (CSE). Not only is the decline in preferenced trading on these two markets smaller, but the decline also comes late when compared with other market centers. For other market centers, preferenced trading starts to decline before decimalization, and the decline is the largest immediately after decimalization. For BSE and CSE, the largest decline comes in the post-decimalization period. It is possible that CSE and BSE are the most competitive and more sophisticated preferencing markets prior to decimalization, therefore, they are able to continue the practice even with smaller spreads. For example, CSE was heavily used by Madoff Investment Securities, who had a very advanced "best execution" algorithm that offered its customers the chance for price improvement on preferenced market orders by exposing the order to other markets at a better price for 30-60 seconds before execution. Since Madoff Investment Securities was giving their customers very good executions in general, their preferenced order flow would be more robust to decimalization.

3.3. The relation between preferenced trading and quote competition

If preferenced trading damages quote competition, we should observe a negative correlation between the changes in the preferencing activity and the changes in quote competition intensity. However, the causality may also run from quote competition to preferenced trading: the more intensive the quote competition, the lower the spreads. Because preferencing dealers are obligated to execute preferenced orders at the best market prices, their profits become smaller with intensified quote competition, which can lead to less preferenced trading. Therefore, this paper examines the correlation between quote competition and market quality but not causality. We estimate the following regression to examine the relation:

$$\Delta QC = a_1 + a_2{*}\Delta PREF + a_3{*}\Delta 1/PRICE + a_4{*}\Delta ATS + a_5{*}\Delta VOL + a_6{*}\Delta STD + a_7{*}MCap + a_8{*}SCap + \varepsilon \qquad (2)$$

where QC is a quote competition intensity proxy variable, measured by either FRQ or DUR. FRQ is the natural log of the frequency of quote revisions and DUR is the natural log of the length of time quotes stay on the NBBO. PREF is the preferenced trading proxy as defined in equation (1); PRICE is the natural log of average trading price; ATS is the natural log of average trading size; VOL is the natural log of trading volume; STD is the standard deviation of quoted middle point returns; and MCap and SCap are dummy variables for medium- and small-cap stocks, respectively.

Table 3 reports regression results with DUR as the measure of intensity of quote competition.[6] In the pre-decimalization period, a one percentage point decrease in PREF leads to a decrease of 0.0052 in ΔDUR (or a 0.52% decrease in the duration of NBBO quotes). The numbers in parentheses are standardized coefficients. For the same

[6] Regression results using FRQ as the quote competition intensity proxy are qualitatively the same as those reported in Table 3 and the same conclusions can be derived.

regressions, one standard deviation decrease in PREF leads to a decrease of 0.21 standard deviation of DUR. In all three periods, the relation between changes in preferencing activity and changes in DUR is significant and positive.

[Insert Table 3]

4. Market Quality

4.1. Market quality around decimalization

Similar to Bessembinder (2003a), we measure market quality using effective half-spreads (ESPD) and realized half-spreads (RSPD). In addition, we also include the information asymmetry costs (IAC) in the set of measurements for market quality.

$$ESPD_t = I_t * (P_t - M_t)/M_t \tag{3}$$

$$RSPD_t = I_t * (P_t - M_{t+5})/M_t \tag{4}$$

$$IAC_t = ESPD_t - RSPD_t \tag{5}$$

where I_t is a trade direction variable that equals one for customer-initiated buys and negative one for customer-initiated sells on the basis of the Ellis, Michaely, and O'Hara (2000) approach; P_t is the trading price; M_t is the midpoint of the NBBO quotes at time *t*; and M_{t+5} is the midpoint of the NBBO quotes five minutes after the trade at time *t*.

Table 4 reports the changes in ESPD, RSPD, and IAC. In the pre-decimalization period, ESPD and IAC for large-cap stocks decline significantly. RSPD declines but insignificantly. For medium- and small-cap stocks, all changes are insignificant in this period. In the decimalization period, all three variables show significant declines across all three portfolios, resulting from significant declines in RSPD and IAC. In the post-decimalization period, ESPD for large-cap stocks declines significantly and RSPD increases significantly, which is due to a significant decline in IAC more than an offsetting increase in RSPD. For medium- and small-cap stocks, ESPD declines significantly, largely due to a continued decline in IAC.

[Insert Table 4]

The overall evidence suggests that market quality improves significantly during the decimalization period only. The large decreases in RSPD in the decimalization period and the increase in the post-decimalization period reflect the adjustment process of market participants. IAC declines significantly for all three portfolios in these two periods. We believe this is partly because decimalization has reduced preferenced trading activity. We return to this issue in Section 5.3.

4.2. Regression results

We use the following regression model to examine the relation between changes in preferenced trading and changes in market quality:

$$\Delta RSPD = a_1 + a_2{*}\Delta PREF + a_3{*}\Delta QCres + a_4{*}\Delta 1/PRICE + a_5{*}\Delta ATS + a_6{*}\Delta VOL$$
$$+ a_7{*}\Delta MedSize + a_8{*}\Delta STD + a_9{*}MCap + a_{10}{*}SCap + \kappa \qquad (6)$$

where RSPD is realized half-spreads as defined in equation (4). PREF is the preferencing activity proxy variable. ΔQCres is the error term from equation (2), which measures the changes in quote competition caused by factors that are not related to the changes in preferenced trading.[7] All other variables are the same as defined in equation (2).

Regression results are presented in Table 5. The changes in RSPD are always positively correlated with ΔPREF. In the pre-decimalization period, a decrease in

[7] One such factor is the lower costs of improving the best bid and ask prices after decimalization. As the tick size declines from 1/16th to one penny after decimalization, the cost of improving the best bid and ask prices also declines to one penny. The significantly lowered cost provides additional incentive for traders to penny-improve the existing best bid and ask prices, which may have a positive impact on market quality. Edwards and Harris (2000) and Battalio and Jennings (2001) find that the frequency of observing trades and quotes one tick better than prevailing quotes rises after decimalization.

preferencing activity of 1% (one standardized deviation) results in a 0.000024 (0.2604 standard deviation) decrease in RSPD. Because RSPD is standardized with respect to quoted midpoint, a decrease in RSPD by 0.01 translates into 50 cents for a quoted midpoint of $50; therefore, the decrease of 0.000024 is equivalent to 12 cents for a quoted midpoint of $50. In the same period, ΔQCres is also significantly correlated with ΔRSPD. For a 1% (one standard deviation) reduction in ΔQCres, RSPD decreases by 0.000557 (0.2106 standard deviation). The decrease in RSPD by 0.000557 is equivalent to a decrease of 2.79 cents for a quoted midpoint of $50. Similar significant correlation can be observed in both the decimalization and post-decimalization periods. These results suggest that the improved market quality after decimalization is significantly correlated to more aggressive quote competition and reduced preferenced trading.

[Insert Table 5]

4.3. Are investors better off on the NYSE?

Preferencing dealers bring low content orders away from the NYSE, leaving the NYSE with relatively higher IAC. As preferenced trading declines, orders that previously would have been preferenced to non-NYSE markets would be executed on the NYSE. The implication is a reduced IAC on the NYSE. In Table 4, we have shown that IAC declines significantly in all three periods for large-cap stocks and declines significantly in the decimalization and post-decimalization periods for medium- and small-cap stocks. While we do not believe the overall decline in IAC is associated with the decline in preferenced trading, we believe that abnormal decline in IAC on the NYSE can be attributed to declining preferencing activity. To examine whether reduction in preferenced trading reduces IAC on the NYSE, we regress the abnormal changes in IAC for NYSE trades against the changes in preferencing activity as follows:

$$\Delta AIAC = a_1 + a_2*\Delta PREF + a_3*\Delta 1/PRICE + a_4*\Delta ATS + a_5*\Delta VOL + a_6*\Delta MedSize + a_7*\Delta STD + a_8*MCap + a_9*SCap + \mu \quad (7)$$

where ΔAIAC is the abnormal change in IAC for NYSE trades, defined as the difference between the changes in IAC for trades executed on the NYSE and the changes in IAC for all trades; all other variables have been defined earlier.

Regression results are reported in Table 6. The coefficient for ΔPREF is significantly positive in all three periods. We conclude that the reduction in preferenced trading leads to significant improvements in NYSE's market quality in terms of lower information asymmetry.

[Insert Table 6]

Subsequent to the decline in preferenced trading, orders that would have been preferenced to the non-NYSE markets for execution are now executed on the NYSE. One important question is whether or not these orders are better off left on the NYSE. We address this issue by examining execution costs on the NYSE around decimalization. Table 7 compares ESPD, RSPD, and IAC on the NYSE around decimalization.

In June and December 2000, before decimalization, NYSE's ESPD and RSPD are significantly lower than non-NYSE markets for large-cap stocks. For medium- and small-cap stocks in the same month, while there is no significant difference in ESPD, RSPD is significantly lower on the NYSE. In February and August 2001, after decimalization, both spreads are significantly lower on the NYSE for all three portfolios with only one exception. We conclude that execution costs are lower for trades executed on the NYSE throughout the period under our investigation. Therefore, orders that would have been routed to non-NYSE markets through preferencing agreements are better off on average in terms of execution cost by being traded on the NYSE as preferenced trading declines.

[Insert Table 7]

4.4. Robustness check

For a further robustness check, we examine 95 NYSE stocks that are decimalized in the pilot program in December 2000. After applying the same filter rules for our main sample to the stocks in the pilot program, we obtain 47 stocks. We then construct a matched sample of 47 stocks from stocks that have not been decimalized.[8] We compute the changes in quote competition intensity, preferenced trading, and market quality for both groups of stocks. The results are presented in Table 8. These results show that the largest improvements in quote competition, as well as the largest decline in preferenced trading and the largest improvement in market quality, occur immediately after decimalization between November 2000 and January 2001 for the pilot stocks. Thus, our results are robust to different samples.

[Insert Table 8]

5. Conclusions

We examine the change in preferenced trading around decimalization for NYSE-listed stocks. We find continued decrease in preferenced trading activity and continued improvement in quote competition in the half-year before and half-year after the NYSE goes decimal. This finding suggests that the market starts to adjust trading strategy and

[8] The 1,291 NYSE-listed stocks that we use to select our sample are grouped into ten portfolios based on market capitalization in November 2000. Subsequently, we match each pilot stock to a corresponding portfolio, and then select a stock from the portfolio that most closely matches the pilot stock's return volatility. We also select the matched sample using market capitalization and relative tick, defined as tick size divided by price. The results are qualitatively the same.

behavior in anticipation of decimalization and continues to adjust over a relatively long period of time after decimalization is implemented. The estimated total magnitude of decline in preferenced trading activity during our study period is as high as 22% for the largest NYSE stocks. Although this number is significantly higher than the 3% decline that Chung, Chuwonganant, and McCormick (2004) report for Nasdaq stocks, it is largely consistent with the view that preferenced trading has survived decimalization.

We find a significantly negative correlation between reduction in preferenced trading and the changes in quote competition. We also find a significantly positive correlation between the changes in preferenced trading and the changes in spreads. We further find that abnormal changes in information asymmetry cost for NYSE trades are positively correlated with the changes in preferenced trading, suggesting greater incremental decline in information asymmetry costs on the NYSE when preferenced trading declines, which is consistent with the cream skimming hypothesis.

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Figure 1
Preferenced trading activity around decimalization

Cross-sectional average of preferencing activity in three periods around decimalization for the sample of 300 NYSE-listed stocks based on market capitalization in June 2000. Preferencing activity is measured using the following proxy variable:

$$\text{PREF} = \frac{\text{Non-NYSE small-sized trade volume when NYSE on NBBO alone}}{\text{Total small-sized trade volume when NYSE on NBBO alone}} \quad (1)$$

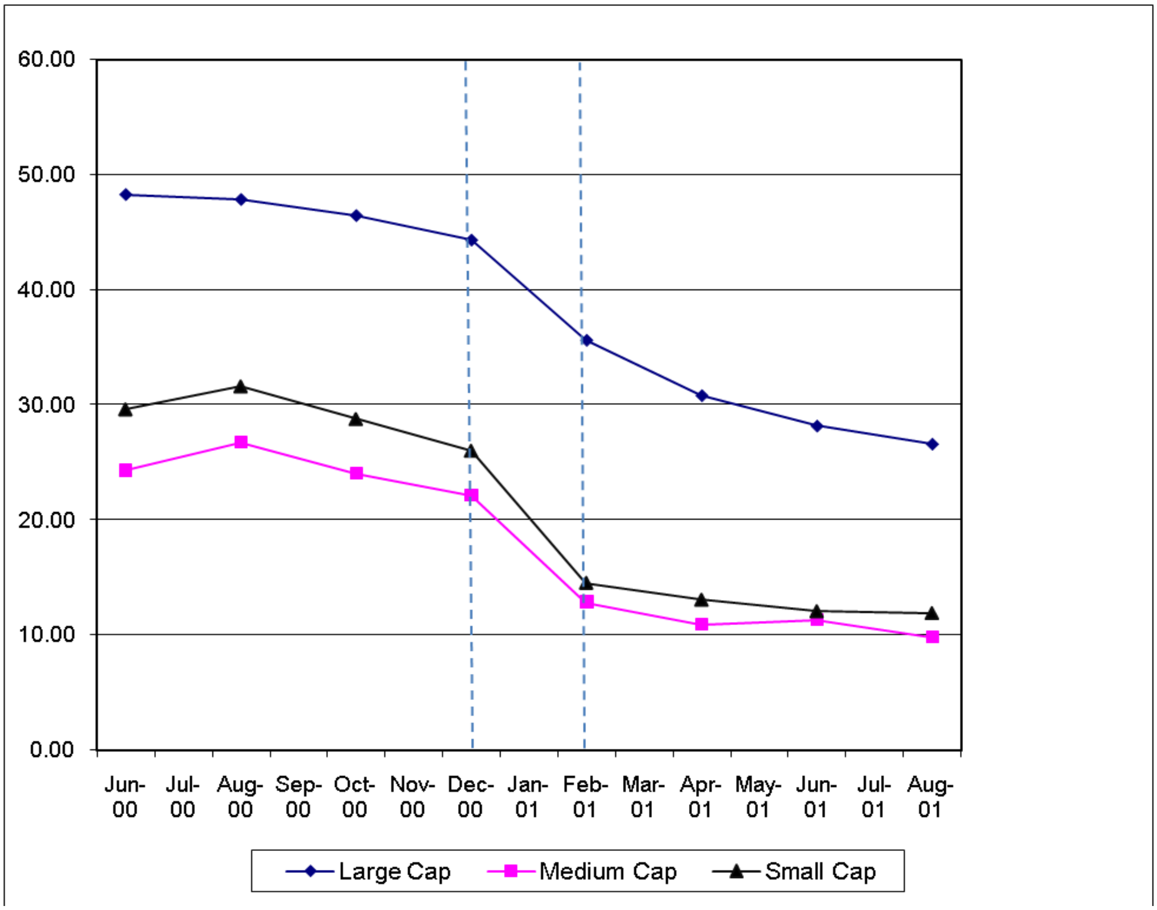

Table 1
Sample statistics

This table reports the mean and median values in June 2000 for the sample of 300 NYSE-listed stocks based on market capitalization in June 2000. Small-sized trades are those of less than 500 shares, medium-sized trades are those between 500 and 5,000 shares, and large-sized trades are those exceeding 5,000 shares.

	Large cap.		Medium cap.		Small cap.	
	Mean	Median	Mean	Median	Mean	Median
Market capitalization (million dollars)	66,384	39,228	2,131	2,021	462	452
Trading volume (million shares)	92.60	68.25	8.27	5.81	6.82	1.88
Small-sized volume as percent of consolidated volume	5.39	4.84	9.76	8.11	10.89	9.62
Medium-sized volume as percent of consolidated volume	32.78	33.15	48.22	49.76	48.41	51.27
Large-sized volume as percent of consolidated volume	61.83	61.79	42.03	40.77	40.70	39.97
Small-sized volume as percent of NYSE volume	3.52	2.94	9.05	7.27	10.45	8.80
Medium-sized volume as percent of NYSE volume	31.59	32.56	48.08	50.80	48.22	49.92
Large-sized volume as percent of NYSE volume	64.89	64.34	42.87	40.73	41.33	41.10
Average trading price (dollars)	53.58	51.18	33.79	29.81	21.89	19.09
Average trading size (shares)	1,894	1,817	1,288	1,183	1,228	1,041
Trade-to-trade return volatility (x1000)	0.0017	0.0011	0.0115	0.0040	0.0351	0.0135

Table 2
Change in quote competition intensity and preferencing activity around decimalization

This table reports the change in quote competition intensity and change in preferencing activity calculated by subtracting beginning month from ending month in each sub-period around decimalization for the sample of 300 NYSE-listed stocks based on market capitalization in June 2000. Quote competition intensity is measured using logged frequency of quote revision (FRQ) and logged length of time a quote stays on the NBBO, that is, duration of NBBO quotes (DUR). Preferencing activity is measured using the following proxy.

$$\text{PREF} = \frac{\text{Non-NYSE small-sized trade volume when NYSE on NBBO alone}}{\text{Total small-sized trade volume when NYSE on NBBO alone}} \qquad (1)$$

where small-sized trades are trades of less than 500 shares.

	Pre-Decimalization (June 2000 – Dec. 2000)	Decimalization (Dec. 2000 – Feb. 2001)	Post-Decimalization (Feb. 2001 – Aug. 2001)
Large cap.			
ΔFRQ	0.1065 ***	0.1219 ***	0.3762 ***
ΔDUR	-0.1574 ***	-0.4724 ***	-0.0939 ***
$\Delta NNMS_A$ (%)	-3.9503 ***	-8.6837 ***	-9.0061 ***
Medium cap.			
ΔFRQ	0.2338 ***	0.4545 ***	0.4551 ***
ΔDUR	-0.2604 ***	-0.6454 ***	-0.1903 ***
$\Delta NNMS_A$ (%)	-2.1733 *	-9.2556 ***	-3.0500 ***
Small cap.			
ΔFRQ	0.2800 ***	0.6032 ***	0.6270 ***
ΔDUR	-0.3591 ***	-0.7658 ***	-0.4561 ***
$\Delta NNMS_A$ (%)	-3.6024 **	-11.4859 ***	-2.6311 ***

***, **, * indicates significance at the 1%, 5%, and 10% levels, respectively.

Table 3
Interaction between preferencing activity and quote competition intensity

This table reports the regression results from the following regression model in each of the three periods around decimalization.

$$\Delta DUR = a_1 + a_2{*}\Delta PREF + a_3{*}\Delta 1/PRICE + a_4{*}\Delta ATS + a_5{*}\Delta VOL + a_6{*}\Delta STD + a_7{*}MCap + a_8{*}SCap + \varepsilon \quad (2)$$

where Δ denotes the differences calculated by subtracting beginning month from ending month in each period; DUR is a quote competition intensity proxy variable, defined as the length of time a quote stays on the NBBO, that is, the duration of NBBO quotes; PREF is the preferencing activity proxy variable; PRICE is the natural log of average trading price. ATS is the natural log of average trading size; VOL is the natural log of trading volume; STD is the standard deviation of quoted middle point returns; MCap (SCap) is the dummy variable, which equals one for medium-cap stocks (small-cap stocks). Numbers in the parentheses are standardized coefficients.

	Pre-Decimalization (June 2000 – Dec. 2000)	Decimalization (Dec. 2000 – Feb. 2001)	Post-Decimalization (Feb. 2001 – Aug. 2001)
ΔPREF	0.0052	0.0045	0.0091
	(0.2063)	(0.1358)	(0.1485)
	***	***	***
Δ1/PRICE	1.0562	1.5007	0.3804
	(0.3100)	(0.3324)	(0.0911)
	***	***	**
ΔATS	0.6770	0.4500	0.8094
	(0.6797)	(0.4129)	(0.6259)
	***	***	***
ΔVOL	-0.6226	-0.4198	-0.6541
	(-0.8825)	(-0.5611)	(-0.8258)
	***	***	***
ΔSTD	-0.0036	0.0049	0.0023
	(-0.0639)	(0.0703)	(0.0264)
MCap	-0.0347	-0.1300	-0.1385
	(-0.0497)	(-0.1842)	(-0.1426)
		***	***
Scap	-0.1638	-0.1962	-0.3324
	(-0.2351)	(-0.2779)	(-0.3423)
	***	***	***
Adj-R^2	0.5840	0.3376	0.6232

***, **, * indicates significance at the 1%, 5%, and 10% levels, respectively.

Table 4
Market quality around decimalization

This table reports cross-sectional average changes in effective half-spreads (ESPD), realized half-spreads (RSPD), and information asymmetry cost (IAC) in three periods around decimalization for the sample of 300 NYSE-listed stocks based on market capitalization in June 2000. ESPD, RSPD, and IAC are defined as follows.

$$ESPD_t = I_t * (P_t - M_t)/M_t \quad (3)$$
$$RSPD_t = I_t * (P_t - M_{t+5})/M_t \quad (4)$$
$$IAC_t = ESPD_t - RSPD_t \quad (5)$$

where the differences are calculated by subtracting beginning month from ending month in each periods; I_t is a trade direction variable that equals one for customer-initiated buys and negative one for customer-initiated sells; P_t is the trading price; M_t is the midpoint of the NBBO quotes at the time of trade *t*; and M_{t+5} is the midpoint of the NBBO quotes five minutes after the trade at time *t*.

	Pre-Decimalization (June 2000 – Dec. 2000)	Decimalization (Dec. 2000 – Feb. 2001)	Post-Decimalization (Feb. 2001 – Aug. 2001)
Large cap.			
ΔESPD	-0.0101 ***	-0.0322 ***	-0.0028 **
ΔRSPD	-0.0021	-0.0201 ***	0.0053 **
As % of ΔESPD	21%	63%	-185%
ΔIAC	-0.0080 ***	-0.0121 ***	-0.0081 ***
As % of ΔESPD	79%	37%	285%
Medium cap.			
ΔESPD	0.0138	-0.1007 ***	-0.0175 ***
ΔRSPD	0.0150	-0.0688 ***	0.0035
As % of ΔESPD	108%	68%	-20%
ΔIAC	-0.0012	-0.0319 ***	-0.0211 ***
As % of ΔESPD	-8%	32%	120%
Small cap.			
ΔESPD	0.0299	-0.1901 ***	-0.0354 ***
ΔRSPD	0.0216	-0.1533 ***	-0.0147
As % of ΔESPD	72%	81%	42%
ΔIAC	0.0083	-0.0368 ***	-0.0207 ***
As % of ΔESPD	28%	19%	58%

***, **, * indicates significance at the 1%, 5%, and 10% levels, respectively.

Table 5
Impact from changing preferencing activity and quote competition on realized spreads

This table reports the regression results from the following in each of the three periods around decimalization.

$$\Delta RSPD = a_1 + a_2*\Delta PREF + a_3*\Delta DURres + a_4*\Delta 1/PRICE + a_5*\Delta ATS + a_6*\Delta VOL + a_7*\Delta MedSize + a_8*\Delta STD + a_9*MCap + a_{10}*SCap + \kappa \qquad (6)$$

where the differences are calculated by subtracting beginning month from ending month in each periods; RSPD is realized half-spreads as defined in equation (6); PREF is the preferencing activity proxy variables; DURres is a measure of quote competition intensity unrelated to preferenced trading, which is the error term from equation (3); PRICE is natural log of average trading price. ATS is the natural log of average trading size; VOL is the natural log of trading volume; MedSize is the medium-sized trading volume as a percentage of the total trading volume; STD is the standard deviation of quoted middle point returns; MCap (SCap) is the dummy variable, which equals one for medium-cap stocks (small-cap stocks). Numbers in the parentheses are standardized coefficients.

	Pre-Decimalization (June 2000 – Dec. 2000)	Decimalization (Dec. 2000 – Feb. 2001)	Post-Decimalization (Feb. 2001 – Aug. 2001)
ΔPREF	0.0024	0.0018	0.0014
	(0.2604)	(0.1102)	(0.1848)
	***	***	***
ΔDURres	0.0557	0.0522	0.0219
	(0.2106)	(0.0903)	(0.1211)
	***	**	***
Δ1/PRICE	0.9935	1.6918	0.3820
	(0.8102)	(0.7537)	(0.7487)
	***	***	***
ΔATS	0.0147	-0.0906	0.0117
	(0.0410)	(-0.1672)	(0.0739)
		**	
ΔVOL	-0.0476	0.0178	-0.0093
	(-0.1873)	(0.0478)	(-0.0957)
	***		**
ΔMedSize	0.0003	-0.0009	0.0001
	(0.0248)	(-0.0557)	(0.0066)
ΔSTD	0.0003	0.0035	0.0005
	(0.0143)	(0.1007)	(0.0484)
		***	
MCap	0.0073	-0.0232	-0.0049
	(0.0289)	(-0.0660)	(-0.0416)
Scap	-0.0236	-0.0245	-0.0292
	(-0.0941)	(-0.0697)	(-0.2460)
	***		***
Adj-R^2	0.6894	0.6566	0.6331

***, **, * indicates significance at the 1%, 5%, and 10% levels, respectively.

Table 6
Change in preferenced trading and abnormal change in information asymmetry on the NYSE

This table reports the regression results for the regression model as follows:

$$\Delta AIAC = a_1 + a_2{*}\Delta PREF + a_3{*}\Delta 1/PRICE + a_4{*}\Delta ATS + a_5{*}\Delta VOL + a_6{*}\Delta MedSize + a_7{*}\Delta STD + a_8{*}MCap + a_9{*}SCap + \mu \quad (7)$$

where the differences are calculated by subtracting beginning month from ending month in each periods; AIAC is abnormal change in information asymmetry on the NYSE defined as the difference between change in information asymmetry costs for trades on the NYSE and change in information asymmetry cost for all trades; PREF is the preferencing activity proxy variable; PRICE is the natural log of average trading price. ATS is the natural log of average trading size; VOL is the natural log of trading volume; MedSize is the medium-sized trading volume as a percentage of the total trading volume; STD is the standard deviation of quoted middle point returns; MCap (SCap) is the dummy variable, which equals one for medium-cap stocks (small-cap stocks). Numbers in the parentheses are standardized coefficients.

	Pre-Decimalization (June 2000 – Dec. 2000)	Decimalization (Dec. 2000 – Feb. 2001)	Post-Decimalization (Feb. 2001 – Aug. 2001)
ΔPREF	0.0003	0.0004	0.0004
	(0.2602)	(0.2876)	(0.2419)
	***	***	***
Δ1/PRICE	0.0105	-0.0569	-0.0136
	(0.0630)	(-0.3088)	(-0.1176)
		***	**
ΔATS	-0.0017	-0.0091	-0.0008
	(-0.0340)	(-0.2043)	(-0.0231)
		*	
ΔVOL	0.0027	0.0080	0.0006
	(0.0792)	(0.2616)	(0.0285)
		***	
ΔMedSize	0.0001	-0.0001	0.0001
	(0.0721)	(-0.0516)	(0.0865)
ΔSTD	0.0003	0.0003	0.0003
	(0.1183)	(0.0926)	(0.1376)
	**	*	**
MCap	-0.0078	-0.0029	-0.0001
	(-0.2269)	(-0.1003)	(-0.0022)
	***		
Scap	-0.0044	-0.0048	-0.0010
	(-0.1272)	(-0.1654)	(-0.0359)
	*	**	
Adjusted R^2	0.1131	0.1755	0.0636

***, **, * indicates significance at the 1%, 5%, and 10% levels, respectively.

Table 7
A comparison of market quality: NYSE vs. Non-NYSE

This table reports the effective half-spreads, realized half-spreads, and information asymmetry costs for trades executed on the NYSE and trades executed on non-NYSE markets around decimalization for the sample of 300 NYSE-listed stocks based on market capitalization in June 2000.

	Pre-Decimalization						Post-Decimalization					
	June 2000			Dec. 2000			Feb. 2001			Aug. 2001		
	NYSE	Non-NYSE	Diff.	NYSE	Non-NYSE	Diff.	NYSE	Non-NYSE	Diff.	NYSE	Non-NYSE	Diff.
Large cap.												
ESPD	0.0718	0.1062	-0.0343***	0.0702	0.0862	-0.0160***	0.0343	0.0564	-0.0221***	0.0283	0.0550	-0.0267***
RSPD	0.0177	0.0631	-0.0454***	0.0163	0.0587	-0.0424***	0.0024	0.0371	-0.0347***	0.0029	0.0446	-0.0417***
IAC	0.0542	0.0431	0.0111***	0.0539	0.0275	0.0264***	0.0319	0.0193	0.0126***	0.0254	0.0104	0.0150***
IAC as % of ESPD	75%	41%	35%	77%	32%	45%	93%	34%	59%	90%	19%	71%
Medium cap.												
ESPD	0.1612	0.1807	-0.0195	0.1744	0.1915	-0.0171	0.0714	0.0962	-0.0248***	0.0527	0.0798	-0.0271***
RSPD	0.0414	0.1350	-0.0936***	0.0568	0.1455	-0.0887***	0.0041	0.0680	-0.0639***	0.0049	0.0752	-0.0703***
IAC	0.1198	0.0457	0.0742***	0.1175	0.0460	0.0716***	0.0673	0.0282	0.0391***	0.0478	0.0046	0.0432***
IAC as % of ESPD	74%	25%	49%	67%	24%	43%	94%	29%	65%	91%	6%	85%
Small cap.												
ESPD	0.3458	0.3671	-0.0213	0.3719	0.3991	-0.0273	0.1859	0.2017	-0.0158	0.1488	0.1928	-0.0440*
RSPD	0.1950	0.2932	-0.0982***	0.2105	0.3192	-0.1087***	0.0678	0.1453	-0.0775***	0.0505	0.1667	-0.1162***
IAC	0.1508	0.0739	0.0769***	0.1614	0.0800	0.0814***	0.1181	0.0564	0.0617***	0.0983	0.0261	0.0722***
IAC as % of ESPD	44%	20%	23%	43%	20%	23%	64%	28%	36%	66%	14%	53%

***, **, * indicates significance at the 1%, 5%, and 10% levels, respectively.

Table 8
Robustness test using pilot stocks

This table reports the changes in frequency of quote revision (FRQ), length of time on NBBO (DUR), effective half-spreads (ESPD), realized half-spreads (RSPD), information asymmetry costs (IAC), preferenced trading (PREF) for a sample of 47 stocks that are decimalized in December 2000. The matched non-decimalized sample stocks are selected based on market cap and trade-to-trade return volatility in November 2000. Each pilot stock is matched with one stock from the pool of 1,291 NYSE-listed stocks that have not been decimalized in December 2000 and are in the same market cap decile with the smallest difference in return volatility. For the pilot stocks, June 2000 to November 2000 period is the pre-decimalization period, November 2000 to January 2001 is the decimalization period, and January 2001 to August 2001 is the post-decimalization period.
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	June 2000 – Nov. 2000			Nov. 2000 – Jan. 2001			Jan. 2001 – Aug. 2001		
	Decimalized	Matched	Difference	Decimalized	Matched	Difference	Decimalized	Matched	Difference
ΔFRQ	0.2437 ***	0.1850 ***	0.0587	0.4730 ***	0.2224 ***	0.2506 ***	0.5917 ***	0.8182 ***	-0.2265 **
ΔDUR	-0.2139 ***	-0.1775 ***	-0.0364	-0.6765 ***	-0.3130 ***	-0.3635 ***	-0.4398 ***	-0.7218 ***	0.2820 **
ΔESPD	0.0466	0.0148	0.0318	-0.1386 ***	-0.0424	-0.0962 **	-0.0284 **	-0.1490 ***	0.1206 ***
ΔRSPD	0.0199	-0.0179	0.0378	-0.0973 ***	-0.0141	-0.0832 **	0.0249	-0.0485 ***	0.0734 **
ΔIAC	0.0267	0.0328	-0.0061	-0.0413 **	-0.0283	-0.0130 *	-0.0533 ***	-0.1005 ***	0.0472 **
ΔPREF (%)	-1.7380	-3.7702 *	2.0322	-10.5747 ***	-2.7392	-7.8355 ***	-6.1903 ***	-11.5923 ***	5.4020 **

***, **, * indicates significance at the 1%, 5%, and 10% levels, respectively.