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Can the Treatment of Limit Orders Reconcile the Differences in Trading Costs between NYSE and Nasdaq Issues?

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Abstract

In this paper, we determine whether each bid (ask) quote reflects the trading interest of the specialist, limit order traders, or both for a sample of NYSE stocks in 1991. We then compare Nasdaq spreads with NYSE spreads that reflect the trading interest of the specialist. Our empirical results show that the average Nasdaq spread is significantly larger than the average NYSE specialist spread. We find that, on average, 49% of the difference between Nasdaq and specialist spreads is due to the differential use of even-eighth quotes between Nasdaq dealers and NYSE specialists. We also find that the NYSE specialist spread is significantly larger than the limit order spread, although NYSE specialists and limit order traders are similar in their use of even-eighth quotes.

I. Introduction

Numerous studies show that the spread of stocks traded on Nasdaq is larger than the spread of comparable stocks traded on the New York Stock Exchange (NYSE).[1] Christie and Huang (1994) and Barclay (1997) find that spreads become narrower when stocks move from Nasdaq to the NYSE. Christie and Schultz (1994) were the first to demonstrate that stocks listed on Nasdaq exhibit considerably fewer odd-eighth quotes than stocks on the NYSE. More importantly, Christie and Schultz show that the excess of Nasdaq spreads over NYSE spreads is due to the rarity of odd-eighth quotes for a large number of active Nasdaq stocks. These findings led some researchers to believe that Nasdaq dealers have implicitly colluded to set larger spreads than their counterparts on the NYSE by avoiding odd-eighth quotes.

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[1]See, for example, Goldstein (1993), Christie and Huang (1994), Christie and Schultz (1994), Huang and Stoll (1996), Barclay (1997), and Bessembinder and Kaufman (1997a).

Although the Department of Justice (DOJ) did not bring criminal charges against Nasdaq dealers, both the DOJ and the Securities and Exchange Commission (SEC) concluded that Nasdaq dealers had indeed engaged in anti-competitive behavior as hypothesized by Christie and Schultz (1994). Eventually more than 30 lawsuits were filed (which were ultimately consolidated into one class action lawsuit) against Nasdaq dealers for fixing and maintaining supra-competitive levels of spreads. While the defendants settled the lawsuit for a record $1.027 billion, they argued that the clustering of quotes at the even-eighth resulted from "permissible conscious parallelism."

Demsetz (1997) suggests that the excess of Nasdaq spreads over NYSE spreads may not necessarily be an indication of collusion among Nasdaq dealers. Demsetz holds that the difference in spreads between NYSE and Nasdaq stocks may be due to the different ways the NYSE and Nasdaq handle limit orders. On the NYSE, both specialists and limit order traders establish the bid-ask spread. The NYSE specialists must reflect in their quotes the highest bid price and the lowest ask price posted in the limit order book when these limit prices better their own quotes. Chung, Van Ness, and Van Ness (1999) find that limit orders play a significant role in reducing quoted spreads on the NYSE.[2]

In contrast, until 1997, Nasdaq limit orders were treated as offers to dealers, not as offers to the general public. Limit orders on Nasdaq were neither exposed to the rest of the market nor executed against incoming market orders, thereby increasing the chance that the limit order would only be executed if prices moved against the limit order. In general, prices set by Nasdaq dealers were the only quotes available to the public. Limit orders, like market orders, were executed against the dealer's quote and waited until the quote reached the limit price. Hence, limit order traders on the Nasdaq system did not compete with market makers as they did on the NYSE.[3]

In short, spreads on Nasdaq were set exclusively by dealers, while NYSE spreads were set by both specialists and limit order traders. Thus, it would be reasonable to expect that, ceteris paribus, Nasdaq spreads would be larger than NYSE spreads even in the absence of the alleged collusion.[4] Hence, as pointed out by Demsetz (1997), p. 92 a comparison of spreads set by Nasdaq dealers

[2]Most theoretical work on market microstructure does not consider the role of limit order traders in the analysis. (See Stoll (1978), Amihud and Mendelson (1980), Copeland and Galai (1983), Ho and Stoll (1980), (1981), (1983), Glosten and Milgrom (1985), Glosten (1989), and Easley and O'Hara (1992).) Only recently have researchers begun to study the various aspects of limit order trading. Glosten (1994) considers two types of traders, those who trade by limit orders and those who trade by market orders, but does not endogenize the trader's decision to use a limit or market order. Handa and Schwartz (1996) extend Glosten's analysis by examining the investor's optimal choice between a market and limit order.

[3]Recent Securities and Exchange Commission (SEC) rules introduce competition from limit orders into the Nasdaq market. The first SEC rule, known as the Limit Order Display Rule, requires that market makers display investors' limit orders in their quotes when they are priced better than the market maker quote. The second SEC rule, known as the Quote Rule, requires market makers to publicly display their most competitive quotes. Previously, market makers placed orders that may have been priced more favorably than their public quotes on proprietary systems. Private system prices were only available to financial professionals. We discuss the implications of these rules later in the paper.

[4]We note that this argument will not hold if competition among Nasdaq dealers drives spreads to competitive levels or if dealers and limit order traders face different costs. In addition, the Demsetz argument cannot explain the absence of odd-eighth quotes.

with spreads set by NYSE specialists for similar stocks *"when these specialists trade for their own account"* provides a more direct test of anti-competitive dealer behavior. This comparison has not been made in the previous studies of dealer collusion and it is the purpose of this study to perform such a comparison.

In this paper, we determine whether each bid (ask) quote originates from the specialist, the limit order book, or both for a sample of NYSE stocks. If the quote reflects the trading interest of the specialist, we categorize it as a "specialist quote." If the quote originates from the limit order book, we categorize it as a "limit order quote." If the quote reflects the trading interest of both the specialist and limit order traders, we classify it as a "mixed quote." We then match each stock in our NYSE sample with a similar stock on Nasdaq and perform a pairwise comparison of the specialist spread with the Nasdaq spread.

We also compare the relative frequency of even-eighths between specialist quotes and limit order quotes to determine whether NYSE specialists and limit order traders differ in their use of even-eighth quotes. Similarly, we compare the relative use of even-eighth quotes by NYSE specialists and Nasdaq dealers to determine whether the difference in the frequency of even-eighth quotes can explain the difference in spreads between the two markets.

Our empirical results show that although the NYSE specialist spread is significantly greater than the limit order spread, the former is significantly smaller than the spread of comparable Nasdaq stocks. We find that the use of even-eighth quotes by NYSE specialists is not materially different from that by limit order traders. However, we find the use of even-eighth quotes to be more prevalent among Nasdaq dealers than NYSE specialists. Our empirical results indicate that the larger Nasdaq spread is due, at least in part, to a more frequent use of even-eighth quotes by Nasdaq dealers. Thus, our results do not support Demsetz's (1997) conjecture that the difference in spreads between Nasdaq and NYSE stocks may be due to the different ways the NYSE and Nasdaq treat limit orders.

Our results indicate, however, that the excess of Nasdaq spreads over NYSE spreads is greater than the level implied by the more frequent use of even-eighths among Nasdaq dealers alone. Our empirical results suggest that there are other factors (e.g., internalization and preferencing) that determine the difference between specialist spreads and dealer spreads. In this respect, the present study bridges an important gap between two previous studies of trading costs. Christie and Schultz (1994) suggest that the excess of Nasdaq spreads over NYSE spreads can largely be attributed to anti-competitive dealer behavior. In contrast, Huang and Stoll (1996) argue that the differential spread between NYSE and Nasdaq stocks is due to structural differences between the two markets. According to the results of the present study, the truth contains important elements from each of these studies.

The paper is organized as follows. Section II describes the data and our stock matching procedure. Section III explains our quote classification algorithm. Section IV compares NYSE specialist spreads with Nasdaq dealer spreads. Section V examines whether NYSE specialists and Nasdaq dealers differ in their use of even-eighth quotes and whether the different use of even-eighth quotes can explain differential spreads. Section VI concludes the paper.

II. Data Source and Sample Selection

A. Data Source

To compare the spread between NYSE and Nasdaq stocks, we use a paired sample of NYSE and Nasdaq stocks. The data for NYSE stocks are obtained from the NYSE's TORQ (Trades, Orders, Reports, and Quotes) database. This database contains detailed information on consolidated transactions, quotes, the NYSE audit trail, and NYSE orders that are handled by the automated SuperDOT system.[5] The data cover 144 randomly selected stocks traded on the NYSE from November 1990 through January 1991. The data are restricted to standard (non-tick-sensitive) market and limit orders. For this study, we use data from the quote, trade, and order files. We use the TORQ database primarily because it contains data that allow us to partition NYSE quotes into those reflecting the specialist's trading interest and those originating from the limit order book.[6] The data for Nasdaq stocks are obtained from the Institute for the Study of Security Markets (ISSM).

B. Sample Selection

We use only those stocks in the TORQ database with at least one transaction per day during the study period to minimize stale quotes in our study sample. In addition, we delete stocks with a large number of quotes that are not in multiples of \$1/8 as we seek to examine the difference in the use of even-eighth quotes among NYSE specialists, limit order traders, and Nasdaq dealers.[7] These sample selection criteria yield a final study sample of 100 NYSE stocks. The ISSM Nasdaq file includes data on 6,058 stocks. We delete Nasdaq stocks with a fifth letter identifier in the ticker symbol because the fifth letter refers to an American Depository Receipt or a stock with several classes.

As in Huang and Stoll (1996), we apply the following filters to further minimize data errors:

i) we exclude bid-ask quotes if the spread is greater than \$4 or less than zero,

ii) we exclude before-the-open and after-the-close trades and quotes,

iii) we exclude trade price p_t when $|(p_t - p_{t-1})/p_{t-1}| > 0.10$,

iv) we exclude ask quote a_t when $|(a_t - a_{t-1})/a_{t-1}| > 0.10$, and

v) we exclude bid quote b_t when $|(b_t - b_{t-1})/b_{t-1}| > 0.10$.

[5]For a detailed description of the database, see Hasbrouck (1992) and Hasbrouck et al. (1993).

[6]Although the TORQ database is the best database available for the task at hand, we note its limitations. First, it covers only 144 stocks and includes only orders submitted to the NYSE. Second, it includes only orders submitted through the electronic routing systems. Orders that are hand-carried to the specialist's post are not captured. Considering the large number and size of orders submitted by floor traders, our data might not be representative of the whole population.

[7]We find that eight stocks in the TORQ database have a large number of quotes that are not multiples of one-eighth. These are all low-price stocks traded at prices under \$1. Note that the minimum price variation on the NYSE (Rule 62) was \$1/8 for stocks priced at and above \$1, \$1/16 for stocks under \$1 and at or above \$0.25, and \$1/32 for stocks under \$0.25. The list of these stocks is available from the authors upon request.

We match each stock in the TORQ database with its counterpart in the Nasdaq file utilizing four stock attributes—share price, number of trades, trade size, and return volatility—that are believed to determine the inter-stock difference in spreads.[8] Our matching procedure differs from those used by Huang and Stoll (1996), Bessembinder and Kaufman (1997a), (1997b), and Bessembinder (1999). Huang and Stoll (1996) match stocks based on the two-digit industry code and firm characteristics identified by Fama and French (1992) as correlated with expected stock returns (i.e., share price, leverage, market value of equity, and the ratio of book-to-market value of equity). Bessembinder and Kaufman (1997a), (1997b) and Bessembinder (1999) match stocks using market capitalizations. In contrast, we match stocks on the basis of stock attributes that are strongly associated with spreads. Our goal is to obtain a matching sample of TORQ and Nasdaq stocks with similar attributes and test for a difference in spreads.

We measure share price by the mean value of the midpoints of quoted bid and ask prices and return volatility by the standard deviation of daily returns calculated from the daily closing midpoints of bid and ask prices. We measure trade size by the average dollar transaction during the study period. We recognize that the reported number of trades on Nasdaq is not directly comparable to that on the NYSE because there are many inter-dealer trades on Nasdaq.[9] Because inter-dealer trades exaggerate the reported volume, Nasdaq volume tends to be larger than the NYSE volume. We also note that the TORQ database includes only orders submitted through the electronic routing systems. Orders that are hand-carried to the specialist's post are not captured. Despite these drawbacks, but for lack of better alternatives, we use NYSE and Nasdaq volume to match stocks between the two markets.

To obtain a matching sample of NYSE and Nasdaq stocks, we first calculate the following score for each NYSE stock using our entire study sample of Nasdaq stocks,

$$(1) \qquad \sum \left[\left(Y_i^N - Y_i^T \right) / \left\{ \left(Y_i^N + Y_i^T \right) / 2 \right\} \right]^2,$$

where Y_i represents one of the four stock attributes, N and T refer to Nasdaq and TORQ, respectively, and $\sum$ denotes the summation over $i = 1$ to 4. We then, for each TORQ stock, select a Nasdaq stock with the smallest score. This procedure results in 100 pairs of NYSE and Nasdaq stocks that are similar in price, number of trades, trade size, and return volatility. (See the Appendix for the ticker symbols of these 100 matching pairs of stocks.)

We report summary statistics of our matched data in Table 1. The average price of our Nasdaq sample is \$21.96 and the corresponding figure for our NYSE sample is \$22.99. The average numbers of transactions and trade size for the Nasdaq sample are 5,508 and \$34,945, respectively, and the corresponding figures for the NYSE sample are 6,835 and \$36,319. The mean values of the standard

[8]See, for example, Demsetz (1968), Benston and Hagerman (1974), Stoll (1978), McInish and Wood (1992), and Huang and Stoll (1996).

[9]Nasdaq uses the same volume counting rules as the NYSE. Every time a trade occurs, either between two market makers, a market maker and a customer, or two customers, it is counted as one trade. The factor that makes it difficult to compare volumes of the two markets is the inter-dealer trading on Nasdaq.

deviation of daily returns for our Nasdaq and NYSE stocks are 0.0245 and 0.0208, respectively.[10]

TABLE 1

Descriptive Statistics for 100 Matching Pairs of NYSE and Nasdaq Stocks

				Percentile				
Variable	Exchange	Mean	Std. Dev.	Min	25	50	75	Max
Share price ($)	NYSE	22.99	16.65	3.93	11.35	19.59	28.57	113.32
	Nasdaq	21.96	13.18	3.83	12.11	20.08	30.43	77.30
No. of trades	NYSE	6835	13863	474	1299	2557	4803	74271
	Nasdaq	5508	9940	379	1198	2315	4541	60332
Trade size ($)	NYSE	36319	32534	2991	12660	27407	49455	195492
	Nasdaq	34945	25712	3990	14333	28056	47352	116859
Return volatility	NYSE	0.0208	0.0099	0.0061	0.0144	0.0193	0.0246	0.0564
	Nasdaq	0.0245	0.0094	0.0073	0.0182	0.0235	0.0280	0.0545
Volume ($) (in thousands)	NYSE	495360	1507000	2976	17803	70773	189230	11790000
	Nasdaq	339180	887380	2716	19537	68753	172280	5563200

To obtain a matching sample of NYSE (TORQ) and Nasdaq stocks, we first calculate the following score for each NYSE stock using our entire study sample of Nasdaq stocks: $\sum[(Y_i^N - Y_i^T)/\{(Y_i^N + Y_i^T)/2\}]^2$, where Y_i ($i = 1$ to 4) represents one of the four stock attributes (i.e., share price, number of trades, trade size, and return volatility), N and T refer to Nasdaq and TORQ, respectively, and $\sum$ denotes the summation over $i = 1$ to 4. We then, for each TORQ stock, pick a Nasdaq stock with the smallest score. This procedure results in 100 pairs of NYSE and Nasdaq stocks that are similar in price, number of trades, trade size, and return volatility. We measure share price by the mean value of the midpoints of all quoted bid and ask prices, and trade size by the average dollar transaction size during the study period. The number of trades is the total number of transactions during the study period. We measure return volatility by the standard deviation of daily returns calculated from the daily closing midpoints of bid and ask prices. Volume is the total dollar trading volume during the study period.

We regress the percentage spread against the four stock attributes to assess whether these attributes are important determinants of the cross-sectional variation in the spread for our sample of stocks. We use the log of share price, number of trades, and trade size in the regressions as the distribution of these variables is skewed. We present the regression results in Table 2. The results show that both Nasdaq and NYSE spreads are strongly related to the four stock attributes in the predicted manner. The spread is negatively related to share price, the number of trades, trade size, and positively related to return volatility. These variables account for 86% of the cross-sectional variation in NYSE spreads and 78% of the variation in Nasdaq spreads.

We also estimate the regression model using the differences in the variables (i.e., the spread and four stock attributes) between our NYSE and Nasdaq stocks. The results of this regression show whether there exists any difference in spreads between our NYSE and Nasdaq stocks, after controlling for their differences in share price, number of trades, trade size, and risk. The regression results, reported in Table 2, indicate that there is a significant difference in spreads between our NYSE and Nasdaq stocks. The highly significant and positive intercept suggests that the average quoted spread for our sample of Nasdaq stocks is larger than the average quoted spread for the matching sample of NYSE stocks.

[10]We find that our NYSE and Nasdaq stocks are similar in their dollar trading volumes as well.

TABLE 2

Quality of the Matching Sample

Independent Variable	Regression Results Based on Level Variables		Regression Results Based on Differences in Variables between Nasdaq and NYSE
	NYSE Spread	Nasdaq Spread	
Intercept	0.0561 (10.68**)	0.1327 (10.95**)	0.0085 (8.84**)
log(share price)	−0.0071 (7.16**)	0.0004 (0.18)	−0.0097 (2.88**)
log(no. of trades)	−0.0009 (2.25*)	−0.0030 (3.43**)	0.0017 (0.44)
log(trade size)	−0.0019 (2.56*)	−0.0101 (5.28**)	0.0039 (1.16)
Return volatility	0.2741 (6.55**)	0.5970 (6.03**)	−0.0847 (0.60)
Adjusted-R^2	0.8611	0.7819	0.0531
F-value	154.48**	89.72**	2.39

To assess the quality of our matching sample, we use two regression models. First, we regress the spread against the four stock attributes using our sample of NYSE stocks and the matching sample of Nasdaq stocks. We use the log of share price, number of trades, and trade size in the regressions. The results from this regression help us assess whether the four stock attributes are important determinants of the cross-sectional variation in the spread for our sample of stocks. Second, we perform regression analysis using differences in the variables (the spread and four stock attributes) between our NYSE and Nasdaq stocks to determine whether there exists any difference in spreads between our Nasdaq and NYSE stocks, after controlling for their differences in share price, number of trades, trade size, and risk. We use the mean percentage spread for each stock in the regressions. The percentage spread for each quote is obtained by dividing the dollar spread (i.e., the difference between the ask and bid prices) by the midpoint of the bid and ask prices. We measure share price by the mean value of the midpoints of all quoted bid and ask prices, and trade size by the average dollar transaction size during the study period. The number of trades is the total number of transactions during the study period. We measure return volatility by the standard deviation of daily returns calculated from the daily closing midpoints of bid and ask prices. Absolute values of t-statistics are reported in parentheses.

*,**Significant at the 5% level and 1% levels, respectively.

III. Quote Origination Classification Procedure

A. Quote Origination Classification Scheme

Chung, Van Ness, and Van Ness (1999) develop an algorithm for determining whether a quote on the NYSE reflects the interest of the specialist, limit order traders, or both. We adopt the same algorithm and classify all bid (ask) quotes in our NYSE sample into one of the three categories: specialist quotes, limit order quotes, or mixed quotes. To determine whose interest is reflected in the quote, we partition each quoted depth into the depth provided by the specialist and the depth provided by limit order traders.

To determine the limit order depth for each posted bid (ask) quote, we compile all outstanding limit orders at the same bid (ask) price (i.e., matching orders). We compile the matching orders from order, execution, and cancellation records in the TORQ database. We obtain matching limit orders at any point in time by netting all prior executions and cancellations from the orders placed prior to the time in question. Matching orders are residual orders that are placed prior to the time in question and are neither executed nor canceled in their entirety as of the time in question.

If a bid (ask) quote has no matching limit orders, we categorize the quote as a specialist quote which we denote as quote class (S). Quote class (S) reflects cases where either the specialist alone has posted the bid (ask) or all limit orders are at prices inferior to the specialist bid (ask) price. If a bid (ask) quote has one or more matching limit orders, we compare the quoted depth (i.e., size) at the bid (ask) with the depth of the matching limit order(s). If the former is equal to the latter, we categorize the bid (ask) quote as the limit order bid (ask) quote, which we denote as quote class (L). If the quoted depth is greater than the depth of the matching limit order(s), then we categorize it as a mixed quote by both the specialist and limit order trader(s) and denote it as quote class (M). This is the case where the specialist adds depth to the limit order(s) at the limit order price.

By following this procedure, we classify each quoted spread into quote class (x, y) where x $(x = S, L, M)$ represents the quote class for the bid price and y $(y = S, L, M)$ represents the quote class for the ask price. For example, (S, S) represents the quote class when both the bid and ask prices are quotes by the specialist alone. Similarly, (L, M) represents the quote class when the bid price is from the limit order book and the ask price is a mixed quote by the specialist and limit order trader(s).

B. Distribution of Quoted Spreads by Quote Class

To examine the distribution of spreads by quote class, we use the following procedure. For each stock, we cluster posted bid-ask quotes into six groups according to their respective quote class. The first three groups include all quotes that belong to quote class (S, S), (L, L), and (M, M), respectively. The fourth group includes all those quotes that jointly belong to either quote class S or L, denoted (S, L). The fifth group includes all those quotes that jointly belong to either quote class S or M, denoted (S, M), and the last group includes all those quotes that jointly belong to either quote class L or M, denoted (L, M).

In addition, we define (S, A) as the quote class that includes all spread quotes in which at least one side of the quote is from the specialist alone. Similarly, quote class (L, A) includes all spread quotes in which at least one side of the quote is exclusively from the limit order book, and quote class (M, A) includes all spread quotes in which at least one side of the quote is the mixed quote. For each stock, we count the number of quotes in each of these quote groups. Finally, the number of quotes in each group is summed across our sample.

Table 3 shows the number of quotes in each quote class for our entire sample of NYSE stocks. The total number of sample quotes is 310,646. Among these quotes, 87,156 (28.06%) quotes originate solely from limit order traders on both sides of the quote. The number of quotes in which at least one side of the quote originates exclusively from limit order traders (i.e., quote class (L, A)) is 234,333 (75.54%). On the other hand, the number of posted spreads quoted exclusively by the specialist (i.e., quote class (S, S)) is only 16,382 (5.27%). The number of quotes in which at least one side of the quote originates exclusively from the specialist (i.e., quote class (S, A)) is 87,267 (28.09%).

In many instances, the specialist quotes for his own trading interest, but does so at the same price as the limit order price. The number of quotes in which the

TABLE 3

Number of NYSE Quotes by Quote Class

Quote Class	Number of Quotes (%)	
(S, S)	16382	(5.27%)
(S, L)	44189	(14.22%)
(S, M)	26696	(8.59%)
(L, L)	87156	(28.06%)
(L, M)	102988	(33.15%)
(M, M)	33235	(10.70%)
(S, A)	87267	(28.09%)
(L, A)	234333	(75.54%)
(M, A)	162919	(52.45%)
Total	310646	(100.00%)

We determine for our sample of NYSE stocks whether each bid (ask) quote is from the specialist, the limit order book, or both. If the quote reflects the trading interest of the specialist, we categorize it as a "specialist quote," and denote it as quote class (S). If the quote originates from the limit order book, we categorize it as a "limit order quote," and denote it as quote class (L). If the quote reflects the trading interest of both the specialist and limit order traders, we classify it a "mixed quote," and denote it as quote class (M). By following this procedure, we classify each quoted spread into quote class (x, y) where x $(x = S, L, M)$ represents the quote class for the bid price and y $(y = S, L, M)$ represents the quote class for the ask price. For each stock, we count the number of quotes in each of these quote groups. Finally, the number of quotes in each group is summed across our sample of stocks. We define (S, A), (L, A), and (M, A), respectively, as the quote class that includes all spread quotes in which at least one side of the quote is exclusively from the specialist, from the limit order book, and from both.

specialist adds depth to limit orders on both sides of the quote (i.e., quote class (M,M)) is 33,235 (10.7%). The number of quotes in which the specialist adds depth (in number of shares) to that of limit order traders on at least one side of the quote (i.e., quote class (M,A)) is 162,919 (52.45%).

Our results show that a significant portion of NYSE quotes reflects the interest of limit order traders. To the extent that spreads established by limit order traders differ from spreads reflecting specialist interest, a comparison of trading directly against intermediaries in both markets requires a comparison between Nasdaq spreads and NYSE spreads that reflect specialist interest.

IV. Specialist Spread, Limit Order Spread, and Dealer Spread

In this section, we test whether NYSE spreads differ between specialists and limit order traders. We then compare specialist spreads with Nasdaq spreads using our matching sample of NYSE and Nasdaq stocks to determine whether Nasdaq dealers set larger spreads than NYSE specialists for similar stocks.

We measure the specialist spread using only those quotes that reflect specialist interest in both the bid and the ask, i.e., quote classes (S,S), (S,M), and (M,M). This sample of specialist quotes includes 76,313 quotes, and biases our results in favor of Nasdaq since we exclude some of the narrower specialist quotes. For each NYSE stock, we first obtain the percentage spread for each quote in quote classes (S,S), (S,M), and (M,M) by dividing the dollar spread (i.e., the difference between the ask and bid prices) by the midpoint of the bid and ask prices. We then calculate the mean specialist spread for each stock using all the specialist's spreads during the study period. Similarly, we measure the limit order

spread using only those quotes that reflect the interest of limit order traders in both the bid and the ask, i.e., quote classes (L, L), (M, M), and (L, M).

We report in Table 4 the average specialist and limit order spreads for our whole sample and for each quartile based on share price, the number of trades, trade size, and return volatility. We also report the average spread for our Nasdaq stocks in the same format. The results show that the specialist spread is larger than the limit order spread across all quartiles of share price, the number of trades, trade size, and return volatility. For the whole sample, the average specialist spread (1.52%) is about 13% larger than the average limit order spread (1.34%). More importantly, Table 4 shows that the average spread (2.25%) of Nasdaq stocks is about 48% larger than the average spread (1.52%) for NYSE quotes that reflect the trading interest of specialists.[11] Indeed, we find these differences statistically significant according to our paired comparison t-test results reported in Table 5.[12]

TABLE 4

Specialist Spread, Limit Order Spread, and Nasdaq Spread

Quartile Based on		NYSE Spread			Nasdaq Spread
		Whole Sample	Specialist Spread	Limit Order Spread	
Share price	Q1	0.0259	0.0287	0.0248	0.0382
	Q2	0.0137	0.0145	0.0131	0.0227
	Q3	0.0108	0.0116	0.0101	0.0169
	Q4	0.0060	0.0061	0.0057	0.0120
No. of trades	Q1	0.0225	0.0251	0.0208	0.0319
	Q2	0.0151	0.0165	0.0144	0.0260
	Q3	0.0107	0.0110	0.0104	0.0196
	Q4	0.0081	0.0083	0.0081	0.0123
Trade size	Q1	0.0242	0.0271	0.0228	0.0375
	Q2	0.0154	0.0166	0.0148	0.0254
	Q3	0.0106	0.0110	0.0100	0.0162
	Q4	0.0061	0.0062	0.0060	0.0107
Return volatility	Q1	0.0094	0.0101	0.0091	0.0200
	Q2	0.0117	0.0128	0.0111	0.0164
	Q3	0.0137	0.0148	0.0126	0.0220
	Q4	0.0217	0.0232	0.0208	0.0314
Whole sample		0.0141	0.0152	0.0134	0.0225

This table reports the average specialist and limit order spreads for our whole sample and for each quartile based on share price, number of trades, trade size, and return volatility. We also report the average spread for our Nasdaq stocks in the same format. We measure the specialist spread using only those quotes that reflect specialist interest in both the bid and the ask, i.e., quote classes (S, S), (S, M), and (M, M). For each NYSE stock, we first obtain the percentage spread for each quote in these quote classes by dividing the dollar spread (i.e., the difference between the ask and bid prices) by the midpoint of the bid and ask prices. We then calculate the mean specialist spread for each stock using all the specialist's spreads during the study period. Similarly, we measure the limit order spread using only those quotes that reflect the interest of limit order traders in both the bid and the ask, i.e., quote classes (L, L), (M, M), and (L, M).

[11] Huang and Stoll (1996) find that the average spread of a sample of Nasdaq stocks is about twice as large as the average spread of a matched sample of NYSE stocks. According to our results, the average Nasdaq spread (2.25%) is about 60% larger than the average NYSE spread (1.41%). The difference between the two figures may be, at least in part, due to different matching procedures and time periods.

[12] An ideal analysis of the specialist's quote behavior would require data from a market without limit order traders as the presence of limit orders effectively censors the specialist quotation data. Hence, our proxy for the specialist spread is imperfect.

TABLE 5

Results of Paired Comparison *t*-Tests

Compared Pair	Mean	Std. Error	*t*-Statistic	*p*-Value
Specialist spread vs. limit order spread	0.0018	0.00022	8.23	0.0001
Nasdaq spread vs. NYSE spread	0.0084	0.00076	10.97	0.0001
Nasdaq spread vs. specialist spread	0.0072	0.00072	10.08	0.0001
Nasdaq spread vs. limit order spread	0.0091	0.00079	11.40	0.0001

This table reports the results of paired comparison *t*-tests for the following pairs of spreads: i) specialist spread and limit order spread, ii) Nasdaq spread and NYSE spread, iii) Nasdaq spread and specialist spread, and iv) Nasdaq spread and limit order spread. The tests show whether the mean difference is significantly different from zero. We measure the specialist spread using only those quotes that reflect specialist interest in both the bid and the ask. For each NYSE stock, we first obtain the percentage spread for each quote in quote classes (S, S), (S, M), and (M, M) by dividing the dollar spread (i.e., the difference between the ask and bid prices) by the midpoint of the bid and ask prices. We then calculate the mean specialist spread for each stock using all the specialist's spreads during the study period. Similarly, we measure the limit order spread using only those quotes that reflect the interest of limit order traders in both the bid and the ask. We calculate NYSE and Nasdaq spreads using all the quote classes.

To assess the sensitivity of our results, we calculate the average specialist spread using only those quotes that belong to quote class (S, S). The results show that the average spread for this quote class is 0.0156, which is only marginally greater than the mean value (0.0152) for the specialist spread as defined above. Hence, our finding of larger Nasdaq spreads in comparison to specialist spreads is robust and not sensitive to how we measure the specialist spread. On the whole, our results suggest that while NYSE specialists set larger spreads than those established by limit order traders, the former is still significantly smaller than spreads established by Nasdaq dealers for comparable stocks.

V. Use of Even-Eighths by Specialists, Limit Order Traders, and Dealers

A. Even-Eighth Quotes

Christie and Schultz (1994) show that the relative frequency of even-eighth quotes on Nasdaq is much higher than the corresponding figure on the NYSE. More significantly, the authors show that spreads of one-eighth are virtually nonexistent for a majority of the 100 most actively-traded Nasdaq issues and this lack of one-eighth spreads can largely be accounted for by the absence of odd-eighth quotes for 70 of the 100 stocks. Based on this evidence, they suggest that there exists implicit collusion among Nasdaq dealers.

Barclay (1997) examines changes in spreads for those stocks that were traded on Nasdaq and subsequently listed on the NYSE or the American Stock Exchange (AMEX). In particular, Barclay compares the effect of exchange listing on the spread of stocks for which market makers avoided odd-eighth quotes with the effect on the spread of stocks for which market makers used both odd- and even-eighth quotes. Barclay finds that when market makers avoid odd-eighth quotes, spreads are large and decline dramatically with exchange listing. In contrast, the study shows that spreads are smaller and decline only slightly with exchange listing when market makers use both odd and even-eighths, despite the differences

in the use of limit orders between the NYSE and Nasdaq. Barclay also shows that after listing on the NYSE or AMEX, there is no difference between these two groups of stocks in their odd-eighth quotes and effective spreads. Based on these results, the author concludes that the avoidance of odd-eighth quotes is used as a coordination device among Nasdaq market makers to maintain supra-competitive spreads.

Although the results of Barclay's (1997) study suggest that the absence of limit orders cannot explain either the large spread or the absence of odd-eighth quotes on Nasdaq, other studies (see, e.g., Greene (1997), Barclay et al. (1999), Chung et al. (1999), and Kavajecz (1999)) show that limit orders have a significant effect on spreads for stocks traded on Nasdaq and the NYSE. In this section, we present further evidence on the issue by examining whether the frequency of even-eighth quotes differs among NYSE specialists, limit order traders, and Nasdaq dealers and whether the differential use of even-eighths among these market participants can explain the difference in spreads between NYSE and Nasdaq stocks.

As shown in Chung et al. (1999) as well as in the present study, a significant portion of NYSE quotes originate from limit order traders. Hence, comparing the relative frequency of even-eighth quotes between Nasdaq and NYSE stocks can give misleading inferences on Nasdaq dealers' propensity to use even-eighth quotes relative to NYSE specialists.[13] We calculate the relative frequency of even-eighth quotes using only those quotes reflecting the trading interest of specialists and compare this with the relative frequency of even-eighth quotes for our Nasdaq sample. We then examine whether the differential use of even-eighths between specialist quotes and Nasdaq quotes can explain the difference between specialist spreads and Nasdaq spreads.

We report in Table 6 the percentage of even-eighth quotes among specialist quotes and limit order quotes. We also report the corresponding figure for our Nasdaq study sample. Note that the proportion of even-eighth quotes (0.536) among those quotes submitted by NYSE specialists is not significantly different from the corresponding figure (0.550) based on quotes submitted by limit order traders. We find, however, that the percentage of even-eighth quotes (0.761) for our Nasdaq sample is significantly greater than the percentage of even-eighth quotes among specialist quotes (see Figure 1).

As noted above, Christie and Schultz (1994) show that the distribution of Nasdaq issues by the percentage of odd-eighth quotes is bimodal. To determine whether our sample of Nasdaq stocks exhibits the same pattern, we calculate the percentage of odd-eighth quotes for each stock, where the percentage is an average of the frequencies at the bid and ask. In Figure 2A, we show the distribution of our Nasdaq stocks by the percentage of odd-eighth quotes. Similarly, we show the distribution of our NYSE stocks in Figure 2B. The figure shows that our Nasdaq stocks' lack of odd-eighth quotes is much more pronounced for some stocks than for others. For a majority of stocks, the percentage of odd-eighth quotes is

[13]Limit order traders resemble specialists in providing liquidity and immediacy to the market but differ because they have the freedom to post *either* a bid *or* an ask quote, while the primary objective of specialists is to provide an orderly and smooth market by continuously posting *both* bid *and* ask quotes. Hence, they may exhibit different quote behavior.

TABLE 6

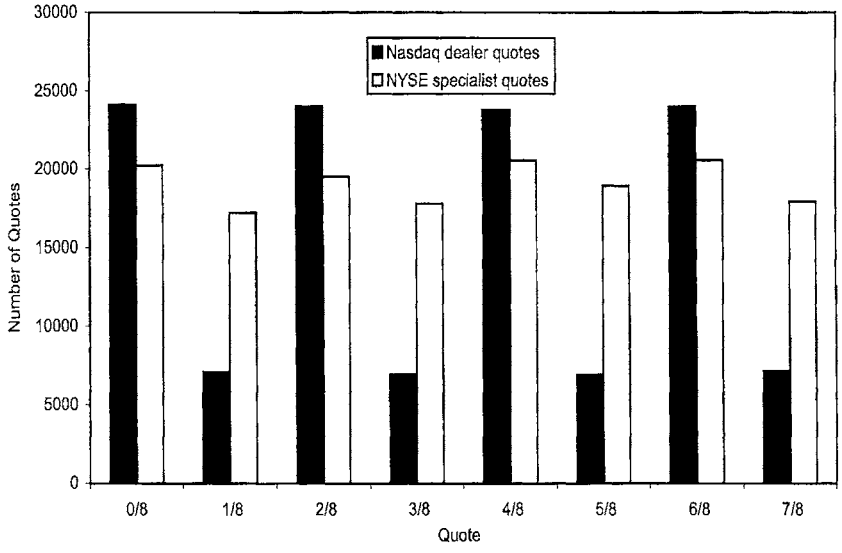
Distribution of Quotes by Even- and Odd-Eighths

	NYSE Quote							
	Whole Sample		Specialist Quote		Limit Order Quote		Nasdaq Quote	
Quote	Bid	Ask	Bid	Ask	Bid	Ask	Bid	Ask
0/8	40299	41750	10066	10144	28474	30179	12115	12010
1/8	36313	35195	8702	8504	26269	25239	3430	3664
2/8	39432	39278	9520	9973	28439	27765	11953	12086
3/8	35743	37314	8967	8821	25554	27041	3511	3411
4/8	40900	40464	10597	9947	28868	28931	11766	12030
5/8	38984	36261	9441	9471	28827	25751	3484	3432
6/8	42276	41290	10206	10355	30506	29943	12049	11960
7/8	36599	39094	8814	9098	26442	28530	3659	3474
Total	310646	310646	76313	76313	223379	223379	62067	62067
Proportion of even-eighth quotes	0.535	0.543	0.530	0.541	0.540	0.560	0.758	0.765
Proportion of even-eighth quotes (bid and ask combined)	0.539		0.536		0.550		0.761	

We define specialist quotes as those quotes that reflect specialist interest in both the bid and the ask, i.e., quote classes (S, S), (S, M), and (M, M). Similarly, we define limit order quotes as those quotes that reflect the interest of limit order traders in both the bid and the ask, i.e., quote classes (L, L), (M, M), and (L, M).

FIGURE 1

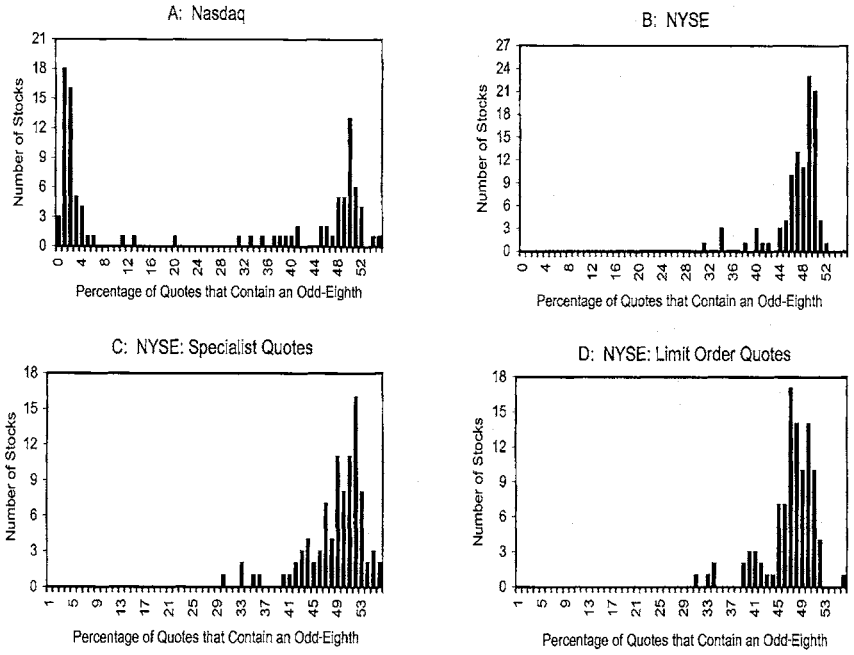
Distribution of Quotes by Even- and Odd-Eighths



very close to either zero or 50%, which is similar to the results reported in Christie and Schultz (1994).

In contrast, we find that the percentage of odd-eighth quotes is between 44% and 52% for a majority of our NYSE stocks. We find that none of our NYSE stocks has a percentage of odd-eighths less than 30%, which is strikingly different

FIGURE 2
The Frequency of Odd-Eighths Quotes across the Sample of 100 Nasdaq Stocks and 100 NYSE Stocks



from our results for Nasdaq stocks. When we obtain the distribution of stocks by the percentage of odd-eighth quotes using only specialist quotes (see Figure 2C) and limit order quotes (see Figure 2D), respectively, the results are similar to those obtained from the entire NYSE quotes.[14]

B. Impact of Even-Eighth Quotes on Spreads

To examine whether the differential use of even-eighth quotes between NYSE specialists and Nasdaq dealers can explain the difference between specialist spreads and Nasdaq spreads, we estimate the following regression model using data for our paired sample of 100 NYSE and Nasdaq stocks,

$$(2)\quad \text{Spread}^N - \text{Spread}^S = \alpha_0 + \sum \alpha_i \left(Y_i^N - Y_i^S\right) + \alpha_5(\text{EV}^N - \text{EV}^S) + \varepsilon,$$

[14] As noted earlier, the reported number of trades for Nasdaq-traded stocks is not directly comparable to that for NYSE-traded stocks due to inter-dealer trades on Nasdaq. Because one of our matching variables is the number of trades, the results of the present study may therefore contain a certain bias associated with different market structures. To assess the significance of this bias, we employ a research design that reflects different volumes between NYSE and Nasdaq issues. Following Atkins and Dyl (1997) and LaPlante and Muscarella (1997), we obtain the "NYSE-comparable Nasdaq trading volume" by multiplying the reported number of trades by 0.5 for our Nasdaq stocks. We then estimate the mean difference between Nasdaq dealer spreads and NYSE specialist spreads, after controlling for differences in stock attributes, even-eighth quotes, and volume counting methods. The results confirm our earlier findings that dealer spreads are wider than specialist spreads and only a part of the difference between dealer spreads and specialist spreads can be attributed to differential even-eighth quotes. These results are available from the authors upon request.

where Y_i ($i = 1$ to 4) represents one of the four stock attributes, N and S refer to Nasdaq and specialist, respectively, $\sum$ denotes the summation over $i = 1$ to 4, EV represents the proportion of even-eighth quotes, and ε is an error term. We expect α_5 to be positive if the differential use of even-eighth quotes between Nasdaq dealers and NYSE specialists can account for at least a part of the difference between specialist spreads and Nasdaq spreads.

We report the regression results in Table 7. The results show that the differential spread is significantly and positively related to the difference in the use of even-eighth quotes between NYSE specialists and Nasdaq dealers. This result suggests that the excess of Nasdaq spreads over NYSE specialist spreads is due, at least in part, to the more frequent use of even-eighth quotes by Nasdaq dealers. Hence, our study, based on a finer measurement of specialist spreads, provides evidence in support of Christie and Schultz's (1994) finding that wider spreads on Nasdaq can be explained by the avoidance of odd-eighth quotes by Nasdaq dealers. These results contradict Huang and Stoll (1996) who conclude that differences in spreads are unrelated to the frequency of odd-eighth quotes once economic variables are included in the analysis. Our results are also consistent with the finding of Christie and Schultz (1999) that while abrupt changes in the use of odd-eighth quotes by Nasdaq dealers are accompanied by large changes in spreads, NYSE or AMEX stocks do not exhibit such a behavior.

TABLE 7

Differential Spread as a Function of Differential Proportion of Even-Eighth Quotes

Independent Variable	Spread		
	Nasdaq−NYSE	Nasdaq−Specialist	Nasdaq−Limit
Intercept	0.0057 (5.30**)	0.0039 (4.00**)	0.0070 (6.25**)
log(share price)	−0.0101 (3.26**)	−0.0101 (3.67**)	−0.0110 (3.38**)
log(no. of trades)	0.0031 (0.90)	0.0019 (0.62)	0.0033 (0.92)
log(trade size)	0.0045 (1.47)	0.0033 (1.21)	0.0057 (1.74)
Return volatility	−0.1273 (0.98)	−0.0917 (0.79)	−0.1950 (1.42)
Proportion of even-eighth quotes	0.0136 (4.41**)	0.0156 (5.57**)	0.0126 (3.85**)
Adjusted-R^2	0.2073	0.2829	0.1883
F-value	6.18**	8.81**	5.59**

To examine whether the differential use of even-eighth quotes between NYSE specialists and Nasdaq dealers can explain the difference between the specialist spread and the Nasdaq spread, we estimate the following regression model: $\text{Spread}^N - \text{Spread}^S = \alpha_0 + \sum \alpha_i (Y_i^N - Y_i^S) + \alpha_5(\text{EV}^N - \text{EV}^S) + \varepsilon$; where Y_i ($i = 1$ to 4) represents the four stock attributes, N and S refer to Nasdaq and specialist, respectively, $\sum$ denotes the summation over $i = 1$ to 4, EV represents the proportion of even-eighth quotes, and ε is an error term. We also examine the effect of even-eighth quotes on spreads using our entire sample of NYSE quotes. For this, we employ the following regression model: $\text{Spread}^N - \text{Spread}^T = \alpha_0 + \sum \alpha_i (Y_i^N - Y_i^T) + \alpha_5(\text{EV}^N - \text{EV}^T) + \varepsilon$; where Y_i ($i = 1$ to 4) represents the four stock attributes, N and T refer to Nasdaq and TORQ, respectively, $\sum$ denotes the summation over $i = 1$ to 4, EV represents the proportion of even-eighth quotes, and ε is an error term. Absolute values of t-statistics are reported in parentheses.

*,**Significant at the 5% and 1% levels, respectively.

Grossman et al. (1997) claim that the less-frequent use of odd-eighth quotes may be attributed to the natural clustering of prices in financial markets.[15] They suggest that the degree of clustering is a function of uncertainty, liquidity, risk, and the informational role of prices. They propose that market participants use a coarser price grid as protection against informed traders, compensation for increased inventory risk, and to minimize the cost of negotiation. To the extent that both NYSE specialists and Nasdaq dealers are likely to face similar inventory and adverse selection problems, however, the less frequent use of odd-eighth quotes by Nasdaq dealers is not likely the result of natural clustering.[16]

Grossman et al. (1997) also suggest that larger costs of making a market in Nasdaq stocks may justify the smaller number of odd-eighth quotes. It is unclear whether costs of market making born by specialists when they trade for their own accounts differ from the costs of market making born by Nasdaq dealers. In addition, we find that the difference in the frequency of even-eighth quotes is a significant determinant of the difference in spreads between NYSE and Nasdaq stocks after controlling for the cost-based determinants of spreads. Hence, it appears that the cost-based explanation for the avoidance of odd-eighth quotes also has limitations. For these reasons, we concur with the ruling of the DOJ and SEC that larger spreads for Nasdaq stocks compared to specialist spreads are at least in part due to anti-competitive behavior among Nasdaq dealers.[17]

C. Additional Explanations for Differential Spreads

We find that the intercept is significantly greater than zero. Hence, at least a portion of the difference between specialist spreads and Nasdaq spreads is due to factors other than differential quote clustering and stock attributes between NYSE and Nasdaq stocks. One such factor is implicit competition from limit order traders exerted on the specialist's quote decision. It is important to note that even when the specialist's quote reflects his own trading interest, his quote decision has already been subjected to implicit competition from limit order traders. The very fact that the specialist quotes his own trading interest implies his *willingness* to quote a price that is at least as good as the best price in the book. Hence, specialist spreads are *conditional spreads* that are bounded by the best bid and offer in the limit order book. Because Nasdaq spreads were not bounded by such competition until 1997, the average Nasdaq spread is expected to be larger than the average specialist spread even in the absence of dealer collusion. Viewed from this perspective, we can interpret the positive and significant intercept as the manifestation, at least in part, of this competitive force.

Other likely sources of wider spreads on Nasdaq are internalization, order preferencing, and payment for order flow. To the extent that Nasdaq dealers com-

[15]The stock price clustering was first noted in Harris (1991).

[16]Note also that the magnitude of price clustering discussed in Grossman et al. (1997) is quite different from the relative frequency of even-eighth quotes across stocks.

[17]We acknowledge that our empirical findings do not rule out the possibility that this anti-competitive behavior was an unintended result of permissible conscious parallelism. We note that the extent to which the absence of odd-eighths actually reflects collusive behavior remains controversial. Kleidon and Willig (1995) and Furbush (1995) argue that there are minimal entry barriers in the Nasdaq market and thus collusive behavior is not sustainable. Doran et al. (1995) and Laux (1995) suggest that factors other than implicit collusion may explain the relative scarcity of odd-eighth quotes.

pete for order flow through these non-price means, there is little incentive for dealers to narrow the spread. (See Huang and Stoll (1996) for a detailed discussion of these issues.)

Earlier, we show that the mean difference between Nasdaq spreads and specialist spreads is 0.0072 (see Table 5). Note also from Table 6 that the mean proportions of even-eighth quotes by Nasdaq and the NYSE specialist (i.e., EV^N and EV^S) across our sample of stocks are 0.761 and 0.536, respectively. Since the estimate of α_5 is 0.0156, the difference between specialist spreads and Nasdaq spreads attributable to the different use of even-eighth quotes between Nasdaq dealers and NYSE specialists is approximately 0.0035[=0.0156 × (0.761 − 0.536)]. Thus, we can conclude that, on average, 49% (=0.0035/0.0072) of the difference between Nasdaq and specialist spreads is due to the differential use of even-eighth quotes between Nasdaq dealers and NYSE specialists. The remaining 51% is due to other factors, including limit orders, internalization, and preferencing.

D. Results from Entire TORQ Sample and Limit Order Quotes

We now examine the effect of even-eighth quotes on spreads using our entire sample of NYSE quotes. For this, we employ the following regression model,

$$(3)\ \text{Spread}^N - \text{Spread}^T = \alpha_0 + \sum \alpha_i \left(Y_i^N - Y_i^T\right) + \alpha_5(\text{EV}^N - \text{EV}^T) + \varepsilon,$$

where Y_i ($i = 1$ to 4) represents one of the four stock attributes, N and T refer to Nasdaq and TORQ, respectively, $\sum$ denotes the summation over $i = 1$ to 4, EV represents the proportion of even-eighth quotes, and ε is an error term. The results are reported in Table 7.

We note from Table 5 that the mean difference in spreads between Nasdaq and NYSE stocks is 0.0084. Note also from Table 6 that the mean proportions of even-eighth quotes for our Nasdaq and NYSE samples are 0.761 and 0.539, respectively. Since the estimate of α_5 is 0.0136, the mean spread difference between Nasdaq and NYSE stocks that is attributable to the differential use of even-eighth quotes is approximately 0.0030 [=0.0136 × (0.761 − 0.539)]. Thus, on average, 36% (=0.0030/0.0084) of the difference between Nasdaq and NYSE spreads is due to the differential use of even-eighth quotes between Nasdaq dealers and NYSE specialists/limit order traders.[18] We find similar results when we replicate the above analysis using only limit order quotes.

Our results contradict the findings of Huang and Stoll (1996) that after controlling for differences in economic factors, no relationship exists between spreads and the frequency of odd-eighth quotes among their sample of 66 paired NYSE-Nasdaq stocks. However, our results are consistent with the findings of Barclay (1997), Bessembinder (1997), and Kandel and Marx (1997). These studies show that the degree of rounding in the frequency of odd-eighth quotes is a significant determinant of differences in trading costs across markets after controlling for the cost-based determinants of spreads.

[18]The remaining 64% is due to other factors, including the effect of limit order quotes on NYSE quotes. It is unclear how much of this 64% is directly attributable to the effect of limit orders discussed above.

On the whole, our findings suggest that the increased pressure on Nasdaq dealers to use more odd-eighth quotes since the publication of the widely publicized article by Christie and Schultz (1994) is expected to induce a significant reduction in spreads on Nasdaq. Consistent with this expectation, Christie, Harris, and Schultz (1994) report that both the spread and the practice of avoiding odd-eighth quotes among Nasdaq dealers declined significantly after the public disclosure of the results of Christie and Schultz (1994).

In addition, pressure from the negative publicity and the investigations by the DOJ and the SEC induced further declines in odd-eighth quotes and spreads. Barclay et al. (1999) find that the practice of avoiding odd-eighth quotes among Nasdaq dealers declined dramatically during the 1994–1996 period. They find that, for a sample of 68 stocks, average spreads declined by 28% from 42.4 cents per share in 1994 to 30.5 cents per share during the months preceding the implementation of the SEC order handling rule changes on Nasdaq.

Barclay et al. also find that the average inside spread for the 44 stocks that are not quoted in odd-eighths in 1994 declined by 36% from 52.6 to 33.6 cents per share between 1994 and the months immediately prior to the new SEC rules. These results are consistent with the findings of the present study and suggest that the decline in the avoidance of odd-eighth quotes has a significant and dramatic effect on the average Nasdaq spreads.

VI. Summary and Conclusion

Several recent studies show that Nasdaq dealers maintain larger spreads than NYSE specialists and suggest that the excess of Nasdaq spreads over NYSE spreads is largely due to collusion among Nasdaq dealers. It is important to note, however, that bid-ask quotes on the NYSE reflect not only the trading interest of specialists, but also more frequently the trading interest of limit order traders. To the extent that spreads established by limit order traders differ from spreads reflecting specialist interest, comparing Nasdaq spreads with NYSE spreads is likely to lead to incorrect inferences on whether there exists implicit collusion among Nasdaq dealers.

In this study, we compare spreads set by Nasdaq dealers to NYSE spreads that reflect the trading interest of specialists. Similarly, we compare the frequency of even-eighths among Nasdaq quotes to the frequency of even-eighths among only those NYSE quotes that reflect the specialist's interest. This new approach provides a direct comparison of quote behavior between Nasdaq dealers and NYSE specialists.

Our empirical results show that the NYSE specialist spread is significantly greater than the limit order spread, although NYSE specialists and limit order traders are similar in their use of even-eighth quotes. We also find that the specialist spread is significantly smaller than the spread of comparable stocks on Nasdaq and that the use of even-eighth quotes is much less prevalent among NYSE specialists than Nasdaq dealers. Hence, our empirical results indicate that the larger Nasdaq spread is due, at least in part, to a more frequent use of even-eighth quotes by Nasdaq dealers. Our results indicate, however, that there are factors (such as internalization and preferencing) other than the use of even-eighth quotes

that determine the difference between NYSE specialist spreads and Nasdaq dealer spreads.

Appendix

Ticker Symbols of 100 Matching NYSE and Nasdaq Stocks

NYSE	Nasdaq	NYSE	Nasdaq	NYSE	Nasdaq	NYSE	Nasdaq	NYSE	Nasdaq
GE	AAPL	PH	ALEX	AC	ALII	IPT	ALLC	KWD	ALLP
MO	AMGN	MX	AMSY	TUG	AMWI	CLE	ATVC	SPF	AWAL
NT	BETZ	DI	BGEN	HFI	BIGB	LPX	BOAT	HTR	BOBE
KFV	BRAN	NI	BRNO	PEO	BSET	ZIF	CASY	WIN	CBRL
IEI	CGES	PIR	CGNE	DP	CGNX	WBN	CHPS	GMH	CONW
SLB	COST	PPL	CPER	CUE	CYTO	BZF	DEMP	UWR	DHTK
NSI	FABC	PMI	FHWN	HF	FITB	ALX	FRTH	RDA	FULL
RPS	GRAR	BMC	GRST	FBO	GULD	AMO	HBAN	GPI	HWKB
BA	INTC	VRC	JAVA	CLF	LAWS	GLX	LIZC	FFB	LMRK
MDP	LNCE	REC	LYTS	XON	MCCS	SJI	MDSN	CPC	MEDC
EMC	MIPS	CP	MLHR	CU	MRCY	CPY	MRIS	IBM	MSFT
ACN	NECC	FMI	NEWP	FNM	NOVL	PCO	NVCR	DSI	NWNG
SNT	OCAS	TEK	ODEP	USH	OKEN	SAH	OSTN	W	PCAR
LOG	PCTL	DBD	PHYB	UAM	PROT	FOE	PSNB	NNP	PSNC
PLP	QFCI	PIM	RCSB	NSP	ROAD	AL	SAFC	BG	SFDS
CYM	SMED	CMH	SNDT	CMY	SNPX	FPC	SOCI	ATE	SONO
FDX	STBK	FPL	STJM	CL	STPL	CYR	STRY	NIC	STUH
T	SUNW	WCS	SVAN	SWY	TLAB	AYD	TNEL	CMI	UBNK
ALL	UCIT	HAN	UNIH	OCQ	USTR	PRI	WAMU	HE	WECO
DCN	WETT	AR	WTHG	POM	XOMA	UEP	YELL	MCN	YESS

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