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# Bid–ask spreads and the avoidance of odd-eighth quotes on Nasdaq: An examination of exchange listings

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**Abstract**

This paper examines 472 securities that were listed on Nasdaq and moved to the NYSE or Amex. When Nasdaq market makers avoid odd-eighth quotes, bid–ask spreads are large and decline dramatically with exchange listing. When market makers use both odd and even eighths, spreads are smaller and decline only slightly with exchange listing. The large spreads observed when Nasdaq market makers avoid odd-eighths cannot be explained by security-specific characteristics. Instead, the results support the conclusion that the avoidance of odd-eighth quotes is used as a coordination device among Nasdaq market makers to maintain supra-competitive bid-ask spreads.

*Keywords*: Microstructure; Spreads; Exchange listing

*JEL classification*: G18

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## 1. Introduction

This paper examines the relation between bid–ask spreads and the avoidance of odd-eighth quotes on Nasdaq. Christie and Schultz (1994) and Christie et al. (1994) document that bid–ask spreads are substantially larger when Nasdaq market makers avoid odd-eighth quotes than when they use both odd and even eighths. They conclude that the avoidance of odd-eighth quotes serves as a coordination device among market makers to maintain supra-competitive bid–ask spreads. An alternative view is that the high spreads observed on Nasdaq reflect high costs of market making for Nasdaq securities. Proponents of this view (for example, Grossman et al., 1995; Kleidon and Willig, 1995) argue that the absence of odd-eighth quotes results from a natural tendency for clustering that is facilitated by large, competitive spreads.

This paper attempts to discriminate between these views by examining 472 securities that were traded on Nasdaq and then moved to the New York Stock Exchange (NYSE) or the American Stock Exchange (Amex) between 1983 and 1992. Christie and Huang (1994) found that bid–ask spreads decline significantly when securities move from Nasdaq to the NYSE or Amex. The focus here, however, is to compare the effect of exchange listing on securities for which Nasdaq market makers avoided odd-eighth quotes with the effect on securities for which market makers used both odd and even eighths.

While trading on Nasdaq, the securities for which market makers avoided odd-eighth quotes have larger bid–ask spreads than the securities for which market makers used both odd and even eighths. If Nasdaq spreads are competitive, and the cross-sectional variation in spreads reflects differential costs of market making, then securities for which market makers avoid odd-eighth quotes on Nasdaq should continue to have larger spreads when they move to the NYSE or Amex. Alternatively, if the avoidance of odd-eighth quotes is used as a coordination device among Nasdaq market makers to maintain supra-competitive bid–ask spreads, then moving from Nasdaq to the NYSE or Amex should reduce the difference in spreads between these two groups.

The frequency of odd-eighth quotes for securities that move from Nasdaq to the NYSE or Amex exhibits the same bimodal distribution as documented by Christie and Schultz (1994). There are almost no odd-eighth quotes during the 60 days prior to listing on the NYSE or Amex for 239 of the 472 securities in the sample used in this study. The remaining 233 securities have 44% odd-eighth quotes during this 60-day period. The avoidance of odd-eighth quotes is strongly related to the size of the Nasdaq bid–ask spread. When Nasdaq market makers avoid odd-eighth quotes, the average effective half-spread is 25 cents; when they use both odd and even eighths, the average effective half-spread is 11 cents. After listing on the NYSE or Amex, there is little difference between these groups. Both groups have more than 44% odd-eighth quotes and, more importantly, both groups have an average effective half-spread of 7 cents. In a multiple

regression setting, I find that the frequency of odd-eighth quotes on Nasdaq is highly correlated with the change in bid-ask spreads when securities move from Nasdaq to the NYSE or Amex, even after controlling for any changes in security-specific characteristics that are commonly associated with the costs of market making.

Since this study examines the same securities before and after they begin trading on the NYSE or Amex, the study holds constant all security-specific characteristics. The decline in effective bid-ask spreads when securities move to the NYSE or Amex, therefore, must be attributed to differences between the stock markets (i.e., to structural differences between the Nasdaq Stock Market and the NYSE or Amex, or to differences in the behavior of the participants in those markets) and not to differences that are specific to the individual securities. In addition, by comparing securities for which Nasdaq market makers avoid odd-eighth quotes with securities for which market makers use both odd and even eighths, it is possible to control for any institutional differences between the markets, such as any differences in commissions charged on Nasdaq trades compared with commissions charged on NYSE or Amex trades.

The nearly identical average effective half-spreads observed on the NYSE or Amex for these two groups of securities (securities for which Nasdaq market makers avoid odd-eighth quotes and securities for which market makers use both odd and even eighths) suggest that they have similar security-specific costs of market making. Thus, differences in security-specific costs of market making cannot adequately explain the larger effective spreads observed when Nasdaq market makers avoid odd-eighth quotes.

Moreover, investors who purchase or sell securities in these two groups face the same institutional differences between Nasdaq and the NYSE or Amex. Since effective spreads decline only slightly when securities for which Nasdaq market makers use both odd and even eighths move to the NYSE or Amex, institutional differences between these markets, such as any differences in commissions charged, cannot explain the two-thirds reduction in effective spreads observed for securities for which Nasdaq market makers avoid odd-eighth quotes.

The results of this study are consistent with the conclusion reached by Christie and Schultz (1994) that the avoidance of odd-eighth quotes is used as a coordination device among Nasdaq market makers to maintain supra-competitive bid-ask spreads.

## 2. Alternative hypotheses

The publication of two academic papers, Christie and Schultz (1994) and Christie et al. (1994), has spawned considerable controversy over the size of bid-ask spreads on Nasdaq. Most parties to the debate now agree that Nasdaq bid-ask spreads are larger, on average, than bid-ask spreads on the NYSE, and

that the frequency of odd-eighth quotes (i.e., quoted bid and ask prices that are not evenly divisible by 0.25) is lower on Nasdaq than it is on the NYSE. The current debate is focused on two primary issues. First, why are spreads higher on Nasdaq than on the NYSE, and second, what is the relation, if any, between the higher spreads on Nasdaq and the avoidance of odd-eighth quotes.

Most of the proposed explanations for the higher spreads on Nasdaq can be grouped into the following three categories. (1) Spreads on Nasdaq are competitive and reflect the higher cost of market making for Nasdaq stocks (2) Spreads on Nasdaq are supra-competitive because of an inefficient market structure, or because of institutional practices that suppress the incentives for price competition, or both. (3) Spreads on Nasdaq are supra-competitive because of implicit or explicit collusion among Nasdaq market makers. Each of these alternative explanations is described below.

### *2.1. Spreads on Nasdaq are competitive*

There is a well-established economic literature documenting cross-sectional variation in the costs of market making. The costs of market making, and consequently, competitive percentage bid–ask spreads, tend to be larger for smaller, younger, rapidly-growing firms, with lower trading volume, lower price per share, and higher stock return variance. Since these attributes more closely describe the typical Nasdaq firm than the typical NYSE firm, proponents of this view argue that the higher spreads on Nasdaq reflect the higher costs of market making for these securities. Under this scenario, there is no direct link between the frequency of odd-eighth quotes and the size of bid–ask spreads. The low frequency of odd-eighth quotes on Nasdaq results from a natural tendency for clustering that is facilitated by the large, competitive spreads on these securities.

### *2.2. Spreads on Nasdaq are supra-competitive because of an inefficient market structure and/or institutional practices that suppress the incentives for price competition*

Nasdaq has a different market structure than the NYSE or the Amex. For example, Nasdaq is usually described as a dealer market while the NYSE and Amex are often described as auction markets. Huang and Stoll (1996) compare trading costs in these two market settings, and conclude that the Nasdaq market structure inhibits competition. Institutional features most often mentioned in this context include the absence of competition from limit orders (Demsetz, 1997), trade preferencing or payment for order flow (Godek, 1996), and use of the one-eighth minimum tick size (Kandel and Marx, 1997). For example, with trade preferencing, many market makers have access to a captive order flow. Thus, narrowing the bid–ask spread results in little additional volume, since a competing market maker will not attract the captive order flow of other

market makers, and reduces the revenues from the market maker's existing order flow. Consequently, market makers have little or no incentive to compete by narrowing spreads. Under these inefficient market structure scenarios, as with the competitive spread scenario, there is no direct link between the frequency of odd-eighth quotes and the size of bid–ask spreads.

### 2.3. *Spreads on Nasdaq are supra-competitive because of implicit or explicit collusion among nasdaq market makers*

The original hypothesis put forward by Christie and Schultz (1994) and Christie et al. (1994) is that the avoidance of odd-eighth quotes is used by Nasdaq market makers as a coordination device to maintain supra-competitive bid–ask spreads. If market makers agree not to submit odd-eighth quotes, then competitive spreads of $\frac{1}{8}$ are increased to at least $\frac{1}{4}$, competitive spreads of $\frac{3}{8}$ are increased to at least $\frac{1}{2}$, and so on. The avoidance of odd-eighth quotes is a convenient coordination device since any violation of the collusive agreement is immediately observed by all market makers on the Nasdaq system. Under this scenario, there is a direct causal link between the avoidance of odd-eighth quotes and the higher spreads on Nasdaq.

### 2.4. *Discussion*

The primary focus of this paper is to distinguish between claims that Nasdaq bid–ask spreads are competitive (category 1) and claims that Nasdaq spreads are supra-competitive (categories 2 and 3). In addition, the study provides evidence on the link between the avoidance of odd-eighth quotes and bid–ask spreads on Nasdaq.

It is important to note that categories 2 and 3 above, asserting that spreads on Nasdaq are supra-competitive, are not mutually exclusive. Many economists would argue that it would be difficult to sustain collusion among 30 or 40 market makers in a well-designed market with no barriers to entry. However, if agreements such as preferencing insulate a large fraction of total volume from price competition, then market makers with significant captive order flow have large incentives to retaliate against smaller potential competitors who cut their profit margins by narrowing the spread.

This paper examines a sample of securities that traded on Nasdaq, and then moved to the NYSE or Amex. Consistent with the results in Christie and Huang (1994), bid–ask spreads fall dramatically when Nasdaq listed securities move to the NYSE or Amex. This result is consistent with the claim that spreads on Nasdaq are not competitive. If the costs of market making are related to security-specific characteristics, such as the firm's size or age, or to potential information asymmetries, then it seems implausible that the large reduction in

bid–ask spreads on the first day of NYSE or Amex trading could be caused by a dramatic overnight shift of these characteristics.

Interpreting the decline in spreads as securities move from Nasdaq to the NYSE or Amex is complicated by the observation that Nasdaq has a different market structure from the exchanges. The structural differences between these markets, such as the treatment of limit orders and commissions, could potentially explain the decline in spreads as securities move from Nasdaq to the NYSE or Amex. Thus, this paper examines the effect of listing on the NYSE or Amex separately depending on whether Nasdaq market makers avoided odd-eighth quotes. If the avoidance of odd eighth quotes serves as a coordination device among Nasdaq market makers, then listing on the NYSE or Amex should cause a greater reduction in spreads for these stocks. Alternatively, if bid–ask spreads are competitive on Nasdaq, and if the avoidance of odd-eighth quotes is simply an artifact of these higher competitive spreads, then there is no reason to expect a relation between the frequency of odd-eighth quotes on Nasdaq and the reduction of bid–ask spreads associated with listing on the NYSE or Amex. Comparing the change in spreads across these two groups of Nasdaq-listed securities that moved to the NYSE or Amex provides a natural control for the effects of any differences in market structures.

Demsetz (1996) raises one important caveat to this interpretation. Demsetz argues that direct customer-to-customer interaction through limit orders can obscure the link between observed bid–ask spreads and the costs of market making. Under this argument, bid and ask prices on the NYSE, for example, may simply reflect the supply and demand conditions of investors rather than the inventory, order processing, and adverse-selection costs of professional market makers. This argument is important because if bid–ask spreads on the NYSE and Amex bear no relation to the costs of market making, then comparing bid–ask spreads on Nasdaq with bid–ask spreads on the NYSE or Amex may provide misleading inferences about the competitiveness of Nasdaq bid–ask spreads.

I address the Demsetz argument in several ways. The first is to note that although limit orders with binding price and time priority provide intense competition for market makers on the NYSE and Amex, successful specialists and floor brokers continue to earn a living by joining this competition for order flow. Other things equal, greater competition and smaller spreads may result in fewer professional market makers on the NYSE or Amex. But, equilibrium spreads must compensate the remaining market makers for their costs of doing business, or they too would exit the industry.

Second, the empirical market microstructure literature indicates that bid–ask spreads on the NYSE and Amex do reflect the costs of market making. As on Nasdaq, NYSE and Amex proportional bid–ask spreads are larger for smaller, younger, rapidly growing securities, with low trading volume, low price per share, and high stock return variance. All of these results are predicted by

theoretical models built on the assumption that bid–ask spreads reflect the costs of market making.

Third, if bid–ask spreads on Nasdaq reflect the costs of market making and spreads on the NYSE and Amex do not, then it should be possible to explain the cross-sectional decline in spreads when securities move from Nasdaq to the NYSE or Amex based on security-specific characteristics that are related to the costs of market making on Nasdaq. Yet, in a multiple regression setting, I find that the frequency of odd-eighth quotes on Nasdaq is highly correlated with the decline in bid–ask spreads when securities move from Nasdaq to the NYSE or Amex even after controlling for other security-specific characteristics.

Finally, I expect the Demsetz argument to be most severe for securities where bid–ask spreads are compressed on the NYSE and Amex to the minimum tick size of one-eighth. If competition from limit orders on the NYSE and Amex drives bid–ask spreads for two dissimilar securities to the minimum tick size of one-eighth, then it may be difficult to know what their spreads would look like in the absence of this limit-order competition. Consequently, in Section 4, I examine separately the sample of securities for which the average quoted bid–ask spread during the first 60 days of trading on the NYSE or Amex is at least one-quarter. Since bid–ask spreads for these stocks could still be reduced significantly, they should be less affected by constraints on the minimum tick size. Results for this subsample are similar to the results for the sample as a whole. When Nasdaq market makers avoid odd-eighth quotes, listing on the NYSE or Amex provides a significant reduction in the bid–ask spread; when Nasdaq market makers use both odd- and even-eighth quotes, listing on the NYSE or Amex provides much less improvement in bid–ask spreads.

## 3. Empirical results

The Center for Research in Securities Prices (CRSP) Nasdaq file identifies 543 Nasdaq National Market System (NMS) securities that were delisted from Nasdaq between 1983 and 1992 because they were added to the NYSE or the Amex.[1] The period 1983–1992 was chosen because this is the full period covered by the Institute for the Study of Security Markets (ISSM) database which was used as the source of bid and ask quotations for the NYSE and Amex. I collected daily closing bid, ask, and transaction prices, both before and after listing on the NYSE or Amex, for 472 of these securities from the CRSP Nasdaq and NMS

[1] The CRSP Nasdaq file identifies an additional 157 securities that moved from Nasdaq to the NYSE or Amex between 1983 and 1992 that were not included in the National Market System at the time of listing on the NYSE or Amex. These securities are not included in the analysis because historical bid and ask prices are not available for them.

files and the ISSM NYSE/Amex files. A complete list of the final 472-security sample is available upon request.

Daily closing prices and quotes are used for most of the analysis in this paper because intraday data are not available for Nasdaq securities before 1990. As a check on the robustness of the results, the full record of quotes and trades is examined for 135 securities that moved from Nasdaq to the NYSE or Amex between 1990 and 1992. Results for this subsample (reported below) suggest that the conclusions reached in this paper are not sensitive to the use of daily closing data.

### 3.1. Variable definitions

Four measures of execution costs are examined in this study. The first is the quoted half- spread, defined as

$$\text{Quoted Half-Spread} = (\text{ask} - \text{bid})/2.$$

The second is the quoted percentage half-spread, defined as

$$\text{Quoted Percentage Half-Spread} = (\text{ask} - \text{bid})/(\text{ask} + \text{bid}).$$

The quoted half-spread measures the execution cost per trade for trades that occur at the quoted bid or ask.[2]

Because transactions sometimes occur at prices other than the quoted bid or ask, I examine the effective half-spread, defined as

$$\text{Effective Half-Spread} = |\text{transaction price} - (\text{ask} + \text{bid})/2|.$$

I also examine the effective percentage half-spread, defined as

$$\text{Effective Percentage Half-Spread} = \frac{|\text{transaction price} - (\text{ask} + \text{bid})/2|}{(\text{ask} + \text{bid})/2}.$$

The effective half-spread measures the execution cost that traders actually pay regardless of whether their trades occur at the quoted bid or ask.

### 3.2. The effect of NYSE or Amex listing on quoted and effective half-spreads

Table 1 provides summary statistics for the four execution-cost measures and other characteristics for the full sample of 472 securities, and for two subsamples partitioned by the frequency of odd-eighth quotes.[3]

[2] It is largely a matter of indifference whether results are reported as spreads or half-spreads. The half-spread is a measure of the cost of one trade whereas the full spread is a measure of the cost of two trades (or one round trip) in the security.

[3] The full 472-security sample described in Table 1 includes 58 securities that split sometime during the 6-month event period examined in this study. Removing these 58 securities has no material effect on the results reported in this table or on any of the conclusions based on these results.

Table 1
Summary statistics for 472 securities that were traded on Nasdaq and moved to the NYSE or Amex between 1983 and 1992. The subsample identified as 'all even quotes' had more than 90% of their closing bid and ask quotations on even eighths during the 60 days prior to listing on the NYSE or Amex. Daily trading volume is measured in thousands of dollars, market capitalization is measured in millions of dollars. For each variable, the table reports the mean, median [in square brackets], and standard deviation (in parentheses).

| | All securities | | All even quotes | | Odd and even quotes | |
|---|---|---|---|---|---|---|
| | Before NYSE/ Amex listing | After NYSE/ Amex listing | Before NYSE/ Amex listing | After NYSE/ Amex listing | Before NYSE/ Amex listing | After NYSE/ Amex listing |
| Quoted half-spread ($) | 0.23 [0.19] (0.20) | 0.13 [0.12] (0.03) | 0.33 [0.26] (0.23) | 0.14 [0.13] (0.03) | 0.13 [0.11] (0.06) | 0.12 [0.11] (0.03) |
| Effective half-spread ($) | 0.18 [0.15] (0.14) | 0.07 [0.06] (0.02) | 0.25 [0.21] (0.16) | 0.07 [0.07] (0.02) | 0.11 [0.09] (0.05) | 0.07 [0.06] (0.02) |
| Quoted half-spread (%) | 1.86 [1.29] (1.89) | 1.04 [0.87] (0.73) | 2.23 [1.52] (2.19) | 0.88 [0.75] (0.47) | 1.48 [1.02] (1.42) | 1.22 [1.00] (0.89) |
| Effective half-spread (%) | 1.50 [1.03] (1.45) | 0.56 [0.45] (0.42) | 1.74 [1.20] (1.62) | 0.44 [0.38] (0.24) | 1.25 [0.88] (1.19) | 0.68 [0.56] (0.52) |
| Even-eighth quotes (%) | 78 [91] (24) | 55 [54] (7) | 99 [100] (2) | 56 [55] (7) | 56 [53] (15) | 54 [53] (6) |
| Price per share ($) | 17.77 [15.01] (12.61) | 17.51 [14.82] (12.18) | 21.45 [18.19] (13.22) | 20.48 [17.77] (12.33) | 13.99 [11.17] (10.60) | 14.47 [10.77] (11.26) |
| Number of market makers | 12.92 [11] (8.63) | 1 | 10.27 [9] (6.64) | 1 | 15.64 [14] (9.05) | 1 |
| Daily trading volume | 1878 [463] (4916) | 977 [255] (2258) | 1847 [361] (4870) | 989 [192] (2326) | 1911 [590] (4974) | 966 [297] (2191) |
| Number of securities | 472 | 472 | 239 | 239 | 233 | 233 |

For the full sample, listing on the NYSE or Amex is associated with a decline in the average quoted half-spread of 10 cents (from 23 cents to 13 cents) and a decline in the average effective half-spread of 11 cents (from 18 cents to 7 cents). The decline in execution costs is significant at the 0.001 level by either measure.

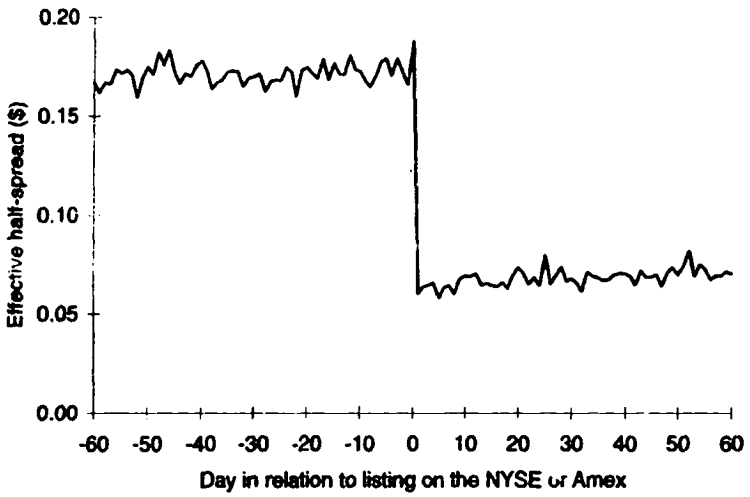


Fig. 1. Effective half-spreads for 472 Nasdaq securities that moved to the NYSE or Amex between 1983 and 1992. Day 0 is the first day of trading on the NYSE or Amex.

Percentage spreads also decline accordingly. The average quoted half-spread declines from 1.86% to 1.04%, and the average effective half-spread declines from 1.50% to 0.56%.

The average effective half-spreads for the full sample are reported on a daily basis in Fig. 1. It indicates that the reduction in spreads occurs on the first day of trading on the NYSE or Amex. The average effective half-spread falls from 19 cents on day −1 (the last day of trading on Nasdaq) to 6 cents on day 0 (the first day of trading on the NYSE or Amex); the average quoted half-spread falls from 24 cents on day −1 to 11 cents on day 0. Although the first day of NYSE or Amex trading is known in advance, there is no change in average spreads on Nasdaq in anticipation of this event. The percentage effective half-spreads and the dollar and percentage quoted half-spreads display a similar pattern to that displayed in Fig. 1.

### *3.3. The effect of NYSE or Amex listing on the frequency of even-eighth quotes*

Table 1 also provides the frequency of closing bid and ask quotations that are evenly divisible by 0.25 for the full sample of 472 securities before and after listing on the NYSE or Amex. If odd- and even-eighth quotes were equally likely, the expected frequency of even-eighth quotes would be 50%. In relation to this benchmark, Nasdaq, the NYSE and Amex all exhibit some clustering on even eighths. However, the degree of clustering on Nasdaq is very different from that on the NYSE or Amex. Before listing on the NYSE or Amex, the average

fraction of even-eighth quotes is 78%; after listing on the NYSE or Amex, the fraction of even-eighth quotes for the same securities is 56%. This difference is significant at the 0.001 level. Since Table 1 presents the fraction of even-eighth quotes for the same securities before and after listing on the NYSE or Amex, it cannot be argued that the frequency of even-eighth quotes for these securities is determined solely by security-specific characteristics. Instead, the frequency of even-eighth quotes appears to be caused by market-wide differences between and the NYSE and Amex.

The evidence in Christie and Schultz (1994) and Christie et al. (1994) suggests that looking at the average frequency of even-eighth quotes is likely to be misleading since the distribution of even-eighth quotes is bimodal. Nasdaq market makers quote odd and even eighths almost equally often for some securities, and avoid odd eighths almost entirely for other securities. The sample of securities switching from Nasdaq to the NYSE or Amex exhibits this same bimodal distribution while trading on Nasdaq.

Sample securities are classified as using only even eighths if more than 90% of all closing bid and ask prices during the 60 days before listing on the NYSE or Amex are evenly divisible by 0.25. This filter is exceeded by 239 of the 472 securities. The remaining 233 securities are classified as using both odd and even eighths. The group that uses only even eighths has nearly 100% even-eighth quotes on Nasdaq. The group that uses both odd and even eighths has 56% even-eighth quotes on Nasdaq. After listing on the NYSE or Amex, the gap between these groups narrows considerably. Securities using only even-eighth quotes on Nasdaq have 56% even-eighth quotes on the NYSE or Amex; the remaining securities have 54% even-eighth quotes on the NYSE or Amex.

The frequency of even-eighth quotes for the two subsamples is reported on a daily basis in Fig. 2. As with the change in the level of the spread, the change in the frequency of even-eighth quotes occurs on the first day of NYSE or Amex trading. When Nasdaq market makers avoid odd-eighth quotes, they avoid odd-eighth quotes through the last day of Nasdaq trading. On the first day of NYSE or Amex trading, the frequency of odd-eighth quotes becomes indistinguishable across the two samples.

### *3.4. Bid–ask spreads and the avoidance of odd-eighth quotes*

Table 1 and Fig. 3 indicate that the decline in bid–ask spreads when securities move from Nasdaq to the NYSE or Amex varies dramatically depending on whether or not Nasdaq market makers avoid odd-eighth quotes. While trading on Nasdaq, the securities in these two subsamples have dramatically different quoted and effective spreads. When Nasdaq market makers avoid odd eighths, the average quoted half-spread is 33 cents (2.23%), and the average effective half-spread is 25 cents (1.74%). When market makers use both odd and

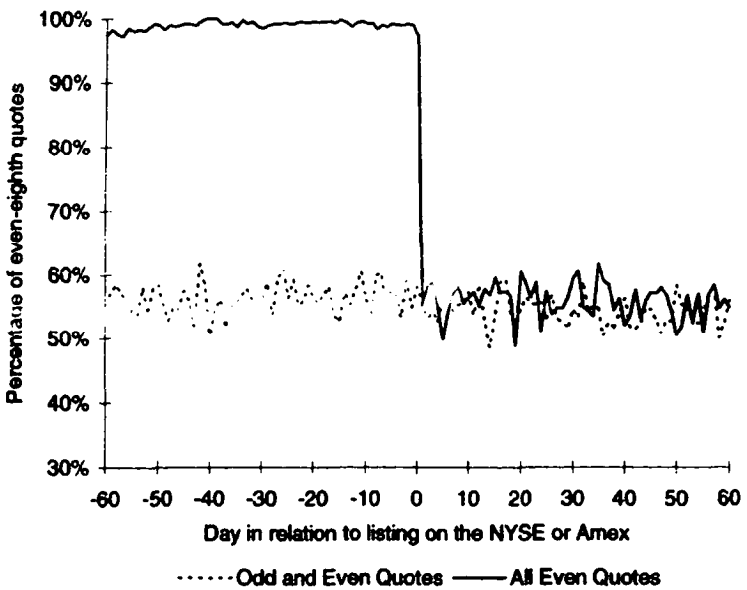


Fig. 2. Percentage of bid and ask prices that are quoted on even eighths for 472 Nasdaq securities that moved to the NYSE or Amex between 1983 and 1992. The subsample identified as 'all even quotes' includes 239 securities that had more than 90% of their closing bid and ask prices on even eighths during the 60 days prior to listing on the NYSE or Amex. The subsample identified as 'odd and even quotes' includes the remaining 233 securities. Day 0 is the first day of trading on the NYSE or Amex.

even eighths, the average quoted half-spread is 13 cents (1.48%), and the average effective half-spread is 11 cents (1.25%).

After listing on the NYSE or Amex, the average bid–ask spread falls for both subsamples. More importantly, however, listing on the NYSE or Amex nearly eliminates the difference in spreads between these two groups. After listing on the NYSE or Amex, the average quoted half-spread is 14 cents for securities with virtually no odd-eighth quotes on Nasdaq, and 12 cents for the remaining securities. The average effective half-spread is 7 cents for both groups.

Table 1 also reports several additional descriptive statistics for this sample of securities. The average price per share is larger for securities for which Nasdaq market makers avoided odd-eighth quotes ($21.45) than for securities for which market makers used both odd and even eighths ($13.99). Low-price stocks typically have larger percentage bid–ask spreads, but smaller dollar bid–ask spreads than high-priced stocks. Thus, market makers for low-priced stocks are less likely to avoid odd-eighth quotes since the large dollar spreads associated with the avoidance of odd eighths would imply extraordinarily large percentage spreads for these low-priced stocks.

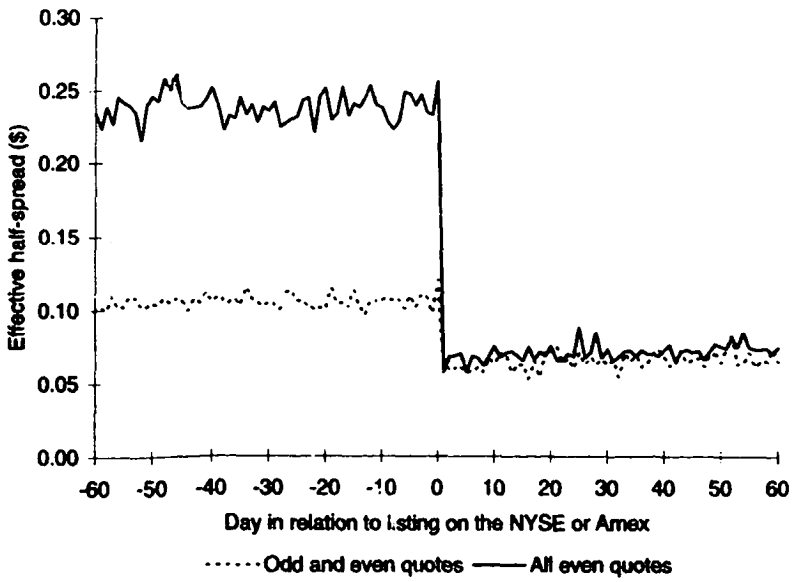


Fig. 3. Effective half-spreads for 472 Nasdaq securities that moved to the NYSE or Amex between 1983 and 1992. Day zero is the first day of trading on the NYSE or Amex. The subsample identified as 'all even quotes' includes 239 securities that had more than 90% of their closing bid and ask prices on even eighths during the 60 days prior to listing on the NYSE or Amex. The subsample identified as 'odd and even quotes' includes the remaining 233 securities. Day 0 is the first day of trading on the NYSE or Amex.

There is a higher average number of market makers for the securities for which market makers use both odd and even eighths (15.64), than for the securities for which odd-eighths are avoided (10.27). This result is a little surprising. If the avoidance of odd-eighth quotes increases the profitability of market making by increasing the bid–ask spread, then the competitive model would predict entry by additional market makers for these securities. Instead, we see fewer market makers for these securities. One potential explanation for this result is that the trading volume for the most profitable securities (i.e., those for which odd eighths are avoided) is almost fully captured by the large market makers through internalization and preferencing agreements. The less profitable securities (i.e., those for which market makers use both odd and even eighths) have less internalization and fewer preferencing agreements, and thus allow smaller market makers to compete for the available order flow.

Finally, Table 1 indicates that the average share volume declines by about one-half when securities move from Nasdaq to the NYSE or Amex. This decline in volume is attributable to the different market structures. On the NYSE and Amex, many customer to customer trades are crossed without the specialist taking a position, and reported as a single trade. On Nasdaq, all trades go

through a market maker. Thus when one Nasdaq customer sells shares and another purchases them, at least two trades will be reported, and sometimes three.[4]

### 3.5. *Multiple regression results*

Table 2 reports multiple regressions of the change in the execution-cost measures when securities move from Nasdaq to the NYSE or Amex on the change in the frequency of even-eighth quotes and on other security-specific characteristics. These regressions include only 468 observations since the number of Nasdaq market makers is unavailable on CRSP for 4 sample securities.[5]

The first four regressions confirm the univariate results discussed above. The small intercepts of these regressions indicate that securities with both odd- and even-eighth quotes on Nasdaq (and, consequently, for which the change in the frequency of even-eighth quotes is small) experience a small decline in half-spreads when they move to the NYSE or Amex. Securities with no odd-eighth quotes on Nasdaq experience a significantly larger change in spread. The regression coefficients indicate that the reduction in the average quoted and effective half-spread associated with a change from all even-eighth quotes on Nasdaq to 56% even-eighth quotes on the NYSE or Amex (the mean in this sample) is 17 cents and 13 cents, respectively (1.21% and 0.84%, respectively).

The frequency of even-eighth quotes on Nasdaq is correlated with other security-specific characteristics. To control for potential changes in these characteristics, the second four regressions include the change in the average price inverse, the daily stock return standard deviation, the log of the daily Nasdaq trading volume (in dollars), the log of the daily trading volume on the NYSE or Amex (in dollars), and the log number of Nasdaq market makers. The price inverse is used instead of price because previous studies have documented that the price inverse provides a better fit in spread regressions. The return standard deviation is calculated using daily closing transaction prices. This will bias the results away from finding a significant coefficient for the variable measuring the change in even eighth quotes since the return standard deviation calculated

[4] The third trade occurs when two market makers trade with each other to rebalance their inventories.

[5] As noted above, the full 472-security sample includes 58 securities that split sometime during the 6-month event period examined in this study. Removing these 58 securities has no material effect on the regression results reported in Table 2, or on any of the conclusions based on these results. When a dummy variable that is set equal to one for securities that split and zero otherwise is included in these regressions, the coefficient on this dummy variable is not significantly different from zero. This indicates that the change-in-price variable is sufficient to control for any price change associated with the stock split.

Table 2
Regressions of the change in bid–ask half-spreads when securities move from Nasdaq to the NYSE or Amex on a constant, the change in the frequency of even-eighth quotes, the change in the average price inverse, the change in the daily stock return standard deviation, the log Nasdaq trading volume, the log NYSE or Amex trading volume, and the log number of Nasdaq market makers. Sample: 468 securities that moved from Nasdaq to the NYSE or Amex between 1983 and 1992. Changes are calculated as the Nasdaq value minus the NYSE or Amex value for each security. (*t*-statistics in parentheses).

| Dependent variable | Intercept | Change in even-eighth quotes | Change in price inverse | Change in return std. dev. | Log Nasdaq volume ($) | Log NYSE/ Amex volume ($) | Log number of market makers | Adjusted $R^2$ |
|---|---|---|---|---|---|---|---|---|
| Quoted half-spread ($) | 0.01 (1.28) | 0.39 (11.88) | | | | | | 0.23 |
| Effective half-spread ($) | 0.05 (5.68) | 0.30 (12.39) | | | | | | 0.25 |
| Quoted half-spread (%) | 0.19 (1.88) | 2.74 (9.09) | | | | | | 0.15 |
| Effective half-spread (%) | 0.50 (6.11) | 1.90 (7.67) | | | | | | 0.11 |
| Quoted half-spread ($) | 0.26 (6.02) | 0.15 (4.96) | − 0.55 (− 4.03) | 2.81 (6.26) | − 0.03 (− 3.54) | 0.05 (4.82) | − 0.15 (− 9.72) | 0.52 |
| Effective half-spread ($) | 0.25 (7.84) | 0.12 (5.51) | − 0.41 (− 4.15) | 2.16 (6.58) | − 0.02 (− 2.46) | 0.03 (3.54) | − 0.11 (− 9.94) | 0.54 |
| Quoted half-spread (%) | 4.08 (15.22) | 0.54 (2.90) | 2.44 (2.90) | 29.61 (10.67) | − 0.38 (− 6.55) | 0.18 (3.01) | − 0.39 (− 4.15) | 0.63 |
| Effective half-spread (%) | 3.48 (10.06) | 1.02 (4.23) | 4.63 (4.27) | 33.91 (9.46) | − 0.46 (− 6.19) | 0.36 (4.64) | − 0.71 (− 5.76) | 0.60 |

using transaction prices is correlated with the bid–ask spread. The number of Nasdaq market makers and the Nasdaq and NYSE or Amex trading volume are regressed in log form since these variables are skewed and the log transformation again provides a better fit. Finally, separate regression coefficients are reported for the average daily trading volume on Nasdaq and on the NYSE or Amex since dealer-to-dealer trades inflate the reported Nasdaq trading volume in relation to NYSE or Amex volume. Including trading volume in these regressions will also bias the results away from finding a significant coefficient for the even-eighth-quote variable since trading volume is endogenous and microstructure theory predicts that it will be correlated with the change in spread.

The variables of these regressions generally have the signs predicted by the microstructure literature. Higher stock prices are associated with higher dollar spreads, but lower percentage spreads; higher stock return standard deviations are associated with higher dollar and percentage spreads; higher trading volume is associated with lower dollar and percentage spreads; and more Nasdaq market makers are associated with lower Nasdaq spreads. Together, these variables increase the $R^2$ measures for the regressions from 0.25 or less in the dollar spread regressions to more than 0.50, and from 0.15 or less in the percentage spread regressions to 0.60 or greater. Including these variables also reduces the size of the coefficient for the variable measuring the change in even-eighth quotes. However, after controlling for these security-specific characteristics in the regressions, the relation between bid–ask spreads and the avoidance of odd-eighth quotes on Nasdaq remains statistically significant and economically important.

Although it might be tempting to use the coefficient on the variable measuring the change in even-eighth quotes in these regressions as a measure of the overcharge resulting from collusion among market makers, this measure is biased downward for several reasons. First, as noted above, a reduction in the bid–ask spread can cause a security to have lower stock return standard deviation (by reducing bid–ask bounce) and higher trading volume. Including these variables in the regression will bias downward the coefficient on the variable measuring the change in even eighth quotes. Second, by comparing securities for which Nasdaq market makers avoided odd-eighth quotes with securities for which market makers used both odd and even eighths, this measure assumes that the spreads for securities for which Nasdaq market makers used both odd and even eighths were competitive. However, the SEC found evidence of a conspiracy among Nasdaq market makers that extended beyond the avoidance of odd-eighth quotes. For example, in addition to a pricing convention governing the use of odd-eighth quotes, the SEC found evidence of: (1) A generalized collusion against narrowing the spread where a number of market makers discouraged their peers from narrowing spreads, even to the extent permitted by the pricing convention;

(2) Pressure, harassment and refusal to deal with market makers who narrowed their spreads; (3) A size convention through which market makers were discouraged from narrowing their spreads unless they were willing to trade substantially more than the minimum quantity required by NASD rules; (4) Coordination of quotes, trades and trade reports; and (5) The sharing of proprietary customer information (see, U.S. Securities and Exchange Commission, 1996). The variable measuring the change in even-eighth quotes in the reported regressions will understate the impact of collusion among market makers to the extent that these activities increased bid–ask spreads beyond the competitive level for securities for which Nasdaq market makers used both odd and even eighths.

If Demsetz (1997) is correct when he argues that bid–ask spreads on Nasdaq reflect the costs of market making while spreads on the NYSE and Amex do not, then it might be more appropriate to regress the change in the bid–ask spread on the level of the Nasdaq security-specific characteristics, rather than on the change in these characteristics between the Nasdaq and NYSE or Amex trading periods. Note, however, that since the Nasdaq and NYSE or Amex trading volume appear in the regression separately, and since the number of market makers on the NYSE or Amex takes the value of one for all observations (securities), the only variables affected by this change in specification are the price inverse and the stock return standard deviation. Replacing the change in these two variables with their levels improves the fit slightly for the dollar spread regressions, and worsens the fit slightly for the percentage spread regressions. The size and statistical significance of the coefficient on the variable measuring the change in even-eighth quotes is not materially affected in any of these alternative regressions, however. Adding a firm-size variable to the regression also does not affect the coefficient for the change in even-eighth quotes. The change in firm size is not included as a regressor in Table 2 since it is nearly collinear with change in price.

These results suggest that the differences in bid–ask spreads between securities where Nasdaq market makers avoid odd-eighth quotes and those where market makers use both odd- and even-eighth quotes cannot be adequately explained by security-specific characteristics. The results support the claim that when Nasdaq market makers avoid odd-eighth quotes, bid–ask spreads are increased to supra-competitive levels.

## 4. Additional tests

This section provides several additional tests to examine the robustness of previous results, and to aid in their interpretation.

### 4.1. A Comparison of listings on the NYSE and Amex

The full sample of 472 securities examined in this paper combines 287 Nasdaq securities that moved to the NYSE and 185 Nasdaq securities that moved to the Amex. These two groups of securities vary in several important dimensions. Securities that move from Nasdaq to the Amex tend to be smaller companies with lower share prices, fewer Nasdaq market makers, and lower trading volume than securities that move from Nasdaq to the NYSE. These security-specific characteristics lead to higher average percentage bid–ask spreads (and lower average dollar bid–ask spreads) on the Amex than on the NYSE. Irrespective of these differences, however, the general pattern of spreads for securities that leave Nasdaq for the NYSE or Amex is the same whether the destination exchange is the NYSE or the Amex.

Fig. 4 provides the average effective half-spreads separately for securities moving to the NYSE (Panel A) and securities moving to the Amex (Panel B). In both cases, consistent with results reported by Christie and Huang, there is a decline in the bid–ask spread on the first day of NYSE or Amex trading. In addition, the decline in bid–ask spreads is much larger when Nasdaq market makers avoid odd-eighth quotes than when they use both odd and even eighths.

### 4.2. Comparison of daily closing prices with the full transaction record

As noted above, daily closing transaction prices, and bid and ask quotations, are used for the bulk of the analysis in this paper because the full transaction record is not available for Nasdaq securities before 1990. As a check on the robustness of the results, however, the full transaction record is examined for 135 securities that moved from Nasdaq to the NYSE or Amex between 1990 and 1992. The results using the full transaction record (reported in Table 3) are similar to the results using daily closing prices and quotations.

As indicated by the row in Table 3 labeled 'All Trades', the average effective half-spread falls from 23 cents to 8 cents when these securities move from Nasdaq to the NYSE or Amex. This decline in the effective half-spread is closely related to the avoidance of odd-eighth quotes on Nasdaq. For the securities for which Nasdaq market makers avoid odd-eighth quotes, the effective half-spread declines from 33 cents to 9 cents, and for the securities for which Nasdaq market makers use both odd and even eighths, the effective half-spread declines from 14 cents to 7 cents. The change in the average effective half-spread is statistically significant in both subsamples.

There are some minor differences between Table 1, which reports daily closing spreads for the full 472-security sample, and Table 3, which reports the average effective spreads for all transactions for the 135-security sample). The basic results, however, are strikingly similar. In both cases, the avoidance of odd-eighth quotes has a significant effect on Nasdaq bid–ask spreads. Yet, when

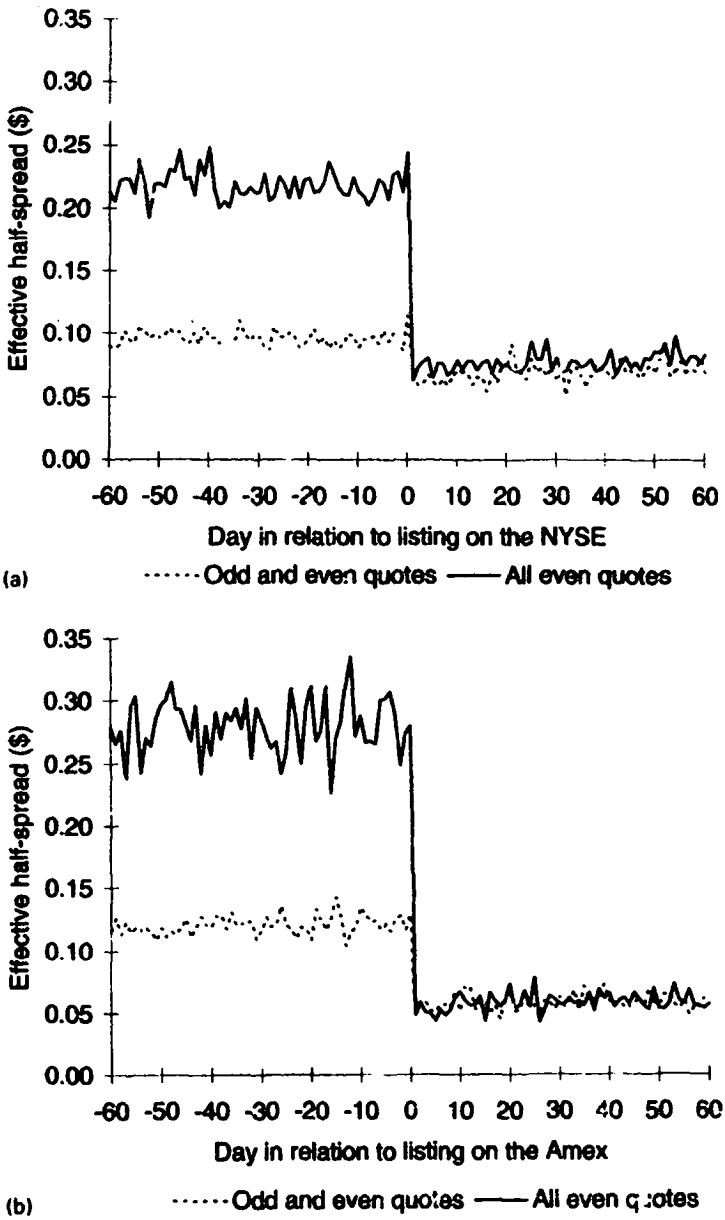


Fig. 4. Effective half-spreads for 287 Nasdaq securities that moved to the NYSE and 185 Nasdaq securities moved to the Amex between 1983 and 1992. Day 0 is the first day of trading on the NYSE or Amex. The subsample identified as 'all even quotes' includes securities that had more than 90% of their closing bid and ask prices on even eighths during the 60 days prior to listing on the NYSE or Amex. The subsample identified as 'odd and even quotes' includes the remaining securities. Sample sizes are in parentheses.

Table 3
Average effective half-spreads calculated using the full transaction record for 135 securities that were traded on Nasdaq and moved to the NYSE or Amex between 1990 and 1992. The subsample identified as 'all even quotes' had more than 95% of their bid and ask quotations on even eighths during the 60 days prior to listing on the NYSE or Amex. (Standard deviations in parentheses).

| | All securities ($N = 135$) | | All even quotes ($N = 78$) | | Odd and even quotes (N = 57) | |
|---|---|---|---|---|---|---|
| | Before NYSE Amex listing | After NYSE Amex listing | Before NYSE Amex listing | After NYSE Amex listing | Before NYSE Amex listing | After NYSE Amex listing |
| Effective half-spread by size of trade* | | | | | | |
| Small | 0.25 | 0.08 | 0.33 | 0.09 | 0.14 | 0.07 |
| | (0.18) | (0.02) | (0.20) | (0.02) | (0.06) | (0.02) |
| Medium | 0.19 | 0.09 | 0.25 | 0.09 | 0.11 | 0.08 |
| | (0.16) | (0.04) | (0.19) | (0.05) | (0.04) | (0.03) |
| Large | 0.15 | 0.09 | 0.20 | 0.10 | 0.11 | 0.08 |
| | (0.17) | (0.05) | (0.24) | (0.05) | (0.04) | (0.04) |
| All trades | 0.23 | 0.08 | 0.30 | 0.09 | 0.12 | 0.08 |
| | (0.18) | (0.02) | (0.19) | (0.03) | (0.05) | (0.02) |
| Even-eighth quotes | 82 | 56 | 99 | 57 | 59 | 54 |
| (%) | (23) | (7) | (1) | (7) | (16) | (56) |

* Small trades are 1,000 shares or less, medium trades are between 1000 shares and 10000 shares, and large trades are 10000 shares or larger.

these securities move to the NYSE or Amex, this effect disappears. Thus, the conclusion that the avoidance of odd-eighth quotes on Nasdaq increases bid–ask spreads to supra-competitive levels is not sensitive to the use of daily closing prices.

Using the full transaction record allows for additional analyses that are not possible with daily closing prices. For example, Table 3 also presents the average effective half-spreads for the 135-security sample by the size of the trade. Trading on the NYSE or Amex reduces the average effective half-spread for all trade sizes. The greatest reduction in trading costs is observed for small trades (1000 shares or less). For these trades, moving to the NYSE or Amex reduces the average effective half-spread from 25 cents to 8 cents for the full 135-security sample, and from 33 cents to 9 cents for the securities for which Nasdaq market makers avoid odd-eighth quotes. Even for the largest trades of 10000 shares or more, however, there is a significant reduction in the average effective half-spread when securities move to the NYSE or Amex. For these large trades, the average effective half-spread declines from 15 cents to 9 cents for the full

135-security sample, and from 20 cents to 10 cents for the securities for which Nasdaq market makers avoid odd-eighth quotes.

The size-related pattern of execution costs on the NYSE and Amex is consistent with the predictions of the existing economic literature. Large trades move the market maker further away from his desired inventory position and have larger potential adverse information costs. Thus these trades are expected to have larger effective spreads. The pattern of spreads on Nasdaq is more surprising, although this pattern has shown up in other recent studies (see, for example, Huang and Stoll, 1995). The results are consistent with the conclusion that bid–ask spreads for small trades on Nasdaq are significantly above the competitive level. Larger trades get better prices for market-making services. These trades often involve institutional traders that trade directly with each other through proprietary trading systems such as Instinet, and that privately negotiate transactions with market makers. The bid–ask spreads for large trades on Nasdaq are also affected by trades between market makers as they manage their inventories.

### 4.3. *Time-period analysis*

Several recent studies, including Huang and Stoll (1996), Stoll (1995), and Kothare and Laux (1995), find that Nasdaq bid–ask spreads increased significantly between 1983 and 1992, while spreads on the NYSE and Amex remained constant or declined slightly during this decade. To examine the influence of this time-period effect, Table 4 reports the average quoted and effective half-spreads separately for the periods 1983 to 1987 (Panel A) and 1988 to 1992 (Panel B) for the full sample of 472.

Consistent with these prior studies, Nasdaq bid–ask spreads increased in the latter period while the NYSE/Amex spreads remained relatively constant. The increase in Nasdaq spreads in this sample is small, however. For all Nasdaq securities, the average quoted half-spread increased from 20 cents in the earlier period to 24 cents per share in the latter period, and the average effective half-spread increased from 17 cents to 19 cents per share. Over the same period, the average NYSE/Amex quoted spread held steady at 13 cents, and the average NYSE/Amex effective half-spread declined from 7 cents to 6 cents.

The increase in bid–ask spreads for the Nasdaq securities in this sample is solely attributable to the securities for which Nasdaq market makers avoided odd-eighth quotes. The average quoted and effective half-spreads for the securities for which Nasdaq market makers used both odd and even eighths held steady at 13 cents and 11 cents per share, respectively, while the average quoted half-spread for the securities for which Nasdaq market makers avoided odd-eighth quotes increased from 28 cents to 35 cents, and the average effective half-spread for these securities increased from 23 cents to 27 cents.

Table 4
Summary statistics for 472 securities that were traded on Nasdaq and moved to the NYSE or Amex between 1983 and 1992 for the time periods 1983–1987 and 1988–1992. The subsample identified as 'all even quotes' had more than 90% of their closing bid and ask quotations on even eighths during the 60 days prior to listing on the NYSE or Amex.

| | All securities | | All even quotes | | Odd and even quotes | |
|---|---|---|---|---|---|---|
| | Before NYSE/ Amex listing | After NYSE/ Amex listing | Before NYSE/ Amex listing | After NYSE/ Amex listing | Before NYSE/ Amex listing | After NYSE/ Amex listing |
| Panel A: 1983–1987 | | | | | | |
| Quoted half-spread ($) | 0.20 | 0.13 | 0.28 | 0.14 | 0.13 | 0.12 |
| Effective half-spread ($) | 0.17 | 0.07 | 0.23 | 0.07 | 0.11 | 0.07 |
| Quoted half-spread (%) | 1.45 | 0.96 | 1.73 | 0.88 | 1.17 | 1.04 |
| Effective half-spread (%) | 1.21 | 0.54 | 1.42 | 0.48 | 1.02 | 0.60 |
| Even-eighth quotes (%) | 79 | 56 | 99 | 56 | 59 | 55 |
| Number of securities | 175 | 175 | 86 | 86 | 89 | 89 |
| Panel B: 1988–1992 | | | | | | |
| Quoted half-spread ($) | 0.24 | 0.13 | 0.35 | 0.14 | 0.13 | 0.11 |
| Effective half-spread ($) | 0.19 | 0.06 | 0.27 | 0.07 | 0.11 | 0.06 |
| Quoted half-spread (%) | 2.10 | 1.09 | 2.51 | 0.87 | 1.66 | 1.33 |
| Effective half-spread (%) | 1.67 | 0.57 | 1.92 | 0.42 | 1.40 | 0.74 |
| Even-eighth quotes (%) | 78 | 55 | 99 | 56 | 55 | 54 |
| Number of securities | 293 | 293 | 153 | 153 | 144 | 144 |

In both time periods, however, the basic pattern of spreads documented above remains the same. When Nasdaq market makers avoid odd-eighth quotes, bid–ask spreads are large and decline dramatically with listing on the NYSE or Amex. When market makers use both odd and even eighths, bid–ask spreads are smaller and decline only slightly with listing on the NYSE or Amex. After listing on the NYSE or Amex, there is little difference between these groups.

### *4.4. Results from a control sample of Nasdaq securities*

It might be suggested that the results reported above are distorted by the classification of securities according to whether Nasdaq market makers avoided odd-eighth quotes. If Nasdaq securities sometimes temporarily have wide spreads because of random events that are unexplained by normal economic

Table 5
Summary statistics for 472 securities that were traded on Nasdaq and moved to the NYSE or Amex between 1983 and 1992 (Panel A) and a paired control sample of 472 Nasdaq-listed securities that did not move to the NYSE or Amex (Panel B). The subsample identified as 'all even quotes' had more than 90% of their closing bid and ask quotations on even eighths during the 60 days prior to listing on the NYSE or Amex. (Standard errors in parentheses).

| | All securities | | All even quotes | | Odd and even quotes | |
|---|---|---|---|---|---|---|
| | Before NYSE/ Amex listing | After NYSE/ Amex listing | Before NYSE/ Amex listing | After NYSE/ Amex listing | Before NYSE/ Amex listing | After NYSE/ Amex listing |
| Panel A: Nasdaq-listed securities that moved to the NYSE or Amex | | | | | | |
| Quoted half-spread ($) | 0.23 | 0.13 | 0.33 | 0.14 | 0.13 | 0.12 |
| | (0.20) | (0.03) | (0.23) | (0.03) | (0.06) | (0.03) |
| Even-eighth quotes (%) | 78 | 55 | 99 | 56 | 56 | 54 |
| | (24) | (7) | (2) | (7) | (15) | (6) |
| Number of securities | 472 | 472 | 239 | 239 | 233 | 233 |
| Panel B: Paired control sample of securities that did not move to the NYSE or Amex | | | | | | |
| Quoted half-spread ($) | 0.27 | 0.26 | 0.41 | 0.40 | 0.13 | 0.13 |
| | (0.30) | (0.26) | (0.36) | (0.31) | (0.06) | (0.06) |
| Even-eighth quotes (%) | 76 | 75 | 99 | 98 | 53 | 54 |
| | (26) | (26) | (2) | (8) | (16) | (19) |
| Number of securities | 472 | 472 | 234 | 234 | 238 | 238 |

factors, then spreads for high- and low-spread securities would tend to converge over time. Since a partition of securities according to odd-eighth usage is highly correlated with a partition based on spread width, it might be argued that this partition will generate a convergence in spreads for any randomly selected sample of securities. To address this concern, I randomly selected one Nasdaq NMS security that did not move to the NYSE or Amex for each of the 472 securities in my sample. I then examined the bid–ask spreads and the percentage of even-eighth quotes for these 'control securities' over the same interval as their matched-pair security in the original sample. As reported in Panel B of Table 5, the control securities for which Nasdaq market makers avoid odd-eighth quotes have wider spreads than the control securities for which market makers use both odd and even eighths, and there is no convergence of the spreads for these two groups over time. Thus, the results in this paper cannot be explained by random events that may temporarily cause some securities to have wide spreads that are unexplained by normal economic factors.

Table 6
Summary statistics for 209 securities that were traded on Nasdaq and moved to the NYSE or Amex between 1983 and 1992 for which the average quoted bid–ask spread for the first 60 days of NYSE or Amex trading was at least 25 cents. The subsample identified as 'all even quotes' had more than 90% of their closing bid and ask quotations on even eighths during the 60 days prior to listing on the NYSE or Amex.

| | All securities ($N$ = 209) | | All even quotes ($N$ = 140) | | Odd and even quotes ($N$ = 69) | |
|---|---|---|---|---|---|---|
| | Before NYSE/ Amex listing | After NYSE/ Amex listing | Before NYSE/ Amex listing | After NYSE/ Amex listing | Before NYSE/ Amex listing | After NYSE/ Amex listing |
| Quoted half-spread ($) | 0.28 | 0.15 | 0.35 | 0.16 | 0.14 | 0.15 |
| | (0.26) | (0.03) | (0.29) | (0.03) | (0.06) | (0.02) |
| Effective half-spread ($) | 0.22 | 0.08 | 0.27 | 0.08 | 0.12 | 0.08 |
| | (0.18) | (0.02) | (0.20) | (0.02) | (0.05) | (0.02) |
| Even-eighth quotes (%) | 86 | 58 | 99 | 58 | 59 | 58 |
| | (20) | (7) | (2) | (7) | (11) | (8) |

### 4.5. *Results from a sample of securities that were traded on Nasdaq and moved to the NYSE or Amex and for which the average quoted bid–ask spread for the first 60 days of NYSE or Amex trading was at least 25 cents*

NYSE and Amex-listed securities trade with a tick size of one-eighth. If competition from limit orders on the NYSE and Amex drives bid–ask spreads to the minimum tick size of one-eighth, then the normal relation between bid–ask spreads and the costs of market making may be obscured. To determine whether the compression of spreads to the minimum tick size of one-eighth affects my results, I examine separately the securities in my sample that moved from Nasdaq to the NYSE or Amex for which the average quoted bid–ask spread during the first 60 days of trading on the NYSE or Amex is at least one-quarter. Since bid–ask spreads for these securities could be reduced significantly while trading in one-eighth price increments, they should be less affected by the minimum-tick-size constraint. Results for this subsample, presented in Table 6, are similar to the results for the sample as a whole. When Nasdaq market makers avoid odd-eighth quotes, listing on the NYSE or Amex provides a significant reduction in the bid–ask spread; when Nasdaq market makers use both odd and even eighths, listing on the NYSE or Amex provides very little improvement in bid–ask spreads. Thus, I conclude that my results are not materially affected by the compression of spreads on the NYSE and Amex to the minimum price increment of one-eighth.

### 4.6. *Securities that voluntarily delist from the Amex*

Through an examination of bid–ask spreads for securities that move from Nasdaq to the NYSE or Amex, this study concludes that the large spreads observed when Nasdaq market makers avoid odd-eighth quotes cannot be explained by security-specific costs of market making. This conclusion is supported by Clyde et al. (1996) who examine securities that voluntarily delist from the Amex and move back to Nasdaq.[6] Clyde et al. find that when these securities begin trading on Nasdaq, they separate into the same two bipolar categories first observed by Christie and Schultz (1994). Clyde et al. also find that although bid–ask spreads increase for both groups, the increase is much larger for the securities for which Nasdaq market makers avoid odd-eighth quotes than it is for the securities for which market makers use both odd and even eighths. Just as in this study of securities that move from Nasdaq to the NYSE or Amex, the Clyde et al. study holds constant all security-specific costs of market making by examining the same securities before and after delisting from the Amex. Thus, the higher spreads observed when market makers avoid odd-eighth quotes cannot be explained by higher security-specific costs of market making.

## 5. Conclusions

There are three potential explanations for the observation that bid–ask spreads are higher on Nasdaq than on the NYSE: (1) Spreads on Nasdaq are competitive and reflect the higher cost of market making for Nasdaq securities; (2) Spreads on Nasdaq are supra-competitive because of an inefficient market structure or institutional practices that suppress the incentives for price competition; and (3) Spreads on Nasdaq are supra-competitive because of implicit or explicit collusion by Nasdaq market makers. The evidence in this paper is inconsistent with the argument that spreads on Nasdaq are competitive.

This study holds all security-specific characteristics constant by examining the same securities before and after listing on the NYSE or Amex. In addition, by comparing securities for which Nasdaq market makers avoid odd-eighth quotes with securities for which market makers use both odd and even eighths, it is possible to control for any institutional differences between Nasdaq and the NYSE or Amex. In this tightly controlled experiment, two important results emerge. First, as noted in Christie and Huang (1994), bid–ask spreads fall when securities move from Nasdaq to the NYSE or Amex. Second, and more

[6] NYSE rules make it difficult to delist from that market once a security is traded there. Thus, there are few voluntary delistings from the NYSE.

importantly, the large difference in effective spreads between securities for which market makers avoid odd eighths and those for which market makers use both odd and even eighths is nearly eliminated when the same securities are traded on the NYSE or Amex. These results support the conclusion that the avoidance of odd-eighth quotes is used as a coordination device among Nasdaq market makers to increase bid-ask spreads to supra-competitive levels.

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