



## **Policy Watch**

# **Did Nasdaq Market Makers Implicitly Collude?**

**William G. Christie and Paul H. Schultz**

Public policies are often made without much recourse to economic reasoning. Economists are often unaware of what is happening in the world of public affairs. As a result, both the quality of public decision making and the role that economists play in it are less than optimal. This feature contains short articles on topics that are currently on the agendas of policymakers, thus illustrating the role of economic analysis in illuminating current debates. Suggestions for future columns and comments on past ones should be sent to Daniel Weinberg, c/o *Journal of Economic Perspectives*, HHES Division, Bureau of the Census, Department of Commerce, Washington, D.C. 20233.

### **Introduction**

We recently had the good fortune, rare for those involved in academic research, to witness the impact of our research while our article was still awaiting publication! Our results, reported in Christie and Schultz (1994), present strong circumstantial evidence that brokerage firms making markets in Nasdaq stocks (that is, stocks traded through the National Association of Securities Dealers Automated Quotation system) implicitly colluded to maintain profits at supracompetitive levels. When we released our findings to the press, we anticipated perhaps a few days of publicity for our respective universities. Instead, the study sparked the filing of dozens of class-action lawsuits, an

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investigation by the Antitrust Division of the U.S. Department of Justice, an inquiry by the Securities and Exchange Commission, and the appointment of a blue-ribbon panel by the National Association of Securities Dealers (NASD).<sup>1</sup>

Christie, Harris and Schultz (1994) report that faced with these investigations and the widespread media reports of our findings, the market making firms changed their pricing practices overnight, producing lower trading costs for investors. This article is intended to familiarize readers with the issues at the heart of this debate.

## Alternative Market Structures

Financial markets employ two distinct trading structures to facilitate the matching of buy and sell orders.<sup>2</sup> The first is an auction market, where orders for a particular stock are routed to a single specialist on the floor of an exchange. The New York Stock Exchange (NYSE) is the most widely known example of an auction market. In this market, public investors or brokers can place "market orders," which receive the highest sales price or the lowest purchase price available at the time the order is placed. Alternatively, investors can place a "limit order," which expresses a willingness to buy at a price less than or equal, or sell at a price greater than or equal, to the limit price. The specialist maintains a record of all limit orders and matches incoming market orders to buy or sell with the best available limit order. Specialists are also required to take the opposite side of a transaction in the absence of other buyers or sellers. The "inside spread," which reflects the best offers to buy or sell from either the specialists quotes or the limit orders, determines the cost of immediacy for a roundtrip transaction. Specialists are compensated through commissions earned in their role as agents for those buying or selling stock, and through their own trading activity.

While auction markets use centralized trading floors, dealer markets are decentralized, and allow geographically dispersed market makers the opportunity to compete for order flow through prices. Nasdaq and the London International Stock Exchange are among the best-known markets centered around multiple market makers. On Nasdaq, market makers (or equivalently, dealers) communicate through computer screens that are linked through computers located in Rockville, Maryland, or through direct phone contact. Dealers are required to post quotes at which they are willing to buy and sell the stocks in which they make markets. Market makers with the greatest demand to buy will post the highest "bid" price, and those with the greatest need to sell will post the

<sup>1</sup>The NASD is a Self-Regulatory Organization (SRO) that both owns and operates the Nasdaq Stock Market. It is also responsible for regulatory oversight of its member firms.

<sup>2</sup>See Stoll (1992) and Schwartz (1991) for a summary of the differences in market structures.

lowest “ask” price. Typically, a market maker will not simultaneously post the best bid and ask prices at a given time.<sup>3</sup> Incoming market orders then trade with the best bid or ask offered by market makers.

The difference between the lowest ask and the highest bid forms the inside spread, which compensates market makers for bearing risks and committing capital. Since limit orders are not an integral part of Nasdaq, investor orders are almost always executed through a market maker rather than against other investor orders. Thus, the wider the spread, the larger the compensation to market makers.

The NASD requires at least two market makers per stock before the firm can trade on Nasdaq. Large, actively traded issues routinely attract as many as 60 market makers. The presence of multiple market makers would be expected to produce competitive spreads through the competition for order flow through prices.<sup>4</sup>

On Nasdaq, price fractions for bid or ask quotes are mandated to be multiples of one-eighth of a dollar for all stocks whose bid price exceeds \$10.<sup>5</sup> Thus, bid or ask quotes can end in either even-eighths (0, 2/8, 4/8, 6/8) or odd-eighths (1/8, 3/8, 5/8, 7/8). The narrowest spread that can be generated from these fractions is one-eighth, such as \$25.50 bid and \$25.625 ask. In a market where dealers compete for orders by posting the most competitive prices, we would anticipate that all price fractions would be used with approximately the same frequency. Indeed, stocks that trade on the NYSE are routinely quoted in both even and odd-eighths.

## The Luck of the Draw

Serendipity is well accepted as an important facet of research in the physical and biological sciences. Our research offers an example of serendipity in the social sciences, since our original research agenda was a far cry from the work that was eventually published. We began examining Nasdaq prices as part of a research program involving a unique data set consisting of all individual market maker quote changes and actual trade prices for 40 large Nasdaq stocks during a 39-day period in 1991. We intended to examine intraday patterns in spreads, the behavior of market makers during periods of market stress, and whether some market maker quotes were more informative than others.

<sup>3</sup>See Chan, Christie and Schultz (1995) for a discussion of the frequency of dealers that simultaneously post both inside bid and inside ask quotes.

<sup>4</sup>Recent empirical work describing the differences in trading costs across market structures includes Blume and Goldstein (1992), Lee (1992), and Christie and Huang (1994). The intraday patterns in spreads for different market structures is documented by Brock and Kleidon (1992), McInish and Wood (1992), Neal (1992), Kleidon and Werner (1993), and Chan, Christie and Schultz (1995).

<sup>5</sup>The NYSE also uses a minimum “tick size” of one-eighth. The optimal tick size is currently under debate and study by the Securities and Exchange Commission, with some advocates proposing a decimal rather than the current system.

But when we began studying the frequency of inside spreads of different widths, we noticed something odd. There were virtually no one-eighth spreads for Apple Computer during the entire 39-day period, despite the fact that Apple is one of the most actively traded and highly visible Nasdaq stocks! We checked for one-eighth spreads for Lotus Development and, again, came up empty. In fact, when we examined the other firms in our sample, the same dearth of one-eighth spreads was shared by the vast majority of stocks. A closer inspection of the individual market maker quotes quickly led to the discovery that these Nasdaq stocks were quoted exclusively in even-eighths. In other words, quotes rarely used any of the one-eighth, three-eighths, five-eighths, or seven-eighths price fractions.

We checked whether we had made any errors in downloading the data, but found none. We checked our programs, and found no code that could have produced such a bizarre result. We turned to an alternative data source compiled by the Institute for the Study of Securities Markets (ISSM). Again, when we examined the inside spreads for these firms during the same 39 days in 1991, the results were identical.

We were stunned. It seemed inconceivable that almost 60 market makers simply forgot to use one-half of the possible price fractions for a period of almost two months. It was particularly surprising since many of the stocks in our sample rival the largest NYSE firms in trading volume, and the NYSE firms are routinely quoted using all eighths.

In light of these results, we abandoned our original research agenda to pursue a more extensive study of the anomalous patterns that we had identified. We obtained all of the inside quote revisions for a sample of 100 of the most active Nasdaq firms for the entire year of 1991. When we replicated our analysis on this data, we found that odd-eighth quotes were extremely rare for 70 of the 100 Nasdaq firms sampled, including such highly visible and actively traded stocks as Intel, Amgen, Microsoft, and Cisco Systems. Of course, the converse is that odd-eighth quotes *were* regularly used for the remaining 30 percent of the sample, including firms such as MCI Communications. Thus, the lack of odd-eighth quotes was not a structural feature of the Nasdaq market. Instead, it seemed to be a conscious decision by the market makers of these 70 firms to avoid odd-eighths when quoting these stocks.

We searched for a rational economic explanation for these results, using variables such as trading volume, price, volatility, and the number of market makers to help us predict which firms were quoted in odd-eighths. Although the share price proved marginally significant, we found that the most important factor in predicting the use of odd-eighths during the last six months of 1991 was a simple dummy variable indicating whether odd-eighth quotes were present at the beginning of the year.

We then asked ourselves, "How is it possible that over 50 market makers in a stock such as Apple Computer could compete for orders without ever using odd-eighth quotes to gain an advantage over their competitors?" In the absence

of any other plausible explanation, we concluded that our results most likely reflected an understanding or implicit agreement among the market makers to avoid the use of odd-eighth price fractions when quoting these stocks. The significance of this agreement is that the inside spread was prevented from narrowing to under \$0.25, thereby inflating trading profits above those that would have been generated in the absence of this policy.<sup>6</sup>

One might argue that just because odd-eighths are not used in quoting these stocks, odd-eighth price fractions may arise if actual transaction prices lie within the spread. For example, a spread of \$20 bid and \$20.25 ask is twice the minimum permitted, but the wide quotes are not as important if market makers routinely buy and sell shares at \$20.125. In examining this issue, we found that when trades require phone contact between market makers, odd-eighth price fractions occur in approximately 22 percent of the trades.<sup>7</sup> However, when orders are automatically executed against the inside quotes through the Small Order Execution System, odd-eighth price fractions arise in only about 5 percent of the trades.<sup>8</sup> Thus, the width of the quoted spread affects virtually all investors, but it is most important to smaller investors who lack the ability to negotiate.

## **How Can Tacit Collusion be Possible?**

Whenever we discuss these results, a basic question arises: “How could 60 independent market makers coordinate the way they quote these stocks?” The answer is “quite easily.” The screen-based system used by Nasdaq market makers displays the bid and ask quotes of every market maker. Thus, the market is essentially transparent, since it is easy to identify the market maker who posts a nonsanctioned price. These patterns can be sustained as long as the expected benefits from attempting to attract orders by narrowing the spread are more

<sup>6</sup>One factor that could offset the anticipated increase in revenues from maintaining a minimum spread of \$0.25 is that the higher trading costs might reduce the demand for market making services. However, we expect that the demand to trade by investors is relatively inelastic with respect to changes in the spread near the statutory minimum of \$0.125. This will be particularly true for smaller investors who are unable to use the alternative proprietary trading systems reserved for larger brokers and institutions (like INSTINET).

<sup>7</sup>Many of the trades that use an odd-eighth price fraction may have been executed on INSTINET, a proprietary trading system operated by Reuter’s that competes with Nasdaq. However, since these trades are reported through Nasdaq, we cannot separate these trades from those executed in the Nasdaq market.

<sup>8</sup>The Small Order Execution System (SOES) is used to automatically execute smaller trades. During the time of our study, a broker wishing to transact 1,000 shares or less would enter the order into SOES, which then executed the order against the best bid or ask price offered by a market maker in that stock. When the same price is posted by multiple market makers, orders are rotated among them.

than offset by the expected future costs imposed by other market making firms.<sup>9</sup> Such punishment could happen explicitly, if the other firms targeted a maverick market maker for especially tough price competition.

Our article also discusses a number of possible sanctions that do not require any form of overt communication, but that can be effectively used to punish a designated market maker.<sup>10</sup> For example, one of the potential costs from being identified as a maverick dealer who posts nonsanctioned prices is that it may be difficult for maverick dealers to locate buyers or sellers when their inventory becomes unbalanced. In addition, despite relatively free entry, market makers are unlikely to receive all of the order flow if they post superior prices, due to a practice known as “preferencing.” Most market makers agree in advance to accept orders of up to 1,000 shares that are preferenced (meaning “routed”) to them, and to execute those orders at the inside bid or ask, independent of their own quotes. Thus, if a market maker with little order flow attempts to garner orders by improving the quotes, there is no guarantee that they will receive most of the orders, since those orders may be preferenced to other dealers.

We also found additional empirical evidence consistent with a hypothesis of tacit collusion. For example, when odd-eighths do surface for stocks that are not routinely quoted in odd-eighths, their average duration is very short, with many in effect for less than 60 seconds. This is drastically shorter than the average time of approximately 22 minutes for even-eighth quotes posted by the same set of market makers. In addition, these rare odd-eighth quotes are more often used to widen the inside spread, rather than to narrow it. We also documented a few cases where odd-eighth quotes were routinely used in the first few months of 1991. Then, in the course of a few trading days, these odd-eighth quotes simply vanished. These patterns, along with the other results, implied that Nasdaq market makers appeared to possess the ability to coordinate the use of odd-eighth quotes.

## Media Blitz

At the prompting of our colleagues, we agreed to issue a press release after our article had been accepted for publication at the *Journal of Finance*.<sup>11</sup> We issued the press release on May 24, 1994. The only call that we initially received

<sup>9</sup>Since we are economists rather than lawyers, we use implicit collusion in a game theoretic framework rather than in a legal context. See Fudenberg and Tirole (1991, p. 155) for a discussion of this application of game theory.

<sup>10</sup>In the aftermath of the public dissemination of our results, the *Los Angeles Times* on October 20, 1994 (pg. 1), reported what they interpreted to be the overt harassment of dealers who “break the spread.” The *Times* wrote that when a dealer narrowed the spread on a stock from \$0.50 to \$0.375, the head of over-the-counter trading at another firm called and said, “You’re embarrassing and pathetic. . . . You’re breaking the spreads for everybody.”

<sup>11</sup>We purposely waited until after the *Journal of Finance* had formally accepted the paper for publication. This provided us with the opportunity to ensure that the various quality checks that the review process affords had been exhausted.

on May 25 was from the *Los Angeles Times*, which ran a story on May 26. We never envisioned the chaos that would soon follow. Beginning on the 26th, we were inundated with calls from reporters asking us to fax them a copy of the report. Although we had solicited comments from both the NASD and market makers prior to the press release, we knew that if we had overlooked something that could challenge our results, it would turn up in these new stories. On May 26, the Dow Jones News Wire quoted the head of Nasdaq institutional sales at one leading brokerage firm, who explained that “it might just be easier to have 1/4-point quotes, and it is probably just habit from the years before machines.” The managing director at another Nasdaq trading firm stated, “The quotations in quarters as opposed to odd-eighths has everything to do with the individual market makers’ spread and nothing to do with collusion. It has a lot to do with tradition and the avoidance of strange-looking quotations.” These comments reassured us that at least we hadn’t overlooked an obvious explanation, and reinforced our conviction that our interpretation of the results was correct.

We were also unprepared for the deluge of calls from law firms nationwide, who later brought lawsuits against the market making firms.<sup>12</sup> These various suits, which are seeking class-action status, were consolidated in the Southern District of New York in September 1994. This flurry of legal action against the various market making firms also apparently caught the attention of the Antitrust Division of the Justice Department. The *Los Angeles Times* confirmed on October 19, 1994, that the Justice Department was “looking at the possibility of anti-competitive practices on the Nasdaq market.” The Justice Department has since issued Civil Investigative Demands that request trading data for up to the past 10 years.<sup>13</sup>

## Market Impact

The legal activity and adverse publicity apparently attracted the attention of the Nasdaq trading desks. At the beginning of May 1994, five of the ten most active Nasdaq listed firms were routinely quoted in odd-eighths, while the other five were quoted exclusively in even-eighths. Interestingly, each of the five firms whose market makers avoided odd-eighths on May 1, 1994, were also quoted without odd-eighths in our sample of 70 firms in 1991. Thus, there was a strong historical precedent for quoting these stocks exclusively in even-eighths.

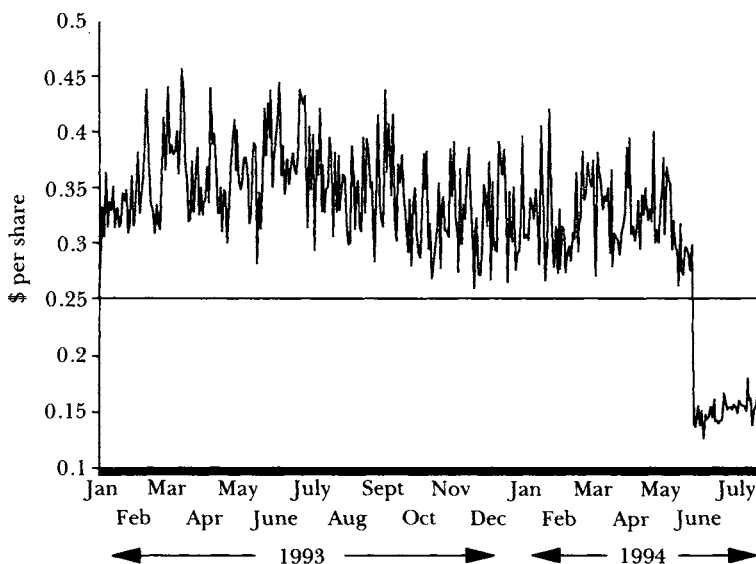
This precedent came to an abrupt end on May 27, 1994, the day after our study was first reported in the *Los Angeles Times* and carried by the wire services. By teaming up with Jeff Harris, also at Ohio State, we found that the market makers in Amgen, Cisco Systems, and Microsoft suddenly began using

<sup>12</sup> For a description of these suits, see “Wall Street on Trial,” *Investment Dealers’ Digest*, August 1, 1994 (pp. 16–19), and “Against the Odds,” *The Economist*, August 20, 1994 (pp. 59–60).

<sup>13</sup> See the article “U.S. Launches Massive Nasdaq Trading Probe” in the December 7, 1994, edition of *The Wall Street Journal* (page C1).

*Figure 1*

**The Time Series of Daily Average Inside Spreads for Microsoft Between January 1, 1993, and July 29, 1994**



odd-eighth quotes en masse. For example, Microsoft was quoted by 45 market makers on both May 26 and May 27. The number of market makers that posted quotes solely in even-eighths declined from 41 on May 26 to one on May 27. The number of market makers using odd-eighths in at least 40 percent of their quotes ballooned from zero on May 26 to 42 on May 27. Overnight, the market makers in these stocks abandoned a pricing practice that had been followed for at least the previous three years. The market makers for Apple required one additional trading day to alter their patterns. Thus, by June 1, 1994, all but one of the 10 most active stocks was quoted using both even and odd-eighths. The lone holdout, Intel Corporation, continued to be quoted by all but one of its market makers exclusively in even-eighths. But after the *Los Angeles Times* reported on October 19, 1994, that the Justice Department had confirmed that it was launching an investigation into possible antitrust violations in the Nasdaq Stock Market, Intel's price quotations abruptly changed.

To illustrate the impact that the use of odd-eighths has on the width of the inside spread, Figure 1 from Christie, Harris and Schultz (1994) shows the daily time-weighted average spread for Microsoft from January 1993 through July 1994. This figure, which is representative of the other stocks whose market makers began routinely to use odd-eighth quotes, clearly shows that the absence of these quotes prior to May 27, 1994, prevented the average spread from breaking through the barrier of \$0.25. However, once odd-eighths are used, the



inside spread falls by almost 50 percent. We also show that trading costs measured using transaction prices also decline by a similar amount.

The significant reduction in market maker revenues subsequent to May 27, 1994, does not appear to have dissuaded these dealers from making markets in any of these stocks. The same market makers that found it profitable to trade these issues with a minimum spread of \$0.25 are still making markets despite a decline in the minimum spread to \$0.125. As of this writing, we have observed no change in dealer behavior or the quality of the market that has been affected by the change in spreads.

Finally, our research appears to have increased the emphasis on spreads in the advertising pitch used by the American Stock Exchange. One recent AMEX advertisement quotes the CEO of Echo Bay Mines as stating, "Investors large and small are assured of the best possible price through the AMEX Auction Market. Spreads in Echo Bay are tighter than the lid on an old jelly jar."

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## References

- Barry, Brian, "Against the Odds," *Economist*, August 20, 1994, 59-60.
- Blume, Marshall, and Michael Goldstein, "Differences in Execution Prices Among the NYSE, the Regionals and the NASD," working paper, Wharton School, September 1992.
- Brock, William, and Allan Kleidon, "Periodic Market Closure and Trading Volume: A Model of Intraday Bids and Asks," *Journal of Economic Dynamics and Control*, July/October 1992, 16, 451-89.
- Chan, K. C., William G. Christie, and Paul H. Schultz, "Market Structure and the Intraday Pattern of Bid-Ask Spreads for Nasdaq Securities," *Journal of Business*, 1995, 68:1, 35-60.
- Christie, William G., and Roger O. Huang, "Market Structures and Liquidity: A Transactions Data Study of Exchange Listings," *Journal of Financial Intermediation*, June 1994, 3, 300-26.
- Christie, William G., and Paul H. Schultz, "Why Do Nasdaq Market Makers Avoid Odd-Eighth Quotes?," *Journal of Finance*, December 1994, 49, 1813-40.
- Christie, William G., Jeffrey Harris, and Paul H. Schultz, "Why Did Nasdaq Market Makers Stop Avoiding Odd-Eighth Quotes?," *Journal of Finance*, December 1994, 49, 1841-60.
- Fudenberg, Drew, and Jean Tirole, *Game Theory*. Cambridge, Mass.: MIT Press, 1991.
- Kleidon, Allan, and I. Werner, "Round-the-Clock Trading: Evidence from U.K. Cross-Listed Securities," working paper, Stanford University, 1993.
- Lee, Charles, "Purchase of Order Flows and Favorable Executions: An Intermarket Comparison," working paper, University of Michigan, March 5, 1992.
- Lux, Hal, "Wall Street on Trial," *Investment Dealers' Digest*, August 1, 1994, 60, 16-19.
- McInish, Tom, and Robert Wood, "An Analysis of Intraday Patterns in Bid/Ask Spreads for NYSE Stocks," *Journal of Finance*, June 1992, 47, 753-64.
- Neal, Robert, "A Comparison of Transaction Costs Between Competitive Market Maker and Specialist Market Structures," *Journal of Business*, July 1992, 65, 317-34.
- Paltrow, Scot J., "Taking Stock of Nasdaq," *Los Angeles Times*, October 20, 1994, A1.
- Power, William, and Jeffrey Taylor, "Small Stock Focus: U.S. Launches Massive Nasdaq Trading Probe," *Wall Street Journal*, December 1, 1994, C1.
- Schwartz, Robert, *Reshaping the Equity Markets: A Guide for the 1990s*. New York: HarperBusiness, 1991.
- Stoll, Hans, "Principles of Trading Market Structure," *Journal of Financial Services Research*, May 1992, 6, 75-107.