QUOTES, ORDER FLOW, AND PRICE DISCOVERY

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Abstract

In its attempt to integrate the trading of NYSE-listed stocks across market places, the SEC has caused the implementation of three electronic systems which provide a partial integration of these markets. The paper analyzes the implications of this partial integration and shows how it has created market niches in which non-NYSE markets can prosper. The empirical analysis shows: The bid and asked prices of the NYSE quote equal the best prices displayed across all markets most of the time. Non-NYSE markets attract a significant portion of their volume for reasons other than matching or bettering the NYSE quote, such as "payment for order flow." When non-NYSE markets post better bids or offers, they do attract additional order flow, but substantial order flow still flows to other markets. In posting better bids or offers, non-NYSE markets do contribute to "price discovery."

A major goal and ideal of the securities markets and the securities industry has been the creation of a strong central market system for securities of national importance, in which all buying and selling in these securities could participate and be represented under a competitive regime. This goal has not as yet been attained.

The Institutional Investor Study Report
of the Securities and Exchange Commission
March 10, 1971, Volume 1, Page xxiv.

The 1975 Amendments to the Securities Exchange Act of 1934 made it US policy to develop a national market system for the trading of securities. The underlying assumption is that "[t]he linking of all markets . . . will foster efficiency, enhance competition, increase the information available to brokers, dealers and investors, facilitate the offsetting of investors' orders, and contribute to best execution of such orders."[1] In view of the potentially significant implications of this Congressional finding, there has been surprisingly little theoretical or empirical work that examines the underpinnings of the assumptions upon which this policy directive rests.[2]

As of yet, the equity markets for NYSE-listed stocks are not fully integrated as envisioned by the regulators at that time, but instead are only partially integrated through three electronic systems.[3] This paper studies the effects of this partial integration on the trading of NYSE-listed stocks with the goal of obtaining a better understanding of the current institutional structure; it makes no attempt to compare and contrast the current institutional structure to other possible structures. The paper describes the institutional structure of the

[1]Securities Acts Amendments of 1975.

[2]In a careful study, Mendelson (1987) compares and contrasts the characteristics of two types of fragmented and consolidated markets and concludes that none of the markets examined is "optimal" as each involves tradeoffs. More recently, Harris (1993) concludes that participants with differing trading needs will prefer different, and therefore fragmented, markets. The case for government-mandated consolidation rests upon arguments of externalities.

[3]For example, the SEC's policy statement [(SEC(1973), p 22] called for "preferential treatment to public orders by preventing any member of the system from participating in any system transaction unless his purchase price is higher, or his sale price lower, than any public bid or offer recorded in the system." As another example, this statement presented situations in which limit orders would be protected throughout the system, though the statement was vague as to how this protection would be provided [SEC(1973), p. 16]. The current system has no mechanism that accomplishes either of these goals.

markets for trading NYSE-listed stocks, discusses the growing practice of non-NYSE market makers to purchase the order flow of small traders, suggests why this practice is profitable, proposes five empirical questions about the trading of NYSE-listed equities across markets, and then presents some empirical evidence on these questions. The questions themselves address the relative importance of the various markets in setting the best bid or offer, the effect of posting better bids and offers in attracting order flow, and the role of these markets in the process of "price discovery." The paper ends with a brief conclusion.

1 The Electronic Systems

NYSE-listed stocks trade in both US and foreign markets. The primary US markets for the trading of NYSE-listed stocks are the New York Stock Exchange itself,[4] the five regional stock exchanges (Boston, Cincinnati, Midwest,[5] Pacific, and Philadelphia), and other non-NYSE member organizations who stand ready to make markets in NYSE-listed stocks. Examples include Bernard L. Madoff Investment Securities, Instinet, and Posit.

Boston, Midwest, Pacific, Philadelphia and the NYSE are traditional exchanges with a physical floor where specialists and traders meet and transact business. Cincinnati does not have a traditional physical floor, but rather provides remote electronic interfaces in which multiple designated dealers can post quotes in a single stock and execute trades in conformity with pre-established priority rules. For NYSE-listed stocks, Nasdaq allows market makers who are generally not members of the NYSE to post bids and offers and to report trades executed in their offices. Both Madoff and Posit utilize Nasdaq to report trades executed in their markets.

[4]In the case of 19c-3 stocks, stocks first listed on the NYSE after April 26, 1979, NYSE member firms are not obligated to take orders in these stocks to the floor of a registered exchange for execution, but can make a market in these stocks in their own offices. Although executed off the floor, such executions are reported through the NYSE.

[5]The Midwest Stock Exchange is now known as the Chicago Stock Exchange. Since this change of name occurred at a later date than the time period of the empirical data used in this study, we will use the older name.

The primary domestic markets for trading NYSE-listed stocks are linked electronically through three major systems. The first is the Consolidated Tape Association (CTA), which reports the trading activity in NYSE-listed stocks on the NYSE as well as the regional exchanges and Nasdaq. The second is the Consolidated Quotation System (CQS), which distributes current quotations on most US markets for NYSE-listed stocks. The third is the Intermarket Trading System (ITS), which allows exchange members and dealers on Nasdaq to route an order to another market for execution at the quote of that market.

The CTA consists of two systems, but the only one of relevance to this paper is system A, which collects all trades in NYSE-listed stocks that are reported by the NYSE, the AMEX, the regional exchanges, and Nasdaq. The CTA disseminates this trade information to the markets themselves and to outside vendors who distribute the information over their own systems.[6] The specific information collected includes the number of shares traded and the execution price.[7]

The CQS is an electronic system similar to the CTA except that it reports the quotes from the NYSE, the regional exchanges, and Nasdaq market makers. Each market maker must transmit through CQS a firm quotation in each stock in which it makes a market.[8] A quotation consists of a bid and an offer: The bid includes a bid price and the depth (the number of shares that can be sold at that price); the offer includes an asked price and the depth (the number of shares that can be purchased at that price).[9] Thus, CQS contains the information necessary to determine the market or markets with the best bid price and the best asked price—in short, the best displayed prices.[10]

[6]The other system, system B, covers AMEX-listed stocks and stocks with primary listings on the regional exchanges that meet the listing requirements of the AMEX. Although NYSE-listed shares can be traded on the AMEX, they are virtually never traded there.

[7]The trade may also include a condition code that qualifies the trade, such as reported out of sequence.

[8]Originally, the SEC required all market makers to post firm quotes, but in February 1982 changed its rules so as only to require the primary market maker to provide firm quotes. This change has had no impact on the regional exchanges since the rules of ITS require specialists on these exchanges to provide firm quotes in the stocks in which they make a market.

[9]As in CTA, the quotation may include a conditioning code.

[10]There is another concept called the best intermarket quote that is based both on the bid or asked prices

In contrast to CTA and CQS, which report previously executed trades and current quotes, ITS is an electronic communication system that facilitates trading among markets. Specifically, a market maker in one market can transmit electronically a "commitment to trade" to another market. The other market has one or two minutes to accept the commitment; otherwise, the commitment expires unexecuted.[11] As such, it is not an automatic execution system.

The rules of ITS require that a public market order submitted to any market be executed at a price no worse than the best price that is displayed on CQS, but it is important to note that these rules provide no guarantee that the market displaying the best bid or offer will be the contraparty to the transaction. Specifically, a market with an inferior quote which receives an order has two choices: First, the receiving market can send a commitment to trade to the market with the best bid or offer, in which case the contraparty to the execution will be the market displaying the best bid or offer. Second, the receiving market can itself execute the order at the best displayed bid or offer or a better price (not the inferior bid or offer of that market), in which case the contraparty to the transaction will not be the market displaying the best bid or offer but instead the market that initially received the market order.

Another intent of the electronic integration of the markets was to preserve the regional exchanges as competitive forces to the NYSE.[12] If the NYSE became too non-competitive,

and their depth. If two or more markets post the same bid price, the bid of that market with the greater depth becomes part of the bid in the best intermarket quote. If there is a tie in both the bid price and depth, the bid of that market posting the earlier bid becomes part of the best intermarket quote. The same algorithm applies to the offer. This paper examines best displayed prices. See Blume and Goldstein (1992) for an examination of best intermarket quotes.

[11]Commitments sent to the NYSE expire after two minutes, while commitments to the regional exchanges expire after one minute. Although there is a presumption that the receiving market will accept all valid commitments [See SEC (1988)], Loss and Seligman (1990, p. 2566) cite evidence that only 78 to 80 percent of the commitments are actually accepted.

[12]SEC(1972, p. 11) states: "The Commission believes that the liquidity needs of individual and institutional investors can best be provided by policies fostering the development of competition among dealers who are specialists, market-makers and block positioners. Such competition will mitigate the very difficult problem which now [e]xists of developing and enforcing rules designed . . . to prevent specialists from

investors could redirect their order flow to a non-NYSE market. It is not the purpose of this paper to examine the effectiveness of this goal, but it might be noted that in late 1989, Goldman Sachs redirected some of its order flow from the NYSE to the Midwest to pressure specialists on the NYSE to cut their fees.[13]

2 Market Structure

At the beginning of the twentieth century, both oral and written communications over long distances were expensive and often so slow as to be non-existent. Doede (1967) argues that these impediments to communication originally required the regional trading of securities, but with gradual improvements over time in communication systems, he goes on to suggest that trading will become more centralized as investors seek out additional liquidity. Consistent with this hypothesis, he finds that there were over 100 regional stock exchanges at the beginning of the twentieth century, 35 by 1935, and 15 by 1965.[14] Today, there are only five regional stock exchanges. In a slightly different setting, the evidence in Silber (1981) confirms the tendency of trading in a specific future contract to concentrate over time in one market.

In view of this strong tendency to centralize trading of a specific security in a specific market, the question naturally arises of why today there are any regional exchanges at all. One reason for their continued existence is that traders can sometimes use the regionals to avoid the rules of the NYSE. In the 1950s through the mid-1970s, investors used the less restrictive rules of the regionals to rebate a portion of trading commissions that were fixed substantially above what they would have been under a competitive regime.[15] Today, the upstairs market sometimes uses the regional stock exchanges to execute a cross of two

abusing their privileged position."

[13]See "Goldman . . . " (1989) and "Goldman . . . " (1990).

[14]But even in 1935, Doede's figures show that the NYSE was still the dominant market with 86.64 percent of trading volume.

[15]SEC (1963) and SEC (1971) document these uses of the regional exchanges.

orders put together in the upstairs market. If brought to the NYSE floor for execution, such an order must sometimes be broken up to satisfy prior orders already represented on the floor with the result that one side of the crossed trade is not fully executed; oftentimes the regional stock exchanges can provide a "clean cross"—an execution in which only the crossed parties participate. As another example, the rules governing short selling sometimes allow an institution to execute a short sale on a regional exchange, but not on the NYSE.[16]

2.1 Payment for Order Flow

In recent years, the regional stock exchanges and other market makers that are not members of the NYSE have found an additional niche to compete with the NYSE by paying brokers to send them the order flow of small retail customers. This practice, known as "payment for order flow," is well documented and involves a payment of $0.01 to $0.02 per share from the market maker to the retail broker for orders that the retail broker sends to the market maker.[17] According to the SEC's "Market 2000" (1994,II-10,11), this activity, which typically only involves the 400 most actively traded stocks, accounted for 5.0 percent of the consolidated tape trades in 1989 and 9.3 percent in 1993. The largest market maker paying for order flow is Bernard L. Madoff Investment Securities, which, according to David Mainzer, a spokesman for the Midwest, handled 80 percent of such trades in 1990.[18] That "payment for order flow" persists is strong evidence of the profitability of this practice. The following suggests possible sources for this profitability.

There is a growing body of literature that shows that trades on the NYSE often take place at better prices than the best bids and offers as displayed on CQS, making the effective spread smaller than the displayed spread.[19] In other words, actual trading prices are sometimes

[16]See Harris (1993) for a more general discussion of reasons why an investor would avoid using the NYSE.
[17]See Stern (1989), Securities and Exchange Commission (1988), and National Association of Security Dealers (1991) for a more detailed discussion of this and related practices.
[18]Mainzer's estimate is given in Weiss(1990).
[19]See Blume and Goldstein (1992), Lee (1993), and Petersen and Fialkowski (1994).

better than the best displayed bid and asked prices. If the effective spread equals or exceeds that which would prevail in a competitive market, a market maker who is able consistently to buy and sell at the wider spread of the displayed quote will make more than a competitive profit and therefore would have an incentive to pay for order flow.[20]

But even if the displayed and effective spread were always the same, a market maker might still find it profitable to pay for order flow. A competitive spread covers two costs: losses to informed traders and inventory and clerical costs. If the market maker could be assured of buying primarily the order flow of uninformed traders, that market maker would face smaller losses to informed traders than implicit in the competitive spread, making it again profitable to pay for order flow. As the industry is now structured, some markets may be able to separate partially the uninformed from the informed order flow. A market that pays for order flow typically enters into an agreement with a brokerage firm with the understanding that the brokerage firm will only send specific kinds of orders to the market, typically the orders of small retail customers who are less likely to have information not already incorporated into market prices. The brokerage firm itself has an incentive to honor this agreement since the market can always stop the payment for order flow in the event of a violation of this understanding.[21]

There may still be another source of profitability from buying order flow. On any NYSE-listed stock with a price greater than one dollar, the minimum displayed spread is one eighth, which, according to the empirical research of Harris (1991), may be in excess of the competitive spread for some stocks. For these stocks, a market maker who matches

[20]In response to the criticism that the effective spread is sometimes less than the displayed spread, Bernard L. Madoff Investment Securities and others have developed procedures that allow for the possibility of a trade being executed within the displayed quote. Madoff provides reports to its clients on the proportion of trades that it executes within the spread when the spread exceeds one eighth, but these reports are not publicly available.

[21]If these arrangements cause a reduction in the uninformed order flows to the primary market, the remaining order flow in the primary market will have an increased percentage of informed order flow, possibly resulting in larger spreads and thereby making the payment for order flow even more profitable.

the displayed spread, even if it is the minimum spread of one eighth, may be willing to pay for order flow, particularly if the market maker can be assured of receiving orders from uninformed investors.

Finally, the ITS system allows non-NYSE market makers to reduce the risk of unwanted inventory. If the market maker does not want an order, that order can be sent over ITS to the market with the best bid or offer. In this case, the market maker does not participate in the trade, but still must pay the sending broker for the order flow. In setting the level of the payment for order flow, a market maker will certainly take into account this potential cost.

2.2 The NYSE Floor

At first blush, it might seem that a competitive response of the NYSE to the loss of retail order flow to other markets would be first to align the displayed spread with the effective spread and then, if necessary, reduce the size of the effective spread. These two steps alone would not be enough to remove all incentives to pay for order flow as long as non-NYSE markets are able to capture uninformed order flow, but they would certainly reduce the incentives.

The traditional ways in which NYSE stocks trade on the floor almost guarantee that the displayed spread will frequently be greater than the effective spread. To make the displayed spread the same as the effective spread would require major changes in how securities are traded on the NYSE—so major that the current incentives to trade on the NYSE floor that are inherent in the existing structure might vanish, destroying the very need for the floor itself.[22]

Orders that make their way to the floor of the NYSE are often much more complex than

[22]Some, such as Mendelson and Peake (1979), have suggested that the financial markets would be better off under a fully electronic trading system and that any advantages from trading on the NYSE floor benefit only a small group of participants such as the specialists. It is not the purpose of this paper to pass judgement on the optimal organizational form for equity markets, but rather to describe and analyze incentives under the existing structure.

simple market or limit orders. As one example, floor traders and specialists often receive "not held" orders—orders which do not lend themselves for display through CQS and by their very nature often lead to a displayed spread of one quarter or more, even though the effective spread is very likely to be one eighth. A "not held" order is an order—often used by institutional investors—that instructs a floor trader to use his or her discretion in how and at what price(s) to execute it; indeed, if the floor trader judges market conditions to be unfavorable, the floor trader can even choose not to execute the order. Such an order cannot be displayed through CQS as CQS as currently configured.[23]

For most NYSE-listed stocks, the minimum displayed spread is one eighth, but as the empirical evidence below will show, the displayed spread is frequently one quarter or more even though a large percentage of the trades actually occur within this displayed spread. To understand this phenomenon, consider a stock whose currently displayed spread is one eighth and each side of the quote represents limit orders on the specialist's book. A floor trader receives a large institutional "not held" buy order and decides to execute a portion of this order against the offer as represented by limit orders. As a result, higher priced limit sell orders come into play, and the displayed spread increases to, say, one quarter. Now, if a small market sell order were to arrive on the floor, the floor trader representing the "not held" order might step in and buy at a price within the best displayed prices.[24]

The floor trader with such a "not held" buy order has little incentive to make a firm bid within the displayed spread, even for a portion of the order. First, the floor trader may not want to reveal his or her buying interest to traders off the floor of the NYSE. Second, the floor trader maintains a valuable option. There is always some lag between the placing of a market order by an investor and its receipt on the NYSE floor. During this time period,

[23]In a broader sense, Grossman (1992) makes the point that no system can be rich enough to capture every feature of every possible type of order.

[24]The execution priority rules on the NYSE require that the floor trader provide a better price than the displayed limit sell price.

market conditions could change, and without having made a firm offer to buy, the floor trader is not obligated to be the contraparty to the next market sell order.

Additionally, if the floor trader does post a firm bid that narrows the displayed spread on CQS, the floor trader might not benefit as an investor under ITS could send a market sell order to any market and receive the same price. Indeed, by not causing a narrowing of the spread, a floor trader may actually enhance the probability of the NYSE receiving the next market sell order if knowledgeable investors believe that there is a greater probability on the NYSE than on other markets that their market order—be it a buy or sell—will be executed at better prices than the best displayed prices.[25] Finally, a NYSE specialist who is unwilling to accumulate any more inventory will not post a better bid.

The above was couched in terms of a "not held" buy order but there are a host of practices on the NYSE that increase the likelihood of an execution occurring within the spread when the spread is one quarter or more: to name a few, stopped orders as described in Petersen and Fialkowski (1994), small limit orders that the specialist chooses not to display as documented in McInish and Wood (1992), and orders to sell short on an uptick.[26]

2.3 Some Issues

The trading of NYSE-listed securities is a complex process and involves many different types of players with various goals and strategies. The importance of each of these players and the effects of their strategies on the trading of NYSE-listed stocks are ultimately empirical questions, namely:

First, how often does one or both sides of a quote of a particular market match or

[25] If the procedures that non-NYSE markets have adopted to provide execution within the displayed spread replicate the probability of such execution on the NYSE, this incentive would vanish.

[26] For an inactively traded stock in which there is little trading interest, there is another reason that the displayed spread might often exceed the effective spread. For such a stock, an NYSE specialist may not wish to take the time to monitor his or her quote and by posting a quote with an artificially large spread avoids the need to monitor the quote continuously. When an actual order arrives, the specialist could then assess the correct price at which to execute the order, which might be within the spread.

determine the best displayed bid or asked price? This question addresses two issues: The first is the role of the various markets in price discovery. The second pertains to the relative importance of price and non-price competition in attracting order flow, and one variable in assessing this competition is the proportion of time that a market displays an inferior quote.

Second, what percentage of a market's order flow occurs when both sides of its quote are inferior to the best displayed prices? If investors always send their orders to the market with the best quote, then markets with inferior quotes will receive no orders. On the other hand, if investors use one market to avoid the rules of another or markets attract order flow for non-price reasons, such as payment for order flow, markets would still receive order flow even when posting inferior quotes.

Third, how often is the NYSE spread one quarter or more? It has been suggested that the trading practices on the NYSE would frequently cause the NYSE spread to be one quarter or more—even for the largest, most active stocks. As floor traders work large orders, they will take out all the limit orders at a specific price, thereby increasing to one quarter or more the NYSE spread as displayed on CQS. When non-NYSE market places do not better this spread, the best displayed spread will be one quarter or more.

Fourth, does bettering one side of the best displayed quote increase the probability of attracting order flow and by how much? If the best displayed spread is frequently one quarter or more (as it turns out to be), a market can temporarily increase its bid price or decrease its asked price in the hope of attracting order flow. The success of this strategy of bettering one side of the quote depends upon the ability of this better bid or asked price to attract order flow. Fifth, does a market which often posts an inferior quote contribute nonetheless to price discovery when it does better the bid or asked price of the best displayed prices? One possibility is that a market with an inferior quote will temporarily better its bid or asked price to attract order flow and, after attracting such order flow, withdraw its better price. A second possibility is that, instead of withdrawing this better price, other markets

improve their quotes to match this better price. In this second case, it could be said that the first market was contributing directly to price discovery.

3 The Empirical Analysis

After a brief description of the data, this section present empirical evidence on each of these five questions.

3.1 The Data

The 1990 Trades and Quotes Transaction File of the Institute for the Study of Security Markets (ISSM) is the main source of data for this study. The particular version of the file used in this study contains all of the quotes of the regional exchanges and Nasdaq, enabling the reconstruction of the best displayed prices at any point in time.[27] Several filters were applied to these data to remove observations that may be subject to error.[28]

[27]The file that ISSM normally disseminates excludes quotes of non-NYSE markets with depth of 100 shares for both the bid and offer. Bids or offers with depths of 100 shares play a special role in ITS. In the case of a bid, a market with an inferior bid is required to execute a market sell order at the better quote displayed on CQS or send a commitment to trade to the market with the best bid, but this requirement is waived when the better bid has a depth of 100 shares. Thus, a market can effectively withdraw from participation in ITS by posting a bid or an offer with a depth of 100 shares. Such bids or offers are frequently entered automatically by computers and termed "auto-quotes." Since posting a bid or an offer with a depth of 100 shares supersedes and makes invalid a prior bid or offer, it is necessary to have the quotes with depths of 100 shares on both sides, which ISSM has excluded, to calculate the best prices that are effective over ITS. The special file obtained for this study from ISSM does contain these quotes and permits the determination of the best displayed prices.

[28]ISSM has flagged some of the quotes and trades that may be in error, and we have eliminated these data points. When we eliminate a quote, we also eliminate subsequent transactions until a new valid quote is obtained. In addition to the ISSM eliminations, we eliminate any best displayed quote with a depth of 100 shares for either the bid or the offer to ensure that the bid and offer are binding on ITS. There were also some possible data errors that we eliminated: 94 quotes in which the best asked price differs from the prior best asked price by more than 50 percent, 140 quotes in which the best bid prices differs from the prior best bid price by more than 50 percent, 492 quotes where the spread of the best displayed quote exceeded 20 percent of the midpoint of that quote where the midpoint was $10 or more, 1237 quotes where the spread of the best displayed quote exceeded $2 and the midpoint of the spread was less than $10 (1165 of these quotes were from ZTR; Cf. Keim[1989] for a justification of this filter), 84 trades with indicated execution prices of zero dollars, 171 observations with trade prices that differ from the prior trade by more than 50 percent, and 100 trades in which the trade price was more than $5 away from the midpoint of the best displayed quote. Additionally, the spread of the best displayed quote was sometimes less than or equal to zero. A visual examination of the data suggests that these zero or negative spreads often occur when one market revises its quote and another market has not yet responded to this change. In total, there were 633,341

The analysis below is based upon those 1442 common stocks in the ISSM data which, according to the Center for Research in Security Prices (CRSP), represent US-domiciled companies listed on the NYSE as of the end of 1989 with a 1989 closing price of one dollar or more. The analysis below will use these closing prices and the associated 1989 year-end market values of the common stock as control variables. To ensure that the minimum spread is one eighth, any stock for which the opening NYSE bid is less than one dollar is excluded from the analysis for that day. Finally, any trade or quote with a special code other than an opening or closing indication is excluded. The array of quotes on CQS is used to determine the best displayed bid and asked prices and the market or markets displaying these prices.

The comparison of trades with quotes requires that the data from CTA and CQS be merged. For various technical reasons, the actual time that a quote is posted or a trade takes place precedes the time stamp reported by CTA and CQS. First, the time stamp is added to the quote or trade record after it is processed through the two separate computer systems supporting CTA and CQS, not when the quote was changed or the trade took place. Second, since there are two separate computer systems, the computer time to process a quote or trade can be different and can vary with the computer loads. Third, trades in some stocks are entered into the computers both electronically and manually, and these processes are subject to differential delays that on occasion can be a minute or more.[29] Thus, not only can the time stamps be in error but the very sequencing of trades in the same stock can be wrong.

Lee and Ready (1991) were the first to present indirect evidence of such errors in the time

instances of zero spreads and 39,695 instances of negative spreads, and these quotes were dropped. We also exclude Berkshire Hathaway and Capital Cities/ABC, both very high priced stocks with extremely large bid-ask spreads and Instinet volume since Instinet does not fall under ITS rules and ISSM does not include quotes from this market. (In interpreting the number of quotes and trades eliminated, it should be kept in mind that some quotes were eliminated for more than one reason.)

[29]On one regional stock exchange, floor traders place copies of their completed trades on a pile next to a clerk who then inputs them into the computer. As observed by one of the authors, a clerk on this exchange took a fifteen-minute coffee break during which the pile of unentered trades grew.

stamps of quotes and trades. Hasbrouck and Sosebee (1992) later confirmed this hypothesis using the TORQ data set and in the process directly calculated delays in the reporting of trades on the floor of the NYSE. The TORQ data set contains additional information about the time of a trade not previously available to academic researchers, but is limited to 144 stocks for the three months November 1990 through January 1991.[30] The median delay for NYSE stocks was 16 seconds. Using the same algorithm as used by Hasbrouck and Sosebee, this study estimated the median delays for the regional exchanges and Nasdaq.[31] A partial adjustment for these errors in time stamps of trades is to adjust downwards the reported time stamps by these median delays, and this study employs this adjustment.

3.2 The Best Displayed Prices

The bid or asked prices displayed on CQS by the NYSE equal the best displayed prices much more frequently than those of the other markets. In 1990, the NYSE reported trades for each of the 1442 common stocks identified above. The percentage of trading time that the NYSE quotes equal one or both sides of the best prices varied across stocks from 89.6 percent to 100 percent with an average of 99.8 percent (Table 1).[32] The NYSE accounted for the bulk of the volume in each of these 1442 stocks with an average market share of 85.1 percent. (As with both of these two averages, most of the statistics reported in this paper are calculated for each stock separately and then averaged.)

The number of these 1442 common stocks in which non-NYSE markets reported trades varied from 1426 for Nasdaq to 453 for Cincinnati. In those stocks in which trades were

[30]See Hasbrouck (1992) for a description of the TORQ data set.

[31]The same filters used on the ISSM data were also applied to the TORQ data set. The median delays in seconds are: 16 for the NYSE, 34 for Boston, 3 for Cincinnati, 16 for Midwest, 5 for Pacific, 29 for Philadelphia, and 31 for Nasdaq.

[32]The trading time used in these calculations is the time from the opening quote on the NYSE to the close of trading on the NYSE. The major effect is to exclude quotes on the Pacific for the half hour following the close of the NYSE when only the Pacific is still open for trading. Another effect is to exclude the time period between an opening quote on a non-NYSE market and the opening on the NYSE—a rare occurrence. All of the calculations for the non-NYSE markets use this same time convention for measuring total trading time.

reported, the percentage of time that one side of its quote matched the best displayed prices varied widely across markets. At one extreme, the quotes of the Pacific matched on average at least one of the best prices 55.2 percent of the time, and those of the Midwest 45.6 percent. At the other extreme, the quotes of Philadelphia matched at least one of the best prices 5.3 percent of the time, and those of Boston 4.4 percent. A possible explanation of these differences among regional exchanges is that both the Pacific and the Midwest evaluate their specialists in part by the proportion of time that they match or determine one or both sides of the best bid and asked prices, while Boston and Philadelphia do not use this measure in evaluating their specialists.

With the exception of the Pacific and Philadelphia, non-NYSE markets are more likely to be part of the best bid and asked prices for stocks with larger market values than those with smaller market values.[33] This trend is particularly pronounced on the Cincinnati and Nasdaq and is consistent with the reported use by Madoff of these markets in making markets in the larger NYSE stocks. There is little relation for Philadelphia between company size and being part of the best bid or ask. The Pacific is more likely to be part of the best bid and asked prices for stocks with smaller market values.

Both sides of the quotes displayed by the NYSE typically match the best displayed prices. The NYSE bid price equals on average the best bid price 94.8 percent of the time, and the NYSE asked price equals the best asked price 94.2 percent of the time. These high percentages could occur only if both the NYSE bid and asked prices equal the best prices most of the time.

The story is quite different for non-NYSE markets. To illustrate, the Cincinnati bid price equals the best bid price 10.9 percent of the time, and its asked price equals the best asked price 11.4 percent of the time. If these matches typically occurred on both sides of the quote at the same time, the joint event of matching both the bid and asked prices would be around

[33]The relation for the Midwest is significant at the five-percent level, but not the one-percent level.

10 percent. In actual fact, Cincinnati has the best bid or best asked price 20.7 percent of the time, indicating that it rarely has both the best bid and the best asked prices at the same time.

3.3 Trading Volume

The NYSE executes a very small proportion of its volume when its quote is not part of the best displayed prices, while non-NYSE markets execute a large portion of their volume while their quotes are not part of the best displayed prices. This result is consistent with the suggestion that non-NYSE markets capture a significant portion of their trading volume for non-price reasons—traders who wish to avoid rules of the NYSE or brokerage houses who receive payment for order flow, not from posting the best prices.

The NYSE executed only 0.2 percent of the dollar trading volume for the average stock in which it reported some volume when it was not part of the best prices (Table 2). In contrast, non-NYSE markets executed on average anywhere from 42.2 percent for the Pacific to 90.7 percent for Nasdaq of their dollar trading volume when not part of the best prices. Like the averages in Table 1, these averages are over the stocks for which a market reported some volume in 1990.

On some non-NYSE markets, the proportion of a market's dollar volume when neither side of its quote matches the best prices varies with the market value of the company's stock. This proportion decreases on Boston (slightly), Cincinnati, and Nasdaq and increases on Pacific and Philadelphia (slightly) as the market value of the stock increases.

3.4 Best Displayed Spreads

The best displayed spread is frequently greater than one eighth even for the larger companies. This is consistent with the conjecture that the trading interest in the crowd on the NYSE floor and interaction with limit orders may result in displayed spreads of one quarter or

more.

The NYSE rules require that all bid and asked prices be stated in increments of one eighth when the price is one dollar or more, making the minimum spread for most NYSE-listed stocks one eighth. As suggested by Harris (1991), this minimum spread may be binding for low price stocks but not for high price stocks. To account for this possibility, the analysis in this section breaks down the 1442 stocks by six price categories.

Of the largest 50 companies, there are 11 with 1989 year-end price of 80 dollars or more, and the average percentage of trading time that the spread of the best displayed prices exceeds one eighth is 52.7 percent (Table 3). Within the largest 50 companies, the percentage of time with a spread greater than one eighth decreases as price decreases but is still 25.5 percent for stocks with 1989 prices of 20 dollars or more and less than 40 dollars. Further, as company size decreases, the percentage of time that the average stock has a spread of more than one eighth tends to increase at all price levels.

When the spread exceeds one eighth, trading practices on the NYSE suggest that a substantial proportion of trades will occur within the best displayed prices, and the prior results of Blume and Goldstein (1992) and Lee (1993) are consistent with this implication. These empirical pieces show that when the displayed spread is one quarter or more, over 50 percent of the trades on the NYSE occur within the best displayed quotes. A replication of these analyses for this paper reaches similar conclusions, and therefore to conserve space will not be presented here.

3.5 Attracting Order Flow

When the spread in the best displayed prices is one quarter or more, as it often is, a market maker can post a bid or offer within this spread in order to attract order flow. The success of posting a better bid or offer in attracting order flow is an empirical question.

To address this question, we have calculated two measures of concurrent market share to

assess the ability of a better quote to attract order flow. To illustrate the general construction of these measures, consider those time periods in 1990 when a specific market place has posted a bid price which is superior to any other posted bid prices for a particular stock–in short, the best bid price. Now, record the total dollar volume of trading that takes place across all markets and for the specific market during those time periods and include only that volume which occurs at the best bid price. Including only this volume focuses on seller-initiated trades—the types of trades that a better bid is designed to attract. The ratio of the market's volume to the total volume provides a concurrent measure of market share when that market posts the best bid price, and these measures averaged over all securities in which the market at some point in 1990 posted the best bid provide a summary measure of concurrent market share. Similar average concurrent measures of market share can be calculated for those time periods in which a market posted an inferior bid.

To be included in these averages for a specific market, a stock must meet two criteria: First, there must be some intervals when that market had the best bid and some intervals when it had an inferior bid. Second, there must be some reported volume on any market both during the times in which the market had posted the best bid and during the times in which the market had posted an inferior bid—a more restrictive condition than previously.

These measures allow a comparison of the percentage dollar volume which a market receives when it posts the best bid price with the percent which it receives when it posts an inferior bid price. If all trades went to the market with the best bid, the market's concurrent volume percentage would be 100 when it posts the best bid and zero percent when it posts an inferior bid.

The evidence shows that posting the best bid does increase concurrent market share. For example, the concurrent market share of Boston when it posts an inferior bid averaged over 958 stocks is 1.8 percent (Table 4). When it posts the best bid with all other markets having inferior bids, its market share climbs to 39.2 percent. Thus, moving from an inferior

bid to the best bid increases Boston's concurrent market share by 37.4 percentage points. Even the New York sees its market share increase from 68.4 percent to 86.1 percent when it moves from an inferior bid to the best bid. The increase in concurrent market share from posting the best bid relative to an inferior bid is greater for smaller companies and greater for Boston, Midwest, and Philadelphia in comparison to the other markets. The results for asked prices, which are not presented, are similar.

3.6 Price Discovery

The best displayed spread is often one quarter or more, allowing a market maker to jump in with a better bid or offer and according to the previous analysis increase the probability of receiving order flow. If a market maker uses this mechanism to adjust inventory and as soon as the inventory is adjusted withdraws the better bid or offer, it may be said that the market maker does not contribute to price discovery. However, if other markets revise their quotes to match such better bids or offers, then it might be said that the first market does contribute to price discovery.

In contrast to this active method of becoming the best bid or offer, a market place can find itself with the best bid or offer if other exchanges worsen their quotes. In this passive case, a market maker has two choices: worsen its bid or offer or maintain its previously posted bid or offer. If the market place worsens it bid or offer, it might be said that market does not contribute to price discovery, but if it maintains its better bid or offer and other markets then match this better bid, it might be said that the market does contribute to price discovery.

There are wide differences in the way in which the various markets become the best bid. In 1990, the NYSE bid became the best bid 956,795 times actively through an improvement in its quote, and 514,392 passively through the worsening of the bids of other markets, for a ratio of active to passive initiations of 1.86 (Table 5). The bids of Boston, Cincinnati,

and Philadelphia were more likely to become the best bid through active improvement than through the worsening of other bids. The Midwest, the Pacific, and Nasdaq more often became the best bid passively through the worsening of other bids than through active improvement.

There are interesting differences in the manner in which a market terminates having the best bid. With the exception of Boston and Nasdaq, a market place that actively initiates having the best bid is more likely to have its bid matched than to withdraw it. In contrast for all market places except the NYSE, a market place whose bid becomes the best through the worsening of other quotes is more likely to worsen its quote than have it matched. Moreover, when a non-NYSE market's bid becomes the best bid passively through the worsening of other bids and when that market actively worsens its bid, it will do so very quickly.

These results indicate that non-NYSE markets do contribute to price discovery, particularly when they actively improve upon the previously displayed quotes. This conclusion is consistent with the empirical finding of Hasbrouck (1994) who finds that non-NYSE quotes explain 7.3 percent of the variance in the best displayed quotes. It also suggests that some bids or offers of a non-NYSE market are more informative than others. Those bids or offers which a non-NYSE market actively changes to become the best bid or offer are as informative as these same type of bids or offers set by the NYSE. The greater overall informativeness of NYSE bids and offers found by Hasbrouck (1994) stems from the NYSE bids and offers matching or determining the best bids or offers most of the time. The results for asked prices, which are not presented, are similar.

4 Conclusion

In 1975, Congress set the goal of integrating the trading of major securities across markets. With this goal in mind, the SEC caused the development of three electronic systems to integrate the trading of NYSE-listed stocks. The evidence in this paper suggests that these

systems have not succeeded in integrating fully the markets that trade NYSE-listed securities. Two fundamental barriers to such an integration of the markets are that the displayed quotes do not reveal all of the trading interest on the NYSE itself, and possibly non-NYSE markets as well, and that markets obtain order flow for reasons other than posting the best prices. The best displayed spread is frequently one quarter or more even though trades often take place within such spreads. The quote of the NYSE is the dominant determinant of the best displayed bid and offer.

Non-NYSE markets obtain a substantial proportion of their total trading volume when both sides of their quotes are inferior to the best displayed bid or offer. Nonetheless, when a market posts the best bid or offer among all the markets, the market does receive increased order flow and often contributes to price discovery during these intervals. An important question that this paper has not addressed is whether the attraction of order flow to a particular market for reasons other than posting a bid or offer equal to or better than other markets retards, if at all, the price discovery process.

One way to integrate the markets is to permit only two types of orders: market and limit orders with strict time and price priority over all markets—a so-called consolidated limit order book. The limit orders would determine the best bid and asked prices, and market orders could only be executed against these limit orders. In this way, trades would only occur at the best bid and asked prices.

Such a system would involve fundamental change. There would be no need to maintain the trading floors of the various markets for NYSE-listed stocks since all trading could and would be done by computer.[34] To date, it is important to note that no one has established that this type of computerized market dominates the trading processes for NYSE-listed stocks that has developed over the last two centuries.

[34]This structure for a market is similar to that proposed by Mendelson and Peake (1979). Glosten (1994) has examined the theoretical properties of this type of market.

In conclusion, as long as the current trading protocols in which traders on the floor of the NYSE and other markets have discretion as to how they reveal their trading interests and execute their orders and markets can attract order flow though means other than displaying the best bid and offer, the bid and offers displayed on CQS will not describe the true trading interest in any security. Thus, the three electronic systems linking the markets that trade NYSE-listed stocks will not be able to provide the integration that the 1975 Amendments envisioned. But, in repetition of the introduction and as a word of caution, there has been little theoretical or empirical work to show that an overriding goal of public policy should be a complete integration of the markets for the trading of NYSE-listed stocks.

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Table 1

Percentage of Trading Time that the Bid or Asked Prices of Each Market Matches or Determines the Best Displayed Prices Averaged across those NYSE-Listed Common Stocks in which a Market Reported Some Volume, 1990

This table measures the percentage of the trading time that the bid or asked price posted by that market matches or determines the best bid or asked price across all markets for NYSE-listed stocks during 1990 for different size categories ranked by year-end 1989 market capitalization. Only stocks for which a market reported a trade in 1990 are included for that market. Panel A measures the percentage of the trading time that the price of at least one of the two quotes (bid or asked) posted by that market matches or determines the respective best intermarket quote price averaged over the stocks included for that market. Panel B (C) measures the percentage of the trading time that the bid (asked) price posted by that market matches or determines the best intermarket bid (asked) price averaged over the stocks included for that market. Panel D indicates the number of stocks per market and size category for which there was at least one trade on the indicated market in 1990. Panel E presents the market share of that market's trading averaged over the stocks included for that market. Because of differing numbers of stocks in each average, the percentages do not sum to 100.0.

Companies Ranked by Market Value	NYSE	Boston	Cincinnati	Midwest	Pacific	Philadelphia	Nasdaq
A. Bid or Asked Price–Percentage of Time[a]							
All	99.8	4.4	20.7	45.6	55.2	5.3	7.7
Top 50	99.8	6.7	41.5	52.0	42.5	5.3	24.7
Next 200	99.7	5.6	22.8	48.4	46.2	4.7	17.4
Next 250	99.8	4.8	14.3	46.4	48.7	5.2	9.2
Next 500	99.8	4.2	14.2	44.7	57.6	5.6	6.0
Last 442	99.9	3.1	21.0	44.0	74.8	5.2	2.5
B. Bid Price–Percentage of Time							
All	94.8	2.4	10.9	29.4	34.5	3.1	4.3
Top 50	93.3	3.3	23.3	28.6	24.0	2.3	11.6
Next 200	93.6	2.5	11.3	27.2	26.7	2.1	8.4
Next 250	94.2	2.8	7.3	27.6	29.7	3.0	5.0
Next 500	94.8	2.6	7.7	29.6	36.4	3.5	3.8
Last 442	95.9	1.7	15.6	31.6	50.7	3.4	1.7
C. Asked Price–Percentage of Time							
All	94.2	2.5	11.4	29.3	34.6	3.0	4.3
Top 50	92.3	3.8	23.6	32.8	25.8	3.3	13.2
Next 200	92.4	3.4	12.7	30.1	28.1	2.8	9.1
Next 250	93.0	2.7	7.7	29.1	30.1	3.3	4.9
Next 500	94.4	2.2	8.0	28.4	36.0	3.1	3.6
Last 442	95.7	1.8	9.6	29.5	49.2	2.6	1.6
D. Number of Stocks with Reported Trades							
All	1442	1258	453	1404	973	1211	1426
Top 50	50	50	49	50	49	50	50
Next 200	200	199	172	199	200	199	199
Next 250	250	248	131	250	235	247	248
Next 500	500	456	88	498	328	449	497
Last 442	442	305	13	407	161	266	432

Table 1, continued

Percentage of Trading Time that the Bid or Asked Prices of Each Market Matches or Determines the Best Displayed Prices Averaged across those NYSE-Listed Common Stocks in which a Market Reported Some Volume, 1990

Companies Ranked by Market Value	NYSE	Boston	Cincinnati	Midwest	Pacific	Philadelphia	Nasdaq
E. Market Share for Stocks with Reported Trades[b]							
All	85.1	1.7	0.7	5.7	3.6	1.3	4.3
Top 50	85.4	1.6	1.7	4.6	2.5	1.2	3.1
Next 200	87.1	1.5	0.8	4.6	2.4	1.4	2.4
Next 250	86.0	1.4	0.5	5.0	2.7	1.6	3.2
Next 500	83.8	1.7	0.5	5.7	3.8	1.2	5.2
Last 442	84.9	1.9	1.0	6.6	6.2	1.2	4.8

[a] A two-way analysis of variance with an interaction term rejects the null hypothesis of no effects at the one-percent level for each of the Panels A, B, and C. For Panel A, F(34, 8132) = 1000.32; for Panel B, F(34, 8132) = 1590.57; and for Panel C, F(34, 8132) = 1702.26. On the basis of a Type III test as outlined in SAS/STAT User's Guide (1990), the firm size effect, the market place effect, and the interaction effect are each significantly different from zero at the one-percent level.

The rank order correlations between the percentage of time that a market place matches or determines the best bid or ask price and its market value category (with a rank of 1 for the top 50 decreasing to a rank of 5 for the smallest 442) are *0.34* for NYSE, *-0.21* for Boston, *-0.38* for Cincinnati, -0.06 for Midwest, *0.34* for Pacific, -0.03 for Philadelphia, and *-0.49* for the Nasdaq. The corresponding rank order correlations for the bid price are *0.28* for NYSE, *-0.20* for Boston, *-0.36* for Cincinnati, 0.03 for Midwest, *0.35* for Pacific, 0.01 for Philadelphia, and *-0.49* for the Nasdaq. The corresponding rank order correlations for the ask price are *0.37* for NYSE, *-0.24* for Boston, *-0.39* for Cincinnati, -0.05 for Midwest, *0.32* for Pacific, *-0.09* for Philadelphia, and *-0.50* for the Nasdaq. Those correlations in italics are significant at the one-percent level.

[b] The total dollar volume for all stocks is $1,330 billion, distributed as follows: $463 billion for the Top 50, $531 billion for the Next 200, $207 billion for the Next 250, $115 billion for the Next 500, and $16 billion for the Last 442.

Table 2

Percentage of a Market's Dollar Volume that Occurs when Neither its Bid Price nor Asked Price Equals the Best Prices Averaged across those NYSE-Listed Common Stocks in which a Market Reported Some Volume, 1990

This table notes the percent of a market's total dollar volume per stock that occur on each market when both the bid and the asked price quoted by that market are worse than the best intermarket quotes for NYSE-listed stocks during 1990 for different size categories ranked by year-end 1989 market capitalization averaged over the stocks in which the market reported some volume in 1990. Panel D of Table 1 gives the number of stocks for each market.[a]

Companies Ranked by Market Value	Percent of Volume						
	NYSE	Boston	Cincinnati	Midwest	Pacific	Philadelphia	Nasdaq
All	0.2	87.1	74.3	50.2	42.2	84.7	90.7
Top 50	0.3	88.6	60.6	44.0	56.5	88.5	71.8
Next 200	0.4	86.6	74.2	46.9	50.8	88.4	79.8
Next 250	0.2	87.2	79.2	50.2	48.0	86.7	89.4
Next 500	0.2	86.8	79.0	51.9	38.7	83.3	92.6
Last 442	0.1	87.4	47.0	50.6	25.6	81.7	96.4

[a]A two-way analysis of variance with an interaction term rejects the null hypothesis of no effects at the one-percent level with a test statistic of F(34, 8132) = 829.91. On the basis of a Type III test as outlined in SAS/STAT User's Guide (1990), the firm size effect, the market place effect, and the interaction effect are each significantly different from zero at the one-percent level.

The rank order correlations between the percentage of a market's dollar volume that occurs when neither its bid price or asked price equals the best prices and its market value category (with a rank of 1 for the top 50 decreasing to a rank of 5 for the smallest 442) are *-0.41* for NYSE, *0.10* for Boston, *0.22* for Cincinnati, 0.02 for Midwest, *-0.37* for Pacific, *-0.10* for Philadelphia, and *0.49* for the Nasdaq. Those correlations in italics are significant at the one-percent level.

Table 3

Percentage of Trading Time that the Best Displayed Spread is Greater than One Eighth Cross Classified by 1989 Market Value and 1989 Closing Share Price Averaged across NYSE-Listed Common Stocks, 1990

This table notes the percentage of the time that the best displayed spread is greater than one eighth for NYSE-listed stocks during 1990, averaged across the relevant set of stocks as shown by the number in parentheses. The best displayed spread is the difference between the lowest asked price quoted across the NYSE, Boston, Cincinnati, Midwest, Pacific and Philadelphia regional exchanges and the Nasdaq less the highest bid price found across these same markets. Stocks were grouped by their 1989 closing stock price and their year-end 1989 market value category.[a]

1989 Market Value Category	1989 Closing Stock Price, P					
	$P \geq 80$	$40 \leq P < 80$	$20 \leq P < 40$	$10 \leq P < 20$	$5 \leq P < 10$	$1 \leq P < 5$
Top 50	52.7 (11)	34.9 (33)	25.5 (6)	none	none	none
Next 200	74.3 (16)	59.1 (98)	34.0 (82)	27.8 (4)	none	none
Next 250	96.5 (2)	71.1 (68)	53.6 (138)	25.4 (39)	1.9 (2)	2.9 (1)
Next 500	86.5 (3)	84.2 (37)	68.6 (232)	45.7 (169)	21.5 (45)	10.0 (14)
Last 442	none	78.6 (2)	83.5 (42)	62.1 (165)	41.3 (142)	29.5 (91)

[a]A two-way analysis of variance with an interaction term rejects the null hypothesis of no effects at the one-percent level with a test statistic of $F(23, 1418) = 56.16$. On the basis of a Type III test as outlined in SAS/STAT User's Guide (1990), the firm size effect and the stock price are each significantly different from zero at the one-percent level. The hypothesis of no interaction is not rejected at the one-percent level.

The rank order correlations between the percentage of trading time that the best displayed spread is greater than one-eighth and the firm's market value category (with a rank of 1 for the top 50 decreasing to a rank of 5 for the smallest 442) are *0.75* for stock with prices of $80 or more, *0.71* with prices $40 or more and less than $80, *0.64* with prices of $20 or more and less than $40, *0.49* with prices of $10 or more and less than $20, *0.42* with prices of $5 or more and less than $10, and *0.38* with prices of $1 or more and less than $5. All correlations are significant at the one-percent level and are shown in italics.

The rank order correlations between the percentage of trading time that the best displayed spread is greater than one-eighth and a firm's stock price category (with a rank of 1 for the highest price category and 5 for the lowest price category) are *-0.54* for the Top 50, *-0.71* for the Next 200, *-0.65* for the Next 250, *-0.68* for the Next 500, and *-0.64* for the Last 442. All correlations are significant at the one-percent level.

Table 4

Concurrent Dollar Volume Market Share for Trades that Occurred at the Best Bid Price Classified by whether a Market is the Only Market Posting the Best Bid Price, or whether a Market is Posting an Inferior Price than the Best Bid Price at the Time of the Trade

This table presents the concurrent market share of dollar volume during those time periods when a market posts a bid price that is inferior to the best displayed bid and when that market posts a bid that is superior to the bids of all other markets averaged over the stocks included for that market. For a stock to be included in the calculations for a particular market, it was necessary that at least once during 1990 a trade occurred on some market while that particular market posted a bid price better than all other markets, and at least once during 1990 a trade occurred on some market while that particular market posted a bid price that was inferior to the best bid price across all markets. Concurrent market share is the ratio of the dollar volume attributable to a particular market during the time period or periods that the market posts an inferior (Panel A) or very best bid (Panel B) to the total volume in the stock over all markets during the same time periods, expressed as a percent. Only dollar volume at the best displayed bid is included. Panel C contains the increase in the concurrent market share while posting the best bid in comparison to the concurrent market share while posting an inferior bid. Panel D give the number of companies in each average.[a]

Companies Ranked by Market Value	Concurrent Market Share in Percent						
	NYSE	Boston	Cincinnati	Midwest	Pacific	Philadelphia	Nasdaq
A. Market Posting Inferior Bid							
All	68.4	1.8	0.7	5.3	3.4	1.2	4.5
Top 50	77.5	1.7	1.3	4.3	2.3	1.2	3.1
Next 200	79.1	1.6	0.7	4.3	2.3	1.2	2.5
Next 250	75.0	1.5	0.5	4.7	2.6	1.3	3.3
Next 500	66.3	1.8	0.7	5.2	3.6	1.1	6.9
Last 442	59.7	2.4	1.7	6.5	5.8	1.2	12.6
B. Market Posting Best Bid							
All	86.1	39.2	3.9	26.9	11.2	38.1	10.1
Top 50	86.4	18.3	5.1	19.8	5.5	26.7	4.0
Next 200	87.8	29.7	3.0	18.7	6.7	27.9	2.8
Next 250	86.6	37.0	3.9	21.6	8.8	36.2	5.4
Next 500	85.6	42.2	4.2	27.5	12.7	41.4	22.4
Last 442	85.4	53.8	10.4	35.7	19.1	47.5	33.0
C. Increase in Market Share from Inferior Bid to Best Bid[b]							
All	*17.7*	*37.4*	*3.1*	*21.6*	*7.9*	*37.0*	*5.7*
Top 50	*9.0*	*16.6*	*3.7*	*15.5*	*3.3*	*25.5*	0.9
Next 200	*8.8*	*28.1*	*2.4*	*14.4*	*4.5*	*26.7*	0.3
Next 250	*11.6*	*35.5*	*3.4*	*16.9*	*6.2*	*34.9*	2.1
Next 500	*19.3*	*40.4*	3.5	*22.3*	*9.1*	*40.3*	*15.5*
Last 442	*25.7*	*51.4*	8.7	*29.2*	*13.3*	*46.4*	*20.4*

Table 4, continued

Concurrent Dollar Volume Market Share for Trades that Occurred at the Best Bid Price Classified by whether a Market is the Only Market Posting the Best Bid Price, or whether a Market is Posting an Inferior Price than the Best Bid Price at the Time of the Trade

Companies Ranked by Market Value	Concurrent Market Share in Percent						
	NYSE	Boston	Cincinnati	Midwest	Pacific	Philadelphia	Nasdaq
D. Number of Firms							
All	1346	958	362	1312	966	993	450
Top 50	50	48	48	50	48	48	48
Next 200	199	194	151	199	200	186	157
Next 250	248	227	102	247	233	222	112
Next 500	486	326	54	477	327	352	102
Last 442	363	163	7	339	158	185	31

[a]A two-way analysis of variance with an interaction term rejects the null hypothesis of no effects at the one-percent level for each of the Panels A and B. For Panel A, F(34, 6352) = 1884.00; and for Panel B, F(34, 6352) = 396.75. On the basis of a Type III test as outlined in SAS/STAT User's Guide (1990), the firm size effect (with the exception of Panel A), the market place effect and the interaction effect are each significantly different from zero at the one-percent level.

The rank order correlations between the concurrent market share for trades in a stock that occurred at the bid price when a market posts an inferior bid and the stock's market value category (with a rank of 1 for the top 50 decreasing to a rank of 5 for the smallest 442) are *-0.40* for NYSE, 0.00 for Boston, *-0.32* for Cincinnati, *0.12* for Midwest, *0.31* for Pacific, -0.07 for Philadelphia, and *0.19* for the Nasdaq. Those correlations in italics are significant at the one-percent level.

The rank order correlations between the concurrent market share for trades in a stock that occurred at the bid price when a market posts the best bid and the stock's market value category (with a rank of 1 for the top 50 decreasing to a rank of 5 for the smallest 442) are -0.02 for NYSE, *0.27* for Boston, *-0.19* for Cincinnati, *0.33* for Midwest, *0.41* for Pacific, *0.20* for Philadelphia, and *0.16* for the Nasdaq. Those correlations in italics are significant at the one-percent level.

[b]Those increases in concurrent market share from posting an inferior bid to the best bid that are significant at the one-percent level are shown in italics.

Table 5

Summary Statistics on Initiating and Terminating the Very Best Bid for NYSE-Listed Stocks, 1990

The table presents summary statistics for every instance on how the bid price of a specific market place became the best bid with every other market having an inferior bid–actively by improving its bid or passively by other markets worsening their bids. It also shows how a market place once having the best bid terminated this position–actively by worsening the bid, passively by other markets matching the bid or the closing of trading on the NYSE. It also gives the average and median time per instance of having the best bid cross-classified by the method of initiating the best bid and terminating this position.[a]

	NYSE	Boston	Cincinnati	Midwest	Pacific	Philadelphia	Nasdaq
A. Number of Instances							
All Active Initiations	956,795	21,585	50,407	107,964	85,169	12,681	11,871
All Passive Initiations	514,392	12,390	34,407	205,900	166,962	10,445	59,404
B. Ratio of Active to Passive Initiations							
	1.86	1.74	1.47	0.52	0.51	1.21	0.20
C. Percentage Breakdown of Instances							
Active Initiation							
Active Termination	34.0	49.2	21.6	45.0	42.9	45.0	51.0
Passive Termination	54.1	48.3	78.2	51.9	54.7	51.5	45.3
End of Trading	11.9	2.5	0.2	3.1	2.5	3.5	3.8
Passive Initiation							
Active Termination	41.9	62.3	64.1	69.2	64.2	61.4	90.4
Passive Termination	45.2	35.6	34.6	28.3	33.5	35.2	9.1
End of Trading	13.0	2.0	1.3	2.5	2.3	3.3	0.6
D. Average Time in Minutes per Instance							
Active Initiation							
Active Termination	25.0	10.3	1.9	11.7	9.9	11.9	13.9
Passive Termination	24.4	9.5	0.5	10.6	8.7	11.4	8.2
End of Trading	241.0	31.1	5.0	46.6	34.5	46.2	108.1
Passive Initiation							
Active Termination	19.7	4.9	1.1	4.0	5.1	5.2	0.8
Passive Termination	24.4	8.6	4.8	10.9	9.9	9.9	7.9
End of Trading	84.1	25.2	6.9	33.5	29.2	23.4	34.0
E. Median Time in Minutes per Instance							
Active Initiation							
Active Termination	8.0	3.8	0.9	3.6	3.3	4.3	1.2
Passive Termination	5.9	3.1	0.1	2.9	2.6	3.6	0.8
End of Trading	341.5	11.3	2.5	14.7	8.8	15.4	52.5
Passive Initiation							
Active Termination	5.9	0.9	0.2	0.6	1.0	1.2	0.1
Passive Termination	8.0	2.9	1.3	3.2	3.3	3.3	1.8
End of Trading	39.1	7.3	1.9	11.4	10.9	8.4	7.3

[a]There are numerous tests that might be made upon the data in this table, but because of the large number of data points, virtually every interesting test would lead to rejection of the usual null hypotheses at high levels of significance–much in excess of one percent. Consider the hypothesis that an active or passive initiation is equally likely. For Philadelphia, the market place with the least number of initiations, the expected number of active initiations is 11,536 with a standard error of 76. The actual number of active initiations is 12,681. Similarly, one can reject for every market the hypothesis that conditional on an active initiation, there is an equal probability of an active or passive termination. The same rejection of active and passive termination applies to passive initiations.