ON THE INTEGRATION OF THE US EQUITY MARKETS

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Abstract

In response to the 1975 Congressional call for a national market system to provide a transparent link across individual markets that trade NYSE-listed stocks, the SEC caused the implementation of three electronic systems that provide a partial integration of these markets. This partial integration together with the trading process on the NYSE floor has created market niches in which non-NYSE markets can prosper. Empirically, the bid and asked prices of the NYSE quote are the primary determinant of the best displayed prices. 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." This fragmentation of trading is a logical outgrowth of the SEC-imposed partial integration and the trading process on the NYSE floor.

> 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 are not fully integrated as envisioned by the 1975 Amendments, but instead only partially and imperfectly integrated through three electronic systems. This paper studies the effects of this partial and imperfect integration on the trading of NYSE-listed stocks. The paper describes the institutional structure of the 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, develops five empirical implications, and then presents some empirical evidence. The paper ends with a brief conclusion.

[1] Securities Acts Amendments of 1975 (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.

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,[3] the five regional stock exchanges (Boston, Cincinnati, Midwest,[4] Pacific, and Philadelphia), and other non-NYSE member organizations who stand ready to make markets in NYSE-listed stocks (for example, Bernard L. Madoff Investment Securities, Instinet, Posit, and the Arizona Stock Exchange[5]).

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 the NASD. 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 the NASD to route an order to another market for execution at the quote of that market.

The CTA consists of two systems, but only 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 the NASD. 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

[3]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.

[4]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.

[5]Some of these organizations, but not all, report their trades through the NASD.

[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.

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 NASD 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]

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.

One of the original intents of ITS was to assure that a public market order submitted to any market would always be executed at the best price that is displayed on CQS. Although

[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 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. There is, however, a presumption that the receiving market will accept all valid commitments [See SEC (1988)], but according to Loss and Seligman (1990, p. 2566), only 78 to 80 percent of the commitments are actually accepted.

a public market order is assured the best displayed bid or offer, it is important to note that the design of ITS provides no guarantee that the market displaying the best bid or offer will be the counterparty 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 counterparty to the execution will be the market displaying the best bid or offer. Second, the receiving market can itself execute the order, but at the best bid or offer, not the inferior bid or offer of that market, in which case the counterparty to the execution will not be the market displaying the best bid or offer.

Another intent of ITS, as well as other initiatives of the SEC, was to preserve the regional exchanges as competitive forces to the NYSE. If the NYSE became too non-competitive, 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.[12]

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.[13] Today, there are only

[12]See Securities Week, December 4, 1989 and February 5, 1990.

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

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.[14] Today, the upstairs market sometimes uses the regional stock exchanges to execute a cross of two 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, but not on the NYSE.[15]

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

[14]The SEC's 1963 Special Study and 1971 Institutional Investors Report document these uses of the regional exchanges.

[15]See Harris (1993) for a more general discussion of reasons why an investor would avoid using the NYSE.

market maker.[16] 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.[17] That "payment for order flow" persists is strong evidence of the profitability of this practice. The following hypothesizes possible sources for this profitability and in the process develops several testable implications.

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.[18] In other words, actual trading prices are sometimes 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.[19]

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

[16]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.

[17]Mainzer's estimate is given in Weiss(1990).

[18]See Blume and Goldstein (1992), Lee (1993), and Petersen and Fialkowski (1994).

[19]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.

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 unlikely 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.[20]

There may still be another source of profitability that provides an incentive to buy 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 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

[20] 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.

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 many advantages of trading on the floor of the NYSE could disappear. Orders that make their way to the floor of the NYSE are often much more complex than simple market or limit orders. As one example, floor traders and specialists often receive "not held" orders that 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.[21]

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

[21] 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.

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.[22]

The floor trader with a "not held" order has little incentive to make a firm bid within the displayed spread, even for a portion of the order. First, the floor trader does not 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, market conditions could change, and without having made a firm offer to buy, the floor trader is not obligated to be the counterparty 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.[23] Finally, if the NYSE specialist is content with his or her inventory position, the specialist has no incentive to post a better offer.

The above was couched in terms of "not held" orders, 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 order to sell short on an uptick.[24]

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

[23]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.

[24]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

2.3 Implications

There are thus numerous undercurrents in the trading of NYSE-listed securities. These undercurrents imply five testable hypotheses:

First, if the quote of the NYSE market is the primary determinant of the best bid and asked prices, the bid and asked prices displayed by the NYSE should equal the best displayed prices virtually all of the time. If there are time periods when a non-NYSE market wishes to attract order flow only from specific types of customers, such as retail customers through the payment of order flow, and exclude other types, the non-NYSE market will display bid and asked prices inferior to the best displayed prices. Only when the non-NYSE market wishes to attract buy or a sell orders from any source will they be part of the best displayed prices, and then only on one side of the best prices.

Second, if investors use the regional exchanges to avoid the rules of the NYSE and if non-NYSE markets pay for order flow with the guarantee of executing that order flow at the best displayed prices or better, a significant portion of the trading volume of a non- NYSE market should occur when neither its bid price nor asked price is part of the best displayed bid or asked prices. (This assumes the accuracy of the first testable hypothesis, i. e., for substantial periods of time, the bid and asked prices of non-NYSE markets do not equal the best prices.)

Third, the trading procedures on the NYSE should cause the NYSE spread to be greater than one eighth a significant portion of the time even for the largest, most active stocks. As floor traders work large orders, they will frequently take out all the limit orders at a specific price, thereby increasing the displayed spread to more than an eighth.

Fourth, if it turns out that the NYSE displayed spread is frequently in excess of one eighth and is equal to the best spread most of the time, non-NYSE markets which wish

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.

to attract a buy or sell order from outside their markets can step inside the NYSE spread when that spread exceeds one eighth and thereby increase the probability of receiving an order either from another market through ITS or from other traders through the normal order submission process. The empirical implication is that the displayed spread when the bid price of a non-NYSE market is superior to all other bid prices will be narrower than the displayed spread when the bid price displayed by the NYSE is superior to all other bid prices. The same implication applies to asked prices.

Fifth, when the displayed spread is in excess of one eighth, there should be a significant portion of trades occurring within the displayed prices due to the presence of trading interest on the floor of the NYSE that is not revealed through CQS.

3 The Empirical Analysis

After a brief description of the data, this section turns to an empirical examination of each of these five hypotheses.

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 the NASD, enabling the reconstruction of the best displayed prices at any point in time.[25] Several filters

[25]The file that ISSM normally disseminates excludes "auto-quotes" of non-NYSE markets. Without these auto-quotes, it is impossible to determine the best displayed prices. The special file obtained for this study does contain these auto-quotes and permits the determination of the best displayed prices. "Auto-quotes" are quotes from non-NYSE markets posted automatically by computers to be outside the best quotes, effectively removing the quotes of those markets from the price determination process. A non-NYSE market will sometimes post bid or asked prices that match or better the immediately prior prices and become part of the displayed prices. To withdraw these bids or offers, the non-NYSE market will then post an auto-quote. Without knowledge of this auto-quote, it is impossible to know that a prior valid non-NYSE quote has been withdrawn.

were applied to these data to remove observations that may be subject to error.[26]

The analysis below is based upon those common stocks in the ISSM data that represent US-domiciled companies listed on the NYSE as of the end of 1989 with a 1989 closing price of one dollar or more and for which the Center for Research in Security Prices (CRSP) has 1989 year-end data, a restriction which allows the construction of control variables based upon data from the preceding year. 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.[27]

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

[26]ISSM has flagged some of the quotes and trades that may be in error, and we have eliminated these data points. We also eliminate some other data. First, any best displayed quote with a bid or an asked price that is more than 50 percent away from the previous best bid or ask is eliminated. This check eliminates those quotes where a digit of the quote was obviously dropped. There are instances, for example, where one side of a quote is $3 when all the other quote and trade prices of a stock are between $30 and $33. The same filter is applied to trade prices. Second, any trade price more than $5 away from the midpoint of the best displayed quote is eliminated. Third, to eliminate large errors in the overall spread, we drop any quote with a spread greater than 20 percent of the stock price for stocks with a price over $10 and greater than $2 for stocks under $10. This filter is based on data in Keim (1989). Fourth, we drop any best displayed quote with a zero or negative spread. Whenever a quote is dropped, we eliminate from analysis any subsequent print of a transaction until we obtained a new and valid quote. We also exclude Berkshire Hathaway and Capital Cities/ABC, both very high priced stocks with extremely large bid-ask spreads.

[27]As mentioned in footnote 25, non-NYSE markets who do not desire to be part of the best displayed prices will use computers to automatically make their bid and asked prices inferior to the best displayed prices, termed "auto-quotes." When there is a change in the best displayed prices, these non-NYSE markets will automatically update their quotes, but with a delay of several seconds. During this delay, it is possible that one side of a non-NYSE auto-quote may appear to be part of the best displayed prices, but in fact it is not a valid quote and a non-NYSE market maker would generally not accept an ITS commitment or any order at that quote. There is no explicit indication that a quote is an auto-quote, but a NYSE spokeswoman has told us that the depth on both sides of an auto-quote is almost always 100 shares. In calculating the best displayed prices, we have assumed that a non-NYSE quote with a depth on both sides of 100 shares is not a valid quote and does not enter into the determination of the best displayed intermarket quote. Any regional quote with a depth on either side of greater than 100 shares is treated as a valid quote.

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.[28] 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 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.[29] 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 the NASD.[30] 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

As hypothesized, 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. There are 1442 stocks in which the displayed bid or asked prices by the NYSE are equal during some part

[28]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. 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.

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

[30]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 NASD.

of 1990 to the best displayed prices, and on average for these stocks, either the bid or asked price or both of the NYSE quote equal one or both sides of the best prices 99.9 percent of the time (Table 1).[31] In calculating similar percentages for non-NYSE markets, one must take into account the wide variability in the number of NYSE stocks in which each non-NYSE market is active, where "active" is defined as posting at some point during 1990 a bid or asked price equal to that of the best displayed prices. On the basis of this definition, the Midwest was active in 1352 stocks at one extreme; the Cincinnati was active in only 458 stocks at the other extreme. Of those stocks in which a non-NYSE market was active, there was wide variation in the percentage of trading time that one side of its quote matched the best displayed quote. At least one side of the Pacific quote matched the best prices 55.3 percent of the time on average for 973 stocks at one extreme; at least one side of the Boston quote matched the best prices only 4.8 percent of the time on 1176 stocks at the other extreme.

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. This trend is particularly pronounced on the Cincinnati and slightly less pronounced on the NASD and is consistent with the reported use by Madoff of these markets in making markets in the larger NYSE stocks.

Also supporting the first hypothesis, both the bid and asked prices of the quotes displayed by the NYSE are likely to match the best displayed prices, while usually only one side of the quotes displayed by non-NYSE markets matches the best prices when there is any match at all. The NYSE bid price equals on average the best bid price 95.1 percent of the time,

[31]The total 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 very rare occurrence. All of the calculations for the non-NYSE markets use this same time convention for measuring total trading time.

and the NYSE asked price equals the best asked price 94.5 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 10.6 percent of the time, and its asked price equals the best asked price 11.2 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 10 percent. In actual fact, Cincinnati has the best bid or best asked price 20.2 percent of the time, indicating that it rarely has both the best bid and the best asked prices simultaneously.

For reference and a further description of the sample, the total dollar volume of the 1442 NYSE-listed stocks studied here was 1.3 trillion dollars in 1990 (Table 2). The NYSE accounted for 84.8 percent of this total at one extreme, while the Cincinnati accounted for 0.2 percent of this total at the other extreme. However, it should be noted that the Cincinnati share of total dollar volume in the largest 50 stocks was 1.7 percent. This relatively larger percentage for these 50 stocks is consistent with Madoff's market making in the larger NYSE-listed stocks and its reported use of the Cincinnati in these activities.

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 significant portion of their volume while their quotes are not part of the best displayed prices. This result is consistent with the second hypothesis that non-NYSE markets capture a significant portion of their trading volume from traders who wish to avoid rules of the NYSE or from brokerage houses who receive payment for order flow, not from posting the best prices.

The NYSE executed on average 0.2 percent of its trading volume when it was not part of the best prices (Table 3). In contrast, non-NYSE markets executed on average anywhere

from 42.0 percent for the Pacific to 90.7 percent for the NASD of their trading volume when not part of the best prices. Like the averages in Table 1, these averages are over the stocks for which at least one side of a market's quote at some point during 1990 matches the best prices.[32]

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 increases slightly on the Midwest and the NASD and decreases on the Pacific as the market value of the stock decreases.

3.4 Displayed Spreads

The displayed spread is frequently greater than one eighth even for the larger companies. This is consistent with the third hypothesis 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.

NYSE rules require that all bid and asked prices must 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. One eighth as a percentage of the bid or asked prices decreases as these prices increase, so that this minimum spread could be binding for low price stocks but not for high price stocks.[33] Therefore, the analysis in this section breaks down the 1442 stocks by five price categories. Of the largest 50 companies, there are six with 1989 year-end price of 100 dollars or more, and the average percentage of the time that the spread of the best prices exceeded one eighth was 57.9 percent (Table 4). Within the largest 50 companies, the percentage of time with a spread greater than one eighth decreases with price but is still 26.6 percent for stocks with 1989 prices of 25 dollars or more and less than 50 dollars.

[32]These large differences in the percentages of volume executed on NYSE and non-NYSE markets when their quotes are not part of the best prices are certainly real and not due to missequencing of the quotes and trades in the merging of the CTA and CQS files.

[33]See Harris (1991) for an empirical confirmation of this possibility.

As the company size decreases, the percentage of time that the average stock has a spread of more than one eighth increases at all price levels. To illustrate, of the 113 companies in the next 200 companies with 1989 prices of 25 dollars or more and less than 50 dollars, the average percentage of time that the spread exceeds one eighth is 45.5 percent, compared to 26.6 percent for the top 50. This percentage increases to 60.0 percent for the next size category and finally reaches 85.5 percent for the smallest companies.

3.5 Relative Sizes of Spreads

The previous analysis confirms that the best displayed spread is often one quarter or more, consistent with the presence of unrevealed trading interest on the NYSE floor and its interaction with orders on the limit book. If so, a non-NYSE market that wishes to generate a trade through ITS can jump inside the quote with a better bid or asked price. If a non-NYSE market betters the best bid or asked price, the best spread should narrow from what it would have been if the NYSE quote alone were determining the best prices.

A test of this prediction confirms its accuracy. Consider those time periods for a specific stock and market in which the bid price posted by that market is the sole determinant of the best displayed bid price; the bid price of every other market is inferior. Now average the spreads for these time periods, weighted by the length of the time period each spread is applicable, and then average these averages across stocks for a specific market. When a non-NYSE market alone determines the best displayed bid price, the average spread during these time periods should be smaller than the average spread when the NYSE is the sole determinant of the best displayed bid price.[34]

The averages of these time weighted spreads over all stocks in which the bid of a market was the sole determinant of the best bid during some part of 1990 show that the non-NYSE spreads are smaller than the NYSE spreads. The non-NYSE spreads range from 80.0 percent

[34]To facilitate the interpretations of these results, the NYSE average for each stock was set to 100 and the averages for non-NYSE markets correspondingly rescaled.

for the Midwest to 93.4 percent for the Cincinnati (Table 5). These results are consistent with the above scenario.

For informational purposes, Table 5 also contains the number of hours averaged across stocks that the bid of each market was the sole determinant of the best bid.[35]

3.6 Proportion of Trades within Spreads

The last implication from the description of trading on the NYSE is that a substantial proportion of trades should occur within the best displayed prices when the spread of those prices exceeds one eighth. The results shown in a tabulation of the proportion of trades on the NYSE within the best displayed prices when the spread exceeds one eighth, cross-classified by price and print size, are consistent with this implication (Table 6).[36] From 50 to 60 percent of the execution prices of 100-share prints are within the best prices. The proportion decreases as print size increases with the largest decrease occurring with the higher priced stocks. As developed in the footnote, this apparent pattern of decreases in proportion of prints within the spread could be due to more mismatching of larger prints.[37]

Although no implications for the proportion of prints within the spread for non-NYSE markets have been developed, a similar analysis to that for the NYSE was performed for non-NYSE markets, but is presented for only three print sizes. Though less than the NYSE percentage, a large proportion of 100-share prints still occurs within the spread in a one-quarter market (Table 7), suggesting that there is unrevealed trading interest on these mar-

[35]Although not presented here, the results are virtually the same for the average spreads when the asked price of a specific market equals the best asked price and every other market has inferior asked prices.

[36]Often, the NYSE reports more than one trade in a single print. The implication is that prints of 100 shares represent 100 share orders, but larger print sizes may contain a number of small orders.

[37]Assume the best prices are 20 for the bid and 20 1/4 for the offer. A market order to buy arrives on the floor and is executed at 20 1/8, and then the quote is revised to 20 1/8 for the bid and 20 3/8 for the offer. If the quote change is reported before the print even after allowing for the median delay in NYSE reporting of trades, this print would be misclassified as executed at the bid price and not within the spread. If the probability of such misclassifying increases with print size, the calculated proportion of prints would decrease with print size. Since stock price is associated with company size and company size with trading volume, it is possible that such misclassification is more likely to occur with higher priced stocks, explaining the apparent decrease in the proportion of prints within the spread.

kets as on the NYSE. If a non-NYSE market has a public buy limit with a price that equals the best bid price and no limit sell orders with prices equal to the best offer, a market maker who receives a market sell order might find it profitable in a one-quarter market to buy within the spread with the expectation that the shares could later be resold at the higher asked price in response to a market buy order. Since participation rates of market makers on non-NYSE markets are not available, it is difficult to test this conjecture.

For the prints of 1000-2000 and over 20,000, the proportion of prints within the spread in a one-quarter or more market is sometimes larger on non-NYSE markets than on the NYSE. As with 100-share prints, there are little, if any, publicly available data to analyze the reasons for these patterns. One possibility is that upstairs market makers find it easier or less costly to execute their crossed trades on non-NYSE markets than on the NYSE, and in a one-quarter market, these trades would occur within the spread.

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 the markets that trade NYSE-listed securities.

The fundamental barrier to such an integration of the markets is that the displayed quotes do not reveal all of the trading interest on the NYSE itself, and possibly non-NYSE markets as well. Trades on the NYSE frequently take place within the displayed spread when that spread exceeds the minimum spread of one eighth, and it should be emphasized that the displayed spread is frequently one quarter or more. There was also evidence that the same phenomenon, but perhaps to a lesser extent, occurs on non-NYSE markets.

One way to integrate the markets is to permit only two types of orders: limit and market orders. 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. The effect of such a system would be radical. There would be no need to maintain the trading floors of the various markets for NYSE-listed stocks since all trading could be done by computer.[38] To date, 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.

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, 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.

[38]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.

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Table 1

Percentage of Time that the Bid or Asked Prices of Each Market Match the Best Displayed Prices

NYSE-Listed Common Stocks, 1990

This table measures the average percentage of the time that the bid or asked price posted by that market matches 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. Panel A measures the average percentage of the time that the price of at least one of the two quotes (bid or asked) posted by that market matches the respective best intermarket quote price. Panel B (C) measures the average percentage of the time that the bid (asked) price posted by that market matches the best intermarket bid (asked) price. Panel D indicates the number of stocks per market and size category.

Companies Ranked by Market Value	NYSE	Boston	Cincinnati	Midwest	Pacific	Philadelphia	NASD
A. Bid or Asked Price–Percentage of Time							
All	99.9	4.8	20.2	47.4	55.3	5.7	21.9
Top 50	99.8	7.1	41.4	52.4	42.8	5.7	25.2
Next 200	99.8	5.8	22.5	48.4	46.5	5.1	21.9
Next 250	99.8	5.0	13.8	46.6	48.9	5.5	19.3
Next 500	99.9	4.7	13.9	45.7	57.6	6.1	25.1
Last 442	99.9	3.6	19.8	48.9	74.8	5.8	18.6
B. Bid Price–Percentage of Time							
All	95.1	2.7	10.6	30.7	34.7	3.5	12.1
Top 50	93.3	3.5	23.2	29.0	24.2	2.6	11.8
Next 200	93.8	2.6	11.1	27.3	27.0	2.4	10.5
Next 250	94.4	2.9	7.0	27.8	29.9	3.3	10.6
Next 500	95.0	2.9	7.5	30.3	36.5	3.9	16.0
Last 442	96.2	2.0	14.5	35.2	50.7	4.0	12.2
C. Asked Price–Percentage of Time							
All	94.5	2.7	11.2	30.5	34.8	3.3	12.3
Top 50	92.3	4.1	23.6	33.0	26.0	3.5	13.4
Next 200	92.6	3.5	12.5	30.1	28.3	3.0	11.4
Next 250	93.2	2.8	7.4	29.2	30.3	3.5	10.3
Next 500	94.6	2.5	7.9	29.2	36.1	3.5	15.1
Last 442	96.0	2.1	9.2	32.9	49.3	3.0	11.9
D. Number of Stocks							
All	1442	1176	458	1352	973	1151	503
Top 50	50	49	49	50	49	49	49
Next 200	200	199	172	200	200	196	158
Next 250	250	246	134	250	235	241	118
Next 500	500	420	89	487	328	423	118
Last 442	442	262	14	365	161	242	60

Table 2

Total Dollar Volume of Trading and Percentage Breakdown by Market

NYSE-Listed Common Stocks, 1990

This table notes the total dollar volume of trades for NYSE-listed stocks during 1990 for different size categories ranked by year-end 1989 market capitalization. The average percentage of the dollar volume traded on each market across the stocks in the sample is also reported.

Companies Ranked by Market Value	Total Dollars (billions)	Percent of Total Dollar Volume						
		NYSE	Boston	Cincinnati	Midwest	Pacific	Philadelphia	NASD
All	1,333	84.8	1.4	0.2	5.5	2.4	1.1	4.3
Top 50	464	85.2	1.6	1.7	4.6	2.4	1.2	3.1
Next 200	532	86.9	1.5	0.7	4.5	2.4	1.4	2.4
Next 250	207	85.8	1.4	0.3	5.0	2.5	1.6	3.2
Next 500	115	83.5	1.5	0.1	5.7	2.5	1.1	5.3
Last 442	16	84.5	1.3	0.0	6.1	2.2	0.7	4.7

Table 3

Percentage of Volume When Neither Bid Price Nor Asked Price Equals the Best Prices NYSE-Listed Common Stocks, 1990

This table notes the average percent of the total volume of trades 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.

Companies Ranked by Market Value	Percent of Volume						
	NYSE	Boston	Cincinnati	Midwest	Pacific	Philadelphia	NASD
All	0.2	87.0	74.3	50.2	42.0	84.6	90.7
Top 50	0.3	88.4	60.4	43.6	56.3	88.3	71.8
Next 200	0.2	86.4	74.5	46.7	50.5	88.1	79.9
Next 250	0.2	87.1	79.1	50.0	47.6	86.6	89.4
Next 500	0.2	86.7	78.6	51.8	38.6	83.3	92.6
Last 442	0.1	87.3	46.6	51.0	25.4	81.6	96.4

Table 4

Percentage of Time that the Best Displayed Spread Is Greater than One Eighth Cross Classified by 1989 Market Value and 1989 Closing Share Price

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. 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 NASD 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. The number of stocks per group is noted below the percentage in parentheses.

1989 Market Value Category	1989 Closing Stock Price, P				
	$P \geq 100$	$50 \leq P < 100$	$25 \leq P < 50$	$15 \leq P < 25$	$1 < P < 15$
Top 50	57.9 (6)	38.6 (30)	26.6 (14)	none	none
Next 200	79.7 (7)	60.4 (61)	45.5 (113)	24.0 (19)	none
Next 250	99.0 (1)	76.8 (32)	60.0 (145)	34.0 (53)	16.5 (19)
Next 500	96.4 (2)	85.9 (17)	73.8 (158)	58.2 (182)	29.1 (141)
Remainder	none	none	85.5 (16)	76.0 (88)	42.4 (338)

Table 5

Average Spread When the Market's Bid Price Equals the Best Bid Price and No Other Market's Bid Price Equals the Best Bid Price (NYSE Spread Set to 100.0)

NYSE-Listed Common Stocks, 1990

This table presents data on the average spread during 1990 for NYSE-listed stocks when that market is quoting the highest bid price and all other markets are quoting a lower bid price. Panel A presents the average spread for each market as a percentage of the NYSE's average spread. Panel B presents the number of hours during 1990 when that market had the best intermarket bid and no other market had as high a bid price.

Companies Ranked by Market Value	Spread as a Percent of NYSE						
	NYSE	Boston	Cincinnati	Midwest	Pacific	Philadelphia	NASD
A. Spread as a Percent							
All	100.0	78.5	93.4	80.0	82.7	77.2	82.4
Top 50	100.0	82.1	88.5	84.8	83.6	81.8	87.7
Next 200	100.0	79.6	89.6	82.3	82.5	79.0	83.8
Next 250	100.0	76.5	92.8	81.1	81.7	76.3	83.9
Next 500	100.0	77.7	107.9	78.7	82.7	76.9	81.6
Last 442	100.0	80.3	74.6	79.2	84.0	76.3	71.3
B. Number of Hours							
All	771.3	3.5	1.0	29.1	22.8	2.8	3.1
Top 50	688.5	3.8	12.4	29.7	24.9	2.6	4.7
Next 200	806.6	5.7	2.5	31.3	31.1	3.8	1.8
Next 250	815.3	4.5	0.6	30.9	31.7	3.6	3.1
Next 500	791.2	3.9	0.3	30.2	23.7	3.1	3.7
Last 442	717.4	1.6	0.1	25.6	12.6	1.7	2.9

Table 6

Percentage of Prints Executed Within the Best Prices When the Best Spread Exceeds One Eighth by Size of Print on the NYSE

This table analyzes prints of NYSE-listed common stock during 1990 where the best displayed quote is one quarter or more and the NYSE reported the print. It cross classifies the prints according to the 1989 year-end price of the stock and the size of the print in shares. Reported is the percentage of prints with a price within the best prices for each category for a given stock, averaged across all stocks in that category.

1989	Print Size									
Closing Price	100	200	300-500	600-1,000	1,100-2,000	2,100-3,000	3,100-5,000	5,100-10,000	10,100-20,000	Over 20,000
$P \geq 100$	53.6	49.6	44.7	39.2	38.6	41.1	41.9	40.0	40.8	32.8
$50 \leq P < 100$	58.2	55.7	51.2	46.8	44.4	43.6	43.3	43.6	42.7	36.3
$25 \leq P < 50$	57.6	53.8	50.0	45.0	42.5	42.6	43.4	44.1	45.6	41.6
$15 \leq P < 25$	58.7	55.0	50.8	45.6	42.8	42.4	42.9	43.9	46.4	41.8
$1 < P < 15$	61.0	59.1	57.2	53.8	50.0	47.9	48.4	46.2	46.0	44.2

Table 7

Percentage of Prints Executed Within the Best Prices When the Best Spread Exceeds One Eighth For Selected Print Sizes for All Markets

This table analyzes all prints of NYSE-listed common stock during 1990 where the best displayed quote is one quarter or more. It cross classifies the prints according to the 1989 year-end price of the stock, the size of the print in shares, and the source of the print. Reported is the percentage of prints with a price within the best prices for each category for a given stock, averaged across all stocks in that category.

1989 Closing Price	NYSE	Boston	Cincinnati	Midwest	Pacific	Philadelphia	NASD
A. Prints of 100							
$P \geq 100$	53.6	39.0	18.2	26.5	32.9	15.4	23.2
$50 \leq P < 100$	58.2	39.8	23.4	30.1	35.8	16.7	22.7
$25 \leq P < 50$	57.6	44.2	31.2	34.9	40.8	18.5	19.0
$15 \leq P < 25$	58.7	48.0	46.4	38.7	48.3	21.8	17.0
$1 < P < 15$	61.0	54.4	39.3	43.4	58.5	28.5	16.2
B. Prints of 1,000-2,000							
$P \geq 100$	38.6	45.4	43.7	45.4	53.7	31.1	31.2
$50 \leq P < 100$	44.4	44.0	46.7	44.4	59.0	30.9	28.2
$25 \leq P < 50$	42.5	44.0	47.5	45.4	64.5	36.5	28.2
$15 \leq P < 25$	42.8	47.6	57.8	49.3	69.7	46.6	26.7
$1 < P < 15$	50.0	59.5	63.8	61.1	79.5	59.5	30.2
C. Prints over 20,000							
$P \geq 100$	32.8	34.2	50.7	32.2	57.1	46.4	31.0
$50 \leq P < 100$	36.3	29.7	42.4	41.1	39.7	26.2	48.3
$25 \leq P < 50$	41.6	40.5	42.0	49.4	43.7	38.8	47.8
$15 \leq P < 25$	41.8	36.4	40.8	53.0	48.5	37.9	49.8
$1 < P < 15$	44.2	31.0	83.3	54.4	46.8	33.3	47.5