Quantifying Best Execution At the New York Stock Exchange: Market Orders

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Abstract

This paper provides a detailed description of the way the NYSE quantifies best execution on market orders and the statistics it proposes to disseminate to member firms. We address two important issues: how to measure best execution on market orders and the need for cross-market standardization to facilitate comparisons. We propose six measures for quantifying best execution on eligible system market orders and present NYSE estimates for August 1999:

- Percent executions inside the quote: 35.5 percent of eligible system market orders (execution reports) not exceeding the quoted size executed at a price better than the quoted price.
- Percent executions outside the quote: 6.9 percent of eligible system market orders not exceeding the quoted size executed at a price worse than the quoted price. The main reason for executions outside the quoted price is multiple orders hitting the quote at the same time.
- Percent discount relative to the quoted price. Percent quoted spreads on eligible system market orders not exceeding the quoted size reports averaged 35.5 basis points and effective spreads 22.1 basis points. On a $50 stock, investors save on average 7 cents per round-trip share relative to the quoted price.
- Percent executions receiving depth improvement. Of the eligible orders exceeding the quoted size, 61.6 percent executed either inside or at the quoted price.
- Percent single price executions: 97 percent of eligible system market orders received single price executions and 95 percent received single print executions.
- Exposure-to-execution time. Excluding stopped orders the average time from order exposure to execution for eligible system market orders not exceeding the quoted size is 16.5 seconds.

Best-execution statistics are sensitive to the calculation methodology. On the same order flow, for example, executions outside the quote can range from 1.9 to 7.0 percent depending on the averaging method; effective spreads can range from 17.7 basis points on 100-share orders to 53.5 basis points on block-size orders. For valid cross-market comparisons, therefore, we must standardize methodologies and control for other factors that may affect best execution performance.

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I. Introduction

In trading equity, investors typically choose a broker and then the broker chooses the market venue to route the order for execution.[1] For NYSE stocks a broker may route an order to the NYSE, route the order to one of the five regional exchanges, "internalize" the order, route the order to another third-market dealer, route the order to an alternative trading system and may even route the order overseas.[2] In choosing among these alternatives, brokers must fulfil their fiduciary responsibilities to their investor clients: they must route orders to the market that delivers best execution.

The Securities and Exchange Commission has been encouraging market centers to provide brokers, directly or indirectly, with the statistics necessary to make informed decisions on which venue to direct orders so as to fulfil their best execution obligations. This paper provides a detailed description of the way the NYSE quantifies best execution on market orders and the statistics it proposes to disseminate to member firms.[3] We address two important issues: how to measure best execution on market orders and the need for cross-market standardization to facilitate comparisons.

There is no legal definition of best execution. Several papers point out the difficulties in defining and measuring best execution.[4] The most important conceptual obstacle is that best execution should be defined relative to investor intentions and expectations, which are hard to observe and quantify. A "patient" investor, for example, may want to wait to get a better price while an "impatient" investor may want immediate execution and may be willing to forego the possibility of a better price. So should the broker send all orders to the faster market? In this paper we sidestep this fundamental problem and propose six measures for quantifying best execution on eligible system market orders:

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[1] Investors may access some market venues directly and may request their broker to direct their orders to a particular market venue.

[2] NYSE members are subject to certain restrictions in NYSE Rule 390 stocks. At the end of October 1999, 23 percent of NYSE issues accounting for 46 percent of the volume were subject to Rule 390.

[3] Beginning with July 1999 data, the Exchange has been disseminating to member firms, on a pilot basis, monthly reports with market order best execution statistics.

(a) Percent executions inside the quote. At the NYSE in August 1999, 35.5 percent of eligible execution reports executed inside the quoted price.[5]

(b) Percent executions outside the quote. At the NYSE in August 1999, 6.9 percent of eligible execution reports executed outside the quoted price. The main reason for executions outside the quoted price is multiple orders hitting the quote at the same time.

(c) Percent discount/premium relative to the quote. In August 1999, the average NYSE percent quoted spread on eligible execution reports was 35.5 basis points and the average effective spread 22.1 basis points. On a $50 stock, investors save on average 7 cents per round-trip share relative to the quoted price.

(d) Percent executions receiving depth improvement (an order exceeding the quoted size executes inside or at the quoted price). Of the eligible orders in our sample exceeding the quoted size, 61.6 percent executed either inside or at the quoted price receiving depth improvement.

(e) Percent single price executions. At the NYSE in August 1999, 99 percent of eligible system market orders received single price executions and 98 percent received single report (print) executions.

(f) Exposure-to-execution time. At the NYSE in August 1999, excluding guaranteed (stopped) orders, the average time from order exposure to execution was 16.5 seconds. Including guaranteed orders the average time from exposure to execution was 22.5 seconds.[6]

In the paper we highlight the sensitivity of best-execution statistics to the calculation methodology. On the same order flow, for example, effective spreads can range from 22.1 to 79.5 basis points and the frequency of executions outside the quote can range from 1.9 to 7.0 percent depending on the averaging method. Another important factor is order size: the effective spread is 17.7 basis points on 100-share orders and 53.5 basis points on block-size orders; 40.4 percent of 100-share orders receive executions inside the quote compared with 25.6 percent for block-size orders. For valid cross-market comparisons, therefore, we must standardize methodologies and control for other factors that may affect best execution performance. Without these common standards cross-market comparisons are meaningless: like comparing the nutritional content of two cereals without having a common measuring unit.

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[4] See for example Macey and O'Hara (1997).

[5] Order size less than or equal to the reference NBBO size. The same for (b), (c), (e) and (f).

[6] For guaranteed orders we measure time the same way as for non-guaranteed orders: from when the order shows up on the screen to execution.

The remainder of this paper is organized as follows. Section II develops the best execution measures we will be using. Section III presents a brief literature review and section IV describes the NYSE order flow. Section V describes the data, section VI discusses our choice of the benchmark reference quotes, and Sections VII and VIII describe stock and order selection. Section IX describes the calculation, and Section X and XI present best execution statistics for eligible market orders. Section XII discusses single price executions and section XIII presents statistics on order exposure-to-execution times. We conclude in Section XIV with a discussion of our findings and directions for future research.

II. Concepts

In this paper we develop and calculate best execution statistics for "regular" market orders ("I want to buy 500 shares at the quoted price") that reach the NYSE specialist post through the NYSE's electronic order transmission system, SuperDot. Typically order routing is done in two steps: (a) the investor routes the order to her broker, and (b) the broker routes the order to the execution venue. The investor chooses a broker, and a broker chooses the execution venue.[7] We focus on the second step: providing information to brokers to assess the quality of executions they receive when they route their orders to the NYSE. We do not have the information (commission fees, broker accessibility, etc.) to help investors in their choice of brokers.[8]

Suppose an investor wants to buy 500 shares of XYZ at the market. The NYSE quote is $50 bid for 5,000 shares, 10,000 shares offered at $50.20 (we use decimal pricing for simplicity); the Other Exchange quote is $50 bid for 1,000 shares, 1,000 shares offered at $50.25. By comparing these quotes, the broker should route the order to the NYSE, which has the lowest offer. The presence of the Intermarket Trading System (ITS), however, makes the comparison of quoted spreads (across ITS-participating venues) irrelevant. ITS is an electronic network that links the participating exchanges and the over-the-counter market, and facilitates the execution of orders in eligible securities at the best ITS quote.[9] Typically an order, therefore, will get the best quoted price across all ITS venues irrespective of where the broker sends the order. In our example, if the broker routes the order to the Other Exchange, then according to ITS rules the Other Exchange, to

[7] The investor may actually specify the execution venue in routing an order to a broker. This two-step process is also changing in another way: the proliferation of direct-access systems allows investors to route their orders directly to an execution venue (e.g. Instinet).

[8] Even if we had data on the commission fees brokers charge investors we would still have to net out additional services some brokerage firms may also be providing for the same fee (e.g. research reports, etc.)

avoid a "trade-through" complaint, can either match the better NYSE quote and execute locally or route a "commitment to trade" to the NYSE and try to execute the order there. Either way the order will typically execute at $50.20.

The quoted spread is irrelevant for another reason: market orders frequently execute inside the quote. Suppose the broker routes the 500-share buy market order to the NYSE. The order may then execute not at the quoted offer of $50.20 but inside the quote at, for example, $50.15. In this example, the investor receives "price improvement" saving 5 cents per share relative to the quoted offer. This potential saving is not available through ITS: if the broker routes the order to the Other Exchange and the Other Exchange routes the order to the NYSE through ITS, the order is not eligible for price improvement and will execute at $50.20. Price improvement, therefore, is a relevant best execution attribute: all else equal, brokers should route market orders to the market providing the most price improvement.

Occasionally, orders may execute outside the quote. In our example, suppose the 500-share buy market order reaches the specialist Display Book a split second after a 10,000-share buy market order. The 10,000-share buy order takes the 10,000 shares offered at $50.20 and the 500-share order executes "up the book" at $50.25. The 500-share order now executes outside the quote that prevailed when the order reached the Display Book. The likelihood of executing outside the quote is also a relevant best execution attribute: all else equal, a broker should route orders to the market with the least likelihood of executing outside the quote (or most *net* likelihood of executing inside the quote). In addition to calculating the percent of orders executing inside the quote, we also calculate and report the percent of orders executing outside the quote.

We also quantify best execution by measuring the discount/premium defined as the quoted minus the effective spread. The effective spread on a buy order is twice the trade price minus the midquote; on a sell order it is twice the midquote minus the trade price. In our example, the NYSE midquote is $50.10, the order executes at $50.15, so the effective (roundtrip) spread is 10 cents. The quoted spread is 20 cents, so the discount--the roundtrip cost saving relative to the quoted spread--is 10 cents per share.

The discount/premium measure has two advantages over simply reporting percent executions inside and outside the quote. The first advantage is that the discount/premium nets the impact of

[9] For a discussion of ITS see Hasbrouck, Sofianos and Sosebee (1993).

executions inside and outside the quote. Executions inside the quote lower the effective spread and increase the discount; executions outside the quote raise the effective spread and lower the discount (or may create a premium).[10] The second advantage of the discount/premium measure us that it puts a dollar value to executions inside and outside the quote. A two-tick price improvement, for example, has a bigger dollar value than a one-tick price improvement and the discount measure captures this.

To facilitate comparison across different-priced stocks and across market venues with a different mix of stocks we report quoted spreads, effective spreads and discounts as a percent of the midquote in percent basis points (bp). In our example, the quoted spread is 40 bp, the effective spread is 20 bp, and the discount 20 bp: on a $100-stock, investors save on average 20 cents per *round-trip* share relative to the posted quote.

One type of outside-the-quote execution deserves special attention. In our example the quote was $50 bid for 5,000 shares, 10,000 shares offered at $50.20. Suppose an investor looks at the quote and sends an order to buy 15,000 shares: the orders size exceeds the quoted depth. Let 12,000 shares execute at $50.20 and the remaining 3,000 shares "walk-up the book" executing at $50.25. In our calculations the 3,000 shares will show up as executions outside the quote and raise the effective spread. But should the market venue be penalized when an investor knowingly sends an order exceeding the quote?

Comparing the execution price to the posted (inside) quote, does not give the correct best execution metric for orders that exceed the quoted size. Bacidore, Battalio and Jennings --BBJ-- (1999) develop a methodology for handling these orders. They propose that for market orders exceeding the quoted depth, the volume-weighted execution price should be compared with the volume-weighted slope of the book including any depth in the book away from the quote.

In our example, the volume-weighted execution price is $50.21. Suppose the offer side of the book consists of 10,000 at $50.20 and 5,000 at $50.25. The best execution that the market venue "owes" the investor is then 10,000 at $50.20 and the remaining 5,000 at $50.25, a volume-weighted "quoted" price of $50.22. The market quotes $50.22 for 15,000 shares and the investor pays $50.21: this is an execution inside the quoted book price and the investor saves 1 cent per

[10] An accounting identity holds for the five measures: percent inside the quote, percent outside the quote, quoted percent spread, effective percent spread and percent discount.

share. This example also illustrates the concept of depth improvement: while the quoted offer was 10,000 shares at $50.20, the investor managed to buy 12,000 shares at that price, a depth improvement of 2,000 shares. It is this depth improvement that results in the 1 cent per share savings compared to the quoted book price.

The BBJ methodology will gain in importance if there is further reduction in the minimum tick size. If the minimum tick size eventually becomes a penny, for example, active stocks may be trading at penny spreads 100 shares by 100 shares and the majority of orders will be walking up the book.

In this paper we split market orders into (a) orders whose size does not exceed the quoted size, and (b) orders whose size exceeds the quoted size. We examine the two types of orders separately. For orders not exceeding quoted depth, our methodology of benchmarking off the quoted best bid and ask is valid. We use the same methodology to present preliminary best-execution statistics for orders exceeding the quoted depth. When an order exceeds the quoted depth, execution inside the quote means depth improvement and price improvement, while execution at the quote means depth improvement but no price improvement. This preliminary approach exaggerates the true number of executions outside the quoted BBJ price.

Another possible best-execution attribute is the time it takes for a market order to execute. Suppose one venue advertises a turnaround time of 6 seconds while another venue advertises a turnaround time of 22 seconds. Should the broker route the orders to the faster market? Why is the speed of execution important? One possible reason is that slower executions increase the likelihood of executing outside the prevailing quote. But this cost of slower execution is already included in the price improvement and effective spread statistics: the market with slower executions will have more executions outside the quote. So there must be other reasons why fast executions are a desirable attribute. Online brokers, for example, promise instantaneous executions. Even if the ultimate investor were willing to wait a few seconds to get a better price, the broker intermediaries having to deal with many orders may want to "mass-produce" executions for their "easy" retail order flow.

Another execution characteristic is the number of execution reports: orders occasionally execute over multiple execution reports at the same price or in multiple prices. All else equal, brokers

prefer single print executions to multiple print executions because it simplifies processing. The percentage of single print executions is another attribute of best execution we will be examining.

Our approach is a "partial equilibrium" approach. Occasionally, for example, when a market order receives price improvement, a counter-side limit order may take longer to execute or not execute at all. To provide the full picture we also need to calculate best execution statistics for limit orders. The extent to which market order price improvement is at the expense of limit orders will then show up as longer limit order times-to-execution and lower fill rates.

One component of execution costs is hard to quantify on a per share basis: the trading fees brokers pay to the NYSE specialists and to the Exchange. Member firms pay trading fees to the Exchange in proportion to the volume they execute at the NYSE. These payments are capped, so that for at least the bigger firms the marginal fee paid to the Exchange is zero. Member firms also pay trading fees to the NYSE specialists. Different specialist units have different fee schedules. The Exchange, however, restricts the ability of specialists to charge commission fees on certain system orders. During our sample period, for example, the Exchange did not allow specialists to charge fees on post-opening market orders of less than 2,100 shares (96.1 percent of the eligible system market orders in our sample).[11] At least some specialists do not charge trading fees on any market orders. The marginal fee cost to brokers for NYSE-executed system market orders is very small and is hard to quantify; we ignore these costs.

To summarize, in this paper we examine the following best-execution attributes of market orders:

(a) Percent executions inside the quote
(b) Percent executions outside the quote
(c) Percent quoted and effective spreads (and the discount/premium relative to the posted quote)
(d) Depth improvement
(e) Exposure-to-execution time
(f) Single price executions

[11] The Exchange is proposing to prohibit specialists from charging fees on all system orders executing within 5 minutes; once approved this will effectively prevent specialists from charging fees on all system market orders.

III. Literature review

Several academic studies examine the issue of best execution. Bessembinder and Kaufman (1997), Blume and Goldstein (1992) and Lee (1993) assess whether significant differences in trading costs exist between the NYSE and the regional exchanges/third market in the trading of NYSE-listed securities. These studies find that trading costs on the NYSE are lower than in other markets. These studies use trade and quote data as opposed to order level data. Peterson and Sirri (1999) show that the use of trade and quote data results in biased estimates of trading costs. To obtain more accurate estimates Petersen and Fialkowski (1994) and Lightfoot, Martin, Peterson, and Sirri (1999) use order level data to assess best execution.[12] These studies also find that trading costs are lowest on the NYSE. Ross, Shapiro and Smith (1996) also use order data to estimate price improvement on the NYSE.

Other studies have assessed the best execution implications of certain industry practices, such as payment for order flow and preferencing. The hypothesis is that both practices amount to "cream skimming" or the selective purchasing or preferencing of only the least informative orders. Cream skimming may lead to increased trading costs to the market as a whole. Empirical tests of this hypothesis have generated mixed results: see Battalio (1997), Battalio, Jennings and Greene (1997, 1998), and Easley, Keifer and O'Hara (1996). A related issue is to what extent competing markets contribute to price discovery. Blume and Goldstein (1997) and Hasbrouck (1995) both investigate each U.S. market's contribution to price discovery and find that the vast majority of price discovery occurs on the NYSE.

All these studies focus on quoted and effective spreads as a measure of best execution. Harris (1995) and Macey and O'Hara (1997) argue that there are additional dimensions of execution quality that also need to be incorporated. Macey and O'Hara also provide a useful discussion of the legal aspects of the brokers' best execution obligations and the difficulties of quantifying best execution.

[12] Almost all studies of execution quality assess the costs incurred by market order traders. Battalio et al. (1999), Harris and Hasbrouck (1996), and Lightfoot et al. (1999) investigate the execution quality of limit order traders as well.

IV. Description of NYSE order flow

Chart 1a shows the composition of executed orders routed to the NYSE.[13] Five percent of executed orders are "floor orders:" a floor broker walks the order to the specialist. Another 33 percent are system limit orders, 16 percent are system marketable limits and 46 percent are system market orders. In terms of executed *share volume* (Chart 1b) floor orders account for 42 percent of executed share volume, system limits 25 percent, system marketable limits 15 percent and system market orders 18 percent. In this paper we focus on system market orders. After discarding ineligible market orders (odd lot orders, market-on-close orders, etc.)[14] our final sample represents 30 percent of the orders executed on the NYSE accounting for 11 percent of NYSE volume.

Chart 2 traces the time path of a NYSE market order from the initiating investor all the way to execution. At time t the investor checks the prevailing quote Q_0 and decides to buy the stock. At time $t+s_1$ the investor attempts to contact her broker to submit the order. The broker receives the order at $t+s_1+s_2$ and decides in which market to send the order. Suppose the broker decides to send the order electronically to the NYSE. At $t+s_1+s_2+s_3$ she enters the order into the brokerage firm's proprietary order management system which routes the order to the NYSE. At $t+s_1+s_2+s_3+s_4$ the order arrives at the NYSE's Central Message Switch (CMS), the electronic "gateway" to the Exchange.[15] From this point on NYSE systems track the order to execution and until the execution report leaves CMS for the electronic trip back to the originating broker's computer.

CMS time stamps the order upon arrival and forwards it to SuperDot. SuperDot processes the order and routes to the appropriate specialist Display Book.[16] The NYSE System Order Database (SOD) file records the CMS order arrival time as *xtime*. The order arrives at the Display Book at $t+s_1+s_2+s_3+s_4+s_5$ and the Book time stamps the order. The SOD file records the Display Book arrival time as *otime*. Typically, the order will immediately show up on the specialist Display

[13] Orders routed to the NYSE but executed on other markets through ITS are included in our sample (in SOD data file contra=ITSN). Orders routed to other markets but executed on the NYSE through ITS are not included in our sample (contra=ITSB (for Boston), ITSC (for Cincinnati), etc.)
[14] Section VIII presents a detailed discussion of the selection of orders to include.
[15] CMS is a store and forward message-switching device that connects member firm and Exchange systems. For more information see Hasbrouck, Sofianos and Sosebee (1993).
[16] More precisely, SuperDot passes the order to the Post Support System (PSS), an internal switching device. From PSS the order travels over the NYSE Floor Network to the appropriate specialist Display Book.

Book screen. Occasionally, however, there may be a short delay. If the specialist, for example, has opened the quote template to change a quote, the book will be "frozen" and the order will not display immediately. The order shows up on the specialist Display Book screen at $t+s_1+s_2+s_3+s_4+s_5+s_6$ and the Book time stamps the order for the second time. The SOD file records the Book screen arrival time as *dbtime*. The specialist executes the order and enters an execution report in the system at $t+s_1+s_2+s_3+s_4+s_5+s_6+s_7$. The SOD file records the execution time as *rtime*. The execution report makes its way from the display book back to CMS from where it leaves the Exchange at $t+s_1+s_2+s_3+s_4+s_5+s_6+s_7+s_8$. CMS time stamps the executed order for the final time and SOD records this time as *ytime*.

Chart 2 also summarizes the various CMS-to-CMS transit times.[17] On average, a non-guaranteed system market order takes 2.9 seconds to travel from CMS to the Display Book (s_5), 1.6 more seconds to show up on the Book screen (s_6), 16.5 seconds to execute (s_7) and another 1.8 seconds for the execution report to return to CMS (s_8). The CMS-to-CMS round-trip averages 22.8 seconds. The electronic transit time averages 6.3 seconds. Most of the round trip time represents the interaction of the system order with the floor, i.e. the specialist exposing the order to the Trading Crowd to get a better price. Table 1 shows that the electronic transit times are roughly constant across different order sizes.[18] The screen-to-execution time (s_7), however, increases sharply with order size, ranging from 15.3 seconds for 100-share orders to 31.6 seconds for block orders exceeding the quoted size. Section XIII examines the exposure-to-execution time in detail.

The time the order takes to travel from the investor to the point of execution is important because the quote may change while the order makes its way to the specialist Display Book screen. Depending on which quote we use to benchmark best execution, these lags will influence the percent of executions inside and outside the quote.

V. Data and sample period

Our sample period consists of the 22 trading days in August 1999. Our data come from the SIAC-created daily SOD and SODQ files. SOD contains detailed information on the entry and processing of all orders that reach the specialist posts electronically through SuperDot ("system"

[17] The transit times in Chart 2 are for August 1999, eligible system non-guaranteed market orders, order size less than the reference NBBO size.
[18] All calculations are based on non-guaranteed, eligible system market order execution reports.

orders). Each file has at least one record for every system order for which something was done (e.g. order entry, execution, cancellation, etc.).

Most of the time an order executes in one execution report, so there is a one-to-one association between orders and execution reports. Occasionally, however, orders may execute over two or more execution reports and an order will be associated with multiple execution reports.[19] In the case of a limit order, the order may never execute and so the order will have no associated execution report but will be associated with a cancellation record.

Table 2 presents a hypothetical example of an order in SOD. The order reached CMS at 14:22:09 (xtime), the Display Book at 14:22:10 (otime) and showed up on the Display Book screen at 14:22:11 (dbtime). The order is a buy (OSIDE=BUY) market order (OTYPE=M) for 7,500 shares (OSHRS). Information pertaining to the order carries through to all associated records. In our example, SOD contains three records associated with the order (INDTOT=3). The three records are the three execution reports over which the order executed, but in general a record may also be an administrative message, order cancellation, etc. At 14:23:25 (RTIME), 4,300 shares (RSHRSB) executed at $30 (EXECPR) and the execution report left CMS at 14:23:26 (YTIME). At 14:23:26, 800 more shares executed at $30 and the execution report left CMS at 14:23:27. Finally at 14:23:43, the last 2,400 shares executed at $30 1/16 and the execution report left CMS at 14:23:44. SOD also contains detailed information on the contra sides and several other order and execution characteristics.

SODQ contains the NYSE and best off-NYSE quotes at various times (otime, dbtime) for every record of the companion SOD file. All quote data are derived from the NYSE's Consolidated Quote (CQ) file.[20] Table 3 uses a hypothetical example to summarize the quotes present in the SODQ file. The file does not contain any information on the quotes prevailing at CMS arrival time (xtime) and contains information on only the NYSE quote at execution time (rtime).

VI. Choosing the reference quote

Best execution statistics are sensitive to the choice of the benchmark "reference" quote to which

[19] An order may be made up of multiple execution reports; a trade is made up of multiple (at least two) orders, and a Tape print (what's available in the TAQ database) may be made up of several trades bunched together.

[20] The CQ file is publicly available as part of NYSE's TAQ database.

we compare the execution price. There are two issues in choosing the reference quote: (a) which quote definition, and (b) the quote prevailing at which time?

(a) Which quote definition?

Table 4 lists several alternative quote definitions. The NYSE quote is the quoted bid and offer on the NYSE. The pure NBBO is the best quoted bid and best quoted offer across all ITS-participating markets: the regional exchanges and the over-the-counter NASD market.[21] Should we be using the NYSE quote or the intermarket NBBO?

Suppose the NYSE offer is 10,000 shares at $50.20 and the NBBO is 500 shares at $50.15 with Boston having the best offer. An order to buy 200 shares arrives on the NYSE. According to the ITS rules, the NYSE specialist can either match the Boston quote and execute on the NYSE at $50.15 or send a message to Boston through ITS giving Boston the opportunity to fill the order at its better quote. According to ITS rules, the order will typically execute at $50.15.[22] In calculating best execution statistics, if we use the NYSE quote as a reference quote, then the NYSE would get price improvement credit while in fact this is the result of having a worse quote than Boston and being forced by ITS to execute at the Boston quote. Using the NBBO as the reference quote is more appropriate.

One complication: not all NBBO quotes are ITS eligible. For example ITS participants are allowed to "trade through" 100-share quotes.[23] In our example, suppose the NYSE offer is still 10,000 shares at $50.20 and the NBBO is 100 shares at $50.15 with Boston having the best offer. An order to buy 200 shares arrives on the NYSE. The NYSE specialist can go ahead and executes the order at $50.20. Using the NBBO as the reference quote we will classify this execution as outside the quote. The ITS-eligible NBBO (Table 4) excludes 100-share quotes.

[21] We will ignore the BPQ used by the NYSE for executing odd lot orders.
[22] An NYSE routed order executing in Boston through ITS is included in the calculation of NYSE best execution statistics.
[23] The history of the 100-share ITS trade-through exemption is the following. The regional exchanges autoquote because of the large number of stocks each specialist is responsible for and to comply with the two-sided quotation obligation in the ITS Plan. When ITS participants tried to trade with these autoquotes, they were autoquoted away -- resulting in ITS cancellations. During the negotiations on the ITS trade-through rule, the ITS participants agreed to limit autoquoting to 100 shares and that these 100-share autoquotes should be exempt from the trade-through rules.

NASD dealer (third market) quotes in Rule 390 stocks are also not ITS eligible. Suppose the NYSE offer for IBM (a Rule 390 stock) is 10,000 shares at $90 1/16 and the NBBO is 100 shares at $90 with a third maket dealer having the best offer. An order to buy 200 shares arrives on the NYSE. The 100-share OTC quote is not ITS eligible so the NYSE specialist goes ahead and executes the order at $90 1/16. Again, if we use the pure NBBO as the reference quote we will classify this execution as outside the quote.

After consultations with the SEC it was agreed that we use the pure NBBO as the reference quote even though this will increase NYSE executions outside the quote. In practice, whether we use the NYSE quote or the NBBO does not make much difference. In our August sample, only 7 percent of system market orders executed when the quote at the relevant side of the market (offer for buy orders, bid for sell orders) was set off-NYSE. [24]

(b) The NBBO at which time?

The time of the reference quote is important because the greater the slippage between reference quote time and execution time the more executions will occur outside the reference quote. Chart 2 shows several possible reference quotes: Q_0, Q_1, Q_2, Q_3, Q_4, Q_5, Q_6 and Q_7. The smaller the time slippage the less likely the order will execute outside the reference quote.[25] To the limit, if we choose the quote at execution time (Q_7) to be the reference quote then by definition there will be no outside-the-quote executions.

Suppose when the investor decides to submit a buy market order the quoted offer is $50 ($Q_0$) and the order eventually executes at $51. From the point of view of the investor, the $1 difference is a trading cost but who is responsible? The investor herself is responsible for the time lag between when she saw the quote and when she attempted to reach her broker (quote slippage Q_0 to Q_1). The broker is responsible for the time it took the investor to reach her (Q_1 to Q_2) and once reached the broker is responsible for the time it takes for her to process and submit the order to the Exchange or some other executing venue (Q_2 to Q_4). The Exchange's responsibility begins from

[24] 93 percent of orders execute when the NYSE sets the relevant quote alone or when the NYSE and other markets set the same best quote. The calculation is based on eligible system market orders (excludes odd lots, market-on-close, etc.); see discussion of order eligibility below.

[25] Also, the less the time slippage the less likely the order will execute inside the quote because of the quote moving ("accidental" price improvement). Ignoring intentional price improvement for a second, the less the time slippage the more likely that the execution price and the reference quote will coincide.

the time the order touches the CMS system and ends when the order executes (Q_4 to Q_7). The NYSE specialist's responsibility begins from the time the order reaches the Display Book (Q_5).

Which reference quote to use, therefore, depends on whom we are evaluating. If we are evaluating the broker we should compare the execution price with the quote (Q_1) when the investor first attempted to reach the broker (so if the broker is hard to reach on the phone, for example, she gets penalized). If we are evaluating the specialist we should compare the execution price with the quote when the order reaches the Display Book (Q_5 or Q_6). We are evaluating the Exchange, however, so we should compare the execution price with the quote when the order first reaches CMS (Q_4). Unfortunately the SODQ file does not include the quote at CMS arrival time (Q_4) so we will be using the next available quote: the quote at Display Book arrival (Q_5).

Table 5 compares best execution statistics using the three available reference quotes: the NBBO at otime, dbtime and rtime. As expected, executions outside the quote increase when we use the earlier quotes. Given the small time difference between otime and dbtime (1.6 seconds) the otime and dbtime statistics are close. For all size orders, executions outside the quote are 6.9 percent using obtime and 6.3 percent using dbtime. Using rtime (the execution time) reduces the executions outside the quote to almost zero (the 0.7 percent executions outside the quote in this case reflect our use of the pure NBBO).

Executions inside the quote actually decrease when we use the earlier quotes: (35.5 percent using the otime quote, 35.8 percent using the dbtime quote and 41.5 percent using the rtime quote). The effective spread is 22.1 bp using the otime quote, 22.0 bp using the dbtime quote and 20.8 bp using the rtime quote. Table 5 highlights the importance of standardizing the choice of reference quote when making inter-market comparisons: if, for example, one market is using the rtime quote while another market uses the otime quote, comparisons will be meaningless. We will be using the quote at Display Book arrival time (otime), Q_5, as our reference quote.

VII. Stock eligibility

We include all NYSE-listed issues (common, preferred, warrants) except 110 "unusual" stocks: 2 stocks priced above $1000; 20 stocks trading in variations of less than 1/16th; and 88 stocks trading in round lots of less than 100 shares. Our August sample consists of 3,665 issues.[26]

VIII. Execution report eligibility

We begin with all NYSE system order execution reports in the 3,665 eligible issues in the 22 daily August SOD and SODQ files. We discard all execution reports associated with non-market orders (marketable limit orders, limit orders, etc.). We now have 7.4 million execution reports associated with market orders (Table 6). We next exclude "special" market orders:

1. Odd lot orders (orders less than a round lot). We exclude odd lot orders because the NYSE handles them differently than regular market orders. The NYSE executes odd lots automatically upon arrival at the prevailing BPQ quote against the specialist inventory.[27] Odd lots, therefore, by design always execute at the quote. We discard the 1.3 million odd-lot execution reports in our sample (1 percent of executed system market order share volume). The NYSE handles partial round lots as follows: consider a 950-share order; the 50 share (PRL) portion goes off when the specialist executes the 900-share round lot part of the order and at the same price. We keep partial round lots in our sample.

2. Opening orders. The NYSE executes opening orders at an opening call; there is no reference quote and so we cannot calculate best execution statistics. Moreover, our definition of best execution does not apply: by submitting an opening order the investor is willing to accept the opening price whatever that may be. We discard the 440 thousand opening order execution reports in our sample (9 percent of executed system market order share volume).

3. Market-on-close (MOC) orders. Again our definition of best execution does not apply. Investors submitting MOC orders are willing to accept the closing price whatever that may be. Moreover, MOC orders arrive throughout the trading day and the reference quote at order arrival may be very different from the execution price, possibly several hours later. We

[26] The NYSE calculates best execution statistics monthly but decides on the list of stocks to be excluded once a year. The 110 stocks excluded from this paper's August sample are based on the information in the NYSE Mast file at the end of February 1999.
[27] Another complication is that the quote used is the BPQ and not the NBBO.

discard the 214 thousand MOC order execution reports in our sample (8 percent of executed system market order volume).

4. Tick sensitive orders (short sales, sell plus and buy minus). Tick sensitive orders are more like limit than market orders: buy minus orders, for example, execute at the bid and sell plus orders execute at the offer. When a buy minus order arrives, for example, it sits at the bid waiting for a minus tick to execute. The order may take some time to execute and the market may move away from the investor, but the investor saves the spread. Because of these special considerations, we exclude tick sensitive orders from our calculations. Our sample contains 505 thousand tick-sensitive order execution reports accounting for 8 percent of executed system market orders volume.
5. Other. This category includes 116 thousand execution reports classified as write-in, combination or crossing session orders. Write-in orders work as follows. A floor broker gets an order, writes it down on paper and walks it over to the specialist. The specialist executes the order. At some later time (usually at the end of the day), the floor broker enters into the system through BBSS (Broker Booth Support System) the information about the order and "writes-in" the approximate execution time. The system fills the order and trade report time fields with the time at which the broker put the information into BBSS, not the actual order or report time. We drop write-in orders because they are not true system orders.[28] Crossing session orders are orders executed in the NYSE's after-hours Crossing Sessions I and II. The "other" category accounts for 13 percent of system market orders volume in our initial sample; we exclude all these orders.

The SODQ file contains the SIAC-calculated NYSE quote and the best off-NYSE quote at different points of time (dbtime, otime). Using this information, we discard 10 thousand execution reports (0.5% of system market volume) for which the NYSE quote at the time of order arrival (otime) was $0 bid and $0 offered. Zero quotes generally indicate that the stock has not yet opened on the NYSE. We construct the NBBO by choosing the lowest of the NYSE and off-

[28] In the SOD file we identify write-ins as follows: the write-in time is not blank and the order was routed to the booth and the broker handled it manually (BOOK=1).

NYSE offer, and the highest of the NYSE and off-NYSE bid. [29] In case of ties, we choose the quote with the biggest depth. [30] Our final sample consists of 4.8 million eligible execution reports.

We divide our sample of eligible execution reports into two categories:

1. Execution reports associated with orders whose size is less than or equal to the reference NBBO size. Suppose the reference NBBO is 10,000 shares bid and 15,000 shares offered. We will then classify in this category all eligible execution reports associated with sell orders of 10,000 shares or less and buy orders of 15,000 shares or less. Of the 4.8 million eligible execution reports in our sample, 4.1 million reports (85 percent), accounting for 68 percent of eligible share volume, are associated with orders of size less than or equal to the reference NBBO size.
2. Execution reports associated with orders whose size is greater than the reference NBBO side. Only 713 thousand reports (15 percent) are associated with orders exceeding the reference NBBO size, but they account for 32 percent of the eligible volume.

IX. The calculations

We classify eligible execution reports into three groups: inside the reference NBBO, at the reference NBBO and outside the reference NBBO. For a buy order execution report, for example, we compare the execution price with the reference NBBO offer price. If the execution price is lower than the reference offer price then we classify the report as "execution inside the reference NBBO," if the execution price is above the reference price we classify it as "execution outside the reference NBBO." For each execution report we also calculate the quoted spread (the reference NBBO), the effective spread, and the time from order exposure (dbtime) to execution (rtime). We then average these figures across all execution reports across all stocks in our sample.

Table 7 shows that best execution statistics are sensitive to the averaging methodology. We essentially calculate report-weighted averages (first panel): (a) each execution report has equal weight irrespective of share size, and (b) if stock A has twice as many execution reports as stock

[29] We already filtered out zero NYSE bids and offers. We compare the NYSE and off-NYSE quote and choose the highest bid, by definition nonzero. We then compare the NYSE and off-NYSE offer choosing the lowest. If the lowest offer is zero we use the NYSE offer. Zero off-NYSE bids and offers usually occur because a stock has not yet opened in other markets. In our sample, the zero bids and offers affected 0.48% of reports.

B, stock A will have twice as much weight in the overall average as stock B. The report-weighted average proportion of executions inside the reference NBBO is 35.5 percent and outside the reference NBBO 6.9 percent.

An alternative methodology is to calculate volume-weighted averages: each execution report is weighted by its share size. Reports with more shares get bigger weight; stocks with more share volume get bigger weight. The volume-weighted average proportion of executions inside the reference NBBO is 28.8 percent and 7.0 percent outside the reference NBBO (Table 7, panel 2). Because larger orders are less likely to execute inside the quote, the volume-weighted average price improvement rate is lower than the report-weighted average.

Another alternative is to first calculate averages per stock and then average across stocks giving each stock equal weight in the overall average. Table 7 shows two examples of this average-of-average approach: (a) calculate report-weighted averages per stock and then average across stocks (panel 3), and (b) calculate volume-weighted averages per stock and then average across stocks (panel 4). In both cases, this approach dramatically reduces the proportion of executions outside the quote down to 1.9 percent. The reason for this is that executions outside the quote occur mostly when multiple orders hit the quote at the same time, which mostly happens in heavily traded stocks. These heavily traded stocks get a much bigger weight in the report-weighted and volume-weighted approaches (panels 1 and 2) than in the average-of-averages approaches (panels 3 and 4). Table 7 also shows that the best execution statistics within each order size bucket are much less sensitive to the averaging methodology.

There is no right or wrong averaging methodology. The differences shown in Table 7, however, suggest large cross-sectional variation in best execution statistics. To make meaningful cross-market comparisons we must be careful about how the averages are calculated. Differences in the stocks included and their relative trading activity across markets, for example, can lead to misleading conclusions when comparing best execution averages.

Because of the sensitivity of best execution statistics to order size, we routinely present statistics for six order-size buckets as in Table 8. We classify execution reports into size buckets according to the size of the originating order. Suppose a 4,000-share buy order executes with one 3,000-

[30] Our sample includes locked and crossed NBBO quotes.

share and one 1,000-share execution report; we classify both reports in the 2,100-4,999 share bucket. Table 8 shows the distribution of reports and volume by order-size bucket.

We are calculating best execution statistics off *execution reports* not orders. Since, however, 97 percent of the orders in our sample execute at a single price, the distinction is irrelevant. Occasionally, however, an order may execute over several execution reports. Suppose the reference NBBO offer is $50. A 4,000-share market buy order executes 3,000 at $50 and 1,000 at $50.10. We evaluate each execution report separately against the $50 reference NBBO offer: 3,000 shares execute at the quote and 1,000 shares execute outside the quote.[31] An alternative approach is to construct an average execution price for the whole order and then classify the whole order according to this price.[32] In our example, the volume-weighted average execution price is $50.025 and we would classify the order as executing outside the quote.

A complication arises in the case of orders arriving at the specialist Display Book in quick succession. Suppose a 5,000-share buy order and a split second later a 3,000-share buy order arrive at the specialist Display Book. The reference NBBO offer when the two orders show up on the screen is 5,000 shares at $50. The specialist executes the first order at $50 exhausting the quote and the second order "walks up the book" executing at $50.05. We classify the second order as executing outside the quote. The reason the second order appears to execute outside the quote is "quote exhaustion:" when the first order showed up on the screen it effectively lifted the reference quote. Multiple orders hitting the quote at the same time is the main reason we observe executions outside the quote at the NYSE.

X. Best execution statistics for eligible market orders that do not exceed reference NBBO size

We report quoted and effective spreads as a percent of price. To help interpret these percentages, Table 9 shows the average prices in our sample. The report-weighted average stock price in our sample is $50. The average price drops with order size from $55 on 100-share orders to $39 on block-size orders. Executions outside the quote tend to occur on average in higher priced stocks: the average price on executions outside the quote is $66 compared to $45 on executions at the quote.

[31] Similarly we calculate the effective spread and time-to-execution per execution report.
[32] Bacidore, Battalio and Jennings (1999) use this alternative approach.

Table 10 summarizes the best execution statistics for the 4.1 million market orders in our sample that do not exceed the reference NBBO size. Overall, 35.5 percent of these orders execute within, 57.6 percent at and 6.9 percent outside the reference NBBO price. The average quoted spread is 36 bp and the average effective spread is 22 bp. The average discount therefore is 14 bp: on an average-priced $50 stock investors save 7 cents per round-trip share relative to the NBBO price.

(a) Order size effect

Table 10 also shows that price improvement decreases with order size. Inside the quote executions are 40.4 percent for 100-share orders and the percentage drops monotonically to 25.6 percent for block-size orders. The percentage of executions outside the quote remains roughly constant irrespective of order size. Both the quoted and the effective spread also rise with order size: the quoted spread increases from 32 bp for 100-share orders to 62 bp for block orders; the effective increases from 18 bp to 54 bp. The discount actually drops from 14 bp for 100-share orders to 8 bp for block orders.

Part of the increase in the percent quoted and effective spreads reflects the fall in average stock price with order size (Table 9): the average price of 100-share orders is $55 compared with $39 for block orders. As order size increases, therefore, the percent minimum tick size also increases raising the quoted and effective spreads.

The sensitivity of best execution statistics to order size indicates the importance of standardizing by order size when doing inter-market comparisons.

(b) Spread effect

Panels 2 and 3 in Table 10 show that the rate of price improvement also increases with the size of the quoted spread. Panel 2 focuses on the 1.6 million executions in minimum variation markets. In minimum variation markets there is less room for executing inside the quote: price improvement can occur only when a buy order executes at the bid or a sell order at the ask.[33] Even in minimum variation markets 10 percent of order executions receive price improvement.

[33] Also NYSE Rule 116.30 imposes restrictions on the ability of the specialist to "stop" stock in minimum variation markets.

The percent quoted spread increases from 21 bp for 100-share orders to 70 bp for block orders. Since by construction the spread is 1/16th for this subset of orders, the increase in the percent quoted spread reflects the price effect: the average price drops from $48 on 100-share orders to $32 on block orders.

For spreads greater than 1/16th (Panel 3), 52 percent of market orders execute inside the spread and 7.6 percent outside the spread. Reflecting the larger quoted spread the average discount is now 20.7 bp: on an average-priced $50 stock investors save 10 cents per round-trip share relative to the NBBO.

(c) Guaranteed orders

Specialists occasionally "stop" system market orders, guarantee the current quoted price and try to execute the order at a better price. "Guaranteed" orders may take longer to execute, but receive on average higher price improvement rates.[34] Guaranteed orders amount to 2.6 percent of the eligible system market orders (2.2 percent of eligible volume).[35] In calculating best execution statistics we handle guaranteed orders the same way as non-guaranteed orders: we identify the prevailing NBBO when the order arrives at the specialist Display Book (otime) and compare the execution price (not the guaranteed price) with this reference NBBO.

Table 11 shows that 61.6 percent of guaranteed orders execute inside the quote compared to 34.8 percent of non-guaranteed orders. For guaranteed orders, price improvement increases with order size from 60.6 percent on 100-share orders to 69.5 percent on block orders; price improvement on non-guaranteed orders actually declines with order size. Only 3 percent of guaranteed orders

[34] When a specialist stops an order, CMS sends an "administrative" message to the originating broker informing her the order has been stopped and the guarantee price so an argument can be made that this is the relevant execution time. The exact text of the message is either UR GUAR <price> or UR STPD <price> (e.g. UR STPD 50 or UR GUAR 50) According to the CMS manual the message "notifies the order originator that a specific Execution price (maybe better but not worse) is being guaranteed."

[35] Over the past few years, the percentage of orders guaranteed declined sharply. In the first quarter of 1996, 20 percent of eligible system market orders were guaranteed. In May 1997, the month before the switch to teenies, this percentage was down to 15 percent. The month after teenies, July 1997, the percentage guaranteed dipped to 10 percent. See also Ready (1999) and Ross, Shapiro and Smith (1996). Although the percent of guaranteed orders was declining prior to teenies and fell drastically after teenies, the price improvement rate on guaranteed orders remained at 56 percent with remarkable regularity. For non-guaranteed orders, on the other hand, prior to teenies, the price improvement rate was around 18 percent, following teenies, the rate increased to 30 percent.

execute outside the reference NBBO. Since the quote is guaranteed, this percentage mostly reflects a slippage in the quote between order arrival and guarantee time.

Table 11 also shows that the effective spread is only 8.6 bp for guaranteed orders compared with 22.5 bp for non-guaranteed orders. The average discount on guaranteed orders is 33.7 bp: on a $50 stock investors save 17 cents per round-trip share relative to the NBBO. The probability of getting this discount, however, is only 2.6 percent.

(d) By stock trading activity

Another important factor influencing best execution statistics is how actively a stock is traded. For very active stocks, multiple orders hit the quote at the same time relatively frequently, increasing the likelihood of executions outside the reference NBBO. Table 12 shows that this is indeed the case. The percent of executions outside the quote is 10 percent for the 100 most active stocks in our sample but only 0.6 percent for the 1000 least active stocks. Because we report trade-weighted averages, the more active stocks get a greater weight, increasing the average of executions outside the quote in the full sample.

Table 12 also shows that spreads are dramatically different between active and inactive stocks. The average quoted spread is 20.2 bp on the top 100 stocks and 118.9 bp on the 1000 least active; the corresponding effective spreads are 12.1 and 75.2 bp. On an inactive stock, the average discount relative to the reference NBBO is 22 cents on a $50 stock; on an active stock the average discount is 4 cents.

(e) Reasons for execution outside the quote

Table 12 suggests an important reason for executions outside the reference NBBO is multiple orders hitting the quote at the same time. In this section we report the results of a detailed analysis of the 11,982 execution reports outside the reference NBBO, on February 11, 1999. Table 13 summarizes the various causes we identified and presents estimates of their relative frequency.

1. Multiple orders hitting the quote at the same time

Market orders arrive almost simultaneously and the reference NBBO is exhausted before all are executed. To quantify the importance of this reason, we calculated the time between the arrival of orders executing outside the NBBO.[36] We find that 43 percent of execution reports outside the NBBO occurred within 2 seconds of the previous order, 62 percent within 5 seconds, 76 percent within 10 seconds and 87 within 20 seconds. Most executions outside the reference NBBO, therefore, occur in fast markets.

2. The reference NBBO is set off NYSE.

In general, 94 percent of NYSE system market order execution reports occur when the NYSE quote makes the NBBO on the relevant side of the market. For executions outside the quote, the NYSE was at the relevant side of the market only 70 percent of the time (bottom panel in Table 13). This suggests that part of the executions outside the NBBO reflect the working of ITS. We identified four ways in which ITS results in executions outside the quote.

i. Order arrives when off-NYSE quote is for 100 shares and is, therefore, not eligible for ITS trade-through complaints. Eight percent of executions outside the reference NBBO occurred when the best quote was 100 shares off-NYSE.

ii. Order arrives when Nasdaq sets the reference NBBO on a Rule 390 stock; the NBBO is not ITS-reachable. Three percent of executions outside the NBBO occurred when the Nasdaq was posting the best price on the relevant side of the quote (i.e., posting the best offer when a buy order arrived or best bid when a sell arrived), but the stock was a Rule 390 stock.

iii. Order arrives, the NYSE specialist sends an ITS commitment, receives a partial fill and executes the remainder of the order at an inferior price. For our sample period, the ITS file contains 815 ITS commitments originating from the NYSE that were not filled entirely by the receiving market. Assuming all these commitments were filled at the NYSE outside the NBBO gives us an upper bound estimate of 7 percent of executions outside the quote due to this reason. To get a more precise estimate, we tried to match commitments to executed orders. Of the 815 returned commitments, only 202 (2 percent of executions outside the NBBO) had matching order records. If we add the constraint that the response occurred prior to execution on the NYSE, this number falls to 91 ITS commitments with matching

[36] We did not control for the possibility that the previous order could be on the other side of the market.

order records (0.76%). This indicates that between 1% and 2% of unfavorable executions could be associated with unfilled ITS commitments.

iv. Order arrives at the NYSE and executes at the NYSE even though the data show an ITS-eligible better quote off-NYSE (apparent "trade-through" order). Our sample contains in total 3,500 executions outside the reference NBBO when the NBBO on the relevant side of the market was made off-NYSE. Of these, 935 occurred while the size equaled 100 shares (accounted in (i) above), 340 occurred in Rule 390 stocks when Nasdaq had the best quote (accounted in (ii) above), and 202 were associated with partially filled ITS commitments (accounted in (iii) above). This leaves 2,142 unexplained executions, 18 percent of the executions outside the quote. These unexplained executions may be the results of: (a) data misalignment, (b) the off-NYSE NBBO was exhausted or updated between the time the order arrived at the NYSE and the time the specialist reacted, and (c) unchallenged "trade-through" orders.

3. Floor orders share the quote

The arrival of a system market order may trigger a percentage order; the market order and the percentage order split the available depth.[37] If the market order is not completely filled, the remaining shares may execute outside the reference NBBO. Suppose, for example, the quote is 10,000 shares offered at $50 and the specialist is holding a 6,000-share percentage market order to buy. A 6,000-share system buy order arrives. The specialist splits the 10,000 shares at the quote between the two orders. The market order receives 5,000 shares at $50 and the remaining 1,000 shares execute outside the reference NBBO. We do not have the data to estimate how often if ever this scenario occurs.

XI. Best execution statistics for eligible market orders that exceed reference NBBO size

So far we have been examining eligible orders whose size is less than or equal to the size of the reference NBBO. In this section we focus on the 713 thousand execution reports (15 percent of eligible orders, 32 percent of eligible volume) in our sample that are associated with orders exceeding the quoted size. Table 14 provides some preliminary statistics.[38] The Table shows that

[37] For a discussion of percentage orders see Sofianos and Werner (1998).

[38] The table is preliminary for two reasons. First, orders exceeding the reference NBBO size tend to have more multiple execution reports (see below) than orders not exceeding the reference NBBO size; this leads to greater slippage because we are classifying reports and not orders. Second, we are not using the BBJ

13.3 percent of eligible orders exceeding the reference NBBO size execute inside the quoted price: these orders therefore receive both depth improvement and price improvement. The rate of price-and-depth improvement decreases with order size: from 16.2 percent for orders less than 500 shares to 9.1 percent for block-size orders.

Another 48.3 percent of orders exceeding the quoted size execute at the quote; these orders receive depth improvement but no price improvement. The remaining 38.4 percent of orders exceeding the quoted size execute partially or wholly outside the reference NBBO. An investor, therefore, sending an order to the NYSE that exceeds the quoted size, stands a good chance (61.6 percent) of executing the order at or inside the quote.

The quoted spread on orders exceeding the quoted size is 35.3 bp (identical to the quoted spread on orders that do not exceed the quoted size). The average effective spread, however, is 55.4 bp: on an average-priced $50 stock investors pay a premium of 10 cents per round-trip share to execute an order that exceeds the quoted size.

Table 14 also summarizes the best execution statistics in minimum variation markets and when the spread is greater than $1/16^{th}$.

XII. Single price executions

Market orders occasionally execute over multiple execution reports either because the order exceeds the quoted depth or because quoted depth decreases between order arrival and execution. Multiple execution reports can be all at the same price or at multiple prices. Multiple reports at multiple prices, in particular, can be a nuisance to brokers and investors.

The first panel in Table 15a classifies eligible market orders into (a) single report executions, (b) multiple report, single price executions, and (c) multiple report, multiple price executions. For multiple report executions, the table also shows where the order executes relative to the reference NBBO.

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methodology to classify (see Section II); instead we are classifying orders and measuring effective spreads relative to the reference NBBO.

Overall, the ratio of execution reports to orders is 1.06, with 97 percent of eligible orders receiving single price executions and 95 percent receiving single report executions. Of the 3 percent of orders in our sample that receive multiple report multiple price executions, one quarter execute at or within the NBBO. Only 2 percent of eligible orders execute with multiple reports at least partially outside the NBBO ("walking up the book").

The second and third panels in Table 15a split eligible orders into (a) order size less than or equal to the reference NBBO size, and (b) order size greater than the reference NBBO size. When order size does not exceed the quoted size (second panel) the ratio of multiple reports to orders is only 1.03, with 99 percent of orders receiving single price executions (over single or multiple prints). When order size exceeds quoted size (third panel) the ratio of multiple reports to orders increases to 1.27, with 82 percent of orders now receiving single price executions.

Table 15a also quantifies the sensitivity of the percentage of single price executions to order size in general. When order size does not exceed the reference NBBO size, the ratio of execution reports per order increases monotonically from 1.01 for 101-499 share orders to 1.26 for block-size orders. When order size exceed the reference NBBO size, the ratio of execution reports per order increases from 1.05 for 101-499 share orders to 1.81 for block-size orders.

Table 15b repeats the analysis in terms of system volume. Because multiple execution reports tend to occur on larger orders, the percent of volume receiving single price executions (88 percent) is lower than the percent of orders (97 percent).

XIII. Time from order exposure to execution

In Table 1 we showed that the electronic transit times (CMS to Display Book Screen and execution to CMS) of system market orders do not change with order size. The time interval beginning when an order shows up on the Display Book screen (dbtime) and ending when the order executes (rtime), however, varies significantly by order size (interval s_7 in Chart 2, column 3 in Table 1). This exposure-to-execution interval reflects the interaction of the floor (specialist, floor brokers) with the electronic order flow. In this section, we examine the exposure-to-execution time interval in greater detail.

We first focus on order sizes not exceeding the reference NBBO size (Tables 16). Including guaranteed orders, the average time from exposure to execution is 22.5 seconds.[39] Even though guaranteed orders are only 2.6 percent of eligible orders, they take considerably longer to execute raising the overall average time to execution: the average time from exposure to execution is 16.5 seconds for non-guaranteed orders and more than 4 minutes (251.1 seconds) for guaranteed orders.

For non-guaranteed orders, the time from exposure to execution ranges from 15.3 seconds for 100-share orders to 27.4 seconds for block-size orders. The time from exposure to execution also varies depending on where the order executes relative to the reference NBBO. On 100-share orders, for example, non-guaranteed executions inside the quote average 17.2 seconds, executions at the quote 12.6 seconds and executions outside the quote 24.4 seconds. We observe similar patterns for all order sizes. Even ignoring guaranteed orders, therefore, price improved orders take longer to execute.[40] The trade-off is slower execution, better price. The slower execution times on price-improved orders reflect the interaction of the trading crowd with the electronic order flow.

The third panel in Table 16 shows the exposure-to-execution times for the 2.6 percent of execution orders in our sample that are guaranteed. In Table 11 we showed that the price improvement rate on guaranteed orders is 62 percent, almost double the rate on non-guaranteed orders (35 percent). On a $50 stock, investors on average save 17 cents per round-trip share (relative to the NBBO) on guaranteed orders and 7 cents per round-trip share on non-guaranteed orders. Table 16 quantifies the time trade-off: investors have to wait on average 251.1 seconds to save 17 cents per round-trip share compared with 16.5 seconds to save 7 cents. In deciding if this trade-off is worthwhile, the investors should bear in mind that there is no price risk when an order is guaranteed.

Table 17 presents the exposure-to-execution times for order sizes exceeding the NBBO size. Intuitively these orders are more difficult and should take longer to execute. Table 17 shows that this is indeed the case. Non-guaranteed orders exceeding the NBBO size take on average 22.5

[39] For guaranteed orders we measure time the same way as for non-guaranteed orders: from when the order shows up on the screen to execution. An alternative way of measuring time for guaranteed orders is from when the order shows up on the screen to when the specialist stops the order and guarantees a price.
[40] Execution of price-improved orders takes even longer in minimum variation markets: 100-share order executions inside the quote average 27.1 seconds while executions at the quote average 11.3 seconds.

seconds to execute compared with 16.5 seconds for non-guaranteed orders not exceeding the NBBO size. The average exposure-to-execution time on non-guaranteed orders exceeding the NBBO size ranges from 17.9 seconds on 100-499 share orders to 31.6 seconds on block-size orders.

XIV. Discussion and qualifications

Best execution statistics are extremely sensitive to the way they are calculated. Best execution measures vary depending on:

1. The averaging method. Effective spreads on the same order flow, for example, can range from 22.1 bp to 79.5 bp depending on how the spreads on individual orders are averaged across all orders and stocks (Table 7). Similarly, the frequency of execution reports outside the reference NBBO can vary from 1.9 to 7.0 percent. Comparisons across markets are meaningless unless the same averaging methodology is used. We use report-weighted averages.
2. Definition of reference quote. There are several possible choices of quotes to use: the NYSE quote, the pure NBBO, the ITS-eligible NBBO. Thirty percent of NYSE executions outside the quote occur when the NYSE does not set the NBBO (Table 13). Using the NYSE quote as the reference quote, therefore, would reduce the frequency of NYSE executions outside the quote. Similarly, using the ITS-eligible NBBO would also reduce executions outside the quote. Again, there is a need for standardization across markets. We use the pure NBBO.
3. Time of reference quote. Executions outside the quote range from 6.9 percent when we evaluate executions using the prevailing quote when an order arrives at the Display Book to 0.7 percent when we use the prevailing quote when the order executes (Table 5). We argue that the conceptually correct quote time to use, is when a market center takes "responsibility" for an order. More important, however, is again the need to standardize across market centers. We use the quote prevailing when an order arrives at the Display Book.
4. Market orders included in calculation. For conceptual reasons, we use a narrow definition of market orders. We do not, for example, know how to evaluate best execution for market-on-close orders. We, therefore, exclude them and other special orders. For valid comparisons across markets, best execution statistics must be calculated using the same definition of "eligible" orders. In this paper we provide a detailed description of how the NYSE defines eligibility.

5. Stocks included in calculation. The average effective spread on the 100 most active stocks in our sample is 12.1 bp; the average effective spread on the 1000 least active stocks was 75.2 bp. For valid cross-market comparisons, the same sample of stocks must be used. We include all but 110 "unusual" stocks.
6. Spreads. Overall, 35.5 percent of executions occur within the quote. In minimum variation markets included in our calculations, only 10.1 percent of executions occur within the quote (at the other side of the quote). If we exclude minimum variation markets, executions inside the quote increase to 52.1 percent. When making cross-market comparisons, therefore, care is needed to make sure we are comparing apples-to-apples.
7. Time period. As our comparison of active and inactive stocks suggests, executions outside the quote increase with trading activity. Trading activity varies across stocks but also over time. In making cross-market comparisons we need to compare the same time periods.
8. As percent of price. Stock prices in our sample range from $1 to $1000. To compare a 6-cent spread on a $1 stock with a $10 spread on a $1000 stock we must standardize by stock price. We report quoted and effective spreads, and the discount/premium as a percent of the mid-quote.
9. Comparisons by order size. The effective spread is 17.7 bp on 100-share orders and 53.5 bp on block-size orders (Table 10). 40.4 percent of 100-share orders receive executions inside the quote compared with 25.6 percent for block-size orders. For valid cross-market comparisons, therefore, we must "control" for order size. The easiest way of controlling for order size is to report best execution statistics in narrow order size buckets, as we do in this paper.
10. Order size greater than the reference NBBO. How should we measure best execution when an investor knowingly sends an order exceeding the quoted depth? Presumably, the investor is aware that the order will most probably execute at least partially outside the quote and is willing to pay the premium relative to the NBBO. In our sample, the average effective spread on block-size orders less than the reference NBBO size is 53.5 bp; investors save 8.5 bp per round-trip share relative to the NBBO (Table 10). The effective spread on block-size orders greater than the reference NBBO size is 78.5 bp; investors pay a premium of 39.8 bp per round-trip share relative to the NBBO (Table 14). At a minimum, we need to separate these two conceptually different types of orders and this is what we do in this paper. For orders exceeding the quoted size, the possibility of depth improvement becomes an important best execution attribute. Moreover, the distinction between orders exceeding the NBBO size and orders that do not needs to carry over in cross-market comparisons.

The case of orders exceeding quoted size highlights a fundamental problem with the measurement of best execution: what are the investor expectations and intentions? Since it is impossible to benchmark best execution measures on the unobservable investor expectations and intentions, we make guesses and assumptions. Consider the simplest case first. When an investor sends a market order to buy 500 shares of XYZ quoted at 10,000 shares offered at $50.20, we assume that the investor expects (a) certain execution, and (b) an execution price of $50.20 or less. But suppose Market A offers $50.20 executions within 5 seconds and Market B offers a 40 percent probability of executing at $50.10 and a 60 percent probability of executing at $50.20 within 20 seconds. Where should the broker direct the order and fulfill her best execution obligations? Perhaps the easiest way for brokers to solve this problem is to pass on the choice to the investor.

But now suppose the investor sends a 15,000-share buy order even though the quote is for 10,000 shares. What does she expect? Where should the broker direct the order? Presumably to the market that has the biggest liquidity *behind* the posted NBBO: the market that provides the biggest chance of depth improvement and has the least "steep" limit order book effective slope.

The concept of depth improvement will become extremely important if the imminent switch to decimals in July 2000 leads to trading in pennies. For active stocks, trading in pennies will result in a dramatic reduction to the quoted size, possibly to as little as 100 shares. If that happens, for most orders, the posted depth will become irrelevant: what will matter is the liquidity behind the best bid and offer. Market centers will have to disseminate size information beyond the best bid and offer, probably disseminate the whole book. We will then have to adjust our best execution measures in the direction Bacidore *et al* (1999) propose: benchmark executions relative to the whole book and not just the inside quote.

The switch to pennies will also increase the likelihood of multiple orders hitting the quote at the same time, the primary reason for executions outside the quote at the NYSE. Unless the NYSE changes the way it updates its quotes, a reduction in the minimum tick size will lead to an increase in executions outside the quote.

We calculate best execution statistics for eligible system market orders accounting for only 11 percent of executed volume on the NYSE. Next on the research agenda is to develop best

execution statistics for other types of NYSE orders: limit orders, special market orders, floor orders.

System marketable limit orders account for 15 percent of NYSE executed share volume. A marketable limit order is a buy (sell) limit order with limit price at or above (below) the reference offer (bid). Specialists handle marketable limits like market orders: buy marketable limit orders, for example, execute at the offer (even if priced above the offer) in time priority.[41] The presence of a designated limit price makes the reference NBBO an irrelevant benchmark and eliminates the possibility of executing outside the NYSE quote.[42] Marketable limits, however, may not execute: consider a marketable limit to buy at $50.20; if the offer moves up to $50.25 before the marketable limit executes, the marketable limit will then be "booked" as a regular limit order making the bid at $50.20. So a best execution attribute of marketable limit orders is the fill rate. An interesting feature of marketable limit orders is that not all of them are intentional. Suppose the offer is $50.25 and the investor submits a buy limit at $50.20 but by the time the order arrives at the Display Book the offer drops to $50.20. The order is now a marketable limit order even though this was not the intention of the investor. Marketable limit orders, therefore, are more likely to occur by accident in active periods and fast moving markets when overall quality of execution declines. This observation is a possible explanation of why the percentage of executions inside the quote is lower for marketable limits than market orders (Lightfoot *et al* (1999).

Battalio et al (1997c) present a first attempt to do inter-market comparisons in limit-order execution quality. Executed non-marketable limit orders account for 25 percent of NYSE executed volume. The fill rate is perhaps the most important attribute of limit order execution. Making cross-market comparisons of fill rates is difficult for at least two reasons. First, ideally what we want to measure is the *marginal* fill rate (given the queue what is the probability of an additional limit order getting filled) but we only easily observe the *average* fill rate (what proportion of limit orders get executed). Second, the fill rate depends on the distance between the limit price and the inside quote. The smaller the distance the higher the fill rate. Cross-market comparisons need to control for the distance between the limit price and the quote. Conditional on limit order execution, time to execution becomes an important attribute. At the NYSE, 70.2

[41] The specialist can distinguish whether an order is a market order or a marketable limit order: a marketable limit order is essentially a limit order on the "wrong" side of the inside quote. The specialist may also "stop" marketable limits like market orders.
[42] The reference NBBO determines, however, whether a limit order is marketable or not.

percent of limit orders execute within 2 minutes, 80.7 percent within 5 minutes and 87.4 percent within 10 minutes.[43]

Several "special" market orders are used extensively by investors. Market-on-close orders, for example, are often used by institutions to capture the closing price and by index arbitragers on index contract expirations. How should we evaluate the execution of MOC orders? They are by design neither time-sensitive, nor price-sensitive. What should the metric be? There is no relevant reference quote when the order is submitted. One possibility is the quality of the closing price.[44] As markets are increasingly offering different trading hours (since October 29, for example, the Chicago Exchange continues trading until 18:30), the quality of the closing price may vary across markets. Similar considerations apply for opening orders.

Floor orders account for 42 percent of NYSE executed volume. Most of these orders are large institutional orders. Institutional investors are typically "patient" traders willing to spread large order executions over time to minimize market impact. For these large orders, the effective spread is a small component of the cost of trading. Institutions are more concerned with pre-trade leakage of information and market impact on execution. Little research has been done to evaluate the quality of floor order executions.[45] The main problem is the lack of data. Floor brokers, for example, will typically break up a large order into smaller orders so that even using the NYSE audit trail data that identifies floor orders we cannot easily reconstruct the original order.[46]

In the U.S. equity markets, order flow is fragmented across several market venues. The measures we develop in this paper are designed to help brokers send orders to the market venue most likely to provide best execution. Best execution cross-market comparisons essentially measure which market provides the best execution price *relative to the prevailing quote*: we take the prevailing quote, the price discovery process, as given. At some point, however, too much order flow fragmentation may harm the price discovery process increasing trading costs at all market venues. Care is needed, therefore, in balancing the benefits of competition across market venues with the costs of order flow fragmentation.

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[43] Non-opening, non-cancelled system limit orders, August 1999 (marketable and non-marketable).
[44] See for example Cushing and Madhavan (1999).
[45] An exception is Handa *et al* (1998); also see the discussion in Sofianos and Werner (1998).
[46] The situation is even more complicated: institutions may actually break up an order before they give to the floor broker. The use of data collected directly from the trading desks of institutions (e.g. by the Plexus Group) is one way around this problem; these data, however, typically do not specify the executing venue.

See Jones and Lipson (1999) for an example of the use of Plexus data in evaluating institutional trading costs.

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Chart 1a. Order flow composition / percent of orders[1]

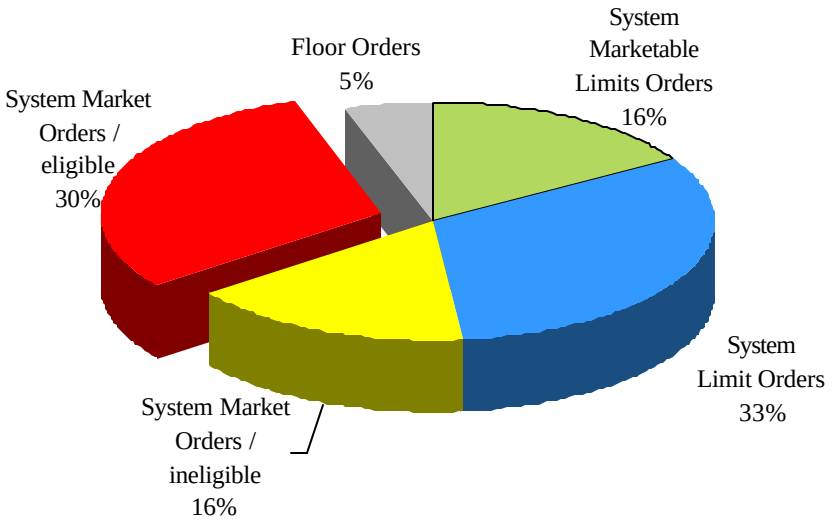
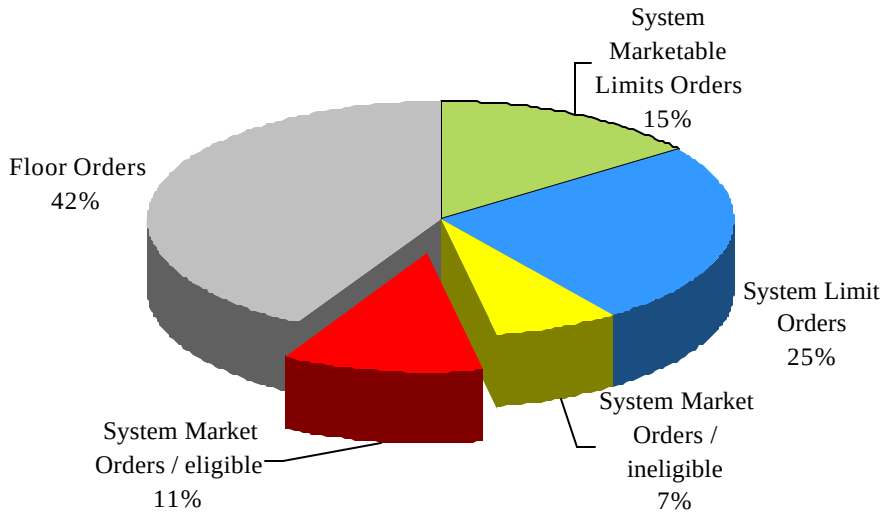
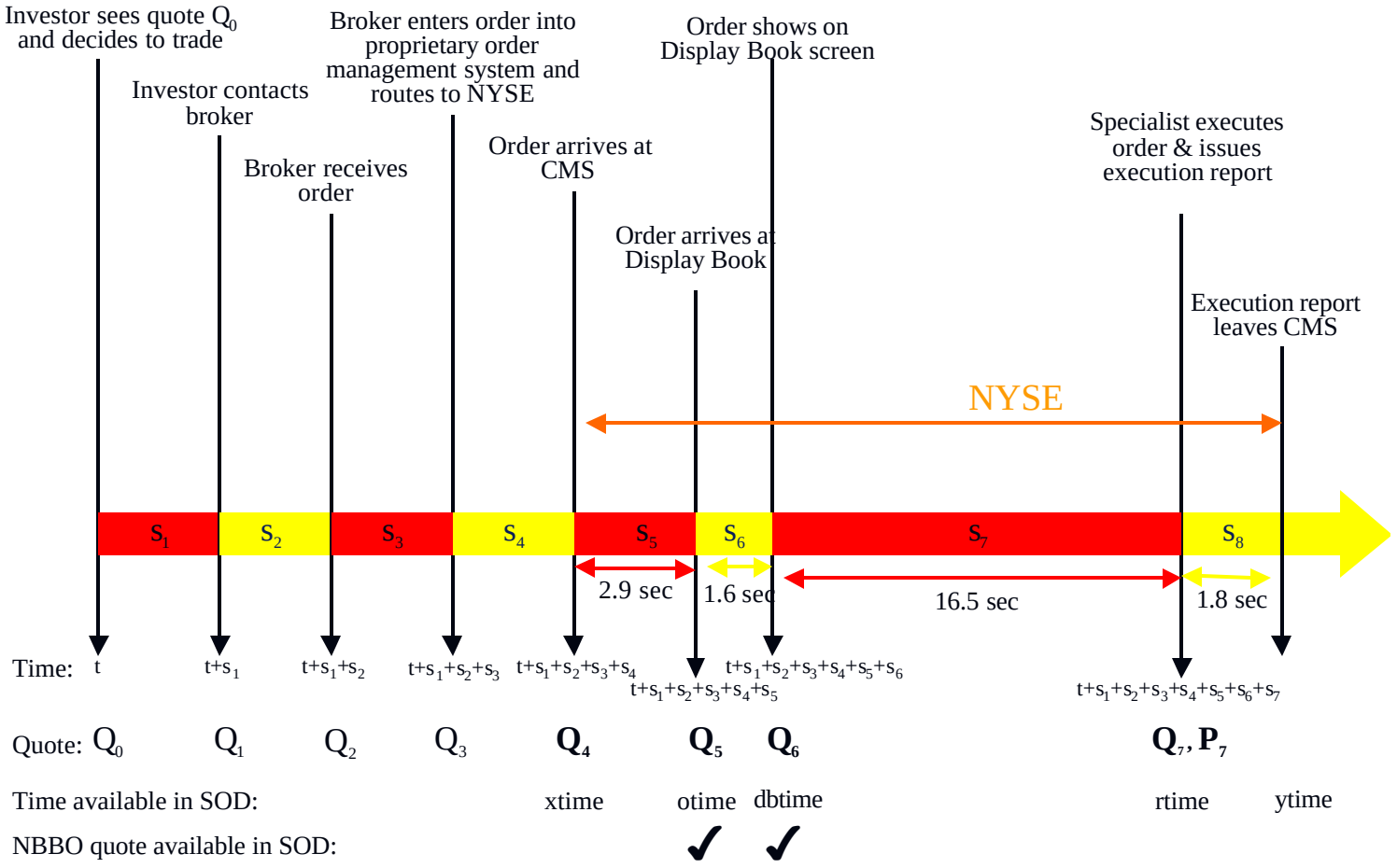


Chart 1b. Order flow composition / percent of volume[1]



1. Estimates for August, 1999; all NYSE issues, all execution reports.

Chart 2. Travel path of a system market order



Transit times are for August 1999, non-guaranteed eligible system market orders not exceeding the quoted order size.

Table 1
Transit Times
Non-guaranteed System Market Orders [1,2]
August, 1999

Order size (shares)	1	2	3	4	1+2+3+4	1+2+4
	S_5	S_6	S_7	S_8		
	CMS to Display Book	Display Book to screen	Display Book screen to execution	Execution to CMS	CMS-to-CMS	Electronic transit
All orders						
100	2.9	1.8	15.3	1.7	21.8	6.5
101-499	2.9	1.3	15.8	1.7	21.7	5.8
500-2099	2.9	1.9	18.3	2.1	25.2	6.9
2100-4999	2.9	1.6	22.7	2.0	29.2	6.5
5000-9999	2.9	2.0	27.1	2.0	34.0	7.0
10000 plus	2.9	2.4	30.3	2.0	37.8	7.4
All sizes	2.9	1.6	17.4	1.9	23.8	6.4
Order size less than or equal to reference NBBO size						
100	2.9	1.8	15.3	1.7	21.8	6.5
101-499	2.9	1.2	15.7	1.7	21.5	5.8
500-2099	2.9	1.9	17.4	2.0	24.2	6.8
2100-4999	2.9	1.7	20.9	1.9	27.5	6.6
5000-9999	2.9	2.2	23.3	2.6	31.1	7.7
10000 plus	2.9	2.4	27.4	1.6	34.4	6.9
All sizes	2.9	1.6	16.5	1.8	22.8	6.3
Order size greater than reference NBBO size						
100	-	-	-	-	-	-
101-499	2.9	1.9	17.9	1.8	24.4	6.6
500-2099	2.9	1.8	21.4	2.5	28.6	7.2
2100-4999	2.9	1.5	24.4	2.1	30.9	6.5
5000-9999	2.9	2.0	29.3	1.6	35.8	6.5
10000 plus	2.9	2.5	31.6	2.2	39.3	7.6
All sizes	2.9	1.8	22.5	2.2	29.5	6.9

1. Except odd lot orders, orders for which no valid NYSE reference quote was available, opening, MOC, tick-sensitive, combination and crossing session orders.
2. All NYSE issues, except (a) stocks priced above $1,000, (b) stocks trading in variations less than $1/16^{th}$ and (c) stocks trading in round lots less than 100 shares.

Table 2
SOD Daily File
Selected Fields

INDTOT	IND	XTIME	OTIME	DBTIME	OSHRS	OTYPE	OSIDE	RTIME	RSHRS	RSHRSB	EXECPR	YTIME
3	1	142209	142210	142211	7500	M	BUY	142325	7500	4300	$30	142326
3	2	142209	142210	142211	7500	M	BUY	142326	7500	800	$30	142327
3	3	142209	142210	142211	7500	M	BUY	142343	7500	2400	$30 1/16	142344

INDTOT: total number of records within order
IND: record counter for each record within order
XTIME: system receipt time (for CMS-entered orders, CMS time stamp).
OTIME: order arrives at Display Book
DBTIME: order shows up on the Display screen
OSHRS: number of share in order
OTYPE: order type (M,GM=market, etc.)
OSIDE: order side (buy, buy minus, sell, sell plus, sell short, etc.)
RTIME: order execution time (in part or in whole)
RSHSRS: cumulative number of shares executed
RSHSRSB: number of reported shares for each report in a given order (includes the odd-lot portion of partial round-lots).
EXECPR: the price at which the order executed
YTIME: time at which report is sent to member firm (CMS time stamp)

Table 3
SODQ Daily File
Selected Fields

	Prevailing NYSE Quotes				Prevailing Best Off-NYSE Quotes			
	Bid		Offer		Bid		Offer	
	Price ($)	Size (shrs)	Price ($)	Size (shrs)	Price ($)	Size (shrs)	Price ($)	Size (shrs)
At CMS arrival time (xtime)	NA	NA	NA	NA	NA	NA	NA	NA
At Display Book arrival time (otime)	30	5000	30 2/16	7000	30 1/16	500	30 3/16	100
At Screen arrival time (dbtime)	30	5000	30 2/16	7000	30	400	30 3/16	100
At execution time (rtime)	30 1/16	4000	30 2/16	7000	NA	NA	NA	NA

Table 4
Quotes Excluded from Calculation

NYSE Quote	Pure NBBO	ITS-eligible NBBO	BPQ
Best quoted bit and best quoted offer on the NYSE	The National Best Bid and Offer: the best quoted bit and best quoted offer across ITS participating markets	Best quoted bit and best quoted offer across ITS participating markets excluding 100-share quotes	The Best Price Quote. The NYSE uses the BPQ for the execution of odd lots.
Standard exclusions			
Late quotes[1]	Late quotes[1]	Late quotes[1]	Late quotes[1]
Regulatory halts[2]	Regulatory halts[2]	Regulatory halts[2]	Regulatory halts[2]
Non-regulatory halts[3]	Non-regulatory halts[3]	Non-regulatory halts[3]	Non-regulatory halts[3]
Re-opening quotes[4]	Re-opening quotes[4]	Re-opening quotes[4]	Re-opening quotes[4]
Other exclusions			
		100-share quotes[5]	100-share quotes[5]
		OTC quotes in Rule 390 stocks	
			Quotes for which bid or ask depth is zero
			Quotes ¼ point away from NYSE quote
			Quotes ¼ point away from primary market quote
			Quotes occurring while the NYSE MDS system is closed

1. After-hours
2. In CQ quote file and TAQ quote mode=4,9,11,19,20
3. In CQ quote file and TAQ quote mode=7,13,14,15
4. In CQ quote file and TAQ quote mode=17,18
5. **Non-ITS eligible**

Table 5
Reference Quote at Different Times[1,2]
Effect on Best Execution Statistics
(order size less than or equal to reference quote[3] size)

	% inside reference quote				% at reference quote				% outside reference quote				% effective spread (percent basis points)			
	xtime	otime	dbtime	rtime[4]	xtime	otime	dbtime	rtime[4]	xtime	otime	dbtime	rtime[4]	xtime	otime	dbtime	rtime[4]
100	NA	40.4	40.6	46.6	NA	51.9	52.3	52.7	NA	7.7	7.1	0.7	NA	17.7	17.5	16.1
101-499	NA	37.3	37.5	42.5	NA	57.1	57.3	56.8	NA	5.6	5.2	0.7	NA	20.3	20.2	19.4
500-2099	NA	31.6	32.0	38.7	NA	60.1	60.5	60.4	NA	8.3	7.5	0.9	NA	25.4	25.2	23.6
2100-4999	NA	26.9	27.2	34.9	NA	65.9	66.4	64.6	NA	7.2	6.4	0.5	NA	30.3	30.1	27.9
5000-9999	NA	26.8	27.1	36.9	NA	65.6	66.3	62.7	NA	7.6	6.6	0.4	NA	35.4	35.3	32.4
10000 plus	NA	25.6	25.5	37.5	NA	67.0	68.1	62.3	NA	7.4	6.4	0.3	NA	53.5	53.7	45.9
All sizes	**NA**	**35.5**	**35.8**	**41.5**	**NA**	**57.6**	**57.9**	**57.7**	**NA**	**6.9**	**6.3**	**0.7**	**NA**	**22.1**	**22.0**	**20.8**

1. August 1999, SuperDot market orders, except odd lot orders, orders for which no valid NYSE reference quote was available, opening, MOC, tick-sensitive, combination and crossing session orders.
2. All NYSE issues except (a) stocks priced above $1,000, (b) stocks trading in variations less than 1/16th and (c) stocks trading in round lots less than 100 shares.
3. Reference quote: NBBO at otime for otime columns, NBBO at dbtime for dbtime columns and NYSE quote at rtime for rtime columns.
4. The rtime quote is the NYSE quote

Table 6
Execution Report Eligibility
System Market Orders [1]

	Order size (shares)							
	All sizes	Odd lot orders	100	101 - 499	500 - 2099	2100 - 4999	5000 - 9999	10000 plus
Execution Reports (thousands)								
All execution reports	7,359	1,326	821	2,312	2,194	387	183	136
Special market orders / Ineligible execution reports[2]								
Odd lot orders	1,326	1,326	-	-	-	-	-	-
Opening orders	440	0	62	180	149	27	13	9
MOC orders	214	0	24	66	79	24	11	9
Tick sensitive orders	505	8	55	106	217	64	35	20
Other[3]	116	0	1	3	21	12	15	63
Data problems / Ineligible execution reports								
No valid reference quote[4]	10	0	1	2	2	0	0	4
Eligible execution reports								
All eligible	4,769	0	680	1,958	1,731	260	110	30
Order size <= NBBO[5]	4,056	0	680	1,865	1,335	126	41	9
Order size > NBBO[6]	713	0	-	94	396	135	69	21
Executed Share Volume (million)								
All execution reports	5,436	54	82	563	1,879	901	741	1,215
Special market orders / Ineligible execution reports[2]								
Odd lot orders	54	54	-	-	-	-	-	-
Opening orders	494	0	6	46	144	84	80	134
MOC orders	414	0	2	18	81	76	75	161
Tick sensitive orders	410	0	5	25	142	88	71	77
Other[3]	710	0	0	1	29	33	63	585
Data problems / Ineligible execution reports								
No valid reference quote[4]	27	0	0	0	2	1	1	23
Eligible execution reports[2]								
All eligible	3,349	0	68	474	1,487	624	454	242
Order size <= NBBO[5]	2,272	0	68	448	1,124	338	202	93
Order size > NBBO[6]	1,078	0	-	26	364	286	252	149

1. August 1999; all NYSE issues, except (a) stocks priced above $1,000, (b) stocks trading in variations less than 1/16th and (c) stocks trading in round lots less than 100 shares.
2. Ineligible execution reports may be in multiple categories.
3. Write-in orders, combination orders, crossing session orders
4. Net of special market orders (odd lots, opening orders, etc.)
5. The order size is less or equal to the reference NBBO size
6. The order size exceeds the reference NBBO size

Table 7
Best Execution Statistics for Eligible System Market Orders [1]
Order size less than or equal to reference NBBO size
Different Averaging Methodologies

Order size (shares)	Percentages			Percent basis points		
	Inside NBBO quoted price	At NBBO quoted price	Outside NBBO quoted price	(1) Quoted spread	(2) Effective spread	(1)-(2) Discount (premium)
Report-weighted[2]						
100	40.4	51.9	7.7	32.0	17.7	14.3
101-499	37.3	57.1	5.6	35.2	20.3	14.9
500-2099	31.6	60.1	8.3	36.9	25.4	11.5
2100-4999	26.9	65.9	7.2	39.9	30.3	9.6
5000-9999	26.8	65.6	7.6	46.6	35.4	11.2
10000 plus	25.6	67.0	7.4	62.0	53.5	8.5
All sizes	**35.5**	**57.6**	**6.9**	**35.5**	**22.1**	**13.4**
Volume-weighted[3]						
100	40.4	51.9	7.7	32.0	17.7	14.3
101-499	36.5	57.9	5.6	35.5	20.9	14.6
500-2099	29.3	62.8	7.9	38.2	27.3	10.9
2100-4999	22.7	70.9	6.4	41.6	33.3	8.3
5000-9999	20.5	73.1	6.4	50.0	41.3	8.7
10000 plus	16.6	77.4	6.1	73.2	68.0	5.2
All sizes	**28.8**	**64.2**	**7.0**	**40.5**	**29.6**	**10.9**
Average of report-weighted stock averages[4]						
100	42.7	55.3	2.0	111.7	60.5	51.2
101-499	39.8	58.6	1.7	119.8	69.2	50.6
500-2099	28.9	68.8	2.3	106.9	78.0	28.9
2100-4999	18.9	78.6	2.6	91.8	76.8	15.0
5000-9999	17.1	80.0	2.8	81.5	68.2	13.3
10000 plus	15.3	80.4	4.2	81.8	75.9	5.9
All sizes	**36.8**	**61.2**	**1.9**	**120.6**	**73.0**	**47.6**
Average of volume-weighted stock averages[5]						
100	42.7	55.3	2.0	111.7	60.5	51.2
101-499	38.9	59.5	1.7	119.6	70.3	49.3
500-2099	27.0	70.9	2.1	105.9	79.0	26.9
2100-4999	17.0	80.8	2.2	91.5	77.5	14.0
5000-9999	15.0	82.7	2.4	81.4	69.7	11.7
10000 plus	12.3	83.8	3.9	80.9	77.3	3.6
All sizes	**30.6**	**67.5**	**1.9**	**118.4**	**79.5**	**38.9**

1. August 1999, all NYSE issues, except: (a) stocks priced above $1,000, (b) stocks trading in variations less than 1/16th and (c) stocks trading in round lots less than 100 shares.
2. Each execution report ("trade") has equal weight irrespective of size; stocks with more execution reports get greater weight.
3. Each execution report is weighted by its share size; reports with more shares get greater weight; stocks with more reports/volume get greater weight.
4. Within each stock, each execution report gets equal weight irrespective of size; calculate averages per stock and then average across stocks; all stocks get equal weight.
5. Within each stock, each execution report is weighted by its share size; calculate volume-weighted averages per stock and then average across stocks; all stocks get equal weight.

Table 8
Report and Volume Distribution by Order Size
Eligible System Market Orders [1]

Order size (shares)	Order size less than or equal to reference NBBO size				Order size greater than reference NBBO size			
	Eligible execution reports	%	Eligible share volume	%	Eligible execution reports	%	Eligible share volume	%
100	679,558	17%	67,955,800	3%	0	0%	0	0%
101-499	1,864,747	46%	447,978,093	20%	93,540	13%	26,243,942	2%
500-2099	1,335,340	33%	1,123,517,683	49%	395,664	55%	363,616,601	34%
2100-4999	125,602	3%	337,584,671	15%	134,689	19%	286,155,317	27%
5000-9999	41,230	1%	201,611,282	9%	68,518	10%	252,008,200	23%
10000 plus	9,322	0.2%	92,963,826	4%	20,968	3%	149,483,893	14%
All sizes	**4,055,799**	**100%**	**2,271,611,355**	**100%**	**713,379**	**100%**	**1,077,507,953**	**100%**

1. August 1999, all NYSE issues, except: (a) stocks priced above $1,000, (b) stocks trading in variations less than 1/16th and (c) stocks trading in round lots less than 100 shares.

Table 9
Average Prices[1] for Eligible System Market Orders[2]
Order size less than or equal to reference NBBO size

Order size (shares)	Eligible execution reports	All eligible	Inside NBBO quoted price	At NBBO quoted price	Outside NBBO quoted price
All spreads					
100	679,558	$55.0	$57.8	$50.4	$71.8
101-499	1,864,747	$48.2	$51.5	44.6	63.6
500-2099	1,335,340	$49.9	$54.1	45.4	66.6
2100-4999	125,602	$43.2	$48.7	39.1	59.8
5000-9999	41,230	$41.6	$49.0	36.6	58.9
10000 plus	9,322	$38.6	$46.9	33.8	52.7
All sizes	**4,055,799**	**$49.7**	**$53.4**	**45.4**	**66.1**
NYSE spread 1/16th					
100	237,657	$47.9	$54.5	$45.9	$63.9
101-499	727,806	$42.4	$48.5	$40.8	$57.1
500-2099	545,505	$43.1	$49.4	$40.8	$60.2
2100-4999	62,829	$37.4	$44.0	$35.3	$53.4
5000-9999	21,321	$34.0	$41.1	$31.7	$51.2
10000 plus	5,348	$31.7	$42.0	$29.5	$43.8
All sizes	**1,600,466**	**$43.1**	**$49.6**	**$41.2**	**$59.0**
NYSE spread greater than 1/16th					
100	441,901	$58.9	$58.2	$56.1	$74.4
101-499	1,136,941	$52.0	$51.8	$49.8	$67.0
500-2099	789,835	$54.7	$54.8	$51.3	$70.1
2100-4999	62,773	$49.0	$49.7	$45.8	$66.3
5000-9999	19,909	$49.7	$50.8	$45.8	$65.8
10000 plus	3,974	$47.7	$48.4	$44.4	$61.7
All sizes	**2,455,333**	**$54.0**	**$53.9**	**$51.2**	**$69.7**

1. "Trade-weighted" averages: execution prices are averaged across the reports irrespective of how many shares were executed in each report.
2. August 1999, all NYSE issues, except: (a) stocks priced above $1,000, (b) stocks trading in variations less than 1/16th and (c) stocks trading in round lots less than 100 shares.

Table 10
Best Execution Statistics for Eligible System Market Orders [1]
Order size less than or equal to reference NBBO size

Order size (shares)	Eligible execution reports	Percentages			Percent basis points		
		Inside NBBO quoted price	At NBBO quoted price	Outside NBBO quoted price	(1) Quoted spread	(2) Effective spread	(1)-(2) Discount (premium)
All spreads							
100	679,558	40.4	51.9	7.7	32.0	17.7	14.3
101-499	1,864,747	37.3	57.1	5.6	35.2	20.3	14.9
500-2099	1,335,340	31.6	60.1	8.3	36.9	24.5	11.5
2100-4999	125,602	26.9	65.9	7.2	39.9	30.3	9.5
5000-9999	41,230	26.8	65.6	7.6	46.6	35.4	11.2
10000 plus	9,322	25.6	67.0	7.4	62.0	53.5	8.5
All sizes	**4,055,799**	**35.5**	**57.6**	**6.9**	**35.5**	**22.1**	**13.4**
NYSE spread 1/16th							
100	237,657	11.6	82.7	5.6	20.7	18.4	2.3
101-499	727,806	10.0	85.2	4.8	23.6	20.9	2.6
500-2099	545,505	9.6	83.0	7.3	28.4	26.4	2.0
2100-4999	62,829	9.3	83.5	7.2	35.5	33.9	1.6
5000-9999	21,321	9.8	83.2	7.0	47.4	44.5	2.9
10000 plus	5,348	10.6	82.9	6.5	69.8	69.5	0.3
All sizes	**1,600,466**	**10.1**	**84.0**	**5.9**	**25.7**	**23.4**	**2.3**
NYSE spread greater than 1/16th							
100	441,901	55.8	35.4	8.8	38.1	17.3	20.7
101-499	1,136,941	54.9	39.1	6.1	42.7	20.0	22.7
500-2099	789,835	46.8	44.2	9.0	42.8	24.8	18.0
2100-4999	62,773	44.6	48.3	7.1	44.2	26.8	17.4
5000-9999	19,909	45.1	46.6	8.2	45.6	25.6	20.0
10000 plus	3,974	45.7	45.6	8.7	51.5	32.1	19.5
All sizes	**2,455,333**	**52.1**	**40.4**	**7.6**	**41.9**	**21.3**	**20.7**

1. August 1999, all NYSE issues, except: (a) stocks priced above $1,000, (b) stocks trading in variations less than 1/16th and (c) stocks trading in round lots less than 100 shares.

Table 11
Best Execution Statistics for Eligible System Market Orders [1]
Order size less than or equal to reference NBBO size
Guaranteed and Non-Guaranteed Orders

Order size (shares)	Eligible execution reports	Percentages			Percent basis points		
		Inside NBBO quoted price	At NBBO quoted price	Outside NBBO quoted price	(1) Quoted spread	(2) Effective spread	(1)-(2) Discount (premium)
Guaranteed orders (all spreads)							
100	14,126	60.6	35.6	3.8	32.8	4.6	28.2
101-499	46,496	60.1	37.1	2.9	38.0	6.8	31.2
500-2099	38,351	62.6	34.5	2.9	47.9	11.5	36.4
2100-4999	4,259	68.6	29.1	2.3	54.5	10.0	44.5
5000-9999	1,456	70.7	26.6	2.7	85.8	21.8	64.0
10000 plus	236	69.5	26.7	3.8	67.5	20.8	46.8
All sizes	**104,924**	**61.6**	**35.4**	**3.0**	**42.3**	**8.6**	**33.7**
Non-guaranteed orders (all spreads)							
100	665,432	39.9	52.3	7.8	32.0	18.0	14.0
101-499	1,818,251	36.8	57.6	5.7	35.1	20.7	14.4
500-2099	1,296,989	30.7	60.8	8.5	36.6	25.9	10.7
2100-4999	121,343	25.5	67.2	7.4	39.4	31.0	8.3
5000-9999	39,774	25.2	67.0	7.8	45.1	35.9	9.2
10000 plus	9,086	24.4	68.1	7.5	61.8	54.4	7.5
All sizes	**3,950,875**	**34.8**	**58.2**	**7.0**	**35.4**	**22.5**	**12.9**

1. August 1999, all NYSE issues, except: (a) stocks priced above $1,000, (b) stocks trading in variations less than 1/16th and (c) stocks trading in round lots less than 100 shares.

Table 12
Best Execution Statistics for Eligible System Market Orders [1]
Order size less than or equal to reference NBBO size
Active and Inactive Stocks

Order size (shares)	Eligible execution reports	Percentages			Percent basis points		
		Inside NBBO quoted price	At NBBO quoted price	Outside NBBO quoted price	(1) Quoted spread	(2) Effective spread	(1)-(2) Discount (premium)
All stocks							
100	679,558	40.4	51.9	7.7	32.0	17.7	14.3
101-499	1,864,747	37.3	57.1	5.6	35.2	20.3	14.9
500-2099	1,335,340	31.6	60.1	8.3	36.9	25.4	11.5
2100-4999	125,602	26.9	65.9	7.2	39.9	30.3	9.5
5000-9999	41,230	26.8	65.6	7.6	46.6	35.4	11.2
10000 plus	9,322	25.6	67.0	7.4	62.0	53.5	8.5
All sizes	**4,055,799**	**35.5**	**57.6**	**6.9**	**35.5**	**22.1**	**13.4**
100 most active stocks [2]							
100	294,521	39.0	49.9	11.2	18.3	10.4	7.9
101-499	690,357	36.7	55.2	8.1	20.7	11.4	9.3
500-2099	606,580	33.7	54.8	11.5	20.2	13.2	7.0
2100-4999	61,020	30.6	59.1	10.3	21.5	14.7	6.7
5000-9999	22,034	32.0	57.7	10.3	23.2	15.7	7.5
10000 plus	5,430	31.2	59.4	9.4	24.1	16.7	7.4
All sizes	**1,679,942**	**35.7**	**54.3**	**10.0**	**20.2**	**12.1**	**8.1**
1000 least active stocks [3]							
100	5,169	50.5	48.5	1.1	125.4	62.6	62.8
101-499	19,047	44.5	55.0	0.5	118.1	71.1	47.0
500-2099	10,506	29.6	69.9	0.6	115.3	86.8	28.5
2100-4999	337	13.9	85.5	0.6	170.5	137.6	32.9
5000-9999	60	8.3	91.7	0.0	90.9	31.9	59.1
10000 plus	15	6.7	73.3	20.0	302.5	278.7	23.7
All sizes	**35,134**	**40.5**	**58.9**	**0.6**	**118.9**	**75.2**	**43.7**

1. August 1999, all NYSE issues, except: (a) stocks priced above $1,000, (b) stocks trading in variations less than 1/16th and (c) stocks trading in round lots less than 100 shares.
2. We rank all stocks in our sample by their NYSE volume for September 1999 and choose the 100 most active stocks.
3. We rank all stocks in our sample by their NYSE volume for September 1999 and choose the 1000 least active stocks (we exclude 43 stocks that had no trades in September).

Table 13 Executions Outside the Quote[1]		
		Executions Outside the Quote[2] by Reason
Reasons for the 11,982 executions outside the quote, February 11		
1	Multiple orders hitting the quote at the same time / arrival of system market orders within 5-seconds window	**62%**
2	Reference NBBO set off NYSE / ITS-ineligible because size=100 shares	**8%**
3	Reference NBBO set by Nasdaq / ITS-ineligible because Rule 390 stock	**3%**
4	Reference NBBO set off NYSE / ITS commitment sent, only partially filled	**1% - 7%**
5	Reference NBBO set off NYSE / apparent "trade-through" orders	**18%**
6	Floor broker stepping in front of system market orders	**N/A**
7	Percentage orders share in the available depth	**N/A**
Who makes the NBBO on the 11,982 executions outside the quote, February 11		
	NYSE was at the relevant side of the NBBO	**70 %**
	Regionals, NASD were at the relevant side of the NBBO	**30 %**

1. February 11.

2. Orders might be included in multiple categories (e.g., quote is ITS-ineligible because the stock is a rule 390 stock and the size of the quote is 100 shares). Therefore, these percentages may sum to more than 100%.

Table 14
Best Execution Statistics for Eligible System Market Orders [1]
Order size greater than reference NBBO size

Order size (shares)	Eligible execution reports	Percentages			Percent basis points		
		Inside NBBO price	At NBBO price	Outside NBBO price	(1) Quoted spread	(2) Effective spread	(1)-(2) Discount (premium)
		Price & depth improvement	**Depth improvement**				
All spreads							
100	0	-	-	-	-	-	-
101-499	93,540	16.2	40.7	43.2	27.5	48.1	(20.6)
500-2099	395,664	14.1	49.0	36.9	36.0	53.1	(17.1)
2100-4999	134,689	11.2	51.9	36.9	37.5	58.4	(20.9)
5000-9999	68,518	10.4	48.1	41.4	36.3	65.5	(29.2)
10000 plus	20,968	9.1	46.2	44.7	38.6	78.5	(39.8)
All sizes	**713,379**	**13.3**	**48.3**	**38.4**	**35.3**	**55.4**	**(20.1)**
NYSE spread 1/16th							
100	0	-	-	-	-	-	-
101-499	18,885	3.5	50.8	45.7	11.3	42.9	(31.5)
500-2099	102,621	3.7	62.0	34.3	18.3	37.4	(19.0)
2100-4999	44,504	3.4	62.0	34.6	21.6	42.5	(20.9)
5000-9999	24,028	3.7	58.2	38.2	24.4	51.5	(27.1)
10000 plus	8,340	2.9	56.1	41.1	31.7	68.4	(36.7)
All sizes	**198,378**	**3.6**	**60.2**	**36.2**	**19.7**	**42.1**	**(22.4)**
NYSE spread greater than 1/16th							
100	0	-	-	-	-	-	-
101-499	74,655	19.4	38.1	42.5	31.6	49.5	(17.9)
500-2099	293,043	17.7	44.4	37.9	42.2	58.5	(16.4)
2100-4999	90,185	15.1	46.9	38.1	45.3	66.2	(20.9)
5000-9999	44,490	14.1	42.7	43.2	42.8	73.1	(30.3)
10000 plus	12,628	13.1	39.7	47.1	43.2	85.1	(41.9)
All sizes	**515,001**	**17.1**	**43.7**	**39.3**	**41.3**	**60.5**	**(19.2)**

1. August 1999, all NYSE issues, except: (a) stocks priced above $1,000, (b) stocks trading in variations less than 1/16th and (c) stocks trading in round lots less than 100 shares.

Table 15a
Single and Multiple Execution Reports for Eligible System Market Orders [1]
Order Distribution

Order size (shares)	Eligible execution reports	Execution reports per order	Orders with one execution report		Orders with multiple execution reports							
					Single price				Multiple prices			
					At or within NBBO		Outside NBBO		At or within NBBO		At least partially outside the NBBO	
			#	% of orders	#	% of orders	#	% of orders	#	% of orders	#	% of orders
All orders												
100	656,250	1.00	656,250	100%	-	0%	-	0%	-	0%	-	0%
101-499	1,880,014	1.01	1,858,951	99%	10,815	1%	595	0%	5,040	0%	4,613	0%
500-2099	1,543,173	1.08	1,429,891	93%	42,689	3%	3,880	0%	18,124	1%	48,589	3%
2100-4999	197,011	1.27	152,597	77%	11,414	6%	1,115	1%	4,846	2%	27,039	14%
5000-9999	73,856	1.42	49,958	68%	5,078	7%	538	1%	2,331	3%	15,951	22%
10000 plus	18,020	1.60	10,538	58%	1,484	8%	196	1%	619	3%	5,183	29%
All sizes	**4,368,324**	**1.06**	**4,158,185**	**95%**	**71,480**	**2%**	**6,324**	**0%**	**30,960**	**1%**	**101,375**	**2%**
Order size less than or equal to NBBO size on order arrival												
100	656,250	1.00	656,250	100%	-	0%	-	0%	-	0%	-	0%
101-499	1,786,865	1.01	1,770,792	99%	9,252	1%	379	0%	4,758	0%	1,684	0%
500-2099	1,237,399	1.05	1,185,008	96%	27,455	2%	1,511	0%	14,488	1%	8,937	1%
2100-4999	108,956	1.12	98,674	91%	5,041	5%	230	0%	2,948	3%	2,063	2%
5000-9999	33,891	1.18	29,679	88%	2,001	6%	76	0%	1,291	4%	844	2%
10000 plus	7,032	1.26	5,871	83%	576	8%	20	0%	323	5%	242	3%
All sizes	**3,830,393**	**1.03**	**3,746,274**	**98%**	**44,325**	**1%**	**2,216**	**0%**	**23,808**	**1%**	**13,770**	**0%**
Order size greater than NBBO size on order arrival												
100	-	-	-	-	-	-	-	-	-	-	-	-
101-499	93,149	1.05	88,159	95%	1,563	2%	216	0%	282	0%	2,929	3%
500-2099	305,774	1.22	244,883	80%	15,234	5%	2,369	1%	3,636	1%	39,652	13%
2100-4999	88,055	1.46	53,923	61%	6,373	7%	885	1%	1,898	2%	24,976	28%
5000-9999	39,965	1.63	20,279	51%	3,077	8%	462	1%	1,040	3%	15,107	38%
10000 plus	10,988	1.81	4,667	42%	908	8%	176	2%	296	3%	4,941	45%
All sizes	**537,931**	**1.27**	**411,911**	**77%**	**27,155**	**5%**	**4,108**	**1%**	**7,152**	**1%**	**87,605**	**16%**

1. August 1999, all NYSE issues, except: (a) stocks priced above $1,000, (b) stocks trading in variations less than 1/16th and (c) stocks trading in round lots less than 100 shares.

Table 15b
Single and Multiple Execution Reports for Eligible System Market Orders [1]
Volume Distribution

Order size (shares)	Eligible volume (thousands)	Execution reports per order	Orders with one execution report		Orders with multiple execution reports							
					Single price				Multiple prices			
					At or within NBBO		Outside NBBO		At or within NBBO		At least partially outside the NBBO	
			Vol.	% of vol.	Vol.	% of vol.	Vol.	% of vol.	Vol.	% of vol.	Vol.	% of vol.
All orders												
100	66	1.00	66	100%	-	0%	-	0%	-	0%	-	0%
101-499	460	1.01	454	99%	3	1%	0	0%	2	0%	1	0%
500-2099	1,434	1.08	1,302	91%	47	3%	4	0%	42	3%	39	3%
2100-4999	602	1.27	462	77%	35	6%	3	1%	41	7%	60	10%
5000-9999	436	1.42	291	67%	30	7%	3	1%	39	9%	72	17%
10000 plus	230	1.60	132	57%	19	8%	3	1%	24	10%	53	23%
All sizes	**3,227**	**1.06**	**2,706**	**84%**	**135**	**4%**	**14**	**0%**	**148**	**5%**	**225**	**7%**
Order size less than or equal to NBBO size on order arrival												
100	66	1.00	66	100%	-	0%	-	0%	-	0%	-	0%
101-499	435	1.01	430	99%	3	1%	0	0%	2	0%	0	0%
500-2099	1,092	1.05	1,038	95%	28	3%	2	0%	19	2%	6	1%
2100-4999	330	**1.12**	298	90%	16	5%	1	0%	12	3%	4	1%
5000-9999	197	1.18	172	87%	12	6%	0	0%	9	5%	3	2%
10000 plus	89	1.26	73	83%	7	8%	0	0%	5	6%	2	2%
All sizes	**2,207**	**1.03**	**2,077**	**94%**	**66**	**3%**	**3**	**0%**	**47**	**2%**	**15**	**1%**
Order size greater than NBBO size on order arrival												
100	-	-	-	-	-	-	-	-	-	-	-	-
101-499	26	1.05	24	94%	1	2%	0	0%	1	2%	1	2%
500-2099	342	1.22	264	77%	19	5%	3	1%	23	7%	33	10%
2100-4999	272	1.46	164	60%	20	7%	3	1%	30	11%	56	21%
5000-9999	239	1.63	119	50%	18	8%	3	1%	29	12%	69	29%
10000 plus	141	1.81	58	41%	12	8%	2	2%	18	13%	51	36%
All sizes	**1,020**	**1.27**	**629**	**62%**	**69**	**7%**	**11**	**1%**	**101**	**10%**	**210**	**21%**

1. August 1999, all NYSE issues, except: (a) stocks priced above $1,000, (b) stocks trading in variations less than 1/16th and (c) stocks trading in round lots less than 100 shares.

Table 16
Average Exposure-to-Execution Time [1]
Eligible System Market Orders [2]
Order size less than or equal to reference NBBO size

Order size (shares)	Eligible execution reports	seconds			
		All eligible executions	Eligible executions Inside NBBO	Eligible executions at NBBO	Eligible executions outside NBBO
All orders					
100	679,558	19.8	23.7	16.0	25.5
101-499	1,864,747	21.2	26.2	17.1	28.4
500-2099	1,335,340	24.6	34.3	18.9	29.1
2100-4999	125,602	29.9	48.0	21.8	36.4
5000-9999	41,230	35.7	64.5	23.2	41.8
10000 plus	9,322	33.8	49.1	26.9	43.4
All sizes	**4,055,799**	**22.5**	**29.0**	**17.8**	**28.6**
Non guaranteed orders					
100	665,432	15.3	17.2	12.6	24.4
101-499	1,818,251	15.7	17.8	13.2	27.1
500-2099	1,296,989	17.4	20.1	14.5	28.2
2100-4999	121,343	20.9	25.4	17.6	35.3
5000-9999	39,774	23.3	29.3	19.1	40.3
10000 plus	9,086	27.4	35.5	23.0	42.1
All sizes	**3,950,875**	**16.5**	**18.6**	**13.8**	**27.5**
Guaranteed orders					
100	14,126	231.8	227.5	250.0	128.9
101-499	46,496	233.7	226.9	252.8	130.1
500-2099	38,351	270.7	270.0	284.2	123.9
2100-4999	4,259	286.3	286.7	297.0	137.4
5000-9999	1,456	373.9	407.9	305.9	155.2
10000 plus	236	277.8	234.1	411.1	140.6
All sizes	**104,924**	**251.1**	**248.6**	**265.9**	**128.2**

1. Time from order arrival at Display Book screen (dbtime) to execution time (rtime).
2. August 1999, all NYSE issues, except: (a) stocks priced above $1,000, (b) stocks trading in variations less than 1/16th and (c) stocks trading in round lots less than 100 shares.

Table 17
Average Exposure-to-Execution Time [1]
Eligible System Market Orders [2]
Order size greater than reference NBBO size

Order size (shares)	Eligible execution reports	seconds			
		All eligible executions	Eligible executions Inside NBBO	Eligible executions at NBBO	Eligible executions outside NBBO
All orders					
100	0	-	-	-	-
101-499	93,540	20.7	27.6	17.7	21.1
500-2099	395,664	24.7	29.5	21.5	27.2
2100-4999	134,689	28.4	30.6	24.6	33.2
5000-9999	68,518	34.2	30.0	28.0	42.3
10000 plus	20,968	35.7	33.4	28.4	43.7
All sizes	**713,379**	**26.1**	**29.5**	**22.5**	**29.5**
Non guaranteed orders					
100	0	-	-	-	-
101-499	92,240	17.9	20.9	15.4	19.1
500-2099	389,937	21.4	24.2	18.2	24.5
2100-4999	132,287	24.4	27.2	20.1	29.4
5000-9999	67,128	29.3	27.5	21.8	38.4
10000 plus	20,536	31.6	28.4	23.3	40.8
All sizes	**702,128**	**22.5**	**24.5**	**18.8**	**26.6**
Guaranteed orders					
100	0	-	-	-	-
101-499	1,300	223.8	496.6	187.7	155.2
500-2099	5,727	253.3	353.7	242.9	222.5
2100-4999	2,402	251.6	214.6	245.1	276.6
5000-9999	1,390	268.1	190.5	270.4	282.5
10000 plus	432	229.6	319.2	224.3	218.7
All sizes	**11,251**	**250.5**	**336.6**	**241.8**	**229.7**

1. Time lag from order arrival at Display Book screen (dbtime) to execution time (rtime).
2. August 1999, all NYSE issues, except: (a) stocks priced above $1,000, (b) stocks trading in variations less than 1/16th and (c) stocks trading in round lots less than 100 shares.