An Analysis of Price Volatility
October 27 and 28, 1997

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Executive Summary

On Monday, October 27, 1997, the DJIA dropped 554 points from the previous Friday close, the largest point drop ever. The price decline triggered the Exchange's Rule 80B market-wide circuit breakers for the first time ever. The next day, October 28, the DJIA rose 337 points, at the time, the largest point rise in the Exchange's history. In this paper, we use NYSE proprietary data to examine various aspects of NYSE trading during these two very unusual days.

We here summarize our main findings.

System Volume

- The ratio of executed system volume to twice total volume was 52 percent on October 27 and 50 percent on October 28, slightly higher than usual (on our control day, October 21, this ratio was 46 percent same as for the whole of 1997).
- On October 27 and 28, buy and sell executed system volume was balanced throughout most of the day.
- The period between the two trading halts on the 27th shows the largest system volume imbalance: buy system volume was 48 percent compared to 62 percent for sell system volume. During this period, therefore, floor brokers and specialists were net buyers.

System Orders

- The average system order size was normal at 1,418 shares on October 27 but declined to 1,267 shares on October 28.
- Between the two trading halts on the 27th, average system order size increased slightly to 1,495 shares (compared to 1,351 shares on the control day).
- On October 28, consistent with the evidence on order size, the proportion of system orders marked as submitted by individual investors was an unusually high 28 percent (compared to 17 percent on the control day and on the 27th).
- The normal-day balance between limit and market system orders was not disturbed on October 27 despite the unusual volatility. On October 28, however, the ratio of market system orders to all system orders was 46 percent, substantially higher than usual.

Trades

- The average print size on October 27 was 2,220 shares, close to normal for most of the day.

- Between the two trading halts, print size increased to 2,844 shares (compared to 2,152 for the same period on the control day). The increased print size during this period is because of increased bunching.
- The average print size on October 28 was 2,494 shares and consistently higher throughout the day than on the control day. The increase in print size on October 28 was again the result of increased bunching.

Spreads

- Spreads widened substantially on October 27 and 28. The average traded-weighted spread was 19 cents on the 27th and 22 cents on the 28th; the usual average spread is 14 cents.
- Between the two trading halts on the 27th trade-weighted spreads averaged 25 cents, double their usual level.
- On the 28th, spreads were particularly wide (27 cents) between 10:00 and 11:00 when the market made its spectacular turnaround.

Opening Delays

- Stocks opened slowly on October 28: on average 10.7 minutes after 9:30 (compared to 3.8 minutes on the control day and 4.4 minutes on October 27).
- On October 28, active stocks opened more slowly than inactive stocks: the 354 most active stocks opened on average 15.5 minutes after 9:30 while the 355 least active stocks opened on average 7.4 minutes after 9:30.

Trading Halts

- During the first trading halt, SuperDot remained opened according to plan; order submissions during this period, however, dropped sharply.
- The data indicate a couple of minutes delay in fully implementing a shutdown of SuperDot's CMS switch after the second trading halt at 15:30:00: SuperDot received 3,941 orders between 15:30:00 and 15:32:00.
- 2,200 trades have time stamps during the two trading halts; most of them in the first minute after the halts were triggered. Most probably, specialists executed these trades right before the halt but reported them to the Tape with a slight delay.
- Stocks re-opened quickly after the end of the first trading halt: on average 3.7 minutes after 15:06:00.
- According to plan, specialist posted closing quotes after the second halt; the closing quotes, however, started appearing after 15:40:00.
- 1,115 market-on-close orders were cancelled because of the early closing.

Specialist Trading

- From its opening value on October 27 to its peak value at 9:55 on October 28, the average specialist inventory position in the 30 DJIA stocks increased six times.
- On October 27, the average specialist opening inventory position in the 30 DJIA stocks was $0.8 million per stock. By 14:00 the average position was $2.2 million per stock; the market then briefly rebounded and specialists re-liquefied. At the first trading halt the average specialist inventory position was $1.1 million per stock. Between the two trading halts, the average position shot up from $1.1 million to $2.7 million per stock.
- A remarkable feature of specialist trading on October 28 is the speed with which specialists unwound their positions as soon as prices started rising. The average specialist inventory position in the 30 DJIA stocks peaked at $4.3 million per stock at 9:55. Prices started rising after 10:05. By 10:30 specialists were short on average $0.3 million per stock; by 10:45 specialists were short $2.0 million per stock.
- The average (unweighted) specialist participation rate in the 30 DJIA stocks was 14.6 percent on October 27 and 15.3 percent on October 28.
- On October 27, the average (unweighted) specialist participation rate reached 19 percent between 14:00 and 14:15 and dropped to 10 percent between the two trading halts.
- On October 27, the average (unweighted) specialist stabilization rate in the 30 DJIA stocks was 85 percent. During the day, the stabilization rate fluctuated between 91 percent (9:30-9:45) and 76 percent (11:15-11:30). The stabilization rate was particularly high during intervals when prices were falling sharply.
- On October 28, the average (unweighted) specialist stabilization rate in the DJIA stocks was 86 percent. During the day, it reached a high of 94 percent between 10:30 and 10:45 when prices were rebounding sharply.

Program Trading

- Overall on October 27 and 28 program trading as a percent of total trading was not unusually high: on both days program trading was 16 percent of total volume (the average for the third quarter of 1997 was 18 percent).
- At the time of the 350-point trading halt, the nearby S&P 500 futures contract was trading at a large discount (4 index points below fair value). The trading halt froze the cash and futures markets in this "sell the cash" position, contributing to more sell pressure on the cash market at the re-opening.
- When the market re-opened the mispricing widened to more than 15 index points. This large mispricing persisted throughout the period between the two trading halts.
- Between the two trading halts, even though the cash futures was selling at a huge discount to the cash, sell index arbitrage volume was low, only 11.4 percent of sell program volume.
- On October 27 overnight trading in the S&P500 futures widened the cash-futures mispricing.

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An Analysis of Price Volatility, October 27 and 28, 1997

1. Introduction

On Monday, October 27, 1997, the DJIA dropped 554 points from the previous Friday close, the largest point drop ever. The price decline triggered the Exchange's Rule 80B market-wide circuit breakers for the first time ever. The next day, Tuesday, October 28, the DJIA rose 337 points, at the time, the largest point rise in the Exchange's history. This price rebound was accompanied by the then largest trading volume in the Exchange's history. In this paper, we use NYSE proprietary data to examine various aspects of NYSE trading during these two very unusual days.

Our main objective in this paper is to understand the dynamics of trading in periods of unusual stress. We hope this paper will provide the institutional detail necessary to facilitate the debate on how to improve trading during unusual circumstances like those experienced on October 27 and 28, 1997. We also hope the paper provides enough institutional background to help researchers who may want to examine in greater depth October 27 and 28, 1997.

The paper is arranged as follows. In the next section, we provide a brief institutional background and go through the chronology of events on October 27 and 28, 1997. In Section 3 we examine order submission. We analyze the mix of market participants—individual investors, institutional investors, program traders, member firms and specialists--and how they interacted on October 27 and 28. In the same section we compare the use of system and floor-entered orders, market and limit orders. In Section 4 we search for unusual patterns in trade size. Section 5 examines the effects of the unusual volatility on spreads. We then turn our attention to the opening delays on October 28 (Section 6). In Section 7 we focus on the two trading halts on October 27 and spell out in detail what should have happened and what did happen. In Section 8 we analyze specialist trading, examining specialist inventory behavior, the extent to which specialists augmented liquidity and their attempts to stabilize the market. In

Section 9 we analyze index arbitrage and other program trading strategies. Section 10 provides suggestions for further research.

2. Institutional background and chronology of events

2.1. Background

Table 1 puts the volatility on October 27 and 28, 1997 in perspective. The 554-point DJIA drop on October 27 was the largest point drop in the index ever. In percentage terms, however, this decline was only the 12th largest. The largest percent decline was on October 19, 1987 when a 508-point DJIA drop was equivalent to 22.6 percent of the index. October 28 and 29, 1929 come next with 12.8 percent and 11.7 percent declines respectively.

The 337-point rise in the DJIA on October 28 translates to 4.7 percent of the index and is not in the list of the 12 largest percent price increases. The largest percent rise in the index occurred on October 6, 1931 when the index rose 14.9 percent. On October 30, 1929 the index rose 12.3 percent. More recently, on October 21, 1987 the index rose 10.2 percent.

Nevertheless, October 27 and 28, 1997 are unique in that the 27th was the first time the NYSE's market-wide circuit breakers were triggered and the 28th was by far the busiest day ever on the Exchange. Table 2 lists the twelve busiest trading days on record through December 31, 1997. October 28 leads the way with 1.2 billion shares. December 19, 1997 (a triple witch) comes second with 793 million shares. Half of the twelve busiest days ever occurred in October 1997.

Table 3 lists the index arbitrage restrictions and market-wide circuit breakers in effect on October 27 and 28. The Rule 80A(c) index arbitrage restriction was triggered on 443 days between the time the Rule (in its current form) became effective on August 1 1990 and the end of 1997. Over the same period, the Rule 80A(a) sidecar was triggered on 58 days. Table 4 shows the annual frequency with which the index arbitrage and sidecar restrictions were triggered. As the 50 points declined from 2 percent of the index when introduced in 1990 to

0.6 percent in December 1997, the frequency with which the index arbitrage restrictions was triggered increased dramatically from 20 days in 1991 to 219 days in 1997. Similarly, the sidecar was only triggered twice in 1991 but 37 times in 1997.

The increased frequency of the Rule 80A triggers, however, is not simply because the trigger levels decreased dramatically on percentage terms. As Table 5 shows, 1997 was an unusually volatile year even when we examine percent price changes. In 1997, for example, there were 80 days in which the DJIA daily close-to-close change was one percent or more. The number of one-percent days was 43 in 1996 and only 17 in 1995. In fact, based on this measure of volatility, 1993 and 1995 were the least volatile years since 1978. Over the same period, 1987 was the most volatile with 96 one-percent days, 1982 had 84 one-percent days, 1980 had 81 and then comes 1997. If we look at the frequency of DJIA changes of 5 percent or more, 1987 again leads the way with four five-percent days. The years 1988, 1989 and 1997 had one five-percent day each.

2.2 Chronology of events

Chart 1 shows the DJIA minute-by-minute on October 27. The market closed on Friday, October 24 at 7,715. On October 27 at 9:36 the DJIA was down 50 points from the Friday's close triggering the Rule 80A index arbitrage sell restriction. Over the next half-hour, the market recovered briefly; at 10:14 the DJIA was only 25 points below Friday's close and the index arbitrage sell restriction was off. At 10:21 the index was again down 50 re-triggering the arbitrage sell restriction. At 11:00 the primary S&P 500 futures contract was down 12 points (the DJIA was down 115) triggering Sidecar.

At 13:59 the DJIA was at 7,372 down 344 points 6 index points away from the 350-point Rule 80B trigger. The market recovered briefly reaching 7,442 at 14:10 before prices started dropping again. At 14:35:55 the market was at 7,361 triggering the 350-point trading halt. The market re-opened at 15:06:00. At 15:30:00 the market was down 550 points and the

Exchange halted trading for the rest of the day. The closing value of the index on the 27th was 7,161.

Chart 2 shows the DJIA on October 28. The market opened at 9:30 with the nearby S&P 500 futures contract 12 points down and Sidecar in effect. At 9:41 the DJIA was down 50 points triggering the Rule 80A index arbitrage sell restriction. The market continued falling dropping to 6,973 by 10:06 (188 points below Monday's close). After 10:06 the market started rising. At 10:20 the arbitrage sell restriction went off and five minutes later with the DJIA up 50 points from Monday's close the Exchange imposed the Rule 80A index arbitrage restriction on the upside. The market continued rising throughout the day closing at 7,498.

Finally, Chart 3, shows the DJIA minute-by-minute on October 21st, our control day. This was an up day with the index opening at 7,921 and closing at 8,060. The Rule 80A index arbitrage restriction was triggered at 10:16 on the upside and remained in effect throughout the rest of the day.

3. Orders

In this section we look for unusual patterns in order submission on October 27 and 28. We compare orders on these two unusual days with orders on the control day, October 21. Table 6 provides summary statistics for the three days we examine. The first row shows the "official" NYSE trading volume figures:[1] 581 million shares on October 21, 685 million shares on October 27 and 1.2 billion shares on October 28. NYSE trading volume for the whole of 1997 averaged 527 million shares per day. Our control day, October 21, therefore, with 581 million shares was slightly busier than the average 1997 day. Table 6 also shows that the ratio of system (SuperDot) executed volume to twice total volume was slightly higher on the two volatile days: 46 percent on October 21, 52 percent on October 27 and 50 percent on October 28.[2] The ratio for the whole year 1997 was 46 percent.

Charts 4 and 5 plot the ratio of system volume to twice total volume by half-hour interval. In these charts, 9:30 denotes the interval 9:30:00 through 9:59:59 and so on. For October 27 we made the following time interval adjustments to allow for the trading halts. We extended the 14:00 interval through to 14:35:59, the beginning of the first trading halt. The 14:30 interval covers the period of the first trading halt, 14:35:59 through to 15:05:59. The 15:00 interval begins with the re-opening after the first halt at 15:06:00 and ends with the second trading halt at 15:29:59. Finally, the 15:30 interval covers the period after the triggering of the second trading halt.[3] We discuss the trading halt intervals in Section 7.

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[1] The "official" NYSE trading volume excludes rights and warrants but includes the crossing sessions. ITS trades are handled according to the rules of the Consolidated Tape Association (CTA): the seller's market gets credit.

[2] System volume data are from the NYSE's daily System Order Data (SOD) files and include all same day system orders submitted, except "write-ins" orders. "Write-ins" 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" in the approximate execution time in the WITIME field. 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-ins because they are not true system orders. 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).

[3] We make similar adjustments in the charts and tables throughout the paper.

On October 21 the ratio of system to total volume was roughly constant at 46 percent throughout the day. The only exceptions were the opening and close: in the first 30 minutes of trading the system-to-total ratio was 53 percent; in the last 30 minutes the ratio was 55 percent.

Chart 4 shows that the system-to-total ratio was slightly higher throughout the day on October 27 than October 21 with system relative to total volume increasing after 11:00. The system-to-total ratio was 55 percent between the two trading halts compared to 46 percent over the corresponding interval on October 21. On October 28 (Chart 5) the system-to-total ratio was again slightly higher than usual throughout the day.

Charts 6 through 8 show the split of executed system volume between buys and sells for the whole day and by half-hour intervals. On October 21, executed system sell volume was 47 percent of total volume while system buy volume was 45 percent. Buy and sell system volume was balanced throughout the day.

On October 27, system sell volume was 53 percent and system buy volume was 51 percent of total volume. Buy and sell system volume was balanced for most of the day. The period between the two trading halts shows the largest imbalance: buy system volume was 48 percent of total compared to 62 percent for sell system volume. During this period, therefore, floor orders (floor broker-represented orders and specialist orders) were net buyers. Chart 8 shows that buy and sell system volume was also fairly balanced for most of October 28.

Having established the relationship between system and total volume, we next focus on system orders and using data from the NYSE's daily System Order Data (SOD) files we provide more details on system order size and placement.

3.1 Order Size

Table 6 shows that SuperDot received 650 thousand orders on October 21, 907 thousand orders on October 27 and 1.5 million orders on October 28. The average system order size was 1,500 shares on both October 21 and 27 but declined to 1,300 shares on October 28.

Charts 9 and 10 examine the average size of orders placed by half-hour interval. On October 21 order size was fairly constant throughout the day. Ignoring the two trading halt periods,[4] order size was fairly constant throughout the day on October 27. Until 13:00 order size on October 27 was about the same as on October 21. After 13:00 order size increased slightly. In the half-hour period before the first trading halt, average order size on October 27 was 1,517 shares compared to 1,403 shares during the corresponding period on October 21. Between the two trading halts, average order size was 1,495 shares compared to 1,351 shares on the 21st.

Chart 10 is interesting because it suggests that following the rebound in prices shortly after 10:00 on October 28, individual investor participation in the market increased. From 10:30 through 14:00 order size was several hundred shares lower on October 28 than on October 21. Between 12:00 and 12:30, for example, the average system order size on the 28th was 1,021 shares compared to 1,375 on the 21st. In the next section, we examine order placement by individuals and institutions in more detail.

3.2 Individuals and Institutions

The NYSE requires member firms entering orders into SuperDot to classify these orders into three groups: (a)"individual" (agency/individual in our terminology), (b) "agency"

[4] We discuss system order submissions during the trading halts below in Section 7.

(agency/institutional in our terminology) and (c) "principal" (principal/member firm in our terminology).[5] Orders submitted by pension funds, mutual funds and non-member securities firms, for example, should be classified as agency/institutional. Orders submitted by Mr. Joe through his broker should be classified as agency/individual.

Table 6 shows that on October 21 agency/individual system orders accounted for 17 percent of all system orders, agency/institutional orders accounted for 65 percent and principal/member firm orders for 16 percent. On October 27 the proportions are almost identical to October 21. Consistent with the evidence on order size, however, on October 28 the proportion of agency/individual orders increased dramatically to 28 percent. This increase was at the expense of agency/institutional orders; the proportion of principal/member firm orders remained unchanged at 17 percent.

3.2.a. Individuals and Institutions on October 27

Chart 11 shows the percent of agency/individual system orders by half-hour interval on October 21 and 27. Chart 12 repeats the analysis for agency/institutional orders. The two charts show that (with the exception of the two trading halt periods) the balance between individual and institutional-investor system orders throughout the day on October 27 was similar to October 21. Between 12:30 and 13:30, the percentage of institutional-investor orders was higher on October 27 than on October 21. From 12:30 to 13:00, for example, the percentage of institutional orders was 73 percent on October 27 compared to 66 percent on October 21. Correspondingly, between 12:30 and 13:30 the percentage of individual-investor orders was lower on October 27 than on October 21. Between 13:00 and 13:30, for example, the percentage of individual-investor orders was only 12 percent on the 27th compared to 20 percent on the 21st.

[5] A small number of orders are not coded properly and we classify them as "unidentified."

Table 7 shows that on October 27 individuals, institutions and member firms were all net sellers on SuperDot: sell orders exceed buy orders for all groups. Orders placed by individuals accounted for 17 percent of all system sell orders and 17 percent of all system buy orders. Orders placed by institutions accounted for 67 percent of all buy system orders and 65 percent of all sell system orders.

Charts 13 through 15 examine buy and sell orders by 30-minute intervals. Chart 13 shows that buy and sell system orders placed by individuals were fairly balanced throughout the day. Sell orders exceeded buy orders slightly until 14:00. After 14:00 as the market drop accelerated individuals were net buyers. Between 14:00 and 14:30, for example, individuals placed 9,758 buy and 8,423 sell system orders. Even between the two trading halts, when the market dropped 200 points in 20 minutes individual-investor buy orders exceeded sell orders.

Chart 14 focuses on institutional investors. From about 13:00, institutional investors were heavy net sellers. Between the two trading halts, in particular, institutional investors placed 43,118 system sell orders and only 18,251 system buy orders. Finally, Chart 15 shows that member firms were also heavy net sellers starting in the second half of the day. Between the two trading halts member firms submitted 16,859 system sell orders and only 2,043 system buy orders.

3.2.b. Individuals and Institutions on October 28

Charts 16 and 17 show the percent of individual and institutional orders on October 28. Throughout the day, the percent of orders placed by individuals was higher on October 28 than on October 21. The presence of individual investors was particularly heavy at the opening: the percent of pre-opening system orders placed by individuals was 43 percent on October 28 compared to 24 percent on October 21 (27 percent on October 27). When the market turned around between 11:00 and 11:30 the presence of individuals in the market was particularly

heavy: 34 percent on October 28 compared to 22 percent on October 21 (18 percent on October 27).

Table 7 shows that on October 28 while individuals and institutions were net buyers, member firms were net sellers. Most striking is the importance of individual investors on the buy side: individuals placed 35 percent of all buy system orders and only 18 percent of all system sell orders.

Chart 18 shows individual investors started buying heavily early in the day. Between 10:00 and 10:30 individual investors placed 31,364 buy and 9,743 sell system orders. Between 10:30 and 11:00 individuals placed 41,541 buy and only 6,885 sell system orders and they remained net buyers throughout the rest of the day. Chart 19 shows that institutional investors were also net buyers for most of the day, but the imbalance between buy and sell system orders in less dramatic than for individual investors. Chart 20 shows member firm principal buy and sell system orders: member firms were net sellers until 14:00.

3.3 Market and Limit System Orders

Of the 1.5 million system orders placed on October 28, 46 percent (671 thousand) were market orders (Table 6). By contrast, market orders accounted for 32 percent of all system orders on October 27 and 34 percent on October 21. For the whole of 1997, market system orders placed accounted for 32 percent of all system orders placed. On October 28, therefore, there was unusually heavy use of market orders. Perhaps more surprising, however, is the fact that on October 27 the ratio of market orders to total system orders was just average and not higher. Because of the rapid change in prices, we expected the demand for immediacy to be high, resulting in a disproportionate use of market orders. This was the case on October 28 but not on October 27. Charts 21 through 30 examine market and limit system order placement at half-hour intervals.

3.3.a. Market and Limit System Orders on October 27

Chart 21 shows system market orders placed on October 21 and 27. October 21 shows a u-shaped pattern of market order submission: a large number of pre-opening orders, a large number of orders during the first half hour and then another peak in the last half-hour of trading (presumably market-on-close orders). On October 27 system market order placement was only slightly above normal (compared to October 21) until 11:00. After 11:00 the arrival of market orders accelerated. In the hour before the first trading halt and in the period between the two trading halts more than twice as many market orders were placed on October 27 than on October 21.

Chart 22 examines system limit order placement. October 21 shows a u-shaped pattern of limit order submissions similar to the market order pattern. On October 27, limit order submissions (possibly re-submissions after cancellation) accelerated dramatically after 13:00. During the 13:00 half-hour interval, for example, on October 27 SuperDot received 62,566 limit orders compared to 20,062 limit orders on October 21.

Chart 23 shows that the ratio of system market orders to all system orders placed was roughly one third throughout the day on both October 21 and 27 (we ignore the trading halt periods). Surprisingly, the normal-day balance between limit and market system orders was not disturbed on October 27 despite the unusual volatility.

Chart 24 splits system market orders into buys and sells. On October 27 SuperDot received 112,917 buy and 180,867 sell market orders (Table 7). The imbalance between buy and sell market orders increased after 12:30. Most dramatically, between the two trading halts, SuperDot received 12,973 buy and 24,260 sell market orders.

A similar picture appears for system limit orders. On the 27th SuperDot received 285,852 buy and 327,476 sell orders (Table 7). The buy and sell imbalance was particularly severe between

the two trading halts, when SuperDot received 44,508 sell and 16,313 buy limit orders (Chart 25).

3.3.b. Market and Limit System Orders on October 28

The ratio of system market orders to all system orders was 32 percent on October 27 identical to the average for the year. On October 28, however, the ratio of market system orders to all system orders was 46 percent, substantially higher than usual. Charts 26 and 27 show that the submission of market and limit orders on October 28 was skewed towards the early part of the trading day, especially between 10:00 and 11:00 when the market started re-bounding. On the 28th between 10:30 and 11:00, SuperDot received 88,675 market system orders compared to 15,282 on October 21. During the same interval on October 28, SuperDot received 74,916 limit orders compared to 33,998 on October 21.

Chart 28 examines the balance between market and limit system orders on October 28. Throughout the day, the ratio of market to all orders was higher than usual, fluctuating between 39 percent and 49 percent most of the time but reaching a peak of 54 percent during the 10:30 interval. This suggests that the demand for immediacy was high on October 28.

Table 7 shows that on October 28 buy market system orders far exceeded sell market orders: SuperDot received 403,091 buy and 268,330 sell market orders. The submission of limit orders was more balanced with SuperDot receiving 436,356 buy and 366,985 sell limit orders. Charts 29 and 30 show buy and sell orders by half-hour interval.

4. Trades

We next turn our attention to trades and examine whether on October 27 and 28 the distribution of trade size was different than usual. The "trade size" data come from the NYSE's daily Consolidated Trades (CT) files.[6] The CT files contain the "report time," share size and price of each "Tape print." The "report time" is the time the specialist reports the trade to the Tape. Usually the execution time and the report time is the same. Specialists, however, execute orders and report the trade times separately so there may be a few seconds slippage between the trade and report time. Another complication: Tape prints usually correspond to trades, but occasionally SuperDot and the specialist "bunch" trades and report them to the Consolidated Tape as one print.

4.1 Bunching

Bunching occurs routinely at the opening and at the close where SuperDot matches a large number of orders in a call auction setting and reports them to the Tape as one print.[7] Bunching may, however, also occur during continuous trading at any time during the trading day. Consider the following example: three buy markets orders 1,000 shares each are flashing on the specialist's Display Book, there is a 2,000-share and a 1,000-share sell limit order at the ask and no trading crowd. The specialist executes the three buy orders against the two sell orders. Two trades have just taken place: (a) two 1,000-share market buy orders traded against the 2,000-share sell order (trade size=2,000) and (b) the remaining 1,000-share market buy order traded against the 1,000-share sell order (trade size=1,000). The specialist through SuperDot

[6] This is the same data set available on the NYSE's TAQ CD-ROM. We include all NYSE –listed issues and exclude "sold last" (COND=L) and "Sold Sale" (COND=Z) trades.

[7] Possibly two prints at the close. For a discussion of the closing prints see Hasbrouck, Sofianos and Sosebee (1993)

may report this transaction to the Tape as two prints corresponding to the two trades or bunch them into one 3,000-share print.[8]

We do not have data on trade size, so we use the Tape print size as a proxy for trade size. Because of the slippage between trades and prints caused by bunching, we may erroneously interpret an increase in print size as reflecting an increase in trade size while in fact it reflects more bunching. More bunching is particularly likely on October 28 with its record trading volume. A proxy for the amount of bunching is the average number of SuperDot orders per trade. In 1996 the average ratio of SuperDot orders to trades was 1.7; for January through November this ratio was again 1.7. Table 6 shows that on October 21 this ratio (excluding the opening print) was 1.6 and on October 27 it was 1.7. On October 28, however, the ratio increased to 2.1.

Charts 31 and 32 look at bunching (measured as the ratio of system orders to trades) by half-hour interval. The ratio is typically high at the opening because of the opening call. On October 21, for example, during the first 30 minutes of trading the ratio was 2.7 compared to 1.7 for the rest of the day. After the opening, the ratio usually remains roughly the same throughout the day. In Chart 31 October 27 looks like October 21 except between the two trading halts when the bunching ratio rose to 2.5 (compared to 1.7 for the corresponding period on the 21st). The increase in bunching during this period reflects the bunching of orders in the re-opening print[9] but may also reflect the increased order flow throughout the period.

Chart 32 shows that on October 28 bunching was higher than usual throughout the day. The difference is most notable in the first 30 minutes of trading when the ratio on the 28th was 4.9 compared to 2.7 on the 21st. Most of the bunching during this period reflects an exceptionally

[8] The default set-up for the Display Book is "group reporting," so that if the specialist simultaneously executes the 5 orders the Book will report them to the Tape as one print.

[9] SuperDot market and limit orders were accumulating throughout the first trading halt (see section 7); a lot of these orders were executed in a bunched mode when the market re-opened.

busy opening call. The average opening print size on the 28th was 21,000 shares compared to 8,000 shares on October 21 and 7,000 shares on October 27 (Table 6).

On October 28, almost all stocks opened by 10:30, nevertheless bunching remained high after that (presumably because of the exceptionally high order traffic). Between 10:30 and 11:00, for example, the bunching ratio on the 28th was 3.0 compared to 1.6 for the corresponding period on the 21st.

The unusually high bunching between the two trading halts on October 27 and throughout the day on October 28 means that we must be careful in making inferences about trade size based on the observed Tape print sizes.

4.2 Tape Print Size

The last row in Table 6 shows that the average post-opening tape print was 2,247 shares on October 21, 2,220 shares on October 27 and 2,494 shares on October 28. Charts 33 and 34 look at the average print size over half-hour intervals on October 21, 27 and 28.[10]
Chart 33 shows that the average print size on October 27 was close to the average print size on October 21 throughout the day except between the two trading halts. Between the two trading halts the average print-size was 2,844 shares compared to 2,152 during the corresponding period on October 21. Most of the increased print size during this period arose because of more bunching and does not reflect a dramatic shift in trade size (or the mix of market participants). Chart 9 does show, however, a slight increase in order size during this period.

[10] We adjusted the October 27 intervals to take account of the trading halts. We extended the 14:00 interval through the first trading halt moving trades that are time-stamped during the first trading halt to this interval. The 14:30 – 15:00 interval covers the first trading halt; the 15:00 – 15:30 interval covers the period between the two trading halts (15:06 – 15:30). We moved trades time-stamped shortly after 15:30 to this interval and we drop 21 trades time-stamped after 15:37. For more details see Table A1 in the Appendix.

Chart 34 shows that the average print size on October 28 was consistently higher throughout the trading day than on October 21. The average post-opening print size was particularly high during the first two hours of trading. Between 10:30 and 11:00, the average print size on October 28 was 3,355 shares compared to 2,310 shares on October 21. The larger print size for October 28 is the result of increased bunching (Chart 32) and does not indicate heavier institutional participation in the market. In fact, the opposite was the case: individual investor participation on October 28 was higher (Chart 16) and order size was lower (Chart 10) than usual.

5. Spreads

Table 8 shows that spreads on October 27 and 28 were higher than usual. The Table lists three spread measures: unweighted, trade-weighted and volume-weighted dollar spreads (in cents). The unweighted average spread is a simple average of NYSE quoted spreads. The trade-weighted spread is the average value of dollar spreads in effect when a trade takes place. Volume-weighted spreads are the same as trade-weighted spreads except each observation is "weighted" by the size of the trade. In our discussion we will focus on trade-weighted spreads. We calculate spreads using data from the NYSE's daily Consolidated Quotes (CQ) data files and the trades in the NYSE's CT files.[11]

The average trade-weighted spread was 19 cents on October 27 and 22 cents on October 28. By comparison, the trade-weighted spread was 14 cents on October 21 and also averaged 14 cents in September. Spreads, therefore, widened substantially on October 27 and 28.

Charts 35 and 36 examine trade-weighted spreads in more detail.[12] On October 27 until 11:00 spreads were only slightly wider than on October 21 (Chart 35). Between 11:00 and 11:30 on October 27 as the morning decline in prices accelerated (SideCar was triggered at 11:00) spreads widened substantially averaging 19 cents compared to 14 cents on October 21. Spreads narrowed over lunch as prices started rebounding but then widened again after 12:30 when the market started dropping again. Between 12:30 and the first trading halt spreads on October 27 averaged 20 cents compared to 14 cents on October 21. Between the two trading halts spreads increased even further averaging 25 cents, double their usual level.

[11] These data are publicly available on the NYSE's TAQ CD-ROM database. In our calculation of spreads we only use NYSE quotes in common and preferred stocks; quotes posted between 9:30 and 16:15; bid not equal to zero, offer greater than the bid, MODE=0, 1, 2, 3, 6, 10 or 12. We filter the trade data as follows: NYSE trades in common and preferred stocks; "good" trades (CORR=0 or 1), COND not equal L or Z. We also dropped trades when the immediately preceding quote did not satisfy our selection criteria.

[12] Charts A1 through A4 in the Appendix repeat the analysis for volume-weighted and unweighted spreads.

Chart 36 shows spreads on October 28. In the first half-hour of trading spreads averaged 25 cents (compared to 18 cents on October 21); between 10:00 and 11:00 when the market made its spectacular turnaround spreads widened further averaging 27 cents. After 11:00 spreads narrowed somewhat averaging 20 cents for the rest of the day, still substantially higher than their usual level (14 cents).

6. Opening delays

In this section we examine the opening of NYSE-listed stocks on October 27 and 28.[13] On the NYSE stocks open either with a trade or a quote.[14] We therefore calculate the opening time for each stock as the time of the opening trade or the opening quote whichever came first. We use quote data from the NYSE's daily CQ files and trade data from the NYSE's daily CT files.

Table 9 and Chart 37 show the number of stocks that had not opened at different times after the 9:30 opening bell. By 9:35 on October 21, 886 stocks had not yet opened compared to 1,187 stocks on October 27 and 2,220 on October 28. By 9:45 on the 21st, 34 stocks had yet to open, 75 stocks on the 27th and 856 stocks on the 28th. By 10:00, the corresponding numbers were 2, 8 and 208 stocks.

Table 10 shows that on October 21, stocks on average opened 3.8 minutes after 9:30, on October 27 stocks opened 4.4 minutes after 9:30 and on October 28, 10.7 minutes after 9:30. Table 10 also shows that while on October 21, 1360 stocks opened with a quote, on October 28 only 785 stocks opened with a quote. Finally, Table 10 shows the number of stocks that did not trade at all on each of the three days: 245 on October 21, 233 on October 27 and 185 on October 28.

Occasionally specialists may report an opening trade in the correct sequence but at a later time.[15] Table 10 shows that on October 21, specialists reported late 19 opening trades, on October 27 they reported late 32 opening trades and on October 28, 264 opening trades. We kept these opening trades in our sample, so the opening time statistics we report exaggerate slightly (especially on October 28) the opening delays.

[13] Our sample includes all NYSE-listed common stocks, preferred stocks, when-issued etc.
[14] On October 21, for example, 1,360 stocks opened with a quote and 1,284 stocks opened with a trade (see Table 10).
[15] The CT data files identify these opening trades with COND=O.

In Tables 11 and 12 we focus on October 28 and examine in more detail the opening times of all NYSE-listed issues. We rank stocks according to their trading volume in September 1997 and then group them into volume deciles. Decile 1 consists of the 354 most active NYSE-listed stocks and decile 10 the 355 least active.[16] Table 11 shows that on October 28 active stocks opened more slowly than inactive stocks. At 9:35, 285 of the 354 most active stocks (decile 1) had not opened compared to 155 of the 355 least active stocks (decile 10). At 9:45, 148 of the most active stocks had not opened compared to 43 of the least active. By 10:30 all but two of the most active stocks had opened. The two decile 1 stocks that had not opened by 10:30 were BBY (Best Buy Co Inc.) which opened with a trade at 10:53:49 and YPF (YPF Sociedad Anonima) that opened with a trade at 10:30:41.

Table 12 and Chart 38 show that on October 28, the 354 most active stocks opened on average 15.5 minutes after 9:30 while the 355 least active stocks opened 7.4 minutes after 9:30. The Table also shows that, not surprisingly, less active stocks are more likely to open with a quote rather than a trade.

[16] Because we use September volume to rank stocks, the deciles sample has 3,548 stocks compared to 3,653 stocks for the overall sample; the difference being the stocks listed after September 30.

7. The October 27 Trading Halts

At 14:35:55 on October 27, the DJIA was down 350 points, triggering a half-hour market-wide trading halt in accordance with the NYSE's Rule 80B. At this time, the Exchange rang the bell on the trading floor and announced the halt to off-floor market participants by disseminating the following message:

"In compliance with NYSE Rule 80B, the New York Stock Exchange equity trading been halted due to a 350 point decline in the Dow Jones Industrial Average. The market will re-open at 15:06. Additionally price imbalances in the designated expiration stocks will be published followed by appropriate size indications of 50,000 shares or more prior to resumption of trading."

This message appeared simultaneously on the Tape, on the Inter-market Trading System and on the Inter-market Communications Network and was delivered to all SuperDot member firms through the CMS switch. On the floor, the same message was announced over the Trading Floor Public Address System and was displayed on the Trading Floor Message Board.

The NYSE's Rule 80B circuit breakers "have been coordinated with (i) all other United States stock exchanges and the National Association of Securities Dealers with respect to the trading of stocks, stock options, and stock index options; and (ii) all United States futures exchanges with respect to the trading of stock index futures and options on such futures."[17] When the NYSE halted trading, therefore, all these other markets should also have stopped trading.

The market re-opened at 15:06:00. The Exchange announced the re-opening by ringing the bell on the floor. At this time, the Exchange did not disseminate any special re-opening message over the Tape.

[17] NYSE Information Memo Number 97-7, February 3, 1997.

At 15:30:00, the DJIA was down 550 points. At this point the Exchange halted trading for the rest of the day. The Exchange rang the closing bell on the floor and disseminated the following message:

"In compliance with NYSE Rule 80B, the New York Stock Exchange equity trading been halted due to a 550 point decline in the Dow Jones Industrial Average. The New York Stock Exchange equity market will not resume trading today. There will be no crossing sessions tonight. Trading will resume, as usual, at 9:30 am on Tuesday, October 28."

Together with this message, the Trading Floor Message Board and the Trading Floor Public Address System made the following additional announcement: "Specialist are instructed to enter closing quotations now." Again, when the NYSE halted trading, equity trading on the regional exchanges, in the over-the-counter market and in equity derivatives should also have stopped.

7.1 Activity during the trading halts

Order submission

During the first trading halt, SuperDot remained open receiving orders and delivering them to the specialists' electronic book on the floor of the Exchange. According to the NYSE's Rule 80B implementation guidelines, during this period specialists should have activated OARS from their Display Books.[18] This would allow orders to accumulate in the OARS file in preparation for the re-opening.

Charts 21 and 22 show that both market and limit system order traffic during the halt was sharply lower relative to the half-hour periods immediately before and after the halt. Order

[18] OARS is the NYSE's Opening Automated Report System. Pre-opening market orders reach OARS electronically through SuperDot where they join floor broker (crowd) orders entered into the system by the specialists. OARS stores the pre-opening SuperDot and crowd-entered orders and continuously pairs buy and sell orders, presenting the imbalance to the specialist up to the opening of each stock.

traffic was also lower relative to the corresponding period on October 21. The reduced order traffic during the halt may either reflect reluctance by market participants to submit orders while the market was closed or indicate that market participants were not aware that they could submit orders during the halt.

Table 13 provides more details on the system orders submitted during the halt. Between 14:36:00 and 15:05:59, SuperDot received 19,877 orders: 8,685 limit and 11,192 market orders; 10,206 buy and 9,671 sell orders.[19] SuperDot received 1,561 orders during the first minute after the halt and 750 orders during the second minute. After 14:40 the pace of order submissions accelerated. SuperDot, for example, received 4,626 orders between 15:00 and 15:05 and 1,481 orders in the minute before the re-opening.

At 15:30:00 the second trading halt was triggered and the NYSE closed the market for the rest of the day. At this point, the NYSE turned off the CMS switch of the SuperDot system so that SuperDot could not receive orders from outside the Exchange. Nevertheless, the NYSE's System Order Data file for October 27 shows that SuperDot did receive some orders during this period.

Table 13 shows that SuperDot received 4,006 orders after 15:30:00. SuperDot received almost all of these orders in the two minutes immediately after the halt was triggered: 3,214 orders between 15:30 and 15:31 and 727 orders between 15:31 and 15:32. Most probably these orders slipped through before the NYSE turned off the CMS switch (the process takes a couple of minutes). SuperDot received a trickle of orders after 15:32 (about two orders per minute). One possibility is that NYSE floor brokers entered these late orders into SuperDot from the floor of the Exchange.

Trades

[19] The specialists executed the market orders they received during the halt (unless they were cancelled) when the market re-opened.

Data from the NYSE Consolidated Trade file summarized in Table 14 shows that some trades have time stamps during the trading halts: 563 trades during the first trading halt and 1,645 trades during the second trading halt. Most of these trades have time stamps during the first 60 seconds after the halts were triggered and almost all of them have time stamps during the first three minutes of the halts. These trades were executed before the trading halt but were reported to the Tape with a slight delay.

Quotes

Data from the NYSE's Consolidated Quote (CQ) data file also summarized in Table 14 shows a trickle of quote activity during the halts. Specialists posted 1,097 quotes during the first trading halt. By comparison, during the corresponding period on October 21 specialists posted 35,910 quotes (44,092 quotes on October 28). After the second trading halt at 15:30, specialists posted 6,590 quotes. After 15:30 on October 21 specialists posted 47,063 quotes (51,244 quotes on October 28).

The CQ data file identifies all the quotes posted during the first trading halt as mode=12 "regular quotes" indicating normal trading environment. Almost all of this quote activity occurred during the first three minutes after the halt: the specialists posted 868 quotes during the first minute after 14:36, 163 during the second minute and 37 during the third.[20] These quotes probably reflect the trailing off of trading during the first few minutes after the halt.

During the second trading halt, the data identify 2,474 of the quotes as mode=12 "regular quotes" and the remaining 4,116 as mode=3 "closing quotes." Specialist posted most of the "regular quotes" during the first few minutes after the halt: 1,074 during the first minute, 453 during the second and 153 during the third. Quote activity slowed down between 15:34 and

[20] The specialists electronic display books have a "quote-assist" feature: specialists have 30 seconds to expose orders (e.g., execute or change the quote to reflect the order); after that, the system changes the quote automatically. Quote-assist generated 87 quotes during the halts, 57 of them between 14:37 and 14:38.

15:40. After 15:40 the data show that specialists started posting closing quotes: between 15:40 and 16:15 the specialist posted a total of 4,073 closing quotes; 2,410 of these quotes were posted between 16:09 and 16:13.

Quote Indications

The Exchange requires "dissemination of an indication upon any delayed opening or regulatory and nonregulatory trading halt, except for a trading halt put in effect pursuant to the "circuit breaker" provisions of Exchange Rule 80B."[21] On October 27, therefore, the Exchange did not require specialists to post indications during the trading halts. Indeed, according to the data in NYSE's CQ data file, specialists did not post any quote indications during the two trading halts.

The Exchange, however, requires specialists to post quote indications "for an opening which will result in a price change constituting the lesser of 10% or three points from the prior NYSE close…..These guidelines shall be effective prior to any openings as well as for the reopening of trading following a trading halt instituted pursuant to the "circuit Breaker" provisions of Exchange Rule 80B." [22] This statement suggests that the Exchange wants the re-opening after an 80B trading halt to be similar to the daily 9:30 opening call. On October 27, after the 15:06 re-opening, specialists posted only two "order imbalance" quote indications, one at 15:18 and the other at 15:21.[23] Several trading halts due to price imbalances, however, were announced following the resumption of trading on October 27.

7.2 Re-opening after the 350-point trading halt

[21] NYSE Information Memo Number 88-30, October 20, 1988.
[22] NYSE Information Memo Number 88-30.
[23] In the CQ file these two quotes are identified by mode=7 which indicates a non-regulatory halt used when there is a severe buy or sell order imbalance.

After the first trading halt, the market re-opened at 15:06:00. In this section we examine the re-opening. We define each stock's re-opening time as the time of the post-15:06:00 re-opening trade or the post-15:06:00 re-opening quote whichever came first.

Table 15 and Chart 39 show that by 15:10:00, four minutes after the re-opening 1,242 stocks have not re-opened. Five minutes later, at 15:15:00, all but 231 stocks had re-opened. By 15:30:00 all but 14 stocks had re-opened. After the trading halt was lifted at 15:06:00, it took an average of 3.7 minutes for all NYSE-listed stocks to re-open.

Table 15 also shows the timing of the re-openings by trading volume decile. The active stocks, on average, re-opened faster.[24] By 15:10 all but 74 of the 354 most active stocks had re-opened, by 15:15 all but 11 of the most active stocks re-opened, and by 15:25 all but 3 had re-opened. The three decile 1 stocks that have not re-opened by 15:25 were: (a) CNC (Conseco Inc.), it re-opened with a trade at 15:28:53; (b) NOKA (Nokia Corp.), it re-opened with a trade at 15:25:29 and (c) WY (Weyerhaeuser Company), it finally re-opened with a trade at 15:28:13.

[24] On October 28, the active stocks were on average slower in opening in the morning (Table 11).

8. Specialist trading

In this section we concentrate on the 30 DJIA stocks and examine various aspects of specialist trading on October 27 and 28. Table 16 shows the times of the opening and closing trades for these stocks on October 27 and 28.[25] The average time of the opening trade on October 27 was 9:34:08; the average opening trade time on October 28 was 9:44:12. Table 16 also shows the time stamps on the last trades before the 350- and 550-point trading halts as well as the time of the re-opening trade after the 350-point trading halt was lifted. The time stamps of the last trades prior to the 350-point trading halt ranges from 14:34:37 (JPM) to 14:37:25 (KO). Even though the NYSE imposed the trading halt at 14:35:55, 17 of the 30 DJIA show a time-stamp a few seconds after that time suggesting a slight delay either in the recording of trades or the actual execution.

The time stamps of the last trades prior to the 550-point trading halt ranges from 15:29:19 (UTX) to 15:33:18 (MO). Again, just like the 350-point halt, even though the NYSE imposed the 550-point halt at 15:30:00, the last trades on several DJIA stocks show a time-stamp a few seconds after the trading halt time. Table 16 also shows the time of the first trade after the NYSE lifted the 350-point halt at 15:06:00. The re-opening times range from 15:06:08 (JPM) to 15:17:34 (UTX). Finally, Table 16 shows the times of the opening trades for the 30 DJIA stocks on October 28. The opening trade times range from 9:30:16 (EK) to 10:06:43 (IP).

8.1 The role of the specialist

When a stock lists on the NYSE, the Exchange through its Allocation Committee assigns the

[25] The times in Table 16 are from the NYSE's daily Consolidated Trade (CT) files. Trade data are from the NYSE's daily Consolidated Trade (CT) files. We included "good" trades (CORR=0 or 1), COND not equal L or Z. A few opening trades were coded "opened last" indicating that the opening trade was reported late. We kept these trades in our sample.

stock to a particular specialist unit.[26] Each NYSE-listed issue trades at a unique location on the floor of the exchange where orders converge electronically through SuperDot or are represented by floor brokers. For the most part, the specialist acts as an auctioneer matching buy and sell orders, maintaining the electronic order book, exposing SuperDot orders to the floor brokers (the "crowd") and supervising the trading process in general. Occasionally, however, specialists augment liquidity by buying and selling stock on their own account acting essentially as "liquidity suppliers of the last resort."

Several Exchange rules govern specialist proprietary trading transactions. Most importantly, at a given price the specialist proprietary trades are always last in line. If for example the bid is $10 and there is a public limit order at the bid, the specialist cannot buy at $10 until after the public order executes.

The Exchange imposes both "affirmative obligations" and "negative obligations" on the specialists. The affirmative obligations require the specialists to engage in proprietary trading to assist in the maintenance of a fair and orderly market. For example, the NYSE expects specialists to provide "price continuity" by keeping transaction-to-transaction price changes as small as possible. The Exchange also wants specialists to short-term "stabilize stock price movements by buying for and selling from their dealer accounts against the prevailing trend of the market, i.e., to purchase on minus and zero minus ticks, and sell on plus and zero plus ticks."[27] The negative obligations limit specialist proprietary trading to those reasonably necessary to maintain a fair and orderly market.

The Exchange uses several programs to measure specialist performance, including (1) specialist capital utilization, which focuses on a specialist unit's use of its own capital in relation to the total dollar volume of trading activity in the unit's stocks; (2) the "near neighbor" approach which compares the performance in a stock over "rolling" three-month periods to the performance of

[26] Since January 1998, an about-to-be-listed company working with the Allocation Committee may chose to interview and select a particular specialist unit. This change was introduced on a pilot basis in March 1997.
[27] See for example NYSE Information Memo, Number 97-55, December 15, 1997.

stocks with similar trading characteristics; (3) quarterly questionnaires and (4) the standards of acceptable performance specified in NYSE Rule 103. Information on these measures is supplied to the Exchange's Allocation Committee for its use in determining the allocation of newly-listed companies.

8.2 Data on specialist trading

The specialist trading data on the 30 DJIA stocks come from the NYSE's daily Specialist Equity Trades (SPET) file. The SPET file contains transaction-by-transaction specialist trades from two sources: (a) "Form 81" specialist self-reported principal transactions (including daily opening inventory position per stock) and (b) NYSE equity audit trail data.

The SPET file matches each "eligible" Form 81 specialist trade with the corresponding audit trail specialist trade. A Form 81 trade is eligible for matching to the NYSE audit trail if it represents specialist participation in a trade that occurs on that day and the trade was reported to the Tape.[28] Most ineligible Form 81 trades are Odd Lot Advisory (OLA) records or "as of" trades. These trades do not have audit trail counterparts.

SuperDot automatically executes odd lot trades against the specialists' inventory. SuperDot does not, however, report these trades to the specialist as they occur. The specialist learns of odd-lot transactions through an Odd-Lot Advisory (OLA): the specialist's odd-lot position accumulates over time until it reaches a threshold level at which point SuperDot issues an OLA informing the specialist of the cumulated position.[29] The specialist may then trade out of the position. A single OLA will generally cover multiple odd-lot transactions. The odd-lot transactions are never reported to the Tape. "As of" transactions are adjustments to specialist inventories caused by unmatched previous-day trades that are assumed by the specialist.

[28] Eligible Form 81 specialist trades are marked ELIG=Y in the SPET file.
[29] The specialist sets the threshold for notification (usually 300 to 1200 shares in either direction).

There is one further complication: a Form 81 specialist trade may not be matched to an audit trail not only because the Form 81 trade is ineligible but also because the audit trail contains no matching trade; we call these trades "unmatched form 81 trades." Table 17 summarizes the discrepancies between Form 81 specialist trades and audit trail specialist trades. These discrepancies are important because the specialist inventory numbers may differ non-trivially depending on whether we use Form 81 or audit trail data. The problem with the "ineligible" and "unmatched" trades is that their time-stamps do not represent the true times of the trades. They do, however, represent true changes in the specialist's inventory positions.

In our calculations of the specialist participation and stabilization rate we only use the audit trail data. We calculate specialist inventories, however, both ways: using the audit trail and Form 81 data. While the audit trail data give a more accurate depiction of the specialist transactions at a particular point of time, the Form 81 data represent more accurately the specialist's inventory position at a particular point of time (as perceived by the specialist).

In calculating the specialist inventory position we always start with the specialists daily opening positions as reported by the specialist in Form 81. Not surprisingly, while each days Form 81 closing inventory position is close to the next day's Form 81 opening position (specialists typically do little trading while the NYSE is closed), the audit trail closing position may differ substantially from the next day's Form 81 opening position. For example, if most odd lot orders during a day were sell orders, the closing position based on the audit trail data will be lower that the Form 81 closing and next day's opening position. Table 17 shows that on October 27 the average Form 81 specialist closing position was 46,522 shares, close to the average Form 81 opening position on October 28 (45,753 shares). The average audit trail closing position, however, was 37,262 shares, almost 10,000 shares less than the corresponding Form 81 position. This large discrepancy suggests that on October 27 the specialists bought a lot of shares trading with sell odd-lot orders.

8.3 Specialist inventory behavior

Chart 40 shows the average specialist dollar inventory position per stock at 5-minute intervals on October 27.[30] At time 0:00, the chart shows the average pre-trade opening inventory. Until a stock's opening trade, we calculate the dollar value of the inventory using the previous trading day's closing price. On October 27, for example, the opening trade for symbol BA occurred at 9:37:57. We therefore calculate the specialist inventory position at 9:30:00 and at 9:35:00 using the BA closing price on Friday, October 24.

Chart 40 also shows the average dollar price of the 30 DJIA stocks.[31] The average closing price of the 30 DJIA stocks on Friday, October 24 was $65.45 (time 0:00). On October 27 the average "closing" price (the price after the second trading halt) was $60.78 cents, a 7 percent decline from the previous close.

Table 18 summarizes the highlights from Chart 40. On October 27, the specialists' average pre-trade opening inventory position (priced at the previous close) was $ 0.75 million (11,862 shares) per stock. As prices dropped in the first 10 minutes of trading, specialists almost tripled their inventory so that by 9:40 their average position was $ 1.98 million (30,541 shares) per stock. The subsequent fluctuations in the specialists' positions mirror the price fluctuations. During intervals when prices were rising, specialist positions dropped; during intervals when prices dropped specialist positions rose. At 12:20 the average specialist position reached its lowest level for the day: $ 0.61 million (8,442 shares) per stock. By 14:00 the average position was up to $ 2.17 million (37,195 shares) per stock; the market briefly rebounded after that giving specialists the opportunity to re-liquify. When trading stopped for the 350-point trading halt at 14:35:55 the average specialist inventory position was $ 1.12 million (18,135 shares) per stock. Between the two trading halts, 15:06:00 to 15:30:00, the market dropped sharply with

[30] Chart A5 in the appendix shows the specialist inventory position per stock in shares.
[31] Price data come from the NYSE's daily CT files. We calculate the average price as follows: for each stock we take the last trade price in each five minute interval and then average (unweighted) across the 30 stocks. Until a stock opens we use the previous day's closing price in calculating the average.

the average price dropping from $62.48 to $60.78 in less than 30 minutes. During this period, in 25 minutes, the average specialist inventory position shot up from $ 1.12 million per stock to $ 2.74 million (47,564 shares) at 15:35:00.

Chart 41 repeats the analysis for October 28 (Table 18 summarizes).[32] On October 28 the average price dropped to its lowest point ($59.21) by 10:05 but then recovered and closed the day at $63.60. The most remarkable feature of specialist trading on October 28 is the speed with which the specialists unwound their positions as soon as prices started rising. The average specialist inventory position peaked at $ 4.28 million (74,016 shares) per stock at 9:55:00. The average price started rising after 10:05:00. By 10:30:00 specialists were short on average $ 0.3 million (4,249 shares) per stock; by 10:45:00 specialists were short $ 2.03 million (28,704 shares) per stock. The average specialist inventory position at the close was $ 0.59 million (9,564 shares) short per stock. From the opening value on October 27 to the peak value at 9:55:00 on October 28 the value of the average specialist inventory position increased almost six times.

In Charts 40 and 41 we calculate the specialist inventory positions using Form 81 data. At each point of time the specialist inventory position includes the OLA odd-lot information, "as of" adjustments and unmatched Form 81 trades, even though the time stamps on these trades do not reflect the true trade time. This slippage in timing explains, for example, the slight changes in specialist inventory positions observed in Chart 40 during the two trading halts.

Charts 42 and 43 repeat the analysis of specialist inventory using the audit trail data (Table 18 summarizes).[33] The audit trail data excludes the OLA information, "as of" adjustments and unmatched trades. The inventory patterns in Charts 42 and 43 are similar to the Form 81 inventory patterns in Charts 40 and 41 except that the average audit trail inventory level is consistently lower than the corresponding Form 81 inventory position. Most of the slippage

[32] Table A6 in the Appendix shows specialist share inventory per stock.
[33] Tables A7 and A8 in the Appendix repeat the analysis, using specialist share inventory per stock.

occurs prior to the opening when a series of "As of" adjustments only reflected in the Form 81 data creates a wedge between the two inventory series.[34] On October 27, by 9:40 the audit trail average inventory position per stock was $1.86 million, $120,000 lower than the Form 81 inventory position. The gap widened progressively throughout the day: by 12:20 the difference was $250,000; by 14:00 it was $540,000 and by the second trading halt $660,000 per stock. The audit trail inventory position falling increasingly below the Form 81 position, suggests a preponderance of sell odd-lot orders.

Similar patterns are observed on October 28. By 9:55 the average audit trail inventory position was 68,667 shares, about 5,500 shares less than the corresponding Form 81 position. By 10:45 the gap widened to almost 8,000 shares but then started shrinking so that at the close of the day the audit trail inventory position was only 4,446 shares below the corresponding Form 81 position.

8.4 Specialist participation

We next turn to an examination of the specialist participation rate in the 30 DJIA stocks. We define the overall specialist participation rate as the sum of specialist purchases and sales divided by twice trading volume. We also examine separately the buy specialist participation rate (specialist purchases divided by single-counted volume) and the sell participation rate (specialist sales divided by single-counted volume).

Table 19 presents the summary picture. The unweighted specialist participation rate on October 27 was 14.6 and on October 28 15.3 percent.[35] The corresponding volume-weighted figures are 14.0 and 15.3.[36] For comparison purposes the Table calculates participation rates

[34] The pre-opening inventory position is the same for both Form 81 and Audit Trail inventory series.
[35] We calculate the participation rate for each stock and then average across the 30 stocks.
[36] In the volume-weighted participation rate we divide total specialist purchases plus sales by total purchases plus sales.

using both Form 81 and audit trail data. The numbers are very similar so for the rest of the section we focus on the rates based on the audit trail data.

October 27

Chart 44 shows the specialist participation rate at 15-minute intervals on October 27. Time intervals are denoted by their starting time: the 9:30 interval, for example, covers the time period starting at 9:30:00 through 9:44:59.[37] Chart 44 shows the *unweighted* average participation rate: for each 15-minute interval we calculate the specialist participation rate for each DJIA stock and then average across the 30 stocks. In this way, each DJIA stock carries equal weight in the calculation of the average.[38] On October 27, the unweighted average specialist participation rate reached a high of 18.9 percent between 14:00 and 14:15 and dropped to between 10 and 11 percent between the two trading halts.

Charts 45 through 47 examine the specialist participation rate on October 27 in greater detail. Of particular interest is the relatively low specialist participation rate between the two trading halts. Chart 45 shows the unweighted average specialist participation rate separately for specialist buys and sells.[39] On October 27 the specialist buy participation rate for the whole day was 15.1 percent while the specialist sell participation rate for the day was 14.1 percent. During the 15-minute intervals the market was falling most sharply (9:30-9:45, 13:00-13:15, 13:45-14:00 and between the two trading halts) the specialist buy participation rate is much higher than the specialist sell participation rate. In the first fifteen minutes of trading, for example, the specialist buy participation rate was 22.2 percent compared to a 9 percent sell

[37] As usual, we extend the 14:15 interval (right before the first trading halt) to include all the trading from 14:15:00 through to the first trading halt. Similarly, we extend the 15:15 interval to include all the trading from 15:15:00 through to the second trading halt (including trades with time-stamps after 15:30.00).

[38] Chart A9 in the appendix repeats the analysis using the *volume-weighted* average specialist participation rate: for each 15-minute interval we aggregate specialist purchases and sales across all 30 stocks and then divide by twice the total volume across all stocks. This procedure is equivalent to taking the volume-weighted average of the 30 specialist participation rates. In the volume-weighted average, stocks that were more traded in a particular interval are more heavily weighted in the average for that interval. The volume-weighted averages are similar to the unweighted averages.

[39] Chart A10 in the appendix repeats the analysis for the volume-weighted averages.

participation rate. Between 15:15 and 15:30, right before the second trading halt, the specialist buy participation rate was 14.9 percent compared to a 6.7 percent sell participation rate.

Chart 45 shows a high specialist sell participation rate between 14:00 and 14:15, 15 minutes before the first trading halt. During this period, the market recovered briefly giving specialists the opportunity to reliquify: the specialist sell participation rate was 25.7 percent during this interval.

The most interesting feature of Chart 45 is, however, how closely balanced the specialist buy and sell participation rate is even within 15-minute intervals. This observation is reinforced in Charts 46 and 47 where we show the number of shares specialist bought and sold during each interval. On October 27, in the 15 minutes before the first trading halt, for example, the specialists in the 30 DJIA stocks bought 1.1 million shares; over the same interval they sold 1.1 million shares (over this interval specialists were in fact net *sellers* for 60,000 shares).

Chart 47 shows specialist net buying (in shares). On October 27, specialist net buying at 15-minute intervals fluctuated narrowly around zero most of the time (between a total of 200,000 shares net buy and 200,000 shares net sell in all 30 stocks). The main exceptions were the periods of particularly sharp price changes. The most notable such interval is the period immediately before the second trading halt when prices were dropping fast. During this time the DJIA stock specialists bought a net total of 700,000 shares in 15 minutes.

October 28

Chart 48 shows the unweighted average participation rate for October 28. The intraday pattern is an inverted u-shape: the specialist participation is relatively low at the open and the close and reaches a peak of almost 22 percent at 14:00. Chart 49 shows the unweighted average

specialist participation rate separately for specialist buys and sells.[40] The specialist buy participation rate for the day was 14.7 percent while the sell participation rate was 15.9 percent. During the 15-minute period the market was rising most rapidly (10:15-10:30) the specialist sell participation rate was 28 percent.

Chart 50 shows the number of shares specialist bought and sold during each 15-minute interval. Finally, Chart 51 shows specialist net buying (in shares) on October 28. As on October 27, on October 28, specialist net buying at 15-minute intervals fluctuated narrowly around zero most of the time. The main exceptions, again were the periods of particularly sharp price changes. Between 10:15 and 10:30, for example, when prices were rebounding sharply the specialists bought 1.5 million shares and sold 2.9 million shares, a net sale of 1.4 million shares.

8.5 Specialist stabilization

Charts 52 and 53 present the specialist stabilization rate by 15-minute intervals (summary statistics in Table 19). The NYSE considers as "stabilizing" buy trades at a downtick or sell trades at an uptick.[41] The specialist stabilization is the sum of shares bought and sold by the specialist in stabilizing trades divided by the sum of all shares bought and sold by the specialist. Charts 52 and 53 show the *unweighted* stabilization rate for October 27 and 28 respectively.[42]

On October 27 (Chart 52), the average specialist stabilization rate in the 30 DJIA stocks was 84.8 percent. During the day, the stabilization rate fluctuated between 91.4 percent (9:30-9:45) and 76.1 percent (11:15-11:30). The stabilization rate was particularly high during intervals when prices were falling sharply. Between 13:15 and 13:30, for example, the specialist

[40] Chart A11 in the Appendix repeats the analysis for the volume-weighted averages.
[41] Downtick is when the previous price change was negative; uptick when the previous price change was positive. Consider the following sequence of trades: $32, $31, $31, $31; the last trade in the sequence is at a "downtick" since the previous price change was negative (from $32 to$31).
[42] Charts A13 and A14 in the Appendix present *volume-weighted* stabilization rates. The patterns are similar to the unweighted averages.

stabilization rate was 90.6 percent; during the interval immediately before the second trading halt, the stabilization rate was 85.2 percent.

On October 28 (Chart 53), the average specialist stabilization rate was 85.7 percent. During the day, it reached a high of 94.3 percent between 10:30 and 10:45 when prices were rebounding sharply.

9. Program Trading

Following the Crash of October 19, 1987 and then again after the market break of October 13, 1989, program trading attracted a lot of attention as a possible cause of (or at least an aggravating factor in) the steep decline in stock prices. In October 1987, regulators and other observers singled out portfolio insurance as a possible destabilizing factor.[43] In October 1989, they focused on index arbitrage. While the role portfolio insurance and index arbitrage played in 1987 and 1989 remains controversial, the attention these strategies received led to several changes. Portfolio insurance stopped after October 1987 while in 1988 the NYSE introduced the Rule 80A restrictions on index arbitrage (see Table 3).[44]

In this section we analyze program trading activity on October 27 and 28, 1997. The Exchange defines program trading as a wide range of portfolio trading strategies involving the purchase or sale of 15 or more stocks having a total market value of $1 million or more.[45] Since May 1988, the Exchange has required all member firms to file with the NYSE daily trade-by-trade reports of principal and customer account transactions that meet the NYSE's definition of program trading.[46] Among other information, member firms identify the type of program trading strategy, time of order submission, size of the trade and whether the transaction is buy or sell.[47] The NYSE uses this information to compile its weekly Program Trading Report, which it then releases to the media every Thursday afternoon.

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[43] See for example the report of the Presidential Task Force on Market Mechanisms (the Brady report).

[44] On January 14, 1988 the NYSE introduced, on a voluntary basis, an index arbitrage "collar." On that date the NYSE requested member firms to refrain from using SuperDot for doing index arbitrage whenever the DJIA moved 75 points from the previous day close. On February 4, 1988 the collar trigger was changed from 75 to 50 points. On April 21, the SEC approved the 50-point collar making it mandatory. The collar remained in effect until October 19, 1988 when it was replaced by the original Rule 80A (sidecar) and Rule 80B (trading halts). The SEC approved the current Rule 80A 50-point "index arbitrage" restriction on August 1, 1990. For more details of the history of the "collar" see New York Stock Exchange (1990) Appendix E.

[45] Index arbitrage is one example of a program trading activity. Other examples of program trading strategies are liquidation of facilitations, liquidation of EFP stock positions, and portfolio management, which includes portfolio realignment and portfolio liquidations.

[46] In addition, member firms must report index arbitrage trades of all sizes.

[47] Member firms do not report orders submitted and subsequently cancelled. For more details, see Sofianos (1993) and Harris, Sofianos and Shapiro (1994).

9.1 Trends in Program Trading

The daily program trading (DPT) reports show that over the past ten years, program trading changed dramatically. Chart 54 shows that program trading as a percent of NYSE volume increased over time, from 10 percent in 1988 and 1989 to 14 percent in 1996 and the first quarter of 1997.[48] Beginning in the second quarter of 1997, program trading jumped to 18 percent of NYSE volume.

Chart 55 shows that an even more dramatic change has been taking place in the mix of program trading strategies. In 1988 index arbitrage accounted for more than 50 percent of all program trading strategies. By 1995 this percentage was down to about a third and by the fourth quarter of 1997 index arbitrage was only 17 percent of program share volume (3 percent of NYSE volume).

The recent decline in index arbitrage was mainly caused by the growth of a new program trading strategy. BNP/Cooper Neff Advisors, a NYSE member firm, is the major user of this new strategy described in an article in the Wall Street Journal.[49] According to the article, BNP/Cooper Neff uses an econometric model to identify stocks that are underpriced (overpriced) relative to a benchmark and then buys (sells) the underpriced (overpriced) stocks in one or several program trades. The firm may trade S&P 500 futures to hedge the market risk of these program trades. Market practitioners refer to this strategy as "paired trading" (a misnomer since buy and sell stock trades need not be balanced).

Program traders in their DPT reports usually classify "paired trading" in the "Other" category. In 1997 "other" accounted for 30.0 percent of all program share volume. In the NYSE's

[48] We calculate daily program trading activity as the sum of the shares bought, sold, and sold short in program trades as a percent of total reported share volume.
[49] "Trading Vast Volumes, Stock Firm Consults Only Its 'Black Box,'" Wall Street Journal, December 16, 1997.

Weekly Program Trading reports BNP/Cooper Neff has been the leading program trader almost every week in 1997, averaging 20 million shares per day.

9.2 Program Trading on October 27 and 28

Table 20 shows that, overall, on October 27 and 28 program trading as a percent of total trading was not unusually high. On both days program trading was 16 percent of total volume, slightly lower than the average for the third quarter of 1997 (18 percent). Buy and sell program trading volume was fairly balanced: on both October 27 and 28, sell programs were 57 percent of total program volume.

Charts 56 through 58 reinforce the impression that program trading as a percent of all trading was not exceptionally high on October 27 and 28.[50] On October 21 the share volume of system sell program orders placed (not necessarily executed) was 24 percent of all system sell orders placed, on October 27 it was 34 percent and on October 28 it was 24 percent. Buy system program volume was 31 percent on October 21, 38 percent on October 27 and 23 percent on October 28. On October 27 the buy system program percentage actually exceeded the sell percentage.

Chart 57 shows that during the period of the sharpest price decline, between the two trading halts on October 27, system program volume accounted for about 50 percent of all system volume. 47 percent of sell system volume was program volume (13.9 out of 29.3 million shares) while 48 percent of system buy volume was program volume (7.6 out of 17.3 million shares).

[50] In these charts we use data from the NYSE's daily System Order Data (SOD) file to calculate system program volume as a percent of all system volume. The NYSE's requires member firms to indicate whether the buy and sell orders they submit through SuperDot are part of program trades.

Table 20 shows that on October 27 share volume in index arbitrage and other strategies subject to Rule 80A was 19 percent of all program volume.[51] On October 28 index arbitrage was 28 percent of all program volume. Surprisingly, index arbitragers were net buyers on October 27 when prices were falling and net sellers on October 28 when prices were rising.

Charts 59 through 61 show index arbitrage and non-index arbitrage buy and sell volume by half hour intervals on October 21, 27 and 28. Chart 60 shows that on October 27 the sell pressure from program trading was coming not from index arbitrage but from the strategies not subject to Rule 80A.

Table 21 provides a breakdown of the strategies not subject to Rule 80A. On October 27, the DTP reports classify 47 percent of these strategies as "other." Most of this activity represents "paired trading."

Table 22 focuses on the period between the two trading halts. During this period, sell program volume was 84 percent of total program volume. Of the sell program volume between the two trading halts, only 11.4 percent was subject to Rule 80A. During this same period, the "Not Subject to Rule 80A/Other" (most of it "paired trading") category accounted for 34.8 percent of the sell program volume.

9.3 S&P 500 Cash and Futures Pricing

Index arbitragers sell stocks (and buy futures) whenever the index futures contract trades at a discount to its component stocks. Conversely, arbitragers buy stocks (and sell futures) whenever the futures trades a premium to the cash. Futures prices tend to move faster than cash prices,[52] so in a sharply falling market futures would trade at a discount generating sell

[51] In addition to index arbitrage, some other strategies are also subject to Rule 80A. For more details see Table 3. These other strategies account for about 1 percent of the total volume subject to Rule 80A. The Exchange began classifying "other strategies subject to Rule 80A" as a separate group in 1995.
[52] See for example Harris, Sofianos and Shapiro (1994).

index arbitrage programs. In this section we examine index arbitrage and the relationship between S&P 500 cash and futures prices on October 27 and 28.

Charts 62 through 64 show the minute-by-minute "mispricing" between the S&P 500 cash index and the nearby S&P 500 futures contract traded on the Chicago Mercantile Exchange. We define the mispricing as the futures price minus the futures fair value (the value of the cash index plus carrying costs).[53] The cash and futures markets are tightly arbitraged: on a normal day the mispricing is between plus and minus just one index point. Chart 62, for example, shows the mispricing on October 21. For most of the day, the mispricing was less than one index point (within the shaded area). The only time the mispricing exceeded one index point was at the open and this most likely reflects the "staleness" of the cash index until all component stocks have started trading.[54] The mispricing on October 21 was low even though Rule 80A was in effect for most of the day.[55]

Chart 63 shows that the mispricing on October 27 was less than one index point until about 13:50 in the afternoon when for a few minutes the futures contract was selling at a sharp discount. This large negative mispricing should have generated a lot of sell index arbitrage programs. Surprisingly, the NYSE's program trading data in Chart 60 shows that between 13:00 and 14:00 sell index arbitrage programs amounted to only 355,000 shares (sell programs not subject to Rule 80A on the other hand amounted to 6.7 million shares). One reason for the small amount of index arbitrage is that Rule 80A was in effect.[56]

[53] For carrying costs we use the simple average of daily carrying costs estimates provided by two NYSE member firms active in index arbitrage. For more discussion of the cash-futures mispricing see Sofianos (1993).

[54] For component stocks that have not opened yet, Standards & Poors uses the previous closing price to calculate the value of the index.

[55] Rule 80A was triggered on the upside at 10:16 and remained in effect for the rest of the day.

[56] The early studies of Rule 80A, however, show that in 1990 and 1991 a reduced but still substantial amount of tick-sensitive index arbitrage used to take place when the Rule was in effect. See for example NYSE 's Rule 80A report (1991) and Overdahl & McMillan (1997).

At the time of the 350-point trading halt, the nearby S&P 500 futures contract was trading at the relatively large discount of 4 index points below its fair value. The trading halt froze the cash and futures markets in this "sell the cash" position, contributing to more sell pressure on the cash market at the re-opening.

When the market re-opened the mispricing widened to more than 15 index points. This large mispricing partly reflects the staleness of the cash index: it took several minutes for all S&P 500 component stocks to re-open (Table 15). The large mispricing, however, persisted throughout the period between the two trading halts. Again, even though the cash futures was selling at a huge discount to the cash for 24 minutes, sell index arbitrage volume was low (1.4 million shares).

When the market closed for the day at 15:30 the nearby S&P 500 futures contract was still trading at a large discount (10 index points). The discount between the cash and the futures market widened further overnight because of S&P 500 futures trading on Globex.

In October 1997, the S&P 500 pit trading hours were 9:15 through 16:15 eastern time. The Globex S&P 500 trading hours were 16:45 (30 minutes after the regular pit close) through 9:00 the next morning (15 minutes before the pit opening). The Globex session has tight price limits. While the daily price limit for S&P 500 pit trading is 90 index points down; the Globex session price limit is 15 index points in either direction from the previous pit close.

Table 23 shows than on October 27, the S&P 500 nearby contract ended the pit session valued at 874. The contract started the Globex session at 865 and quickly dropped to 859, reaching the 15–point session price limit where it remained for the rest of the session (there was some trading up from the limit throughout the session). The contract started the pit session on October 28 valued at 859, a huge 30-point discount to the October 27 closing value of the cash index. The Table also shows that trading in the October 27 Globex session was relatively thin:

8,812 contracts compared to 85,146 contracts for the October 27 pit session (136,430 contracts on October 28).[57]

Chart 64 shows the mispricing on October 28. Part of the huge mispricing during the first 30 minutes of trading reflects opening delays at the NYSE. Of the 354 most active NYSE stocks (top decile) 148 had not opened by 9:45 and 37 had not yet opened by 10:00 (Table 11).

The mispricing and index arbitrage activity between 10:30 and 12:00 is unusual. Shortly after 10:00 the cash market started rallying sharply. Between 9:41 and 10:20 Rule 80A was in effect on the downside restricting sell index arbitrage. At 10:25 Rule 80A was triggered on the upside restricting buy index arbitrage. Typically, when the cash market is rising fast, the futures rises faster creating a positive mispricing. Not so on October 28: between 10:30 and 12:00 while the cash market was rallying, S&P 500 futures contracts were still trading at a discount. Unrestricted by Rule 80A, sell index arbitrage volume soared during this period: between 10:30 and 11:00 sell index arbitrage volume was 18.6 million shares (Chart 61).

[57] In 1997, Globex S&P 500 trading was about 3 percent of total (Globex plus pit) trading.

10. Further research

Throughout the paper, we focused on trading at the New York Stock Exchange. An interesting question for further research is how well did the U.S. intermarket coordination of the circuit breakers work: did all U.S. markets close down simultaneously as they were supposed to or was there slippage? Another interesting question is how did the different U.S. markets perform during these periods of high stress?

The increasing globalization of equity markets over the past ten years raises a number of important issues that need to be researched further:

- Was there any trading in U.S. stocks abroad while the U.S. markets were closed on October 27? Since the beginning of 1993, the NYSE requires member firms to report to the Exchange all their U.S. and non-U.S. off-exchange trading in NYSE stocks that they do not otherwise report to the Consolidated Tape.[58] These so-called "410B Reports" show no unusual trading activity by NYSE member firms overseas on October 27. In the case of non-U.S. stocks, however, the Exchange does not require member firms to report their overseas trading in the underlying home-market security; firms only have to report their trading in listed ADRs.

- On 31 October 1997, 352 of the 3,028 companies listed on the NYSE were non-U.S.[59] For some of these non-U.S. stocks a significant amount of trading takes place in the U.S. The question, therefore, of how the home market responded when the Exchange halted trading is an important one. The Toronto Stock Exchange, the Mexican Bolsa and the Lima Stock Exchange, for example, informally coordinate their trading hours with the NYSE: all

[58] Rule 410B, "Reports of Listed Securities Transactions Effected Off the Exchange, " New York Stock Exchange, Constitution and Rules. The Rule was implemented in two phases: (a) January 4, 193 for the largest NYSE member firms and (b) April 5, 1993 for all others. For more details see NYSE Information Memo 92-32, November 13, 1992.
[59] Non-U.S. companies with either common or preferred stock listed.

three exchanges stopped trading (in all stocks) when New York halted trading. Bovespa (the Sao Paolo Stock Exchange) was already closed when the NYSE halted trading at 14:35:55. Interestingly, in this case New York went on trading even though the home market had stopped. Similarly, on October 28 the NYSE was trading its Brazilian stocks even when the home market had halted trading.[60] A systematic analysis of cross-country circuit breaker co-ordination is needed. Should there be an attempt to formalize this cross-country co-ordination in the same way that the coordination among U.S. markets is formalized? What are the implications of not co-ordinating? Was home market trading during the NYSE halts stabilizing or destabilizing? Was NYSE trading during home-market halts stabilizing or destabilizing?

- Cross-listed non-U.S. stocks also raise a more general issue of spillover effects. Are cross-listed stocks with active markets away from the home market less or more volatile under stress? Does the fact that these stocks have a more globally diversified shareholder base act as a stabilizing factor? Some of these stocks (Finland's NOKIA is a good example), effectively trade around the clock: is this stabilizing or destabilizing in times of stress?

The opening delays on October 28 and opening delays in general are interesting research issues. Following the extreme volatility on October 27 what did the limit order book look like at the opening the next day? Did the opening delays help reach a "better" price? What would have been the opening price without the opening delays?

Another issue that deserves more investigation is the changing nature of program trading. What is behind the decline in index arbitrage? Do the new strategies that currently dominate program trading affect volatility?

[60] On Tuesday, the 28th of October, the opening of the Sao Paulo stock exchange was delayed until 12.30 local time, after trading had begun on Wall Street. The authorities then closed the market again after just three minutes of trading when the Bovespa index fell by 12.76%. By the time the market re-opened, Wall Street had begun to recover.

On October 27 overnight trading in the S&P500 futures widened the cash-futures mispricing. An interesting research question is: how does overnight trading in the S&P 500 futures on Globex affect the quality of opening prices on the New York Stock Exchange? Does a decline in the S&P 500 futures contract overnight force prices down in the cash market at the open? And if yes, does this decline in cash prices persist or is it temporary?

In this paper we did not address several other important issues simply because that is not where we have a comparative advantage. For example: what caused the drop? We are glad to leave this question for others to answer, but we suspect investor psychology had a lot to do with it. Did the circuit breakers help? Another tough question we leave for others to examine. Technically, the implementation of the circuit breakers was remarkably smooth given that this was the first time ever. And on hindsight there seems to be a consensus that the trigger levels should be raised: on February 5, 1998 the NYSE's Board of Directors approved a substantial widening of the trigger levels.

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Table 1
October 27 and 28 Volatility in Perspective

Through December 31, 1997. Data source: Dow Jones.

	Close	Point Change	Percent Change		Close	Point Change	Percent Change
Point DJIA changes (close-to-close)							
Down Days				**Up Days**			
10/27/1997	7,161	-554	-7.2	10/28/97	7,498	337	4.7
10/19/1987	1,739	-508	-22.6	09/02/1997	7,880	257	3.4
08/15/1997	7,695	-247	-3.1	11/03/1997	7,674	232	3.1
06/23/1997	7,604	-192	-2.5	12/01/1997	8,013	190	2.4
10/13/1989	2,569	-191	-6.9	10/21/1987	2,028	187	10.2
10/23/1997	7,848	-187	-2.3	04/29/1997	6,962	179	2.6
03/08/1996	5,470	-171	-3.0	09/16/1997	7,896	175	2.3
07/15/1996	5,350	-161	-2.9	04/22/1997	6,834	173	2.6
03/13/1997	6,879	-160	-2.3	07/22/1997	8,062	155	2.0
11/12/1997	7,401	-157	-2.1	06/24/1997	7,758	154	2.0
03/31/1997	6,583	-157	-2.3	05/05/1997	7,214	143	2.0
10/26/1987	1,794	-157	-8.0	10/21/1997	8,060	139	1.8
Percent DJIA changes (close-to-close)							
Down Days				**Up Days**			
10/19/1987	1,739	-508	-22.6	10/06/1931	99	13	14.9
10/28/1929	261	-38	-12.8	10/30/1929	258	28	12.3
10/29/1929	230	-31	-11.7	09/21/1932	75	8	11.4
11/06/1929	232	-26	-9.9	10/21/1987	2,028	187	10.2
12/18/1899	58	-6	-8.7	08/03/1932	58	5	9.5
08/12/1932	63	-6	-8.4	02/11/1932	79	7	9.5
03/14/1907	76	-7	-8.3	11/14/1929	217	19	9.4
10/26/1987	1,794	-157	-8.0	12/18/1931	81	7	9.4
07/21/1933	89	-8	-7.8	02/13/1932	86	7	9.2
10/18/1937	126	-11	-7.8	05/06/1932	59	5	9.1
02/01/1917	89	-7	-7.2	04/19/1933	68	6	9.0
10/27/1997	7,161	-554	-7.2	10/08/1931	106	8	8.7

Table 2
Twelve Busiest Trading Days on Record

Through December 31, 1997. Based on the "official" NYSE trading volume figures: excludes rights and warrants but includes crossing sessions. ITS trades are handled according to CTA rules (seller gets credit).

Date	Rank	Share Volume (thousands)	Comment
10/28/97	1	1,201,347	
12/19/97	2	792,946	Triple Witch
10/29/97	3	776,331	
10/30/97	4	711,969	
1/23/97	5	684,588	
10/27/97	6	684,571	
7/16/96	7	680,913	
10/24/97	8	677,241	
10/23/97	9	672,506	
12/20/96	10	654,110	Triple Witch
10/20/87	31	608,149	
10/19/87	35	604,330	

Table 3
NYSE Index Arbitrage Restrictions and Circuit Breakers
As of October 1997

At current levels, eight points on the Dow Jones Industrial Average are equivalent to approximately one point on the S&P 500 Index.

Event	Rule
The Dow Jones Industrial Average moves 50 points up or down from the previous day's close.	**Rule 80A (c) "Index Arbitrage Restrictions."** In an up market, index arbitrage program buys in S&P 500 stocks must be executed on a minus or a zero-minus tick. In a down market, index arbitrage program sells (including short sales) in S&P 500 stocks must be executed on a plus or zero-plus tick. Rule 80A(c) also affects non-expiring derivative-related program strategies such as liquidation of facilitations, liquidation of EFP stock positions, liquidation of error accounts, risk modifications, customer facilitations and index substitutions. Rule 80A (c) applies for the remainder of the day, unless the DJIA moves back to within 25 points of the previous day's close. *(Since 8/1/90)* On expiration Fridays market-on-close orders to liquidate previously established stock positions against expiring derivative products are exempt from the index arbitrage restrictions. *(Since 10/18/90)*
The primary S&P 500 futures contract declines 12 points from the previous day's close. (Approximately 100 DJIA points.)	**Rule 80A (a)** "**5-Minute Sidecar**." All program trading SuperDot market orders for NYSE-listed S&P 500 stocks are diverted to a separate blind file. After the sidecar period ends, buy and sell orders are paired off and become eligible for execution. If there is an order imbalance, the specialist may make up the difference and/or adjust the price and resume trading. Alternatively, if the imbalance is large, the specialist with Floor Official permission may halt trading and publicly disseminate the imbalance information. If the imbalance is greater than 50,000 shares and if the stock is a "pilot" stock, then the imbalance information is publicly disseminated immediately after the sidecar period ends even if orderly trading has resumed. The pilot stocks consist of the 50 NYSE S&P 500 stocks with the highest market capitalization plus any other component stocks of the Major Market Index. New stop and stop limit orders in all stocks are banned for the rest of the day, except for those orders from individuals for 2,099 shares or less. Does not apply in the last 35 minutes of trading. *(Since 10/19/88.)*
The Dow Jones Industrial Average declines by 350 points from the previous day's close.	**NYSE Rule 80B "350-Point Circuit Breaker**." Trading in all stocks is halted for half an hour. *(Since 10/19/88; amended 02/03/97.)*
The Dow Jones Industrial Average declines by 550 points from the previous day's close.	**NYSE Rule 80B "550-Point Circuit Breaker**." Trading in all stocks is halted for one hour. *(Since 10/19/88; amended 02/03/97.)*

Table 4
Rule 80A

Through December 31, 1997. Data source: NYSE.

	90*	91	92	93	94	95	96	97
Index Arbitrage Restriction								
Total days	22	20	16	9	28	28	101	219
Down days	15	8	8	5	19	14	51	113
Up days	7	12	8	4	9	14	53	125
Multiple triggering	1	0	0	0	2	1	18	84
Total activations	23	20	16	9	30	29	119	303
Trading days	106*	253	254	253	252	252	254	253
Ratio of total days to 80A	4.8	12.7	15.9	28.1	9.0	9.0	2.5	1.2
Sidecar								
Total days	5	2	1	0	1	1	11	37

* Rule 80A index arbitrage restriction was introduced August 1, 1990.

Table 5
Frequency of DJIA close-to-close percent daily changes

The table shows the frequency (number of trading days) of 1 percent, 2 percent, 3 percent, 4 percent and 5 percent close-to-close absolute percent value changes in the DJIA annually from 1978 through the end of 1997. Data sources: 1978 through 1995 from ExShare via FactSet; 1996 and 1997 from Bridge Data.

Year	1% or more	2% or more	3% or more	4% or more	5% or more
1978	57	6	1	1	0
1979	37	2	0	0	0
1980	81	10	1	1	0
1981	57	8	0	0	0
1982	84	22	6	3	0
1983	65	6	0	0	0
1984	52	10	1	0	0
1985	31	1	0	0	0
1986	56	11	2	1	0
1987	96	41	17	7	4
1988	70	21	5	2	1
1989	46	6	2	1	1
1990	73	14	3	0	0
1991	56	10	4	1	0
1992	31	1	0	0	0
1993	15	1	0	0	0
1994	31	3	0	0	0
1995	17	0	0	0	0
1996	43	4	1	0	0
1997	80	19	5	2	1

Table 6
Orders and Trades
Summary Statistics

We report both the "official" NYSE trading volume and the unadjusted "Consolidated Tape" (CTS) NYSE trading volume. The official volume excludes rights and warrants but includes crossing sessions; ITS trades are handled according to CTA rules (seller gets credit). System order data are from the NYSE's daily System Order Data (SOD) files and includes all same day system orders submitted, except "write-ins" orders. We calculate the average Tape Print size from the NYSE's daily Consolidated Trade (CT) files. In the tape print calculation we exclude "sold last" (COND=L) and "Sold Sale" (COND=Z) trades.

	October 21	**October 27**	**October 28**
Volume (million shares)			
Official NYSE trading volume	581.0	684.6	1,201.3
CTS NYSE trading volume	586.8	694.7	1,204.4
System executed volume	542.8	723.0	1,215.4
System as percent of twice CTS total	46%	52%	50%
System Orders Placed			
Total number of orders	650,025	907,112	1,474,762
Average order size (shares)	1,390	1,418	1,267
System Orders Placed by Account (number of orders)			
Agency / Individual	112,696	153,885	407,234
Agency / Institutional	422,628	589,241	804,552
Principal / Member Firm	103,344	151,830	244,271
Unidentified	11,357	12,156	18,705
System Orders Placed by Account (percent of total)			
Agency / Individual	17%	17%	28%
Agency / Institutional	65%	65%	55%
Principal / Member Firm	16%	17%	17%
Market and Limit System Orders Placed (number of orders)			
System market orders	222,404	293,784	671,421
System limit orders	427,621	613,328	803,341
Market as percent of total	34%	32%	46%
Bunching			
SuperDot orders per trade*	1.6	1.7	2.1
Print Size (shares)			
Average opening print size	8,185	7,092	20,946
Average tape print size*	2,247	2,220	2,494

*Excluding opening print

Table 7
Buy and Sell System Orders
Summary Statistics

System order data are from the NYSE's daily System Order Data (SOD) files and includes all same day system orders submitted, except "write-in" orders.

	October 27		October 28	
	Buy	**Sell**	**Buy**	**Sell**
System Orders Placed by Account (number of orders)				
Agency / Individual	67,423	86,462	292,369	114,865
Agency / Institutional	261,894	327,347	452,551	352,001
Principal / Member Firm	63,981	87,849	84,023	160,248
System Orders Placed by Account (percent of total)				
Agency / Individual	17%	17%	35%	18%
Agency / Institutional	67%	65%	55%	56%
Principal / Member Firm	16%	18%	10%	26%
Market and Limit System Orders Placed (number of orders)				
System market orders	112,917	180,867	403,091	268,330
System limit orders	285,852	327,476	436,356	366,985
Market as percent of total	28%	36%	48%	42%

Table 8
Average Quotations Spreads
All NYSE-listed issues

Quote data are from the NYSE's daily Consolidated Quote (CQ) files. NYSE quotes in common and preferred stocks; bid not equal to zero, offer greater than the bid, MODE=0, 1, 2, 3, 6, 10 or 12. The trade data we use to calculate trade and volume-weighted quotes are from the NYSE's daily Consolidated Trade (CT) files. NYSE trades in common and preferred stocks; "good" trades (CORR=0 or 1), COND not equal L or Z. We also dropped trades when the immediately preceding quote did not satisfy our selection criteria.

	Unweighted (cents)	Trade-weighted (cents)	Volume-weighted (cents)
September 1997	19	14	14
October 21, 1997	18	14	13
October 27, 1997	23	19	18
October 28, 1997	25	22	23

Table 9
Opening delays

Opening time is the time of the opening trade or the time of the opening quote, whichever comes first. Quote data are from the NYSE's daily Consolidated Quote (CQ) files. Trade data are from the NYSE's daily Consolidated Trade (CT) files. Our sample includes all NYSE-listed common stocks, preferred stocks, when-issued etc. On October 21, 3645 issues were eligible to trade on the NYSE. Of those issues, quotes were posted in 3644 (BAE wasn't quoted) and there were trades in 3399. By October 27, the number of listed issues increased by nine, bringing the total to 3654. Of those, quotes were posted in 3653 (again, BAE wasn't quoted) and there were trades in 3420. On October 28, BAE again had neither quotes nor trades, so the number of stocks was 3654. The selection for trades was (OC=1,3) & CORR≤1 & EX=N; the selection for quotes was EX=N & BIDSIZ NE 0 & OFRSIZ NE 0 & BID>0 & OFR>BID & (MODE NE 4,9,17).

	Stocks	Number of stocks that have not opened by…					
		9:35	9:40	9:45	10:00	10:30	11:00
October 21	3644	886	202	34	2	1	1
October 27	3653	1187	298	75	8	2	1
October 28	3653	2220	1466	856	208	27	4

Table 10
More on Openings

Opening time is the time of the opening trade or the time of the opening quote, whichever comes first. Quote data are from the NYSE's daily Consolidated Quote (CQ) files. Trade data are from the NYSE's daily Consolidated Trade (CT) files. Our sample includes all NYSE-listed common stocks, preferred stocks, when-issued etc. On October 21, 3645 issues were eligible to trade on the NYSE. Of those issues, quotes were posted in 3644 (BAE wasn't quoted) and there were trades in 3399. By October 27, the number of listed issues increased by nine, bringing the total to 3654. Of those, quotes were posted in 3653 (again, BAE wasn't quoted) and there were trades in 3420. On October 28, BAE again had neither quotes nor trades, so the number of stocks was 3654. The selection for trades was (OC=1,3) & CORR≤1 & EX=N; the selection for quotes was EX=N & BIDSIZ NE 0 & OFRSIZ NE 0 & BID>0 & OFR>BID & (MODE NE 4,9,17). An "Opened Last " trade (COND=O) is an opening trade that is reported to the tape in the correct sequence but at a later time.

	Stocks	Minutes after 9:30	Stocks that opened with quote	Stocks that did not trade	Stocks reported "Opened Last"
October 21	3644	3.77	1360	245	19
October 27	3653	4.37	1247	233	32
October 28	3653	10.72	785	185	264

Table 11
Opening delays
By Volume Decile, October 28

Opening time is the time of the opening trade or the time of the opening quote, whichever comes first. Quote data are from the NYSE's daily Consolidated Quote (CQ) files. Trade data are from the NYSE's daily Consolidated Trade (CT) files. Our sample includes all NYSE-listed common stocks, preferred stocks, when-issued etc. On October 21, 3645 issues were eligible to trade on the NYSE. Of those issues, quotes were posted in 3644 (BAE wasn't quoted) and there were trades in 3399. By October 27, the number of listed issues increased by nine, bringing the total to 3654. Of those, quotes were posted in 3653 (again, BAE wasn't quoted) and there were trades in 3420. On October 28, BAE again had neither quotes nor trades, so the number of stocks was 3654. The selection for trades was (OC=1,3) & CORR≤1 & EX=N; the selection for quotes was EX=N & BIDSIZ NE 0 & OFRSIZ NE 0 & BID>0 & OFR>BID & (MODE NE 4,9,17). Stocks are ranked according to their share trading volume in September 1997. Stocks that listed after September 30 are not included in the by decile breakdown; they are however included in the overall sample.

	Stocks	Number of stocks that have not opened by…					
		9:35	9:40	9:45	10:00	10:30	11:00
All stocks							
	3653	2220	1466	856	208	27	4
By decile							
1 (most active)	354	285	221	148	37	2	0
2	355	251	188	118	49	2	0
3	355	252	163	95	23	8	1
4	355	242	169	97	22	3	0
5	355	221	140	83	20	4	0
6	355	197	122	56	14	2	1
7	355	207	123	71	12	1	0
8	354	179	103	54	7	1	0
9	355	167	96	60	11	0	0
10	355	155	92	43	7	2	2

Table 12
More on Openings
By decile, October 28

Opening time is the time of the opening trade or the time of the opening quote, whichever comes first. Quote data are from the NYSE's daily Consolidated Quote (CQ) files. Trade data are from the NYSE's daily Consolidated Trade (CT) files. Our sample includes all NYSE-listed common stocks, preferred stocks, when-issued etc. On October 21, 3645 issues were eligible to trade on the NYSE. Of those issues, quotes were posted in 3644 (BAE wasn't quoted) and there were trades in 3399. By October 27, the number of listed issues increased by nine, bringing the total to 3654. Of those, quotes were posted in 3653 (again, BAE wasn't quoted) and there were trades in 3420. On October 28, BAE again had neither quotes nor trades, so the number of stocks was 3654. The selection for trades was (OC=1,3) & CORR≤1 & EX=N; the selection for quotes was EX=N & BIDSIZ NE 0 & OFRSIZ NE 0 & BID>0 & OFR>BID & (MODE NE 4,9,17). Stocks are ranked according to their share trading volume in September 1997. Stocks that listed after September 30 are not included in the by decile breakdown; they are however included in the overall sample.

	Stocks	Minutes after 9:30	Open with quote	No trade
All				
October 28	3653	10.72	785	185
By decile, October 28				
1 (most active)	354	15.45	23	0
2	355	14.43	16	0
3	355	12.61	25	1
4	355	12.05	24	1
5	355	10.84	29	1
6	355	8.94	49	3
7	355	9.21	68	4
8	354	7.92	83	6
9	355	8.07	137	8
10	355	7.39	275	120

Table 13
System Orders Placed During Trading Halts, October 27

Data are from the NYSE's daily System Order Data (SOD) files and include all same day system orders submitted during the time periods listed, except 1,185 "write-in" orders that we dropped.

Time	Total	Limit	Market	Buy	Sell
350-Point Trading Halt (14:35:55-15:05:59)					
14:36:00 – 14:36:59 (1)	1,561	973	588	580	981
14:37:00 – 14:37:59 (1)	750	387	363	299	451
14:38:00 – 14:38:59 (1)	541	197	344	296	245
14:39:00 – 14:39:59 (1)	440	166	274	228	212
14:40:00 – 14:44:59 (5)	2,286	864	1,422	1,240	1,046
14:45:00 – 14:49:59 (5)	2,394	954	1,440	1,341	1,053
14:50:00 – 14:54:59 (5)	2,727	1,043	1,684	1,532	1,195
14:55:00 – 14:59:59 (5)	3,071	1,287	1,784	1,754	1,317
15:00:00 – 15:04:59 (5)	4,626	2,194	2,432	2,339	2,287
15:05:00 – 15:05:59 (1)	1,481	620	861	597	884
	19,877	**8,685**	**11,192**	**10,206**	**9,671**
550-Point Trading Halt (15:30:00-rest of the day)					
15:30:00 – 15:30:59 (1)	3,214	1,130	2,084	1,397	1,817
15:31:00 – 15:31:59 (1)	727	339	388	312	415
15:32:00 – 15:32:59 (1)	12	11	1	5	7
15:33:00 – 15:33:59 (1)	3	3	0	0	3
15:34:00 – 15:34:59 (1)	2	2	0	0	2
15:35:00 – 15:35:59 (1)	2	2	0	0	2
15:36:00 – 15:36:59 (1)	2	2	0	1	1
15:37:00 – 15:37:59 (1)	5	5	0	0	5
15:38:00 – 15:38:59 (1)	4	4	0	1	3
15:39:00 – 15:39:59 (1)	3	3	0	0	3
15:40:00 – 15:44:59 (5)	12	12	0	2	10
15:45:00 – 15:49:59 (5)	10	10	0	0	10
15:50:00 – 15:54:59 (5)	7	7	0	0	7
15:55:00 – 15:59:59 (5)	0	0	0	0	0
16:00:00 – 16:14:59 (15)	2	2	0	0	2
After 16:15:00	1	1	0	0	1
	4,006	**1,533**	**2,473**	**1,718**	**2,288**

Table 14
Trade and Quote Activity During Trading halts
October 27

Trade data are from the NYSE's daily Consolidated Trade (CT) files. NYSE trades in common and preferred stocks; "good" trades (CORR=0 or 1), COND not equal L or Z. Quote data are from the NYSE's daily Consolidated Quote (CQ) files. NYSE quotes in common and preferred stocks; bid not equal to zero, offer greater than the bid, MODE=0, 1, 2, 3, 6, 10 or 12.

Time	Number of Trades	Number of Quotes		
		All	Closing (Mode 3)	Regular (Mode 12)
350-Point Trading Halt (14:35:55-15:05:59)				
14:36:00 – 14:36:59 (1)	522	868	0	868
14:37:00 – 14:37:59 (1)	37	163	0	163
14:38:00 – 14:38:59 (1)	2	37	0	37
14:39:00 – 14:39:59 (1)	0	11	0	11
14:40:00 – 14:44:59 (5)	1	10	0	10
14:45:00 – 14:49:59 (5)	0	2	0	2
14:50:00 – 14:54:59 (5)	0	1	0	1
14:55:00 – 14:59:59 (5)	0	0	0	0
15:00:00 – 15:04:59 (5)	0	4	0	4
15:05:00 – 15:05:59 (1)	1	1	0	1
	563	1,097	0	1,097
550-Point Trading Halt (15:30:00-rest of the day)				
15:30:00 – 15:30:59 (1)	1,236	1,074	0	1,074
15:31:00 – 15:31:59 (1)	250	453	0	453
15:32:00 – 15:32:59 (1)	80	153	0	153
15:33:00 – 15:33:59 (1)	29	126	0	126
15:34:00 – 15:34:59 (1)	10	65	0	65
15:35:00 – 15:35:59 (1)	12	65	0	65
15:36:00 – 15:36:59 (1)	7	88	0	88
15:37:00 – 15:37:59 (1)	2	14	0	14
15:38:00 – 15:38:59 (1)	1	21	0	21
15:39:00 – 15:39:59 (1)	2	87	0	87
15:40:00 – 15:44:59 (5)	4	758	430	328

15:45:00 – 15:49:59 (5)	0	894	894	0
15:50:00 – 15:54:59 (5)	0	197	197	0
15:55:00 – 15:59:59 (5)	0	73	73	0
16:00:00 – 16:14:59 (15)	1	2,479	2,479	0
After 16:15:00	10	43	43	0
	1,645	6,590	4,116	2,474

Table 15
Re openings, October 27

Quote data are from the NYSE's daily Consolidated Quote (CQ) files. Trade data are from the NYSE's daily Consolidated Trade (CT) files. Re-opening time is the time of the post-15:06 re-opening trade or the time of the post-15:06 re-opening quote, whichever comes first. Stocks are ranked according to their share trading volume in September 1997. Stocks that listed after September 30 are not included in the by decile breakdown; they are however included in the overall sample. Our sample includes all NYSE-listed common stocks, preferred stocks, when-issued etc. The re-openings sample consists of 3,650 stocks, three stocks less than the opening sample for the same day (Table 9) because three stocks (IF, MML and TRWPRB) had no valid quotes after 3:05.

	Stocks	Number of stocks that have not re-opened by:								Delay
		15:07	15:08	15:09	15:10	15:15	15:20	15:25	15:30	
All stocks										
	3650	3008	2244	1693	1242	231	43	21	14	3.72
By decile										
1 (most active)	354	226	160	109	74	11	3	3	0	2.62
2	355	257	168	116	85	20	3	0	0	2.89
3	355	284	189	149	107	26	6	1	1	3.41
4	354	286	213	149	100	26	5	2	1	3.49
5	355	298	224	163	109	11	1	0	0	3.22
6	355	318	234	163	121	13	2	1	0	3.45
7	354	311	236	191	138	21	4	2	0	3.86
8	355	312	249	196	146	30	3	0	0	4.08
9	355	318	248	205	155	29	1	0	0	4.08
10	354	310	253	193	154	32	13	11	11	5.75

Table 16
Opening and Closing Trade Times
30 DJIA Stocks

Trade data are from the NYSE's daily Consolidated Trade (CT) files. We included "good" trades (CORR=0 or 1), COND not equal L or Z.
An asterisk (*) indicates trades identified as "Opened Last" (COND=O). An "Opened Last " trade is an opening trade that is reported to the tape in the correct sequence but at a later time.

	Symbol	October 27				October 28
		Opening Trade	Last Trade At 350-Point Halt (14:35:55)	First Trade After 350-Point Halt (15:06:00)	Last Trade At 550-Point Halt (15:30:00)	Opening Trade
01	AA	9:35:26	14:35:06	15:09:52	15:31:09	10:00:14*
02	ALD	9:37:33	14:35:37	15:08:58	15:30:39	9:38:20
03	AXP	9:31:08	14:35:25	15:07:43	15:30:22	9:45:35
04	BA	9:37:57	14:36:46	15:06:59	15:31:10	9:34:38
05	CAT	9:35:02	14:35:35	15:12:11	15:31:10	9:54:39*
06	CHV	9:34:44	14:36:01	15:06:22	15:30:07	9:37:39
07	DD	9:32:56	14:36:35	15:06:09	15:31:11	9:46:33
08	DIS	9:34:44	14:35:42	15:06:43	15:31:10	9:43:03*
09	EK	9:34:38	14:36:10	15:07:28	15:30:57	9:30:16
10	GE	9:31:37	14:36:08	15:06:31	15:30:09	9:35:19*
11	GM	9:30:43	14:35:42	15:08:11	15:30:21	9:42:11
12	GT	9:38:24	14:36:04	15:06:45	15:29:37	9:43:28
13	HWP	9:32:30	14:36:36	15:06:24	15:30:38	9:37:27
14	IBM	9:31:18	14:35:41	15:06:16	15:32:01	9:45:56
15	IP	9:34:31	14:36:01	15:08:28	15:30:10	10:06:43
16	JNJ	9:32:51	14:36:27	15:08:35	15:31:42	9:45:30
17	JPM	9:31:36	14:34:37	15:06:08	15:30:53	9:39:25
18	KO	9:34:09	14:37:25	15:06:27	15:31:24	9:33:26
19	MCD	9:32:49	14:35:51	15:06:14	15:31:27	9:37:54
20	MMM	9:34:39	14:35:44	15:08:46	15:29:28	9:42:39
21	MO	9:39:14	14:36:40	15:09:48	15:33:18	9:43:18
22	MRK	9:36:17*	14:35:45	15:09:42	15:30:27	9:47:11*
23	PG	9:31:44	14:35:57	15:06:58	15:30:35	9:41:44*
24	S	9:31:43	14:36:02	15:06:53	15:30:37	9:39:08
25	T	9:33:14	14:36:06	15:07:07	15:30:14	9:33:32
26	TRV	9:32:05	14:35:50	15:09:34	15:31:04	9:49:02
27	UK	9:30:39	14:36:00	15:10:34	15:29:31	9:46:32*
28	UTX	9:45:39	14:35:42	15:17:34	15:29:19	10:03:23
29	WMT	9:30:31	14:36:48	15:06:53	15:31:23	9:50:29
30	XON	9:33:51	14:36:33	15:09:18	15:30:24	9:50:36
Average		**9:34:08**	**14:36:01**	**15:08:10**	**15:30:45**	**9:44:12**

Table 17
Form 81 Data and Audit Trail Data Compared

The Form 81 closing inventory is as of 16:15; the audit trail closing inventory is as of the last trade at the time of the 550-point trading halt. The opening inventory is the opening inventory reported by the specialist in Form 81; the audit trail data does not contain opening inventory information.

	Form 81	**Audit Trail**
Odd-lot trades	Included	Not included
As-of trades	Included	Not included
Unmatched trades	Included	Not included
Average closing specialist inventory per stock, Oct. 27 (shares)	46,522	37,262
Average opening specialist inventory per stock, Oct. 28 (shares)	45,753	NA

Table 18
Specialist Average Inventory Position per Stock
30 DJIA Stocks
Select Times, October 27 and 28

The data are from the NYSE's daily Specialist Trading (SPET) files. The Form 81 inventory position we calculate by starting with specialist-reported Form 81 opening inventory position (valued at previous closing prices) and cumulating Form 81 transactions (including OLA, "as-of" and unmatched). The audit trail inventory position we calculate again by starting with the same specialist-reported Form 81 opening inventory position (valued at previous closing prices) and cumulating audit trail matched specialist transactions.

	Value per stock ($ million)		Shares per stock	
	Form 81	Audit Trail	Form 81	Audit Trail
October 27				
Pre-opening	0.75	NA	11,862	NA
09:40	1.98	1.86	30,541	28,878
12:20	0.61	0.36	8,442	4,712
14:00	2.17	1.60	37,195	28,782
14:40 (1st halt)	1.12	0.58	18,135	9,775
15:35 (2nd halt)	2.74	2.08	47,564	37,262
October 28				
Pre-opening	2.61	NA	45,753	NA
09:55	4.28	3.92	74,016	68,667
10:30	-0.30	-0.78	-4,249	-10,150
10:45	-2.03	-2.52	-28,704	-35,663
16:15 (close)	-0.59	-0.65	-9,564	-14,010

Table 19
Specialist Participation and Stabilization Rates
30 DJIA Stocks
Summary Statistics, October 27 and 28

Data source: NYSE daily SPET files for October 27 and 28. We dropped all records representing comparison sides or Form 81 activity not matched to a reported trade (SEQNUM=0). Total purchases plus sales equals twice the sum of trade size (in shares) reported to the Consolidate Tape or as determined by the NYSE audit trail (MDSSIZ). We measure specialist activity in two ways: using audit trail data and Form 81 data. In the unweighted measure we calculate the participation and stabilization rates for each stock and then average across the 30 stocks. In the volume-weighted participation rate we divide total specialist purchases plus sales by total purchases plus sales. In the volume-weighted stabilization rate we divide stabilizing specialist purchases plus sales by total specialist purchases plus sales.

	Total Purchases plus Sales (mil. shares)	**Specialist Purchases plus Sales (mil. shares)**	**Participation Rates (%)**	**Stabilization Rates (%)**
October 27				
Unweighted (audit trail data)	187.3	26.3	14.6	84.8
Volume-weighted (audit trail data)	187.3	26.3	14.0	82.6
Volume-weighted (form 81 data)	187.3	26.1	13.9	82.9
October 28				
Unweighted (audit trail data)	328.1	50.1	15.3	85.7
Volume-weighted (audit trail data)	328.1	50.1	15.3	84.2
Volume-weighted (form 81 data)	328.1	49.8	15.2	84.3

Table 20
Program trading

The data in this table come from the NYSE's Daily Program Trading (DPT) reports. Since May 1988, the NYSE has required all member firms to file with the NYSE daily trade-by-trade reports of principal and customer account transactions that meet the NYSE's definition of program trading. In addition, members must reports index arbitrage trades of all sizes. Among other information, member firms identify the type of program trading strategy, time of order submission, size of the trade and whether the transaction is buy or sell. Member firms do not report orders submitted and subsequently cancelled. For more details, see Sofianos (1993) and Harris, Sofianos and Shapiro (1994).

	1997 3rd quarter	**October 21**	**October 27**	**October 28**
Program trading (million shares per day)	94.1	70.3	110.8	194.3
Program trading (percent of all volume)	18 %	12 %	16 %	16 %
Buys and sells (million shares per day)				
Sells	45.2	27.0	63.7	111.0
Buys	48.9	43.3	47.1	83.3
Buys and sells (percent of all program volume)				
Sells	48 %	38 %	57%	57 %
Buys	52 %	62 %	43%	43 %
Strategies (shares per day)				
Subject to Rule 80A*	20.4	11.4	21.2	54.4
Not subject to Rule 80A	73.7	58.9	89.5	139.9
Strategies (percent of all program volume)				
Subject to Rule 80A*	22 %	16 %	19%	28%
Not subject to Rule 80A	78 %	84 %	81%	72%

	Buy	**Sell**	**Buy**	**Sell**	**Buy**	**Sell**	**Buy**	**Sell**
Strategies / Buys and sells (million shares per day)								
Subject to Rule 80A*	10.1	10.3	6.7	4.7	15.8	5.4	3.0	51.3
Not subject to Rule 80A	38.8	34.9	36.6	22.3	31.3	58.2	80.3	59.6
Strategies / Buys and sells (percent of all program volume)								
Subject to Rule 80A*	10 %	11 %	10 %	7 %	14%	5%	2%	26%
Not subject to Rule 80A	41 %	37 %	52 %	32 %	28%	53%	41%	31%

* Mostly index arbitrage; some other strategies are also subject to Rule 80A. For more details see Table 3. These other strategies account for a small percentage (about 1 percent) of the total volume subject to Rule 80A.

Table 21
Breakdown of Strategies Not Subject to Rule 80A

The data in this table come from the NYSE's Daily Program Trading (DPT) reports. Since May 1988, The NYSE has required all member firms to file with the NYSE daily trade-by-trade reports of principal and customer account transactions that meet the NYSE's definition of program trading. In addition members must reports index arbitrage trades of all sizes. Among other information member firms identify the type of program trading strategy, time of order submission, size of the trade and whether the transaction is buy or sell. Member firms do not report orders submitted and subsequently cancelled. For more details, see Sofianos (1993) and Harris, Sofianos and Shapiro (1994).

	October 21	**October 27**	**October 28**
Other	52.15 %	47.35 %	30.62 %
Portfolio Realignment	35.02 %	26.98 %	37.84 %
Risk modification/hedge	4.99 %	12.80 %	15.93 %
Portfolio liquidation	2.57 %	1.83 %	3.51 %
Exchange for Physicals	2.35 %	0.00 %	5.36 %
Trading Long	1.98 %	9.11 %	6.20 %
Trading Short	0.08 %	0.04 %	0.23 %
Customer Facilitation	0.84 %	0.00 %	0.00 %
Liquidation of Facilitation	0.04 %	0.10 %	0.32 %

Table 22
Program Trading Between the Two Trading Halts
October 27, 15:06:00 – 15:30:00

The data in this table come from the NYSE's Daily Program Trading (DPT) reports. Since May 1988, The NYSE has required all member firms to file with the NYSE daily trade-by-trade reports of principal and customer account transactions that meet the NYSE's definition of program trading. In addition members must reports index arbitrage trades of all sizes. Among other information member firms identify the type of program trading strategy, time of order submission, size of the trade and whether the transaction is buy or sell. Member firms do not report orders submitted and subsequently cancelled. For more details, see Sofianos (1993) and Harris, Sofianos and Shapiro (1994).

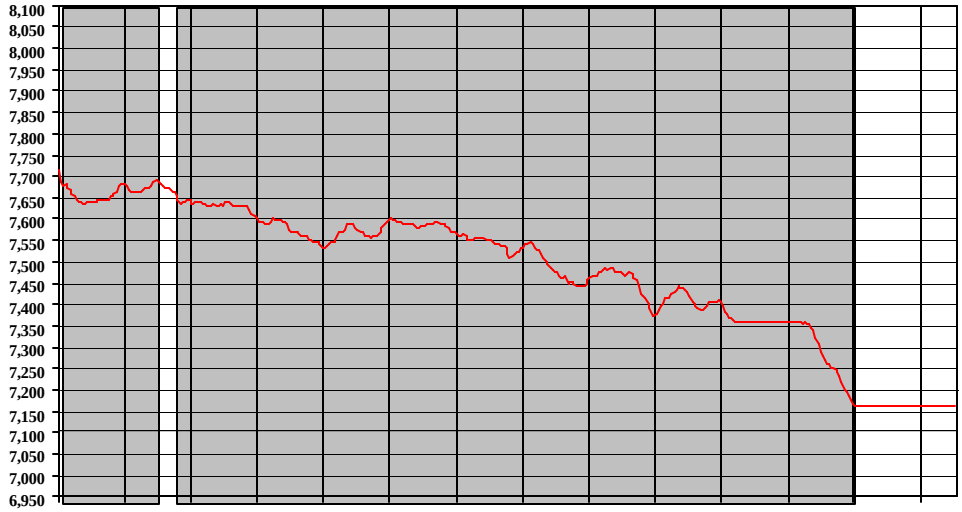
	Total	**Buy**	**Sell**
Subject to Rule 80A			
Index arbitrage	9.6 %	-	9.6 %
Other	-	-	-
Not Subject to Rule 80A			
Other	29.3 %	-	29.3 %
Portfolio Realignment	31.2 %	12.0 %	19.2 %
Risk modification/hedge	4.2 %	-	4.2 %
Portfolio liquidation	6.4 %	-	6.4 %
Exchange for Physicals	-	-	-
Trading Long	18.4 %	2.8 %	15.5 %
Trading Short	-	-	-
Customer Facilitation	-	-	-
Anticipatory Hedge	1.0 %	1.0 %	-
Liquidation of Facilitation	-	-	-
	100 %	15.8 %	84.2 %

Table 23
S&P 500 Futures Trading, October 26 through 28

The data in this Table come from the Chicago Mercantile Exchange's Web page (cme.com).

	Globex	Pit Trading	Globex	Pit Trading
	Sunday, Oct 26, 18:30 through Monday, Oct. 27 9:00	Monday, Oct. 27, 9:15 through 16:15	Monday, Oct 27, 16:45 through Tuesday, Oct. 28 9:00	Tuesday, Oct. 28 9:15 through 16:15
Total number of contracts	4,185	85,146	8,812	136,430
Opening value of nearby	943	938	865	859
Closing value of nearby	934	874	859	926

1. The DJIA on October 27, 1997 minute-by-minute



Rule 80(B) DJIA down 550 points: 15:30:00 market closes for day

Rule 80(B) DJIA down 350 points: 14:35:55 trading halted for 30 minutes

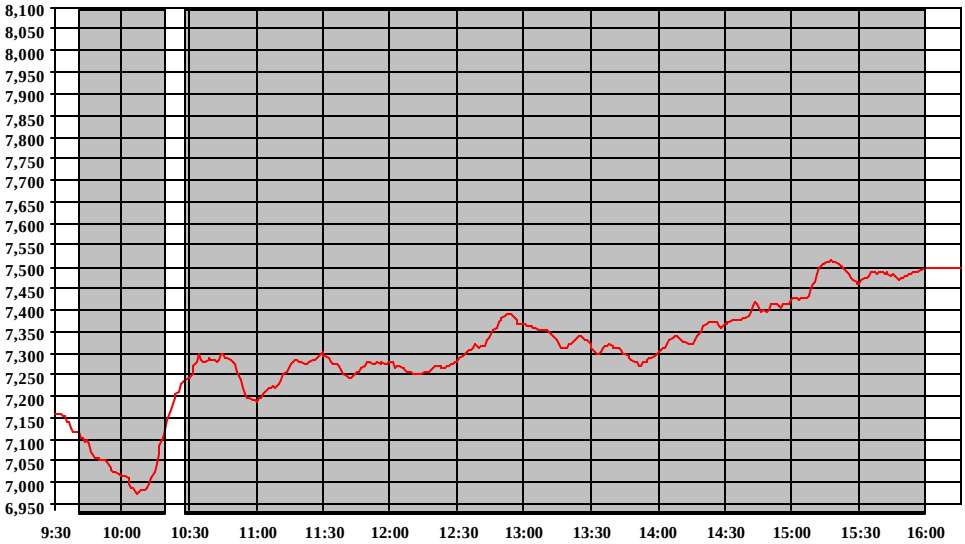
Rule 80(A)(a) Sidecar: 11:00.

Rule 80(A)(c) Index Arbitrage sell restriction: 10:21 to close

Rule 80(A)(c) Index Arbitrage sell restriction: 9:36-10:14

Data source: Bridge Data

2. The DJIA on October 28, 1997 minute-by-minute



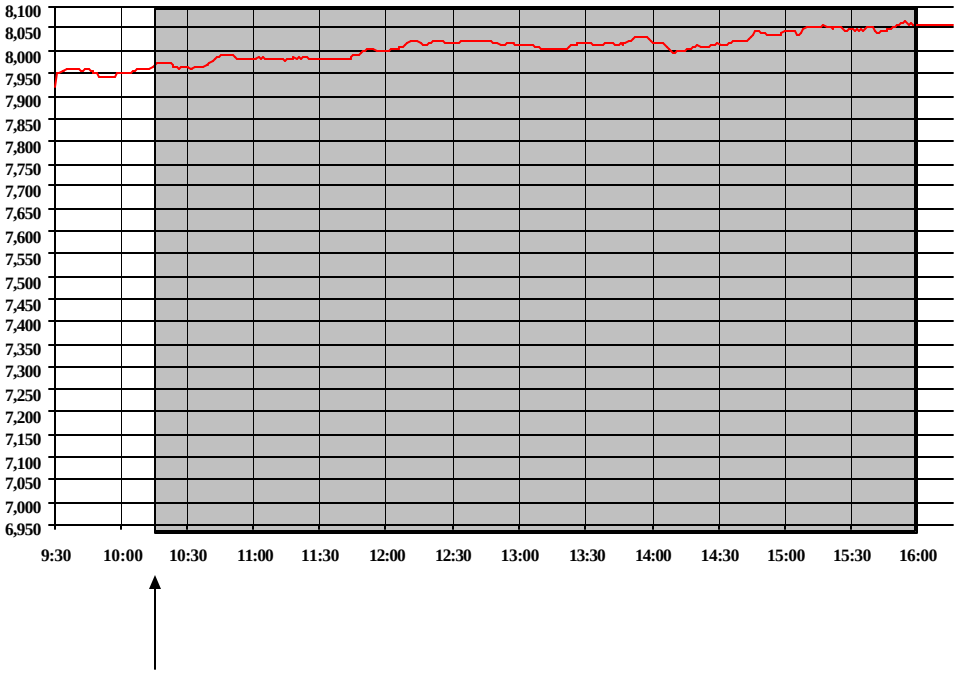
Rule 80(A)(c) Index Arbitrage buy restriction: 10:25 to close

Rule 80(A)(c) Index Arbitrage sell restriction: 9:41-10:20

Rule 80(A)(a) Sidecar: 9:30

Data source: Bridge Data

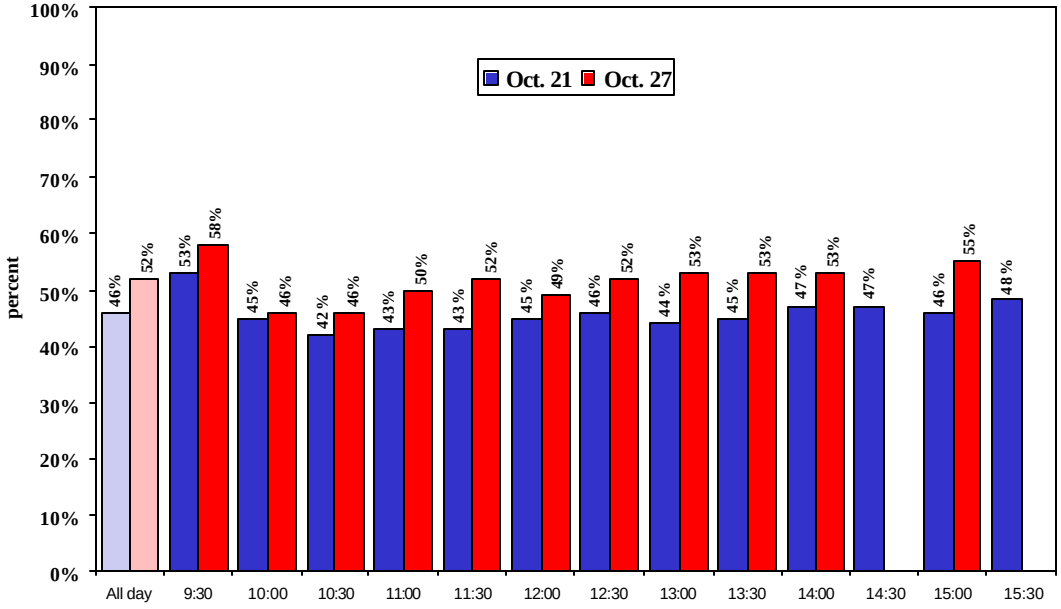
3. The Control Day: DJIA on October 21, 1997 minute-by-minute



Rule 80(A)(c) Index Arbitrage buy restriction: 10:16 to close

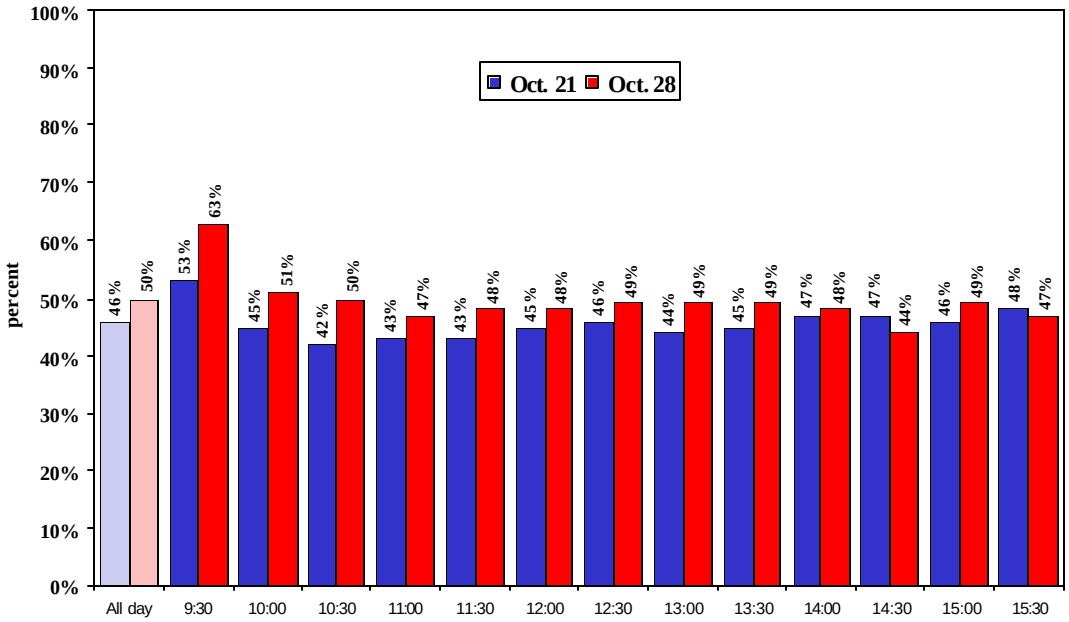
Data source: Bridge Data

4. System Executed Volume as Percent of Twice NYSE Volume*
Oct. 27 compared to Oct. 21



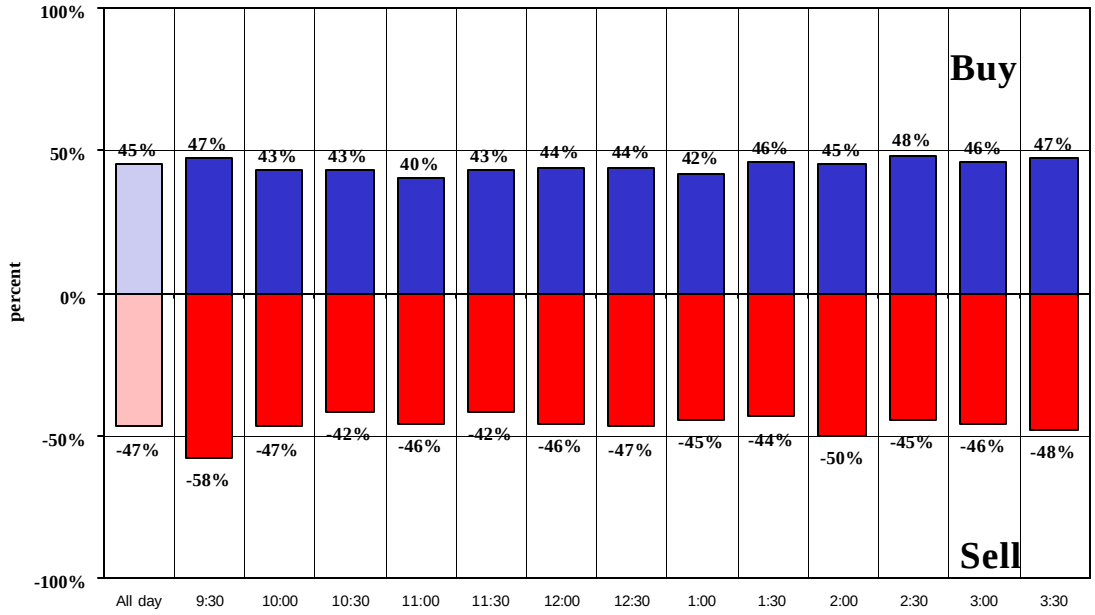
All NYSE issues.
Data source: NYSE's daily SOD and CT files.

5. System Executed Volume as Percent of Twice NYSE Volume*
Oct. 28 compared to Oct. 21



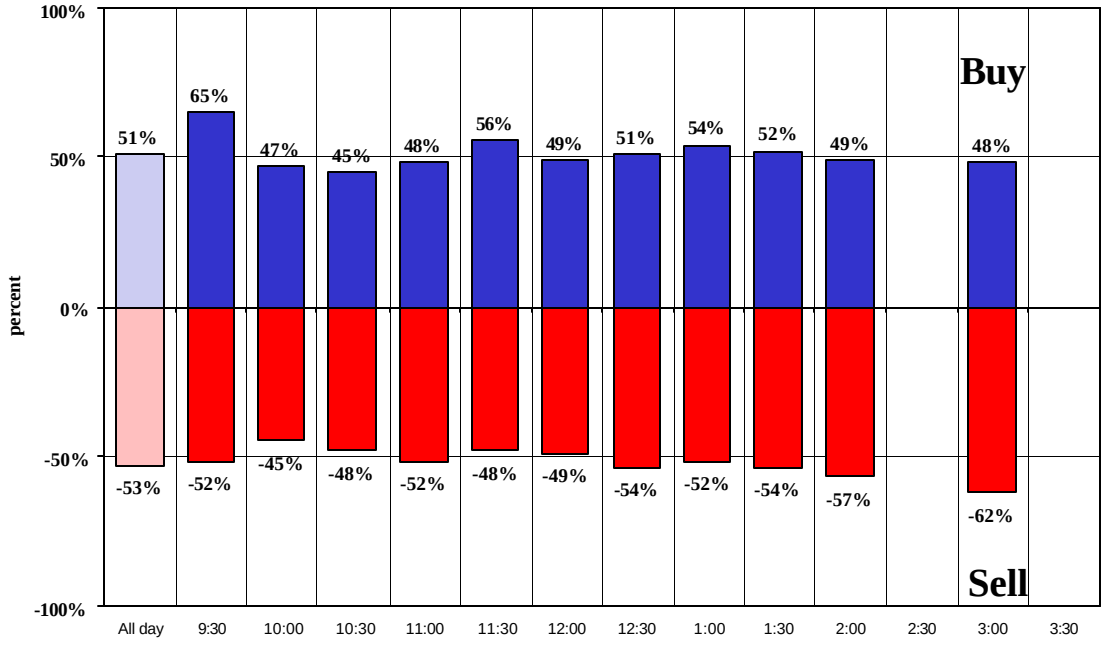
All NYSE issues.
Data source: NYSE's daily SOD and CT files.

6. Buy and Sell System Executed Volume as Percent of All Volume
October 21



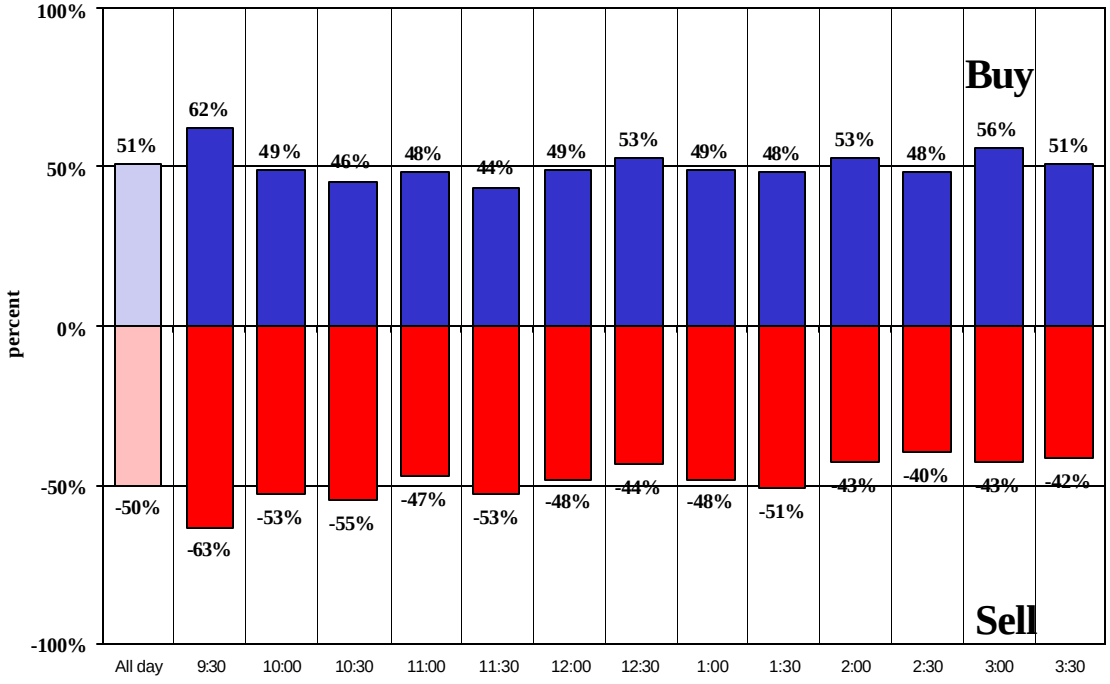
All NYSE issues.
Data source: NYSE's daily SOD and CT files.

7. Buy and Sell System Executed Volume as Percent of All Volume
October 27



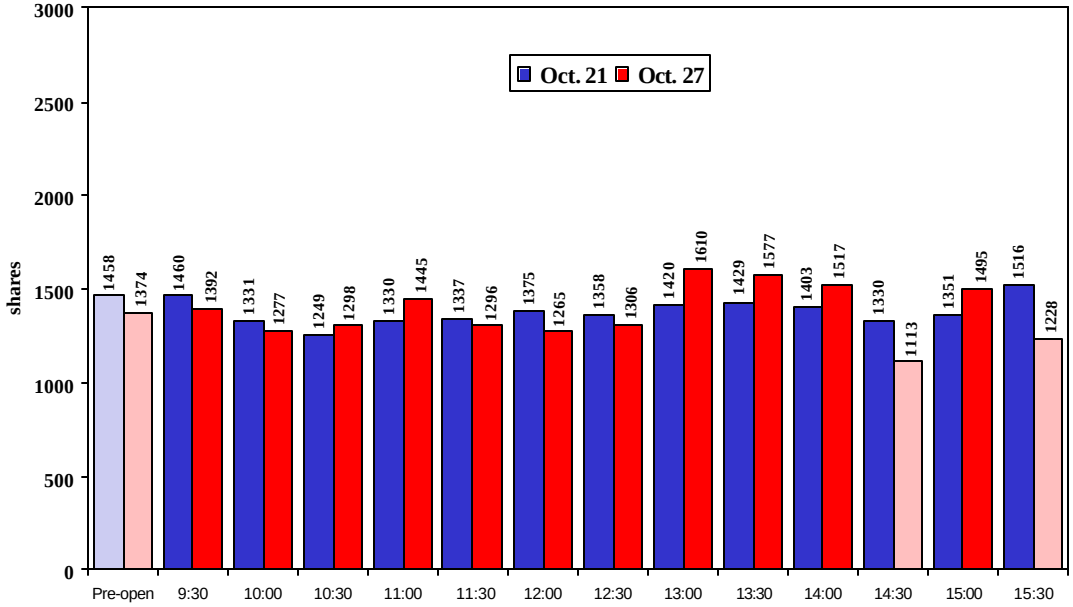
All NYSE issues.
Data source: NYSE's daily SOD and CT files.

8. Buy and Sell System Executed Volume as Percent of All Volume
October 28



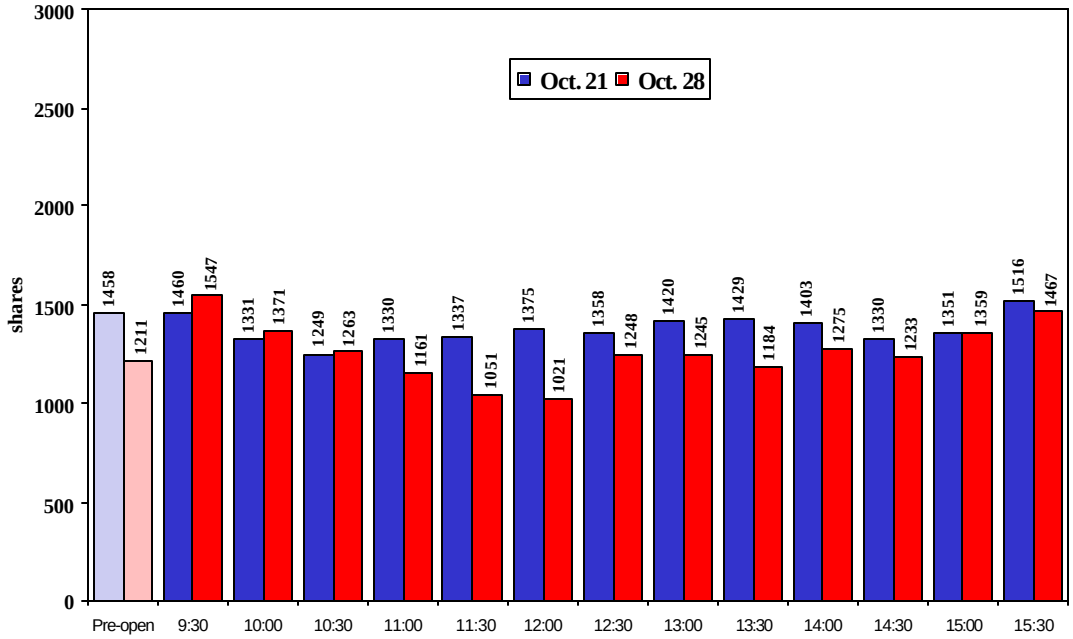
All NYSE issues.
Data source: NYSE's daily SOD and CT files.

9. Average Size of System Orders Placed
Oct. 27 compared to Oct. 21



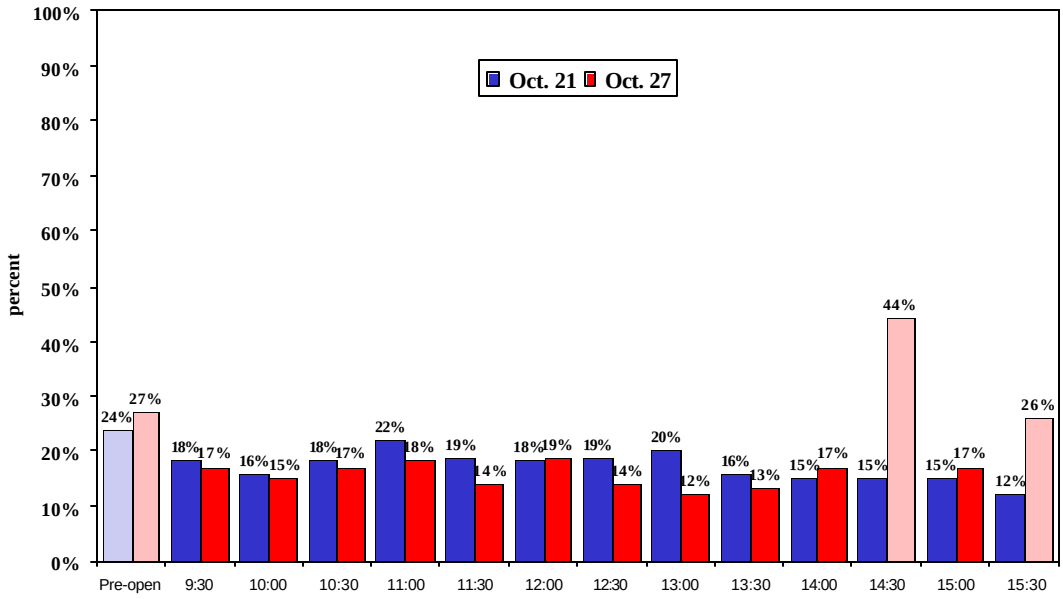
All NYSE issues.
Data source: NYSE's daily SOD files.

10. Average Size of System Orders Placed
Oct. 28 compared to Oct. 21



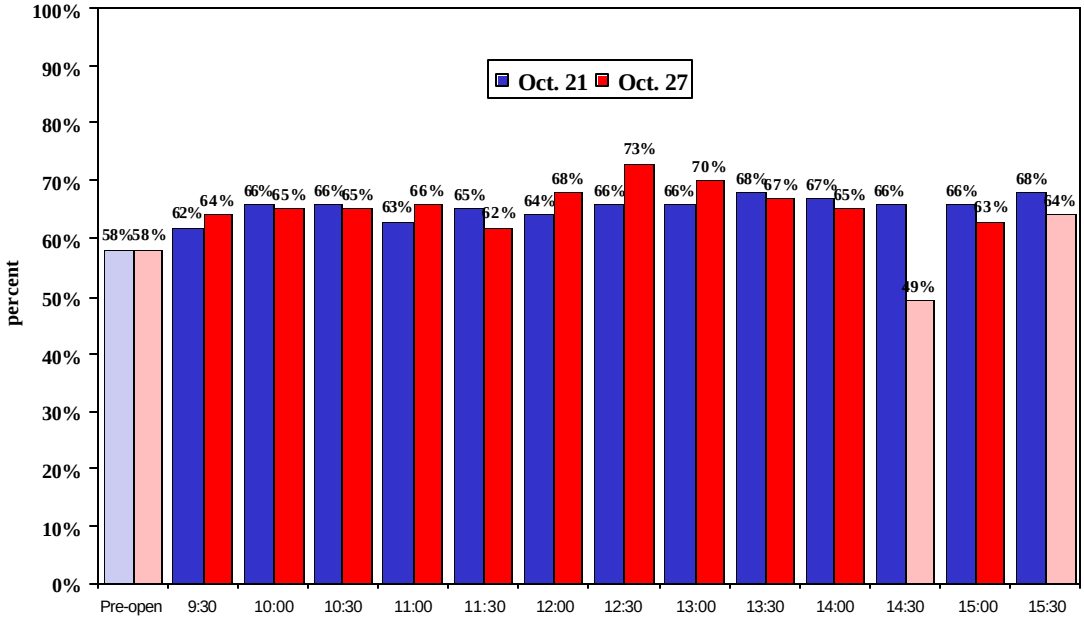
All NYSE issues.
Data source: NYSE's daily SOD files.

11. Agency/Individual Orders as Percent of All Orders Placed
System Orders, Oct. 27 compared to Oct. 21



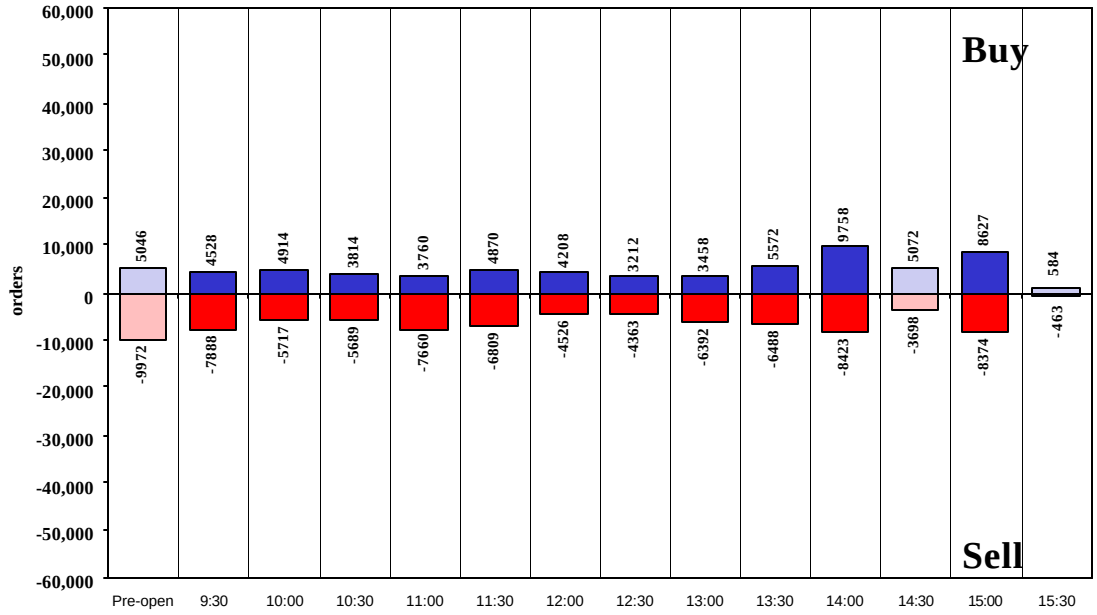
All NYSE issues.
Data source: NYSE's daily SOD files.

12. Agency/Institutional Orders as Percent of All Orders Placed
System Orders, Oct. 27 compared to Oct. 21



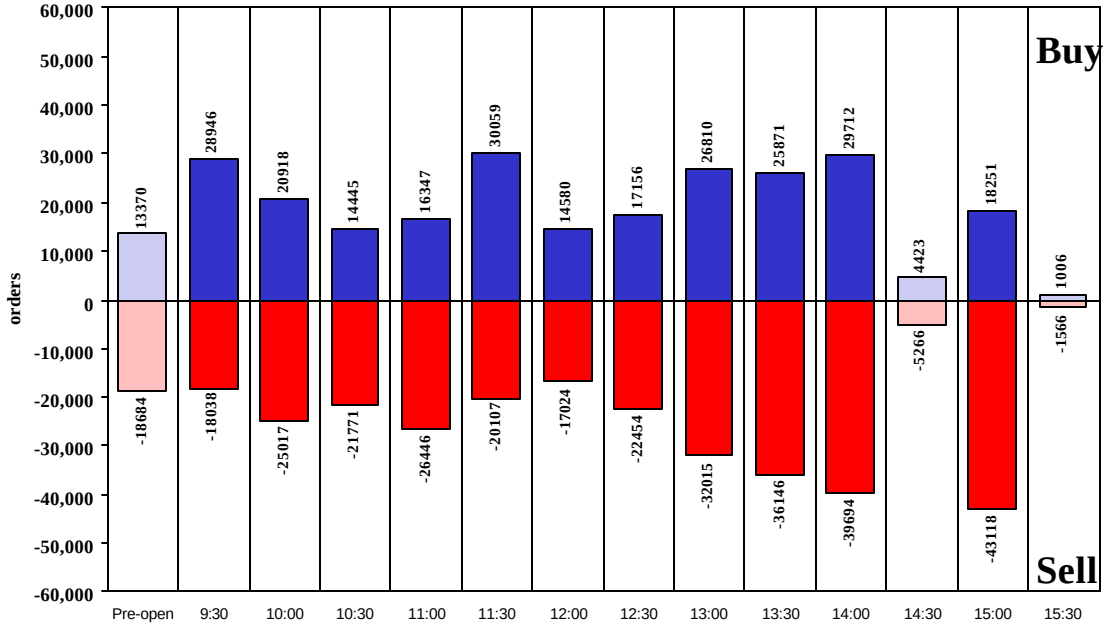
All NYSE issues.
Data source: NYSE's daily SOD files.

13. Agency/Individual Buy and Sell Orders Placed
System Orders, October 27



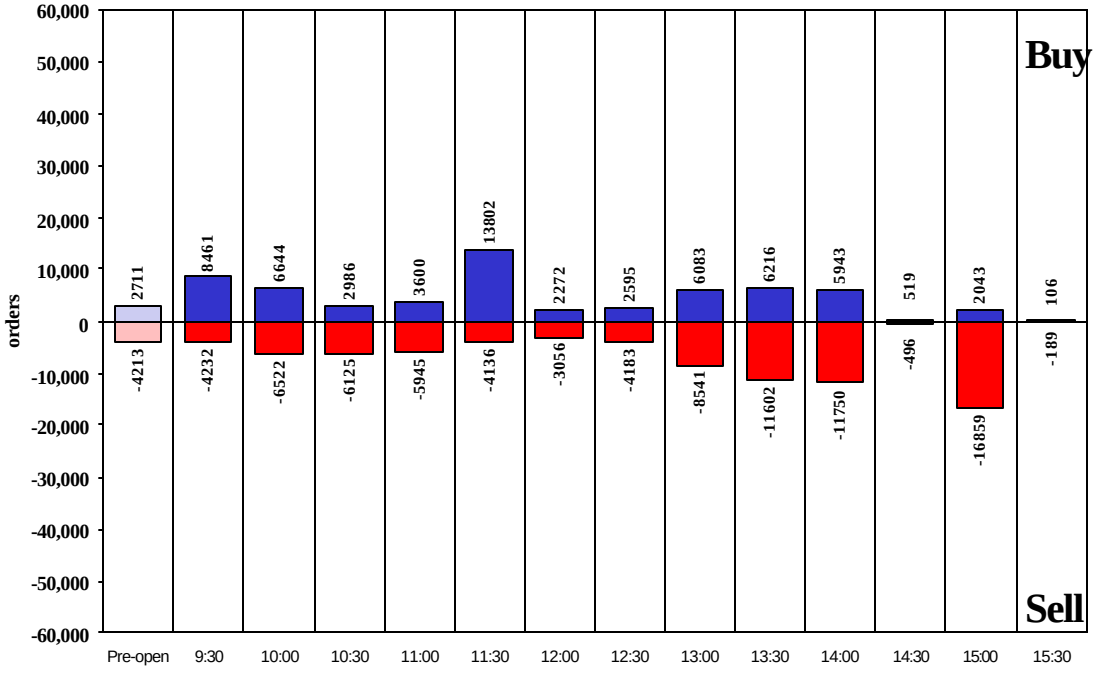
All NYSE issues.
Data source: NYSE's daily SOD files.

14. Agency/Institutional Buy and Sell Orders Placed
System Orders, October 27



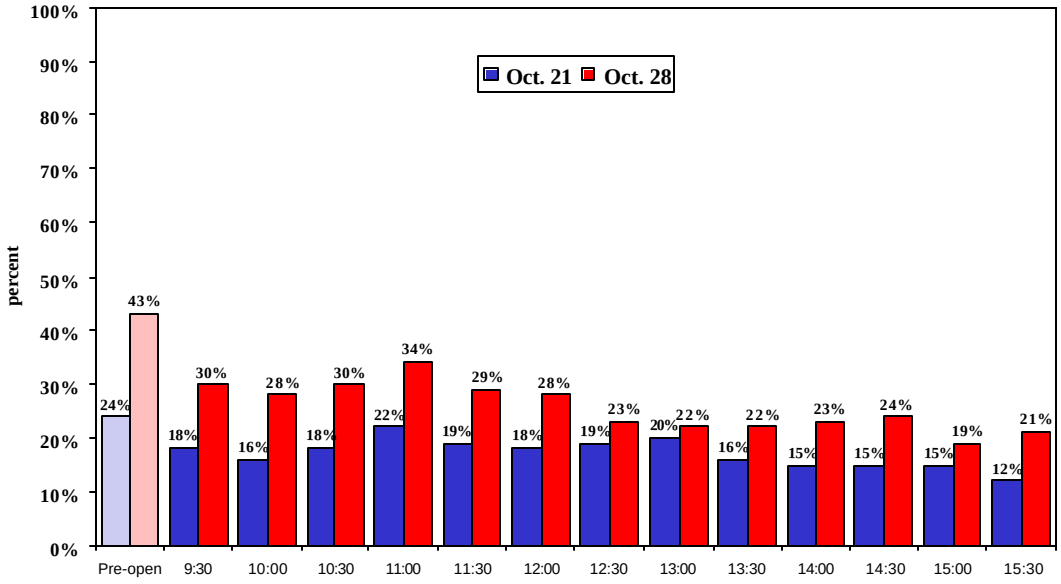
All NYSE issues.
Data source: NYSE's daily SOD files.

15. Member Firm Principal Buy and Sell Orders Placed
System Orders, October 27



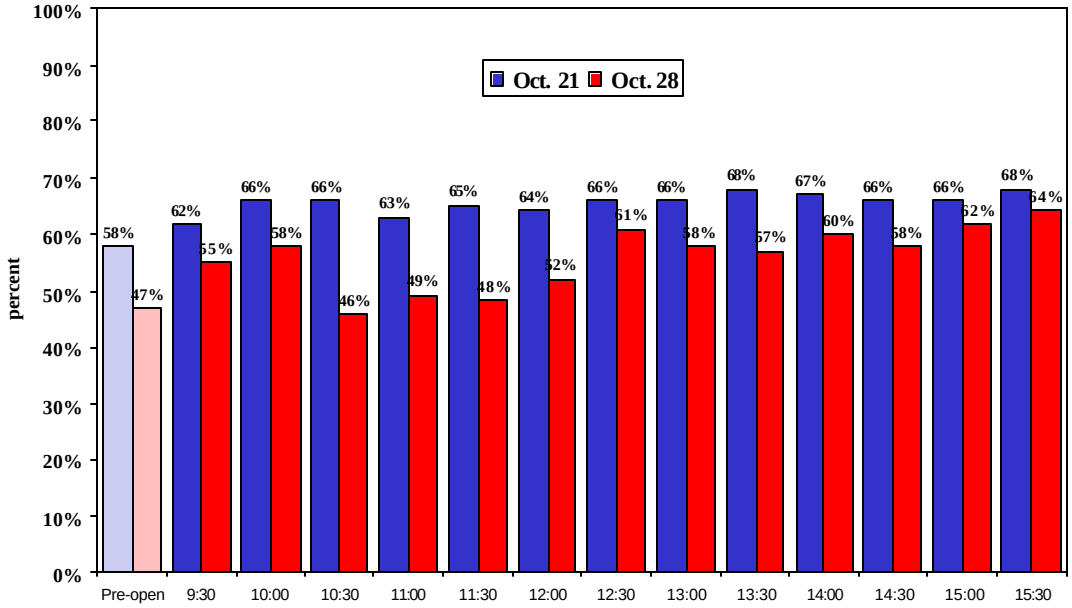
All NYSE issues.
Data source: NYSE's daily SOD files.

16. Agency/Individual Orders as Percent of All Orders Placed
System Orders, Oct. 28 compared to Oct. 21



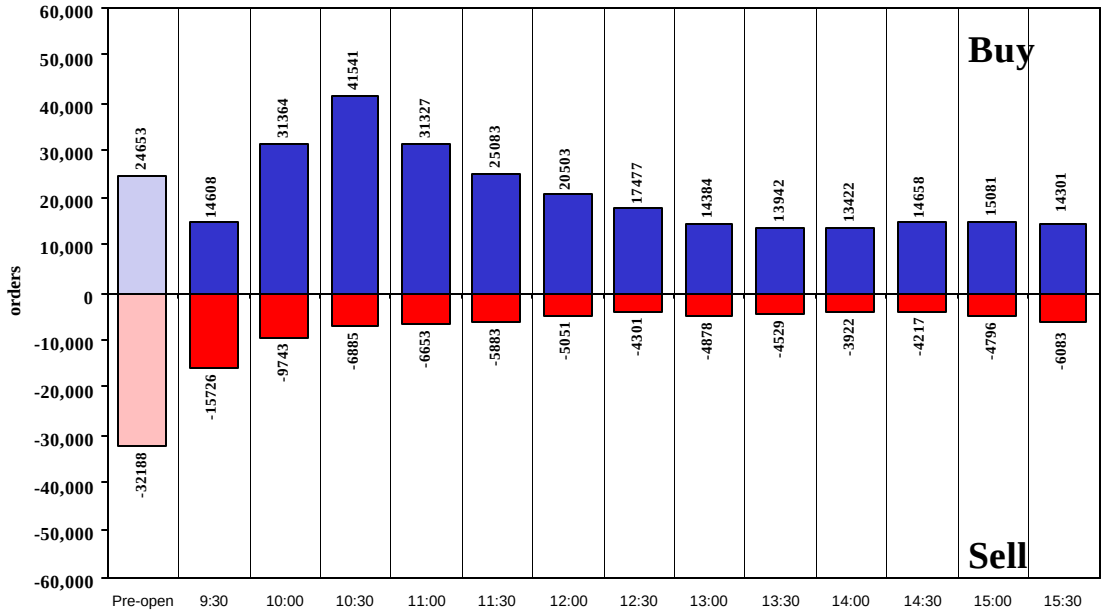
All NYSE issues.
Data Source: NYSE's daily SOD files.

17. Agency/Institutional Orders as Percent of All Orders Placed
System Orders, Oct. 28 compared to Oct. 21



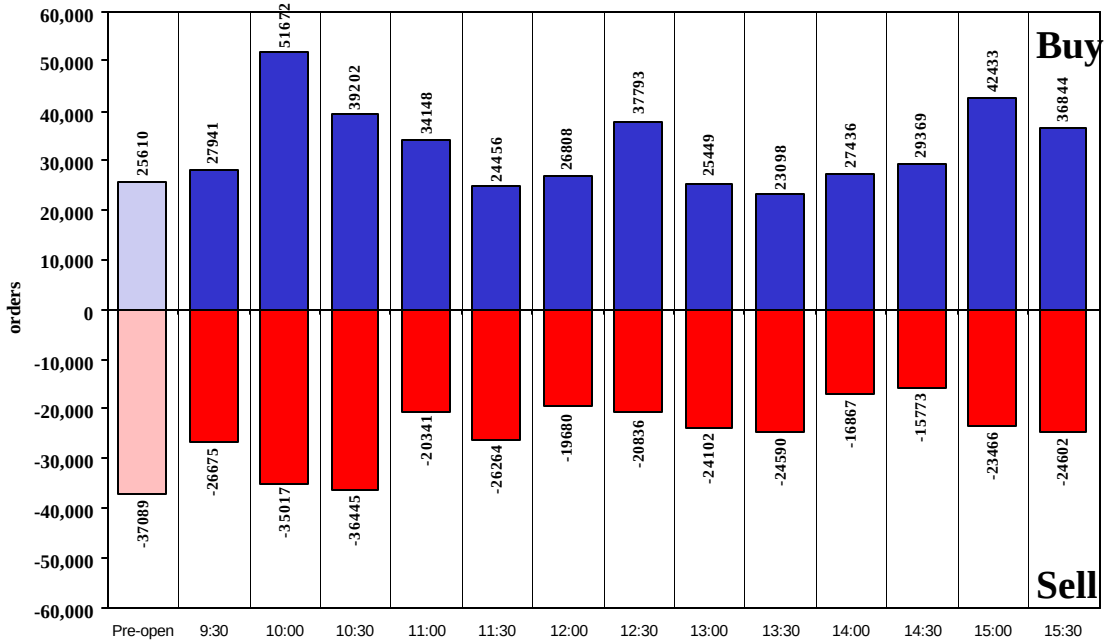
All NYSE issues.
Data source: NYSE's daily SOD files.

18. Agency/Individual Buy and Sell Orders Placed
System Orders, October 28



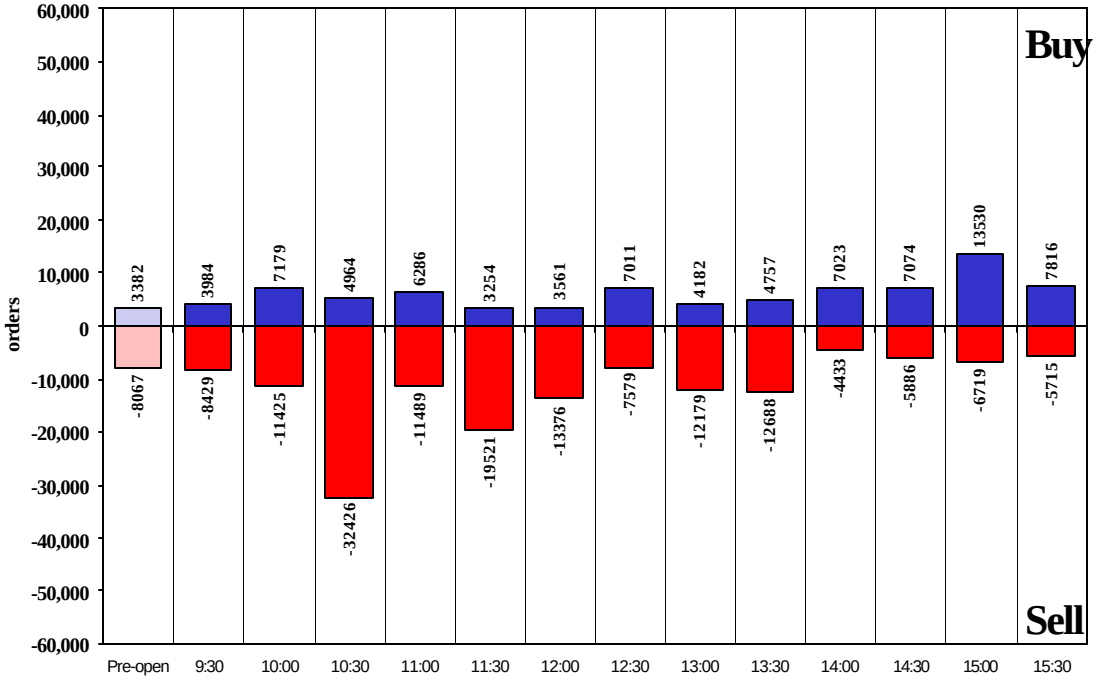
All NYSE issues.
Data source: NYSE's daily SOD files.

19. Agency/Institutional Buy and Sell Orders Placed
System Orders, October 28



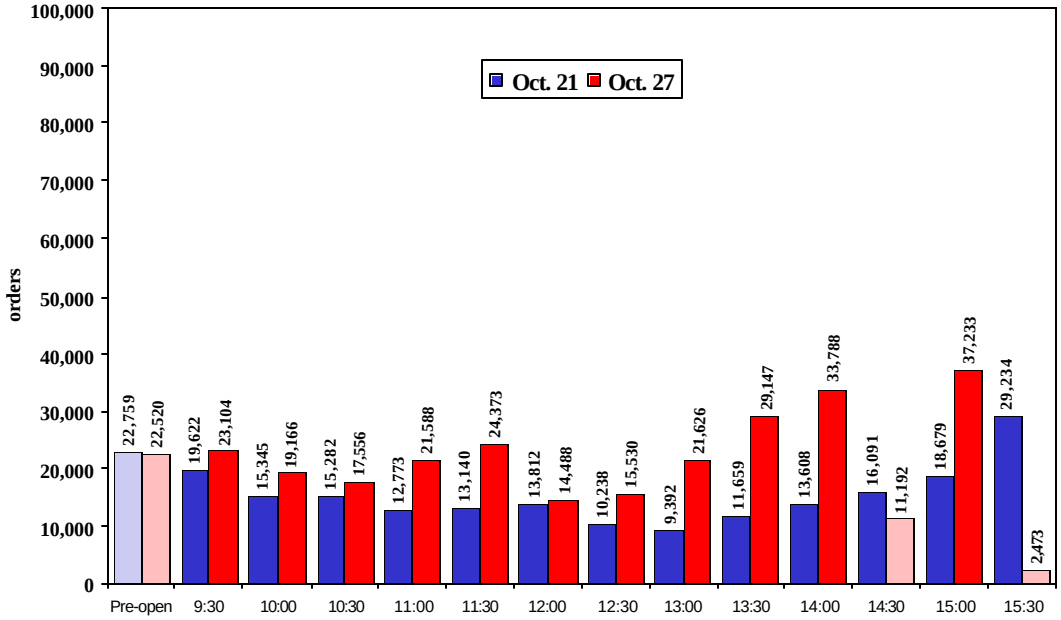
All NYSE issues.
Data source: NYSE's daily SOD files.

20. Member Firm Principal Buy and Sell Orders Placed
System Orders, October 28



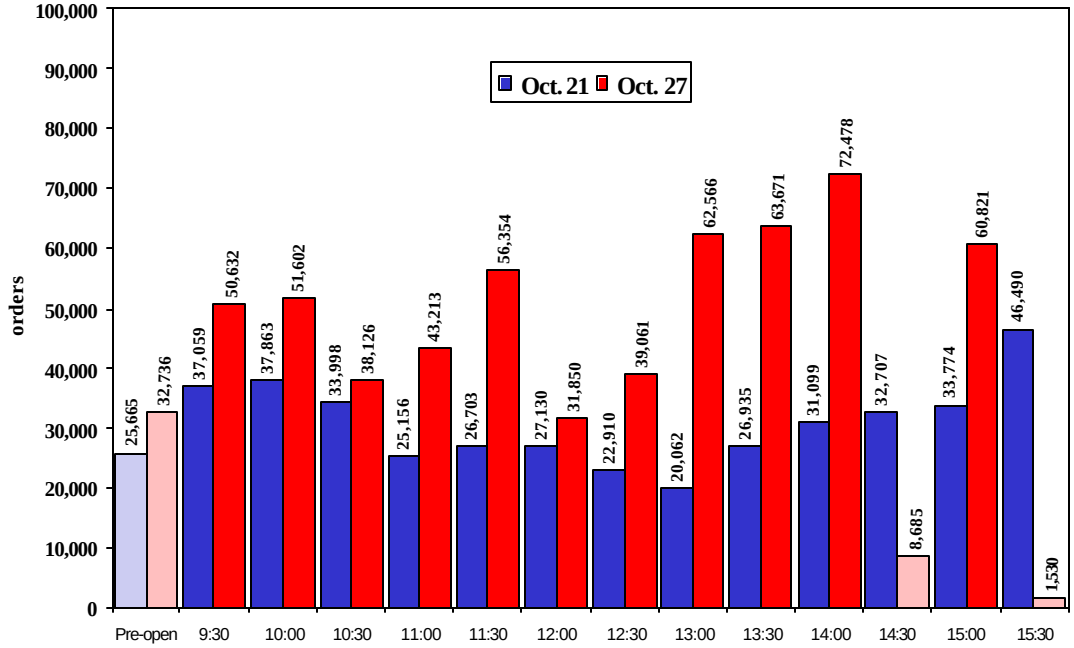
All NYSE issues.
Data source: NYSE's daily SOD files.

21. Market Orders Placed
System Orders, Oct. 27 compared to Oct. 21



All NYSE issues.
Data source: NYSE's daily SOD files.

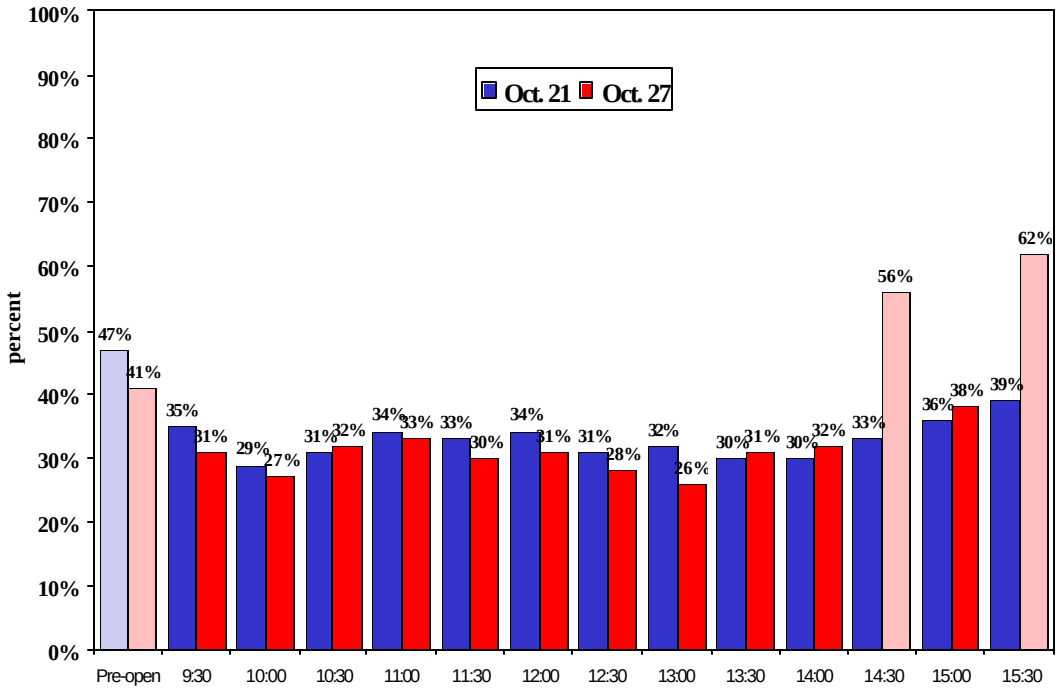
22. Limit Orders Placed
System Orders, Oct. 27 compared to Oct. 21



All NYSE issues.
Data source: NYSE's daily SOD files.

23. Market Orders as Percent of All Orders Placed

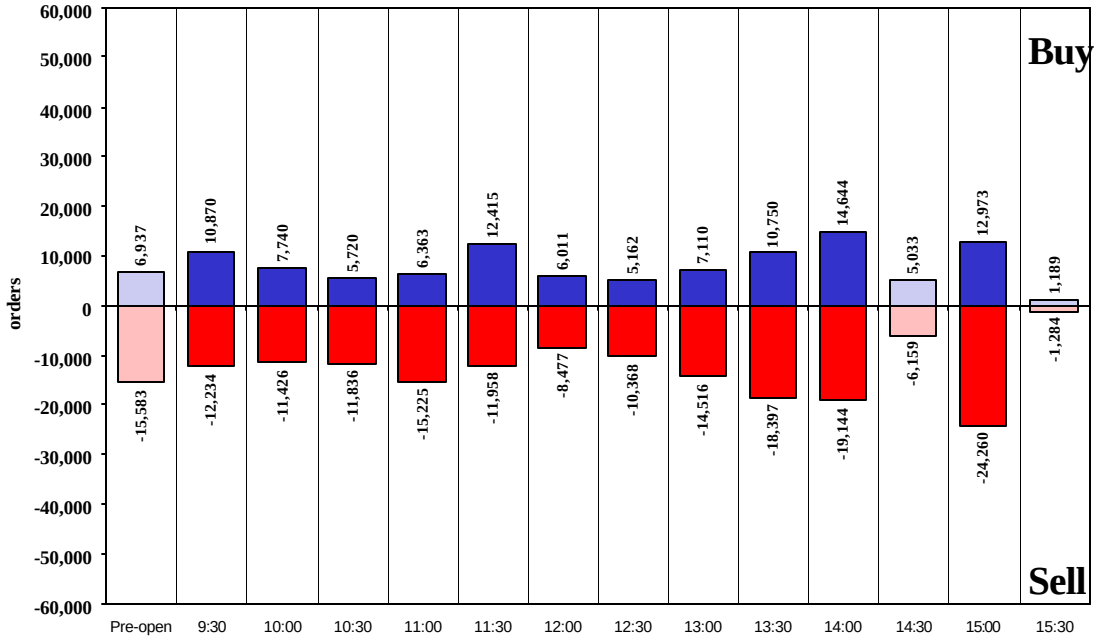
System Orders, Oct. 27 compared to Oct. 21



All NYSE issues.
Data source: NYSE's daily SOD files.

24. Market Buy and Sell Orders Placed

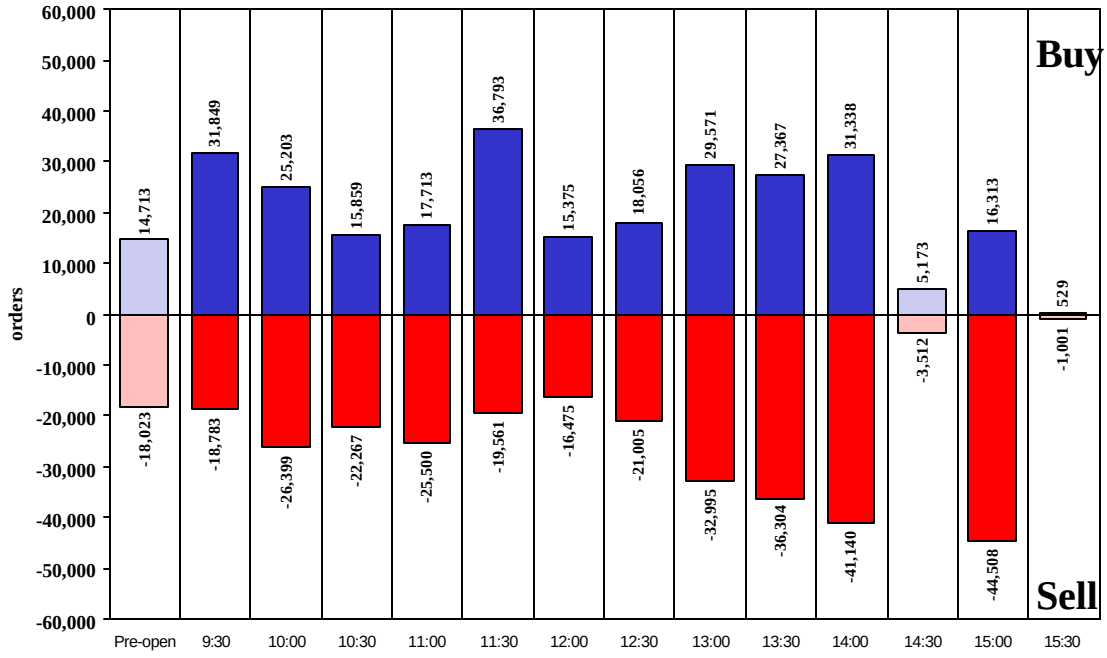
System Orders, October 27



All NYSE issues.
Data source: NYSE's daily SOD files.

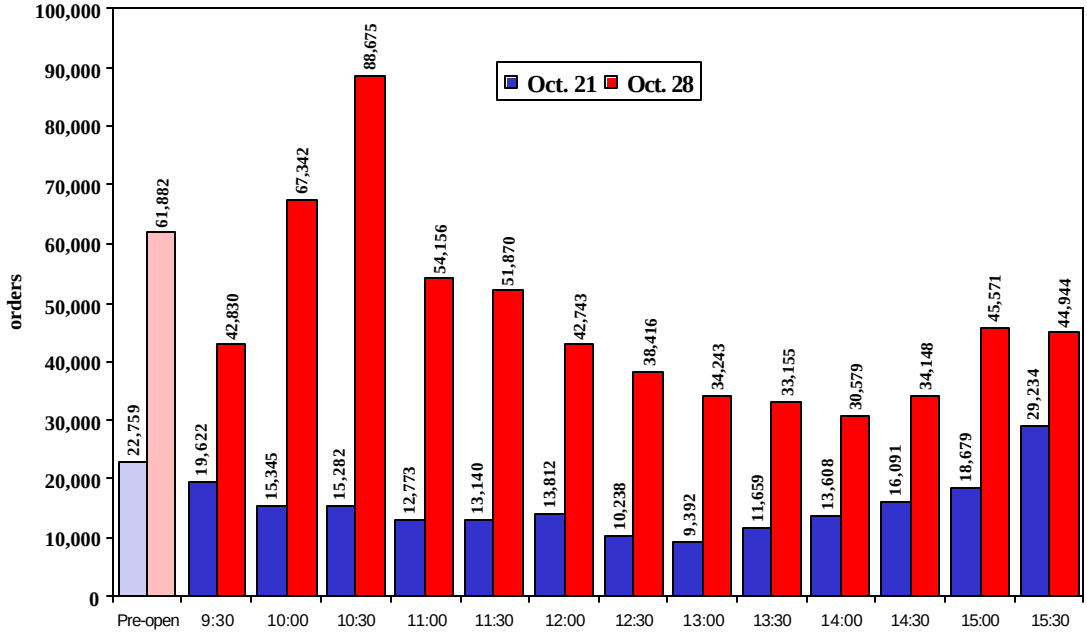
25. Limit Buy and Sell Orders Placed

System Orders, October 27



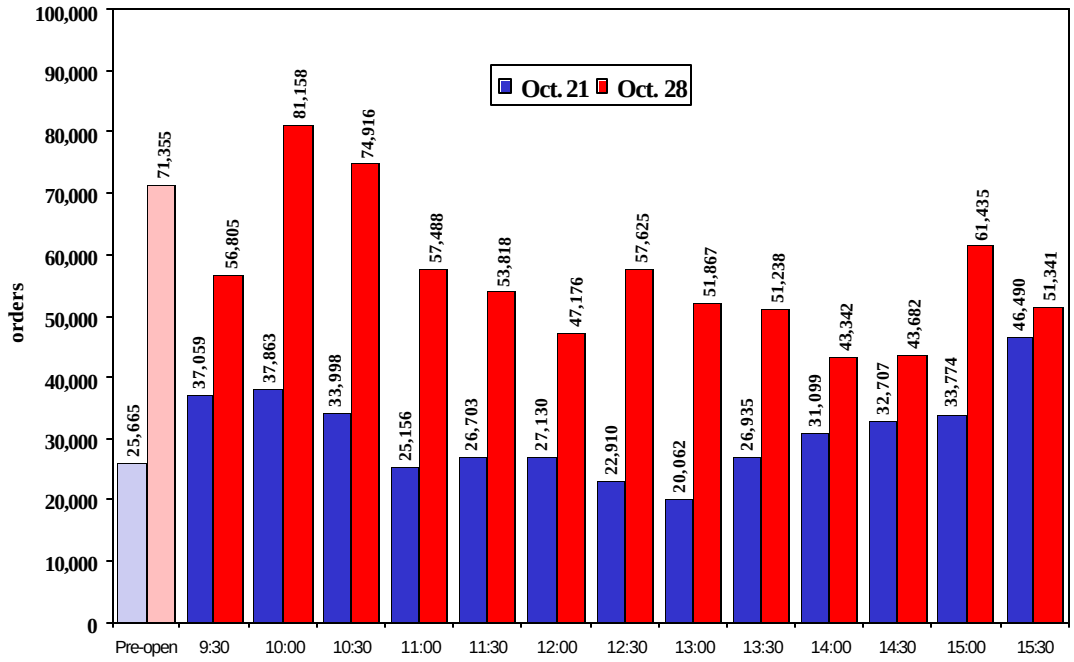
All NYSE issues.
Data source: NYSE's daily SOD files.

26. Market Orders Placed
System Orders, Oct. 28 compared to Oct. 21



All NYSE issues.
Data source: NYSE's daily SOD files.

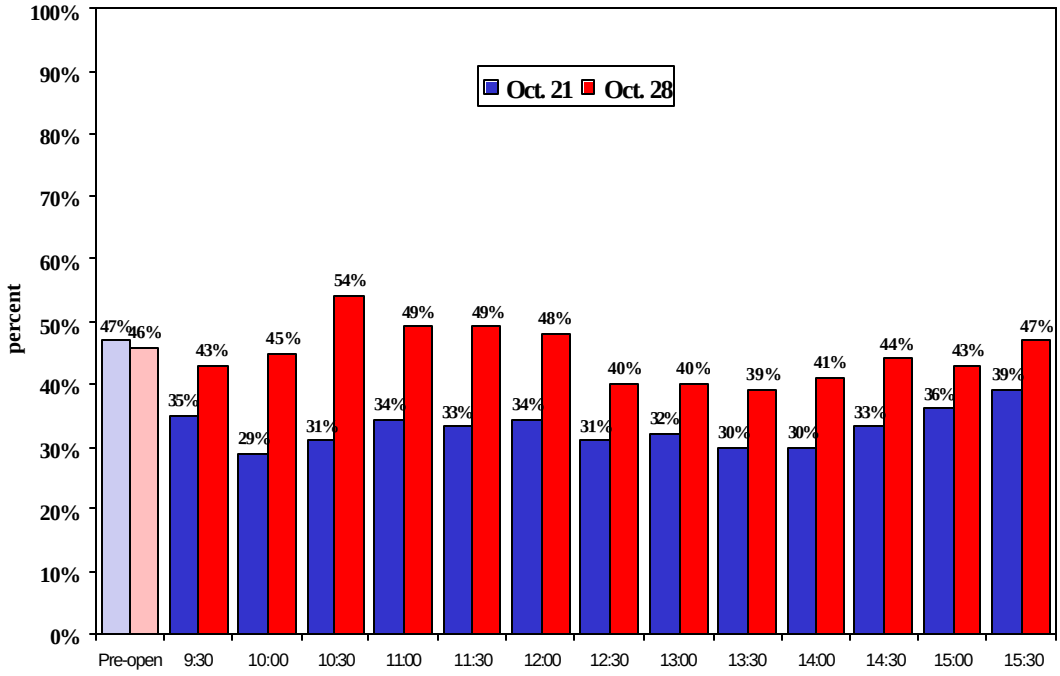
27. Limit Orders Placed
System Orders, Oct. 28 compared to Oct. 21



All NYSE issues.
Data source: NYSE's daily SOD files.

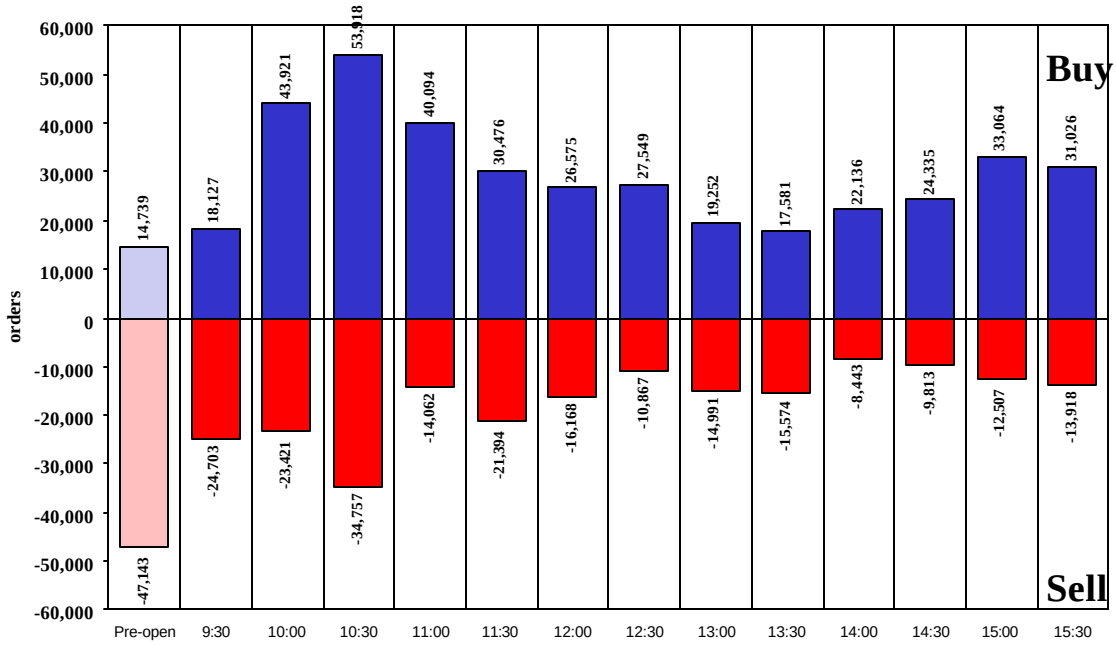
28. Market Orders as Percent of All Orders Placed

System Orders, Oct. 28 compared to Oct. 21



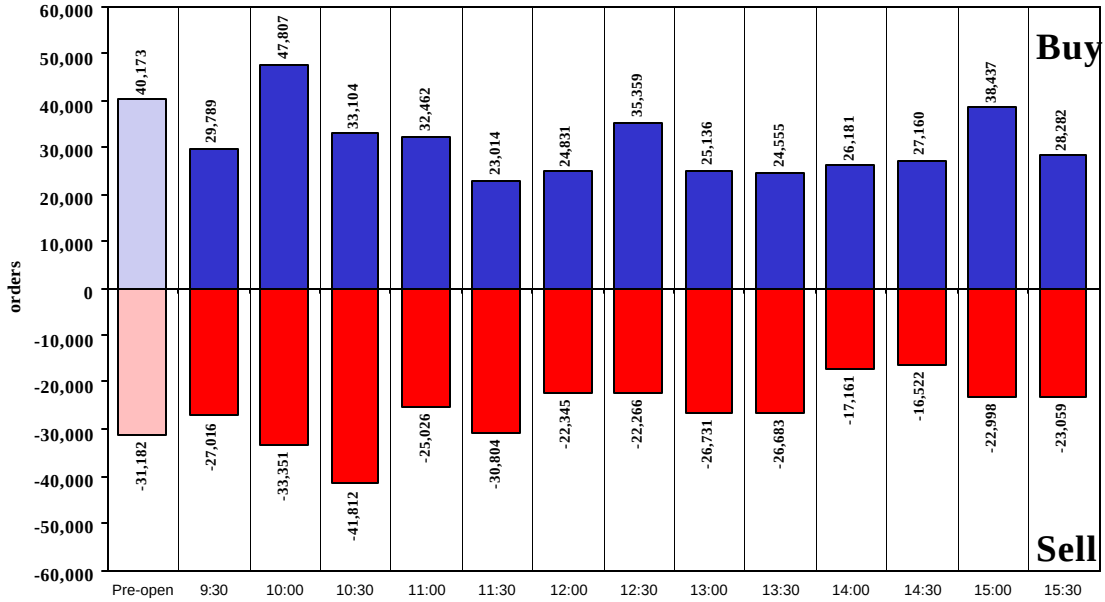
All NYSE issues.
Data source: NYSE's daily SOD files.

29. Market Buy and Sell Orders Placed
System Orders, October 28



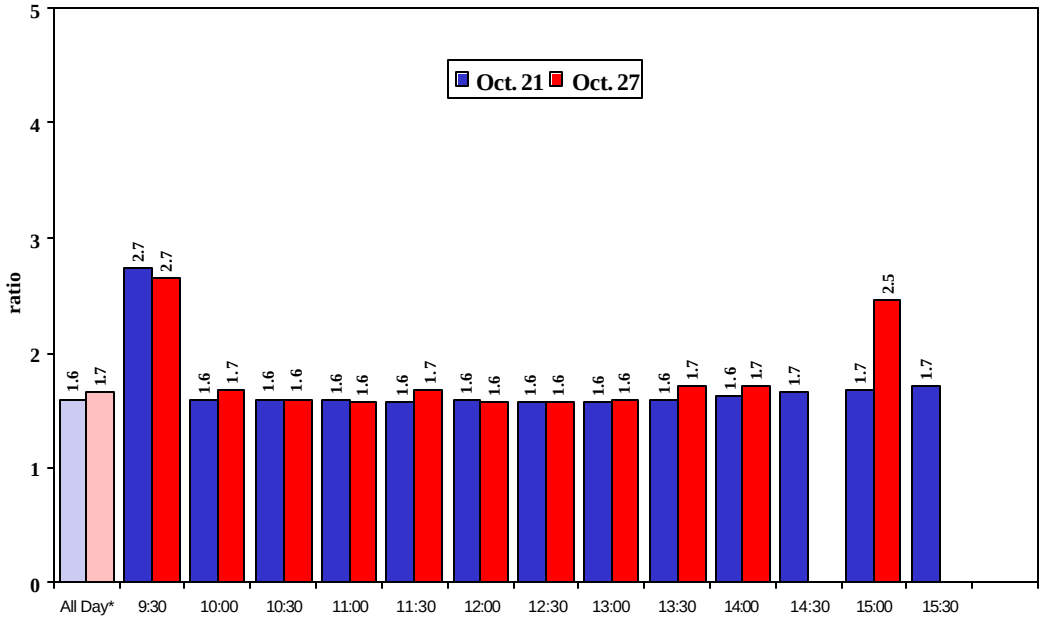
All NYSE issues.
Data source: NYSE's daily SOD files.

30. Limit Buy and Sell Orders Placed
System Orders, October 28



All NYSE issues.
Data source: NYSE's daily SOD files.

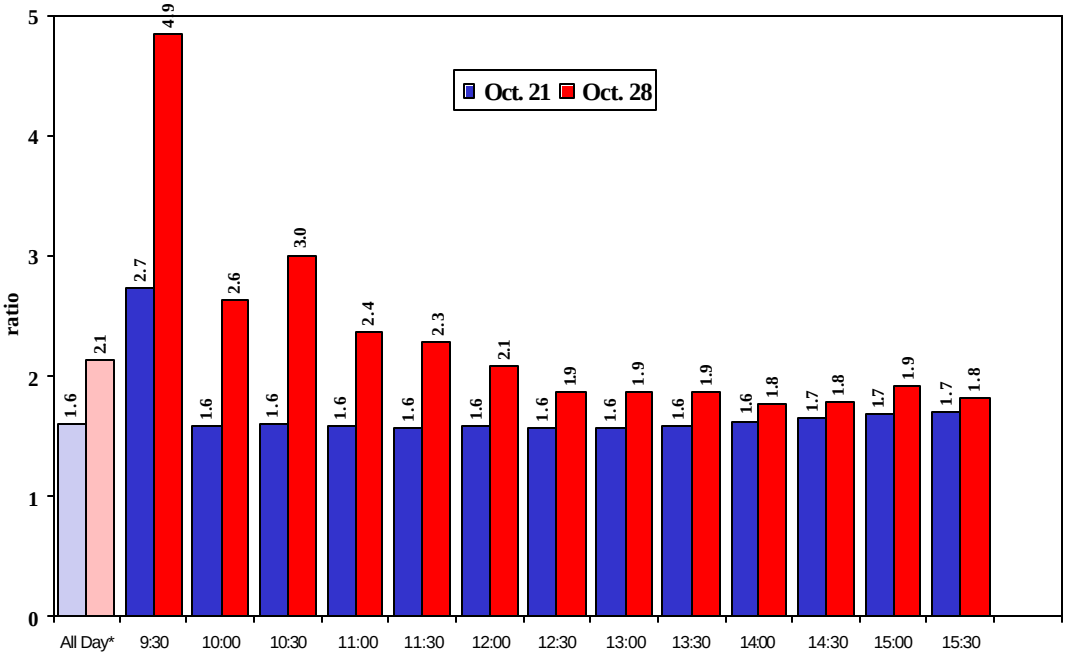
31. Bunching / System Orders per Trade
Oct. 27 compared to Oct. 21



*All day average print size excludes opening print

All NYSE issues.
Data source: NYSE's ISIS and SOD files.

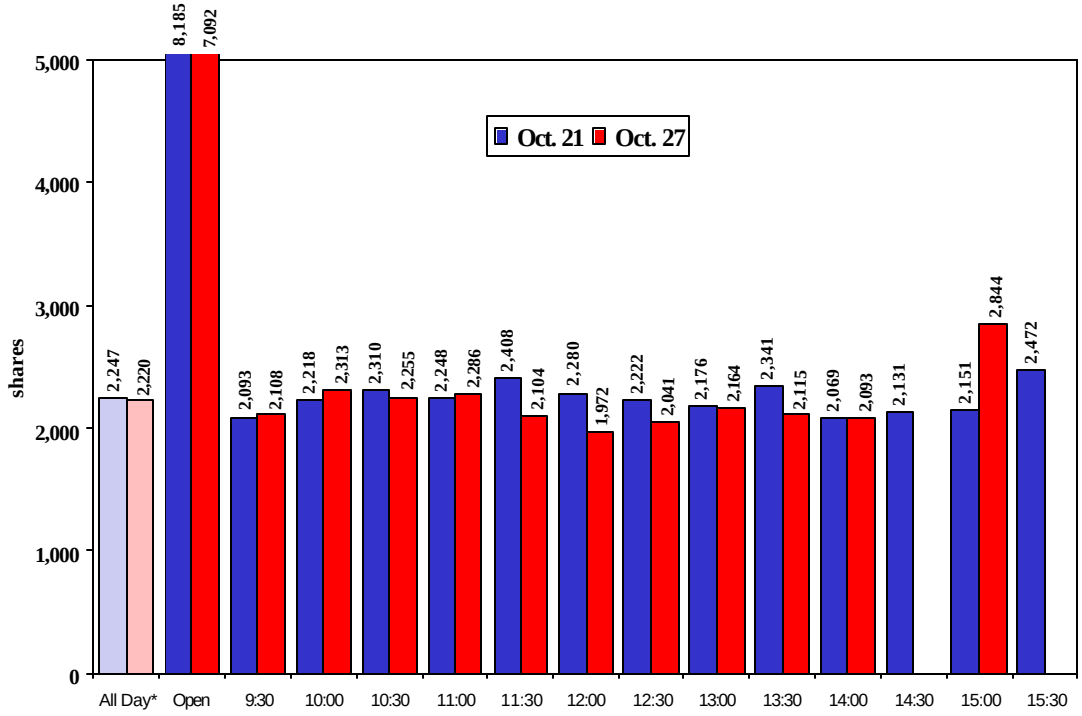
32. Bunching / System Orders per Trade
Oct. 28 compared to Oct. 21



*All day average print size excludes opening print

All NYSE issues.
Data source: NYSE's ISIS and SOD files.

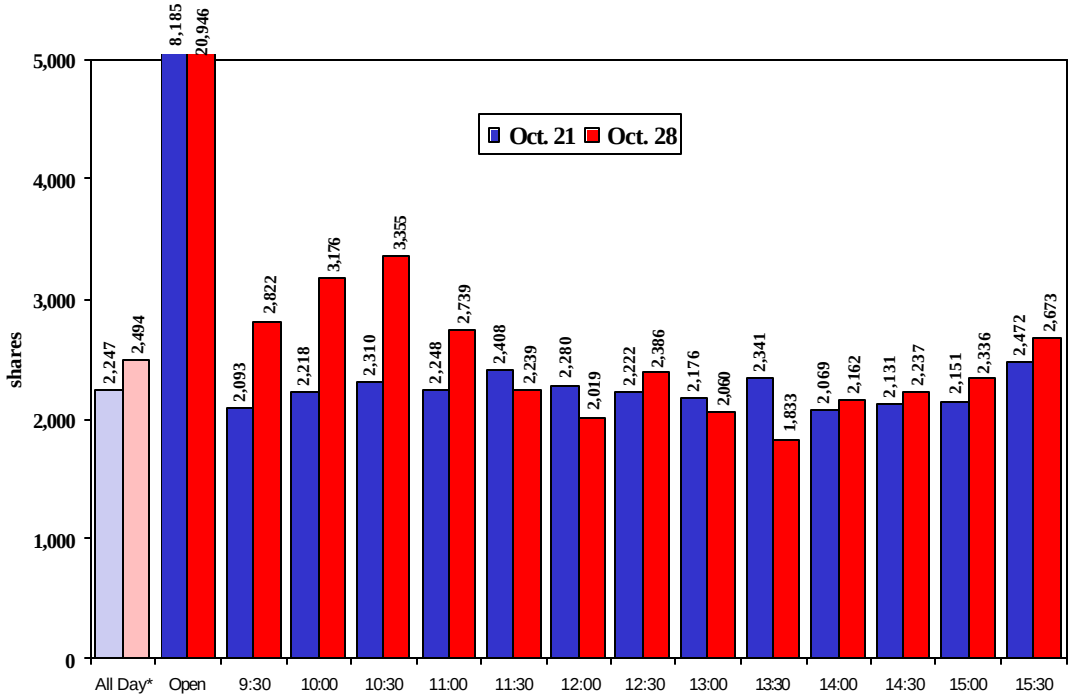
33. Average Size of Tape Print
Oct. 27 compared to Oct. 21



*All day average print size excludes opening print

All NYSE issues.
Data source: NYSE's daily CT files.

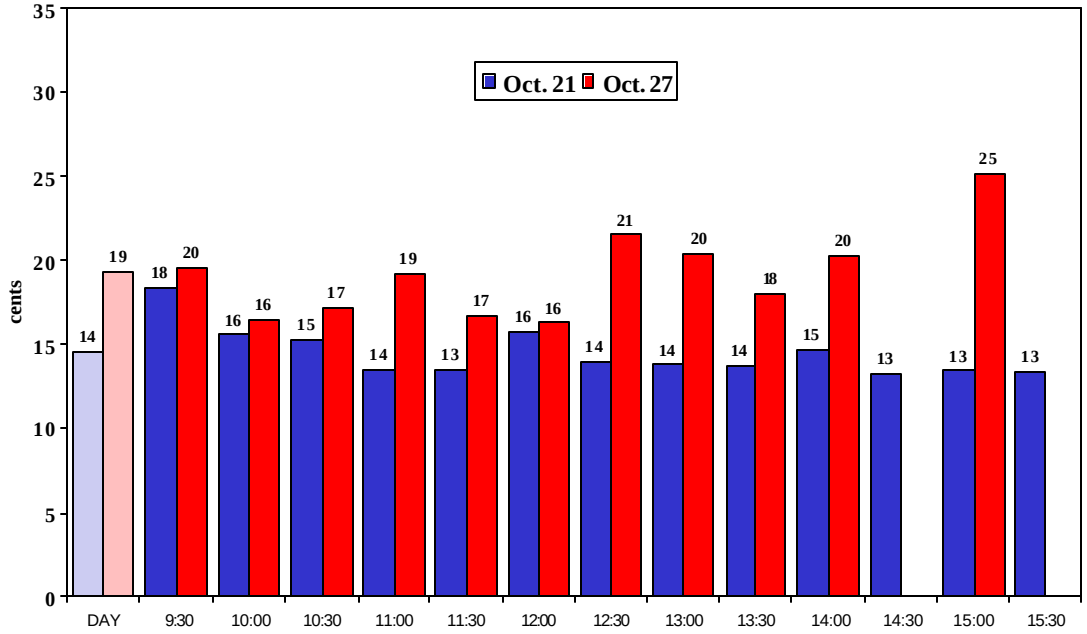
34. Average Size of Tape Print
Oct. 28 compared to Oct. 21



*All day average print size excludes opening print

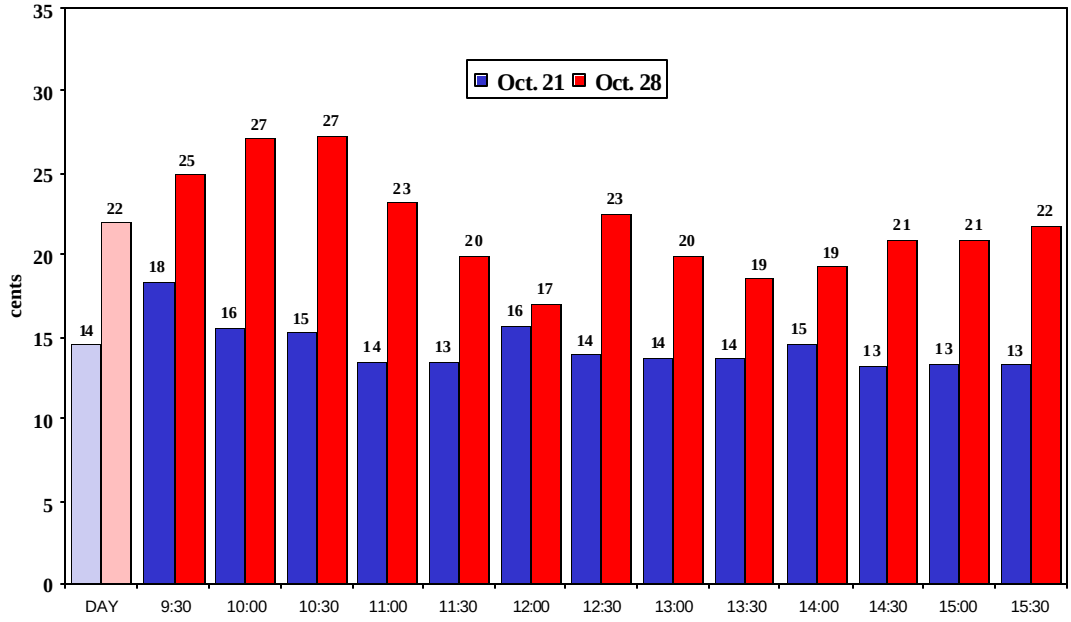
All NYSE issues.
Data source: NYSE's daily CT files.

35. Trade-weighted Average Spreads
Oct. 27 compared to Oct. 21



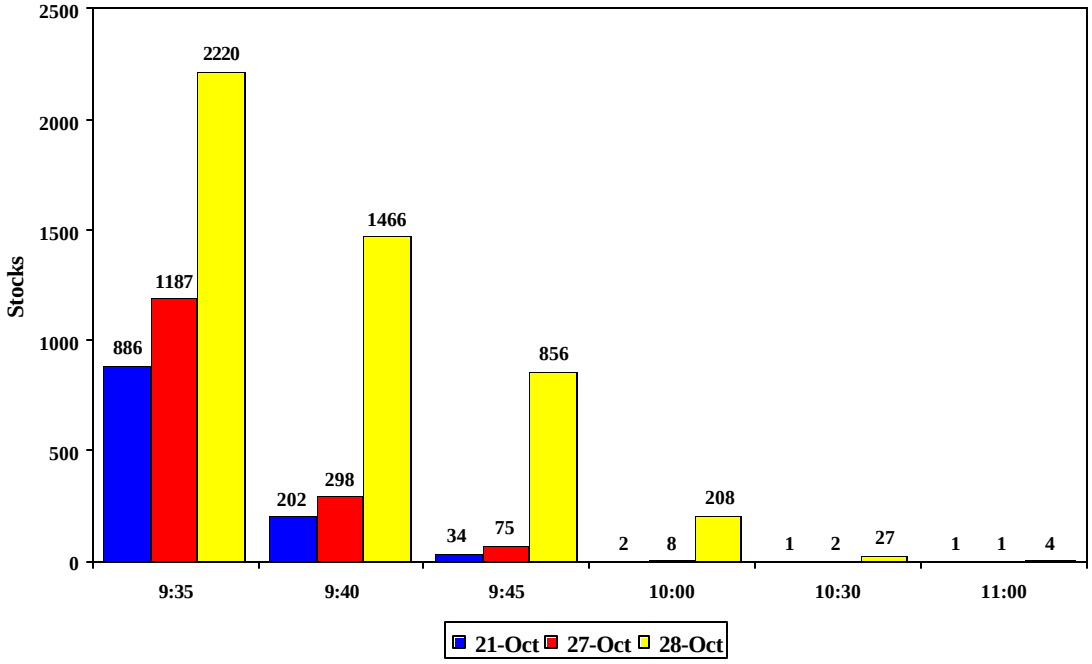
All NYSE-listed issues
Data source: NYSE daily CT and CQ files

36. Trade-weighted Average Spreads
Oct. 28 compared to Oct. 21



All NYSE-listed issues.
Data source: NYSE daily CT and CQ files

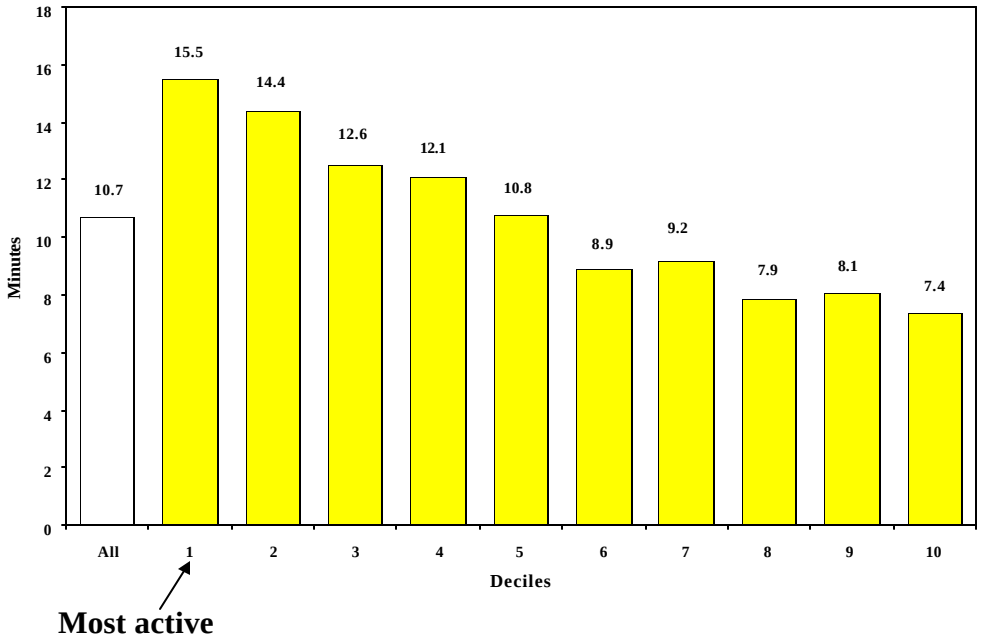
37. Number of stocks that have not opened by ….



All NYSE-listed issues.

Data source: NYSE daily CT and CQ files

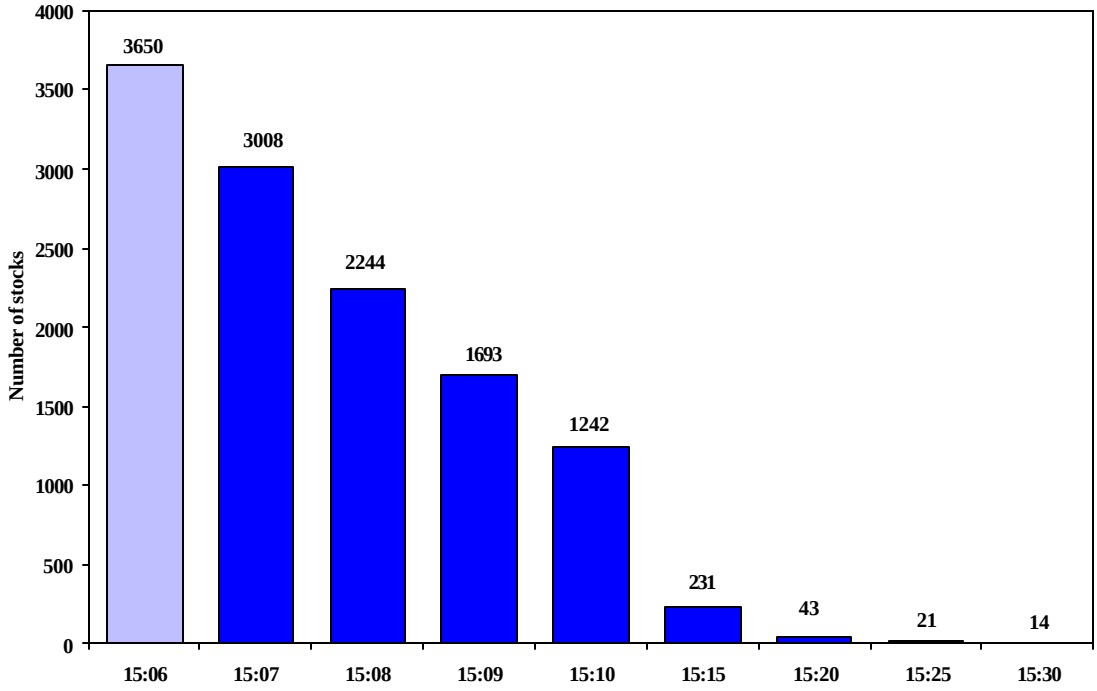
38. Opening time: number of minutes after 9:30
October 28



All NYSE-listed issues.

Data source: NYSE daily CT and CQ files

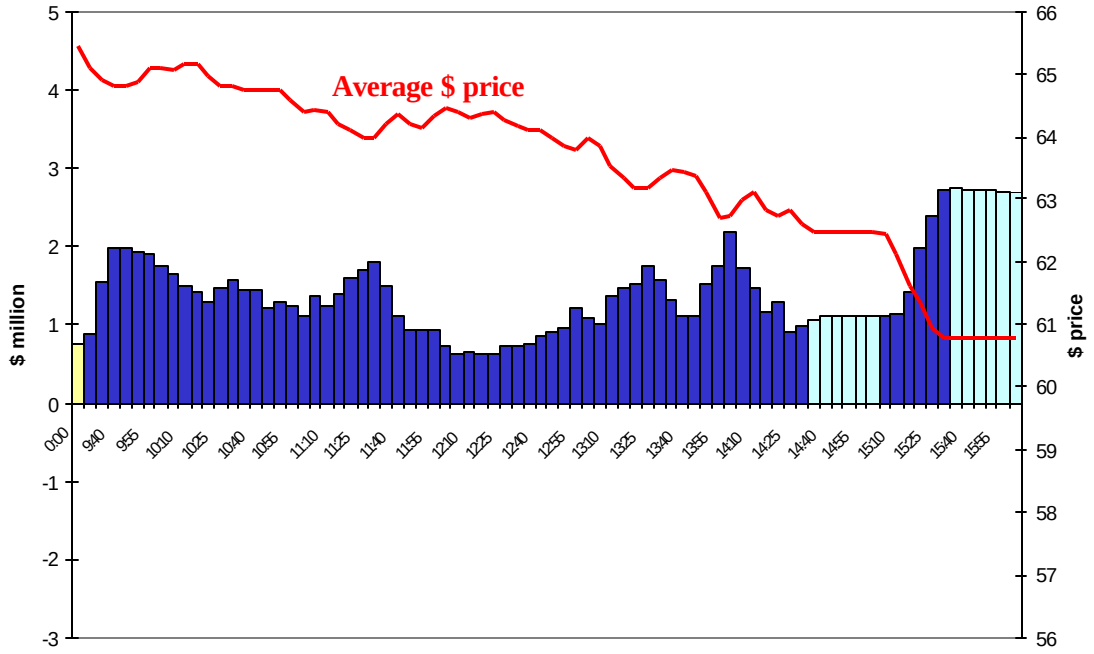
39. Monday, October 27 Trading Halt
Number of stocks that have not re-opened by ….



All NYSE-listed issues (3,650).

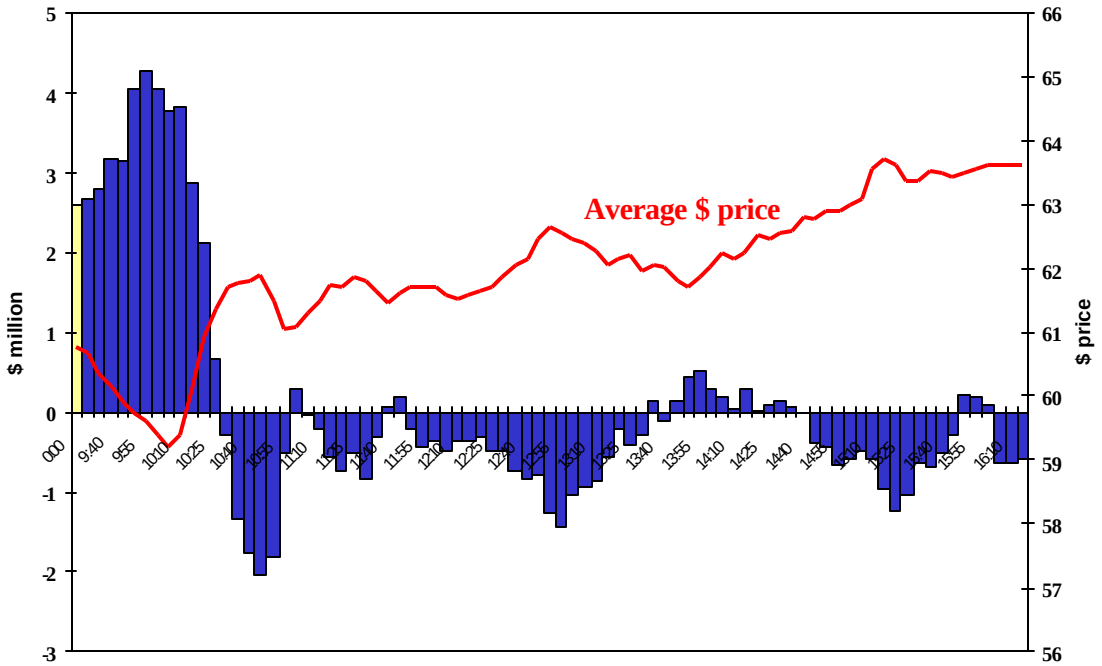
Data source: NYSE daily CT and CQ files

40. Specialist Dollar Inventory per Stock
30 DJIA Stocks, October 27 (form 81 data)



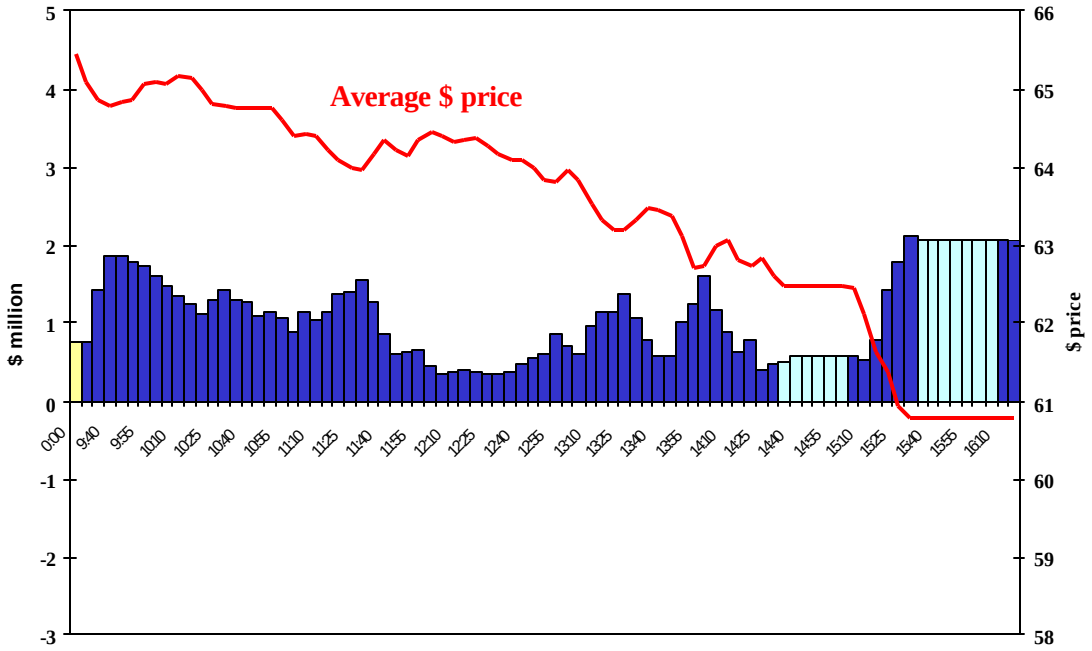
Data source: NYSE daily SPET files

41. Specialist Dollar Inventory per Stock
30 DJIA Stocks, October 28 (form 81 data)



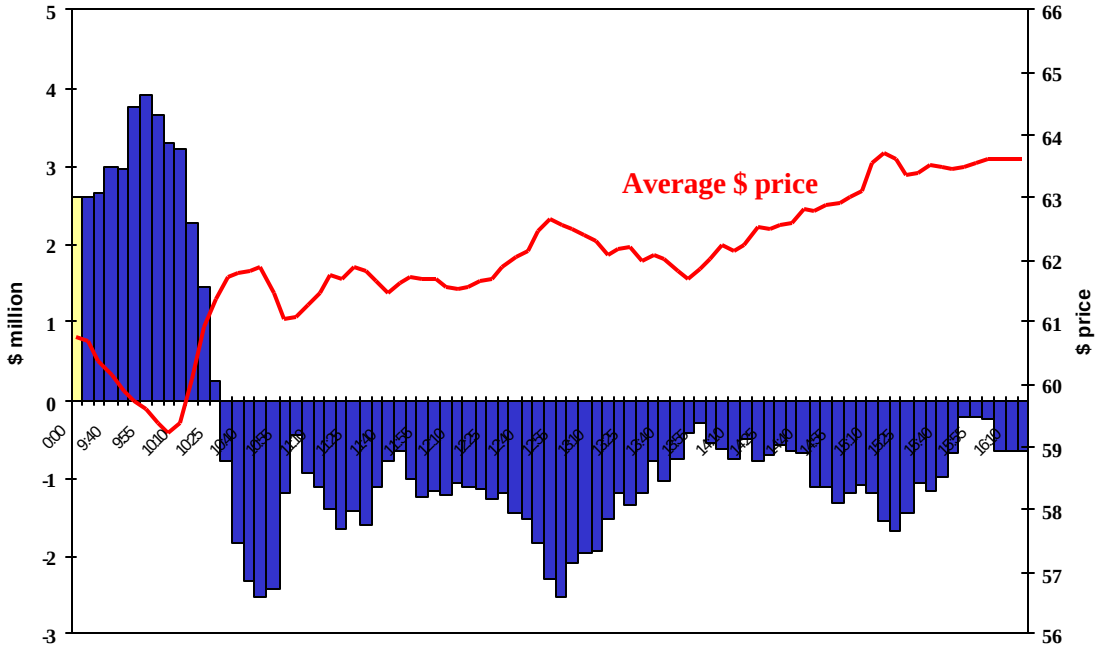
Data source: NYSE daily SPET files

42. Specialist Dollar Inventory per Stock
30 DJIA Stocks, October 27 (audit trail data)



Data source: NYSE daily SPET files

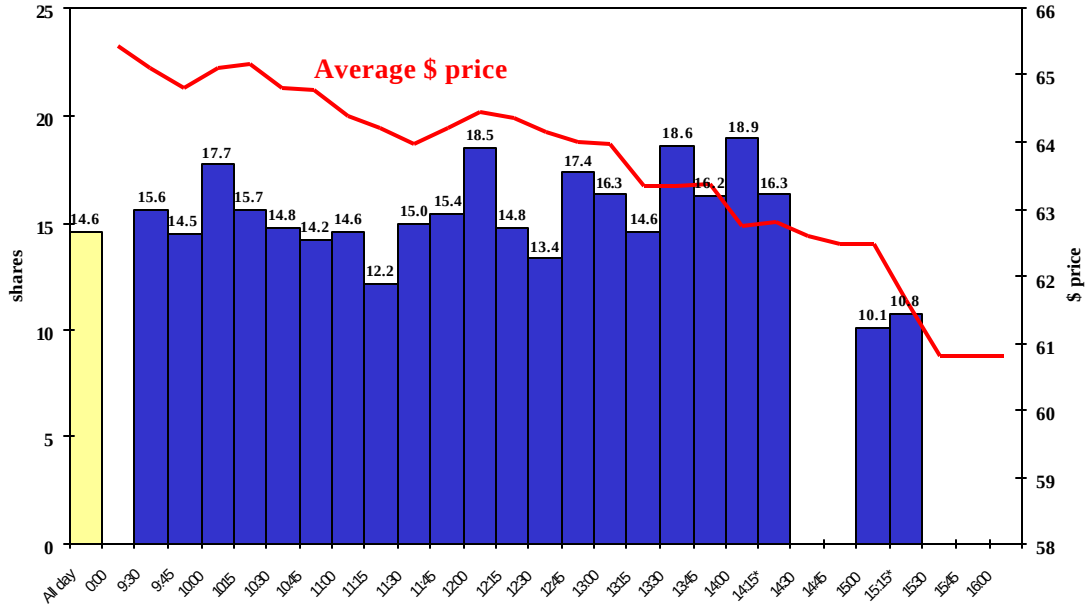
43. Specialist Dollar Inventory per Stock
30 DJIA Stocks, October 28 (audit trail data)



Data source: NYSE daily SPET files

44. Specialist Participation Rate

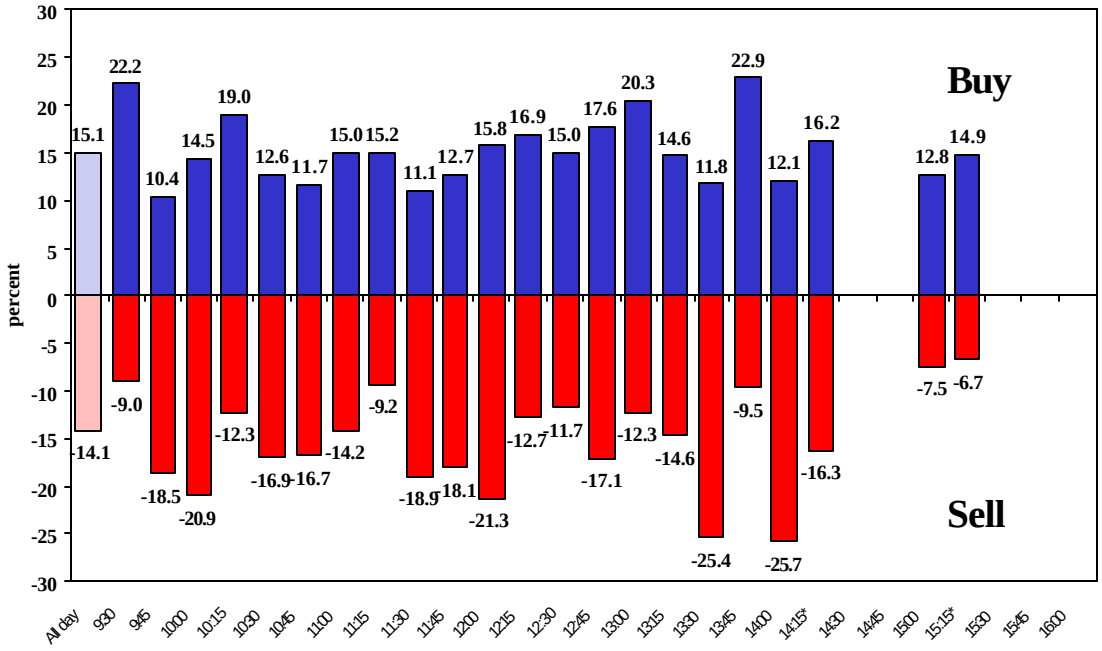
30 DJIA Stocks, October 27 (unweighted, audit trail data)



Data source: NYSE daily SPET files

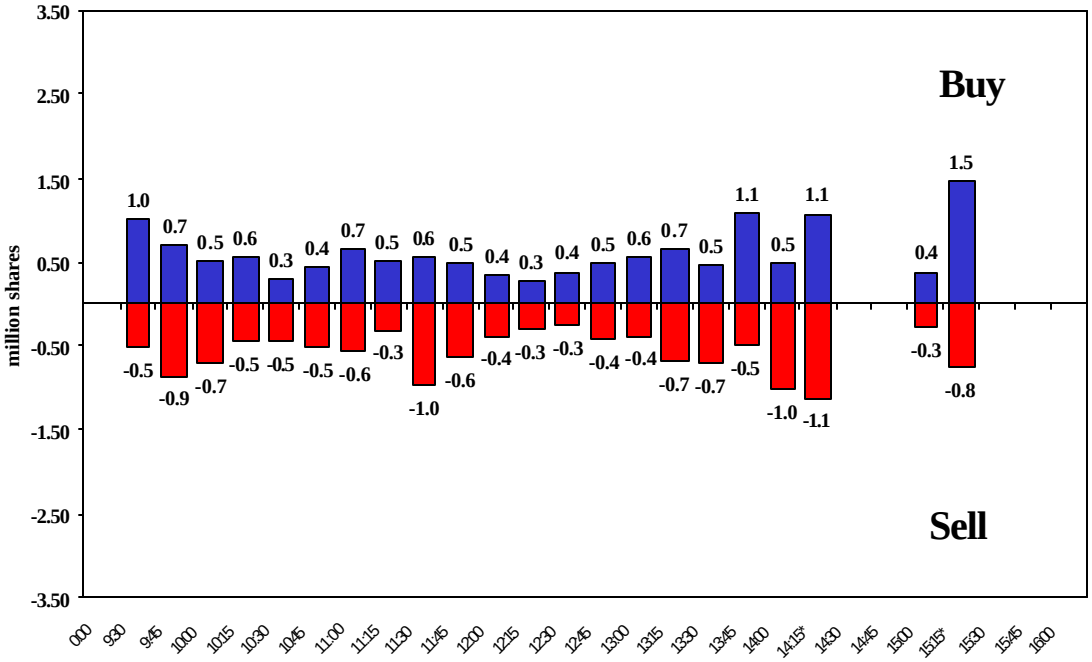
45. Specialist Buy and Sell Participation Rates

30 DJIA Stocks, October 27 (unweighted, audit trail data)



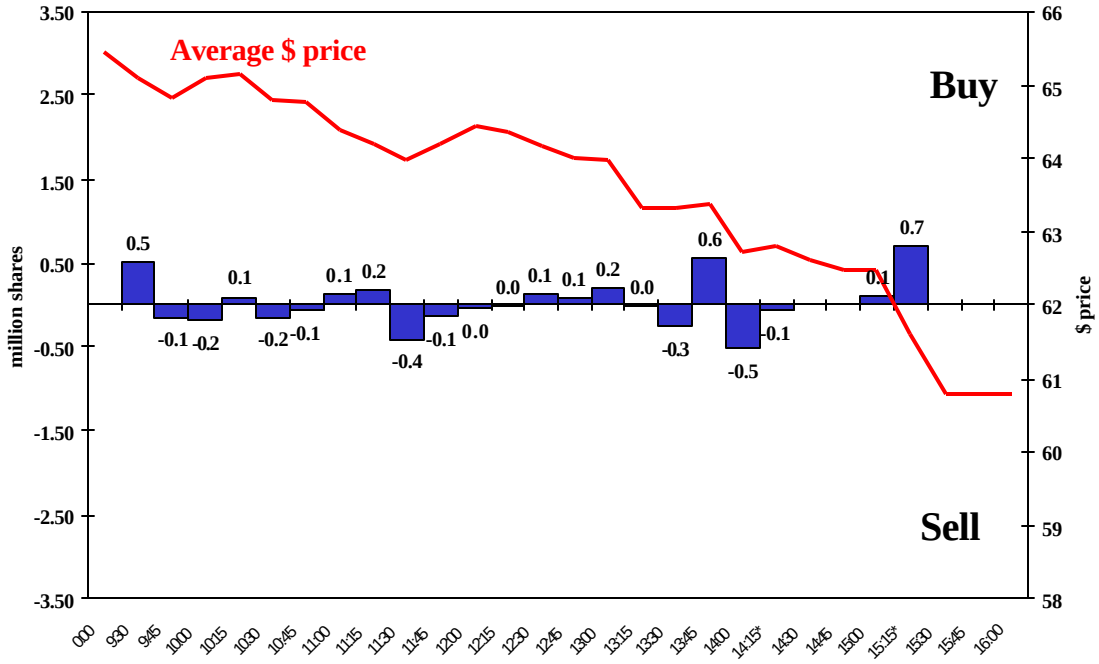
Data source: NYSE daily SPET files

46. Specialist Purchases & Sales
30 DJIA Stocks, October 27 (audit trail data)



Data source: NYSE daily SPET files

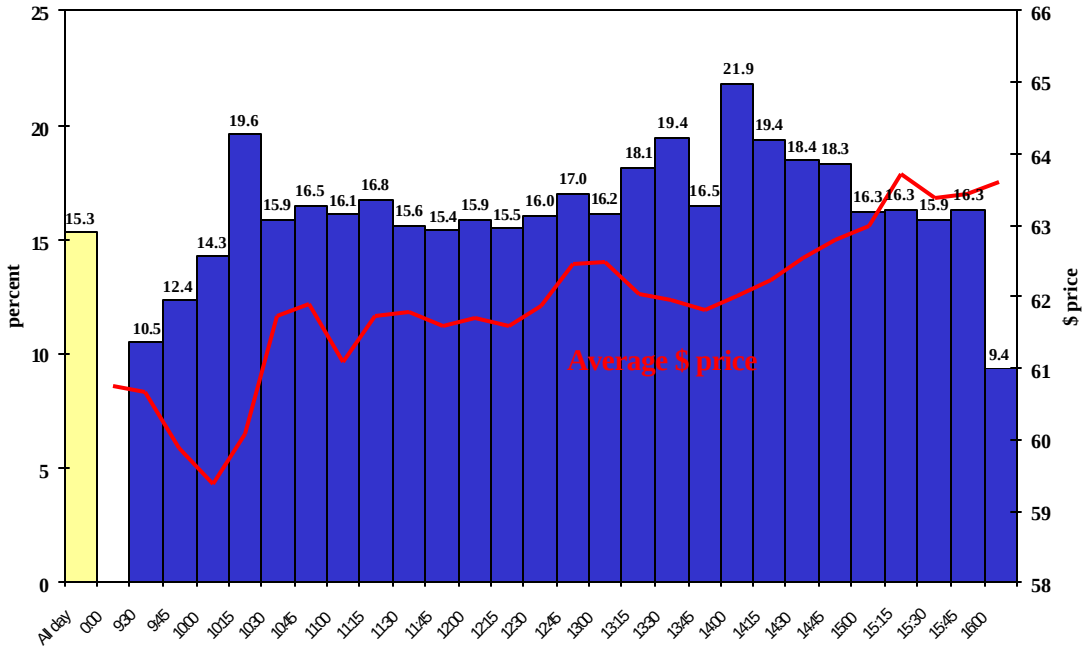
47. Specialist Net Purchases
30 DJIA Stocks, October 27 (audit trail data)



Data source: NYSE daily SPET files

48. Specialist Participation Rate

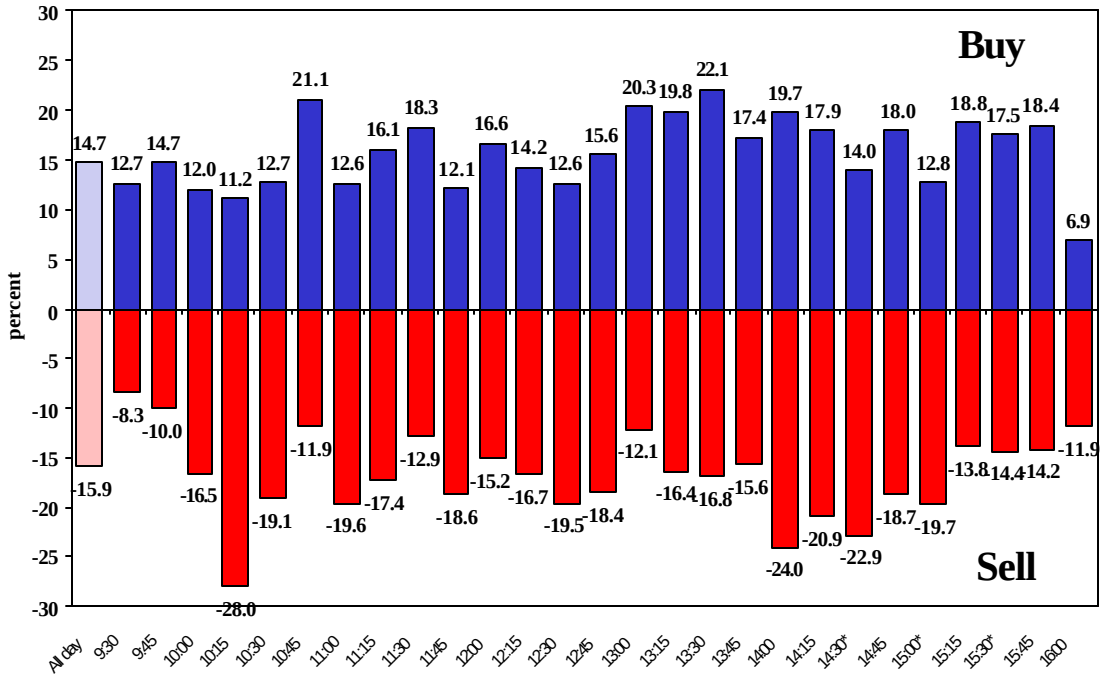
30 DJIA Stocks, October 28 (unweighted, audit trail data)



Data source: NYSE daily SPET files

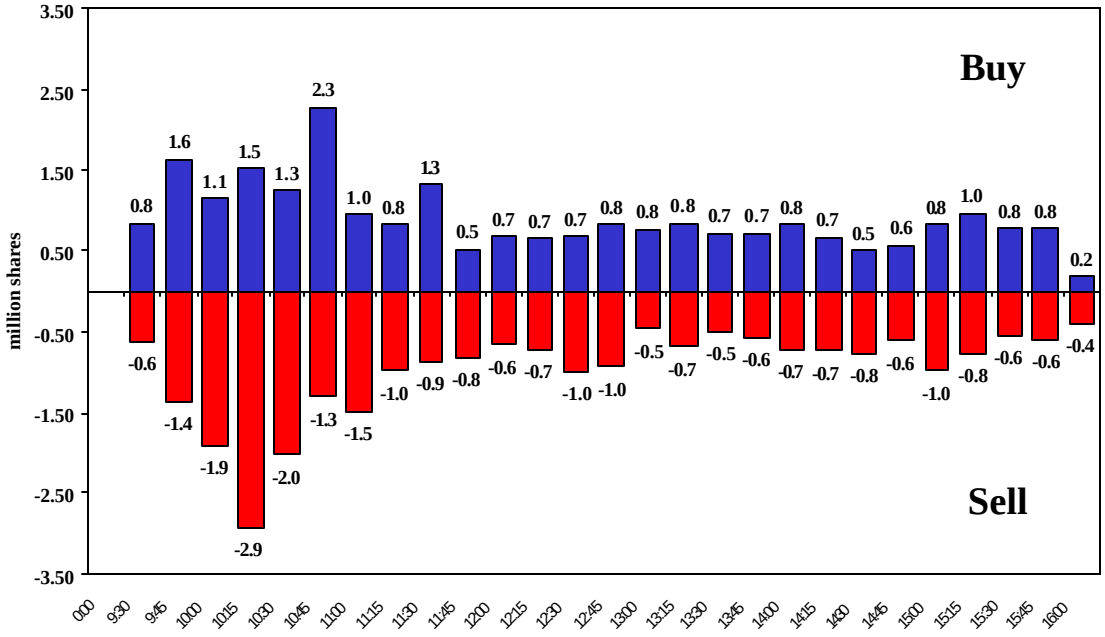
49. Specialist Buy and Sell Participation Rates

30 DJIA Stocks, October 28 (unweighted, audit trail data)



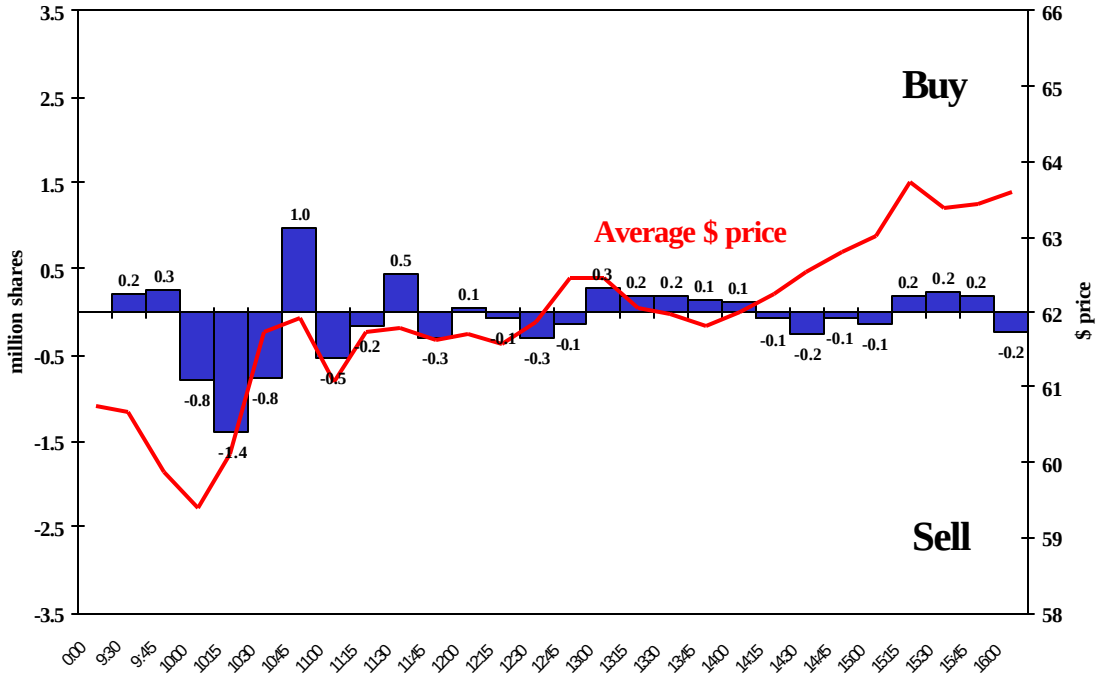
Data source: NYSE daily SPET files

50. Specialist Total Purchases & Sales
30 DJIA Stocks, October 28 (audit trail data)



Data source: NYSE daily SPET files

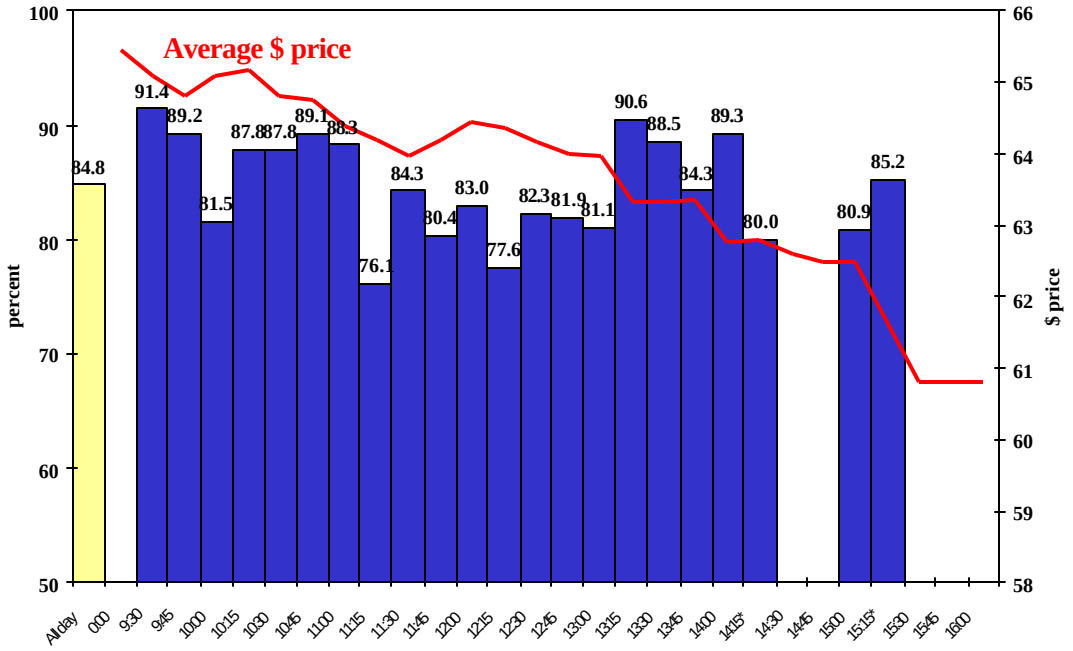
51. Specialist Total Net Purchases
30 DJIA Stocks, October 28 (audit trail data)



Data source: NYSE daily SPET files

52. Specialist Stabilization Rate

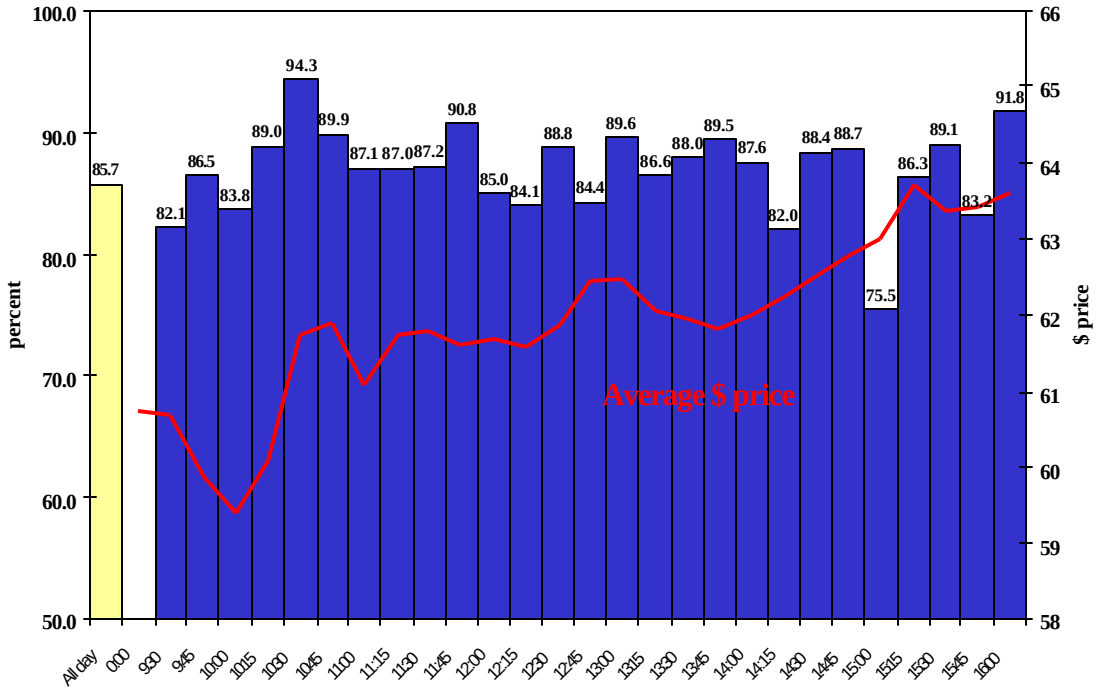
30 DJIA Stocks, October 27 (unweighted, audit trail data)



Data source: NYSE daily SPET files

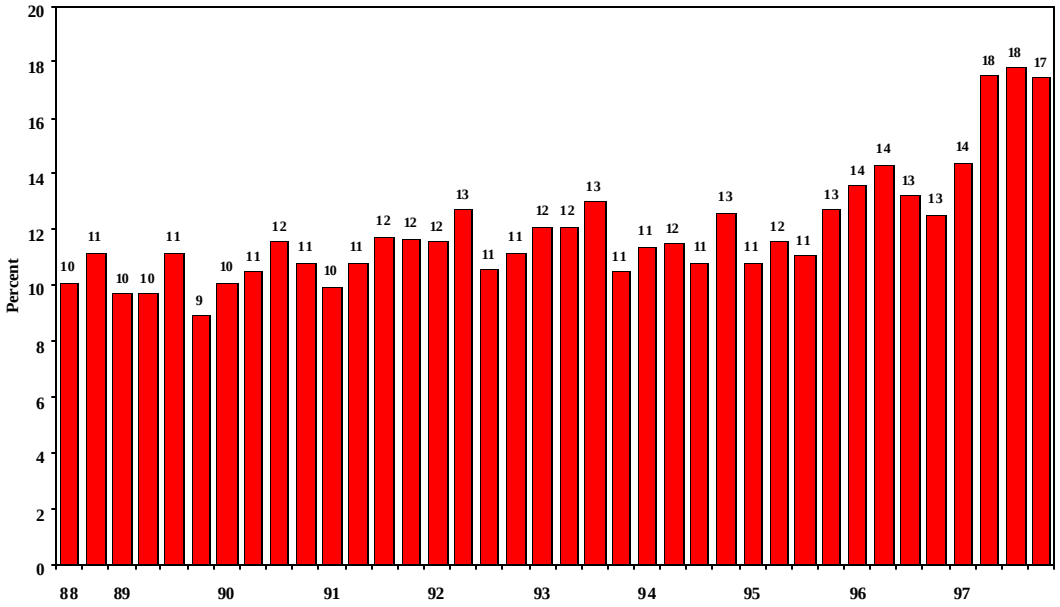
53. Specialist Stabilization Rate

30 DJIA Stocks, October 28 (unweighted, audit trail data)



Data source: NYSE daily SPET files

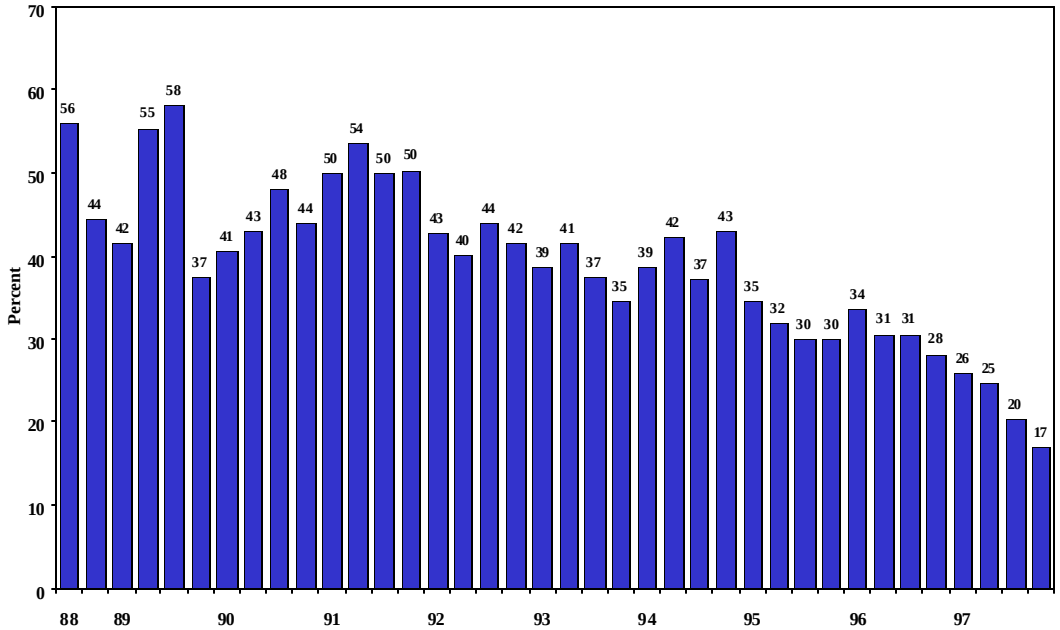
54. Program Trading as Percent of NYSE Volume*
Quarterly, 1988 Q3 through 1997 Q4



*The sum of shares bought, sold, and sold short in program trades as a percent of total reported share volume.

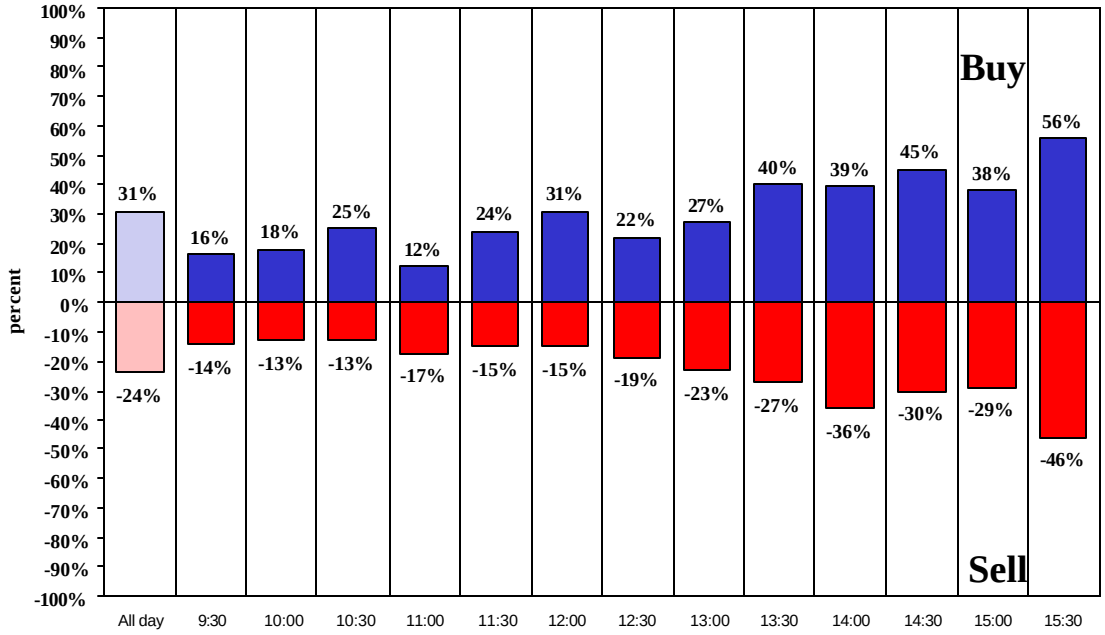
Data source: NYSE Daily Program Trading Reports

55. Index Arbitrage as Percent of All Program Trading
Quarterly, 1988 Q3 through 1997 Q4



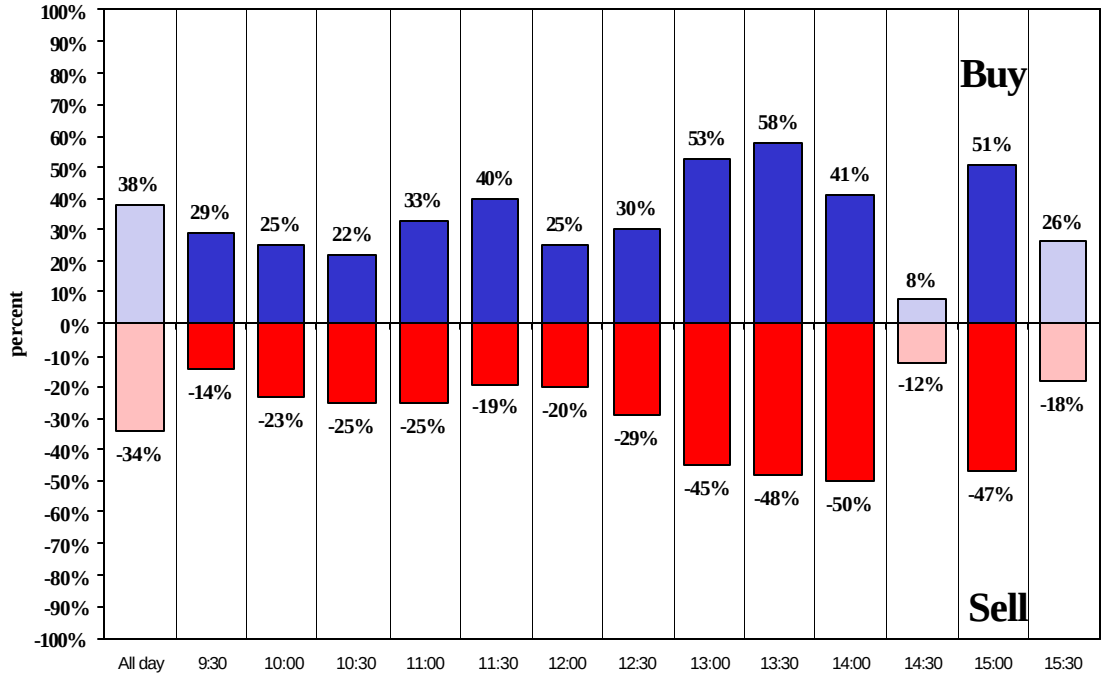
Data source: NYSE Daily Program Trading Reports

56. System Program Volume as Percent of All System Volume*
October 21



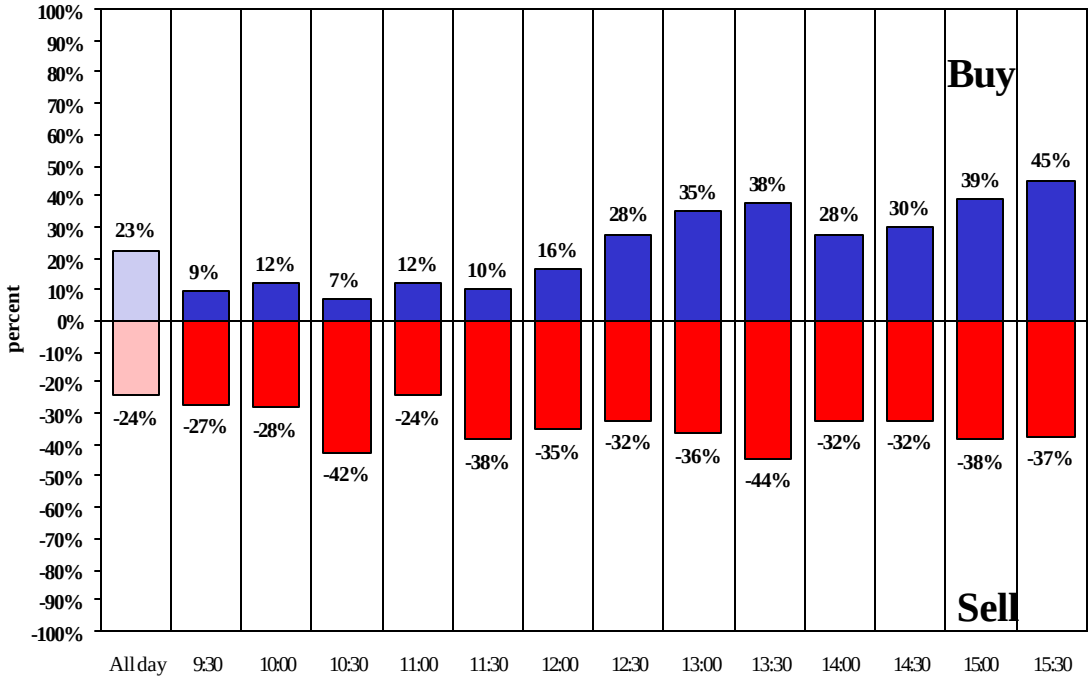
* SuperDot orders placed.
Data source: NYSE Daily SOD files

57. System Program Volume as Percent of All System Volume*
October 27



* SuperDot orders placed.
Data source: NYSE Daily SOD files

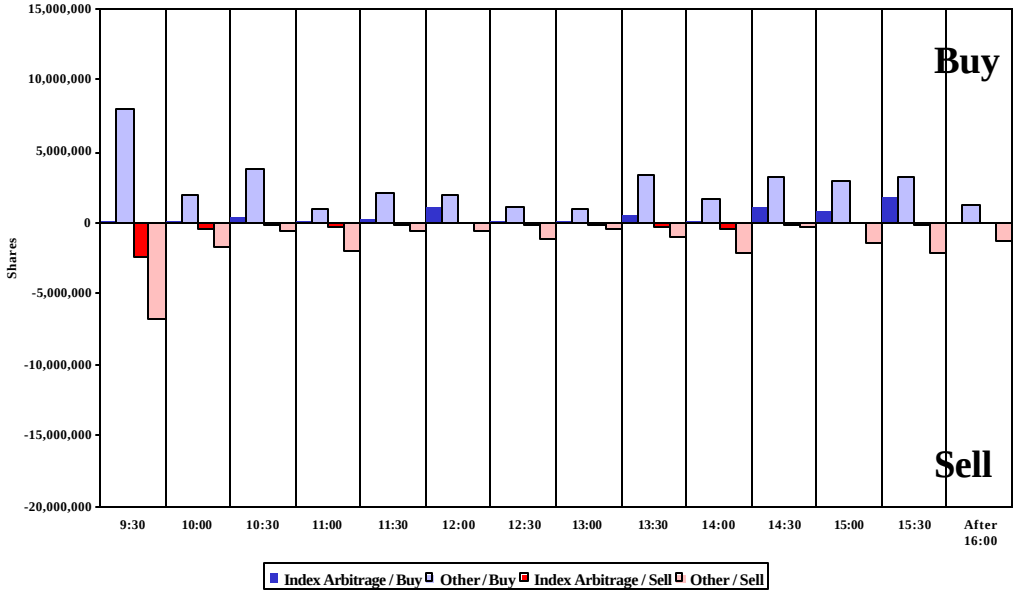
58. System Program Volume as Percent of All System Volume*
October 28



* SuperDot orders placed.

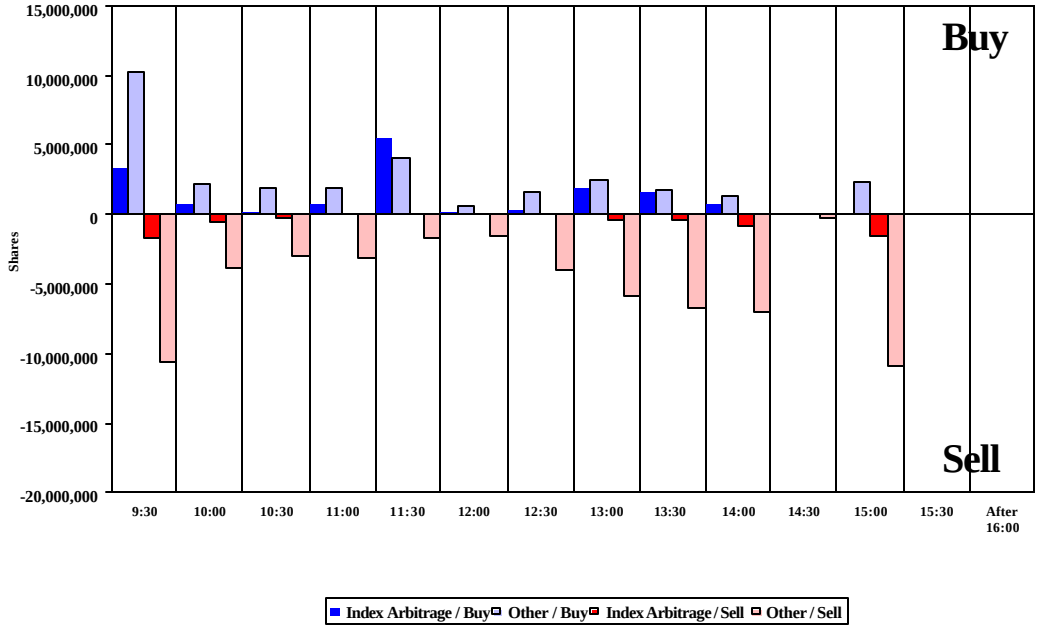
Data source: NYSE Daily SOD files

59. Program Trading by Strategy, October 21



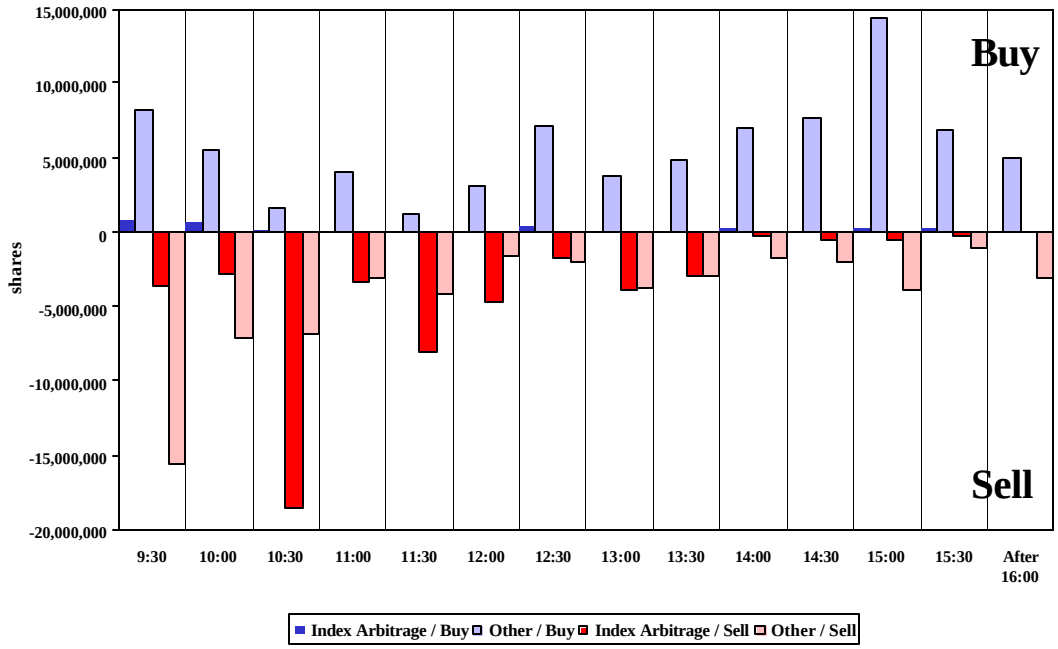
Index arbitrage includes other strategies subject to Rule 80A
Data source: NYSE Daily Program Trading Reports

60. Program Trading by Strategy, October 27



Index arbitrage includes other strategies subject to Rule 80A
Data source: NYSE Daily Program Trading Reports

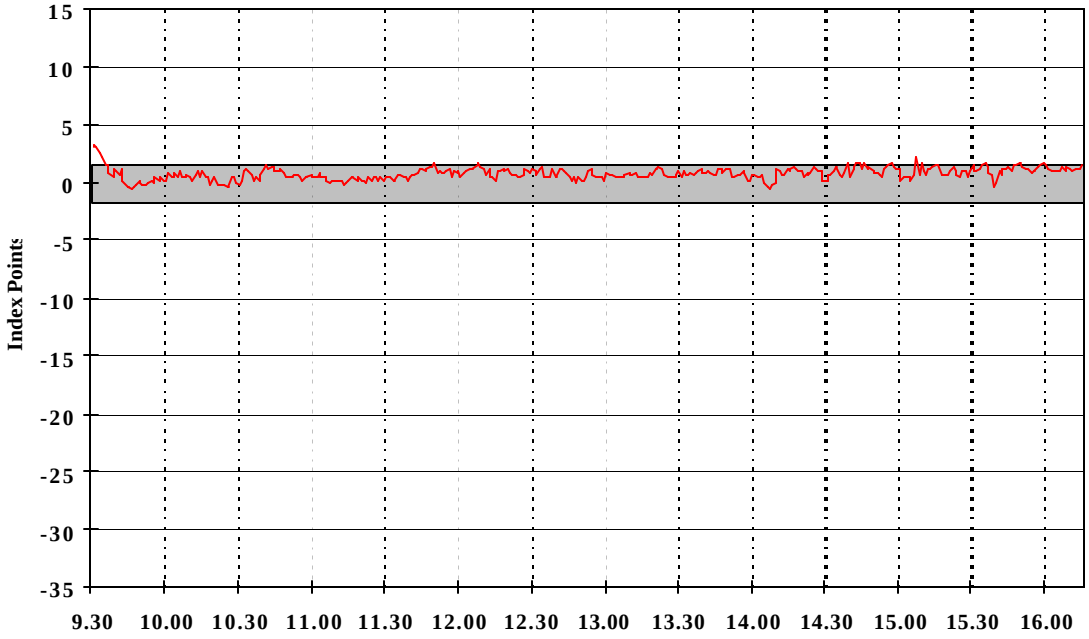
61. Program Trading by Strategy, October 28



Index arbitrage includes other strategies subject to Rule 80A

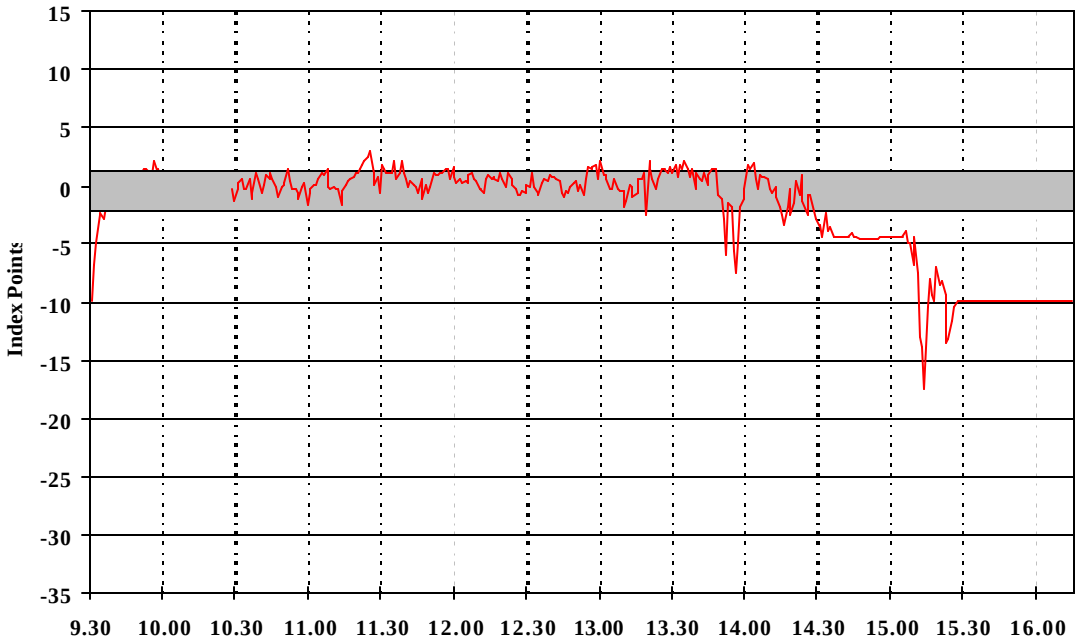
Data source: NYSE Daily Program Trading Reports

62. S&P 500 Cash Futures Mispricing
October 21



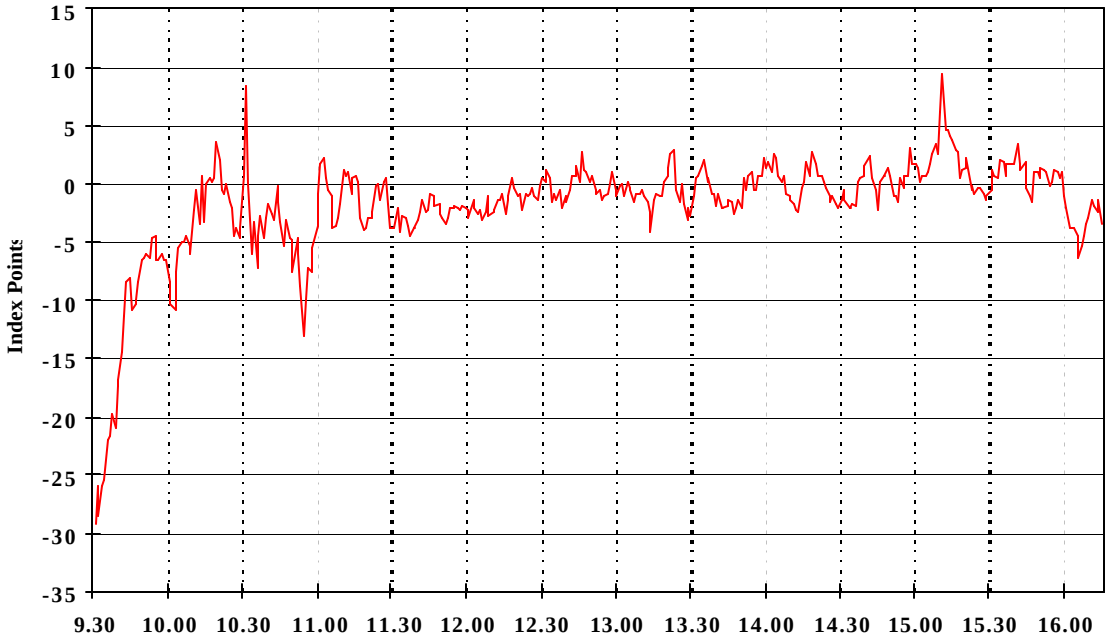
Data source: Bridge Data and two NYSE member firms

63. S&P 500 Cash Futures Mispricing
October 27



Data source: Bridge Data and two NYSE member firms

64. S&P 500 Cash Futures Mispricing
October 28



Data source: Bridge Data and two NYSE member firms

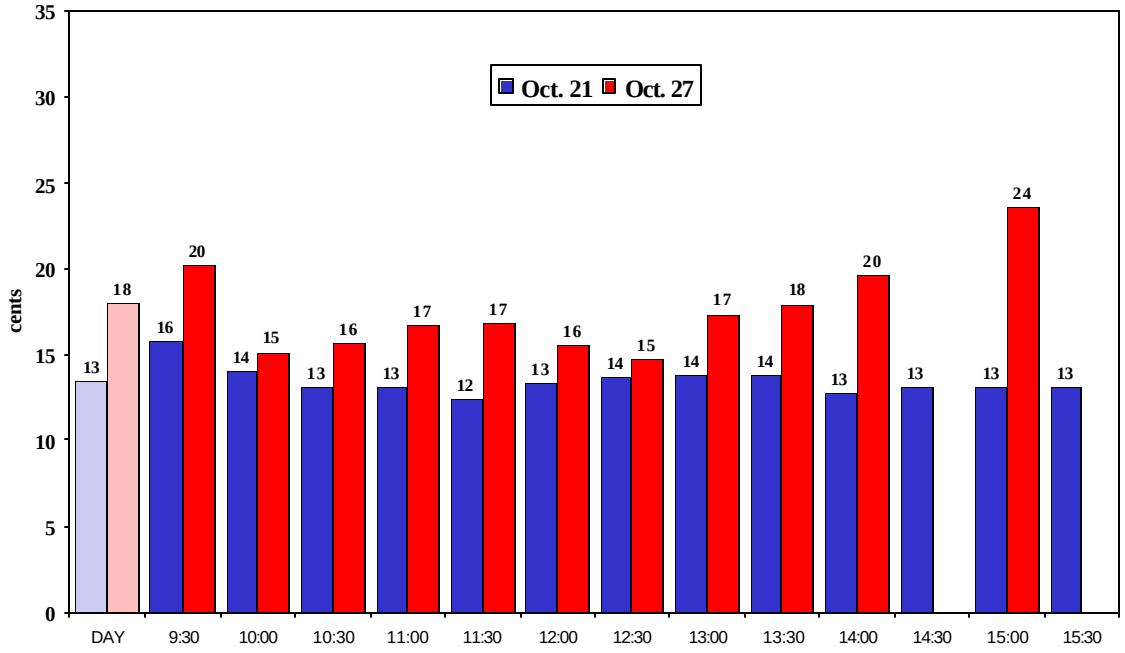
Appendix:
Additional Tables and Charts

Table A1
CT Trades with Time Stamps during Trading Halts
October 27

NYSE trades, common and preferred stocks; "good" trades (CORR=0 or 1), bid not equal to zero, offer greater than the bid, COND not equal L or Z and mode not equal 4, 9 or 17.

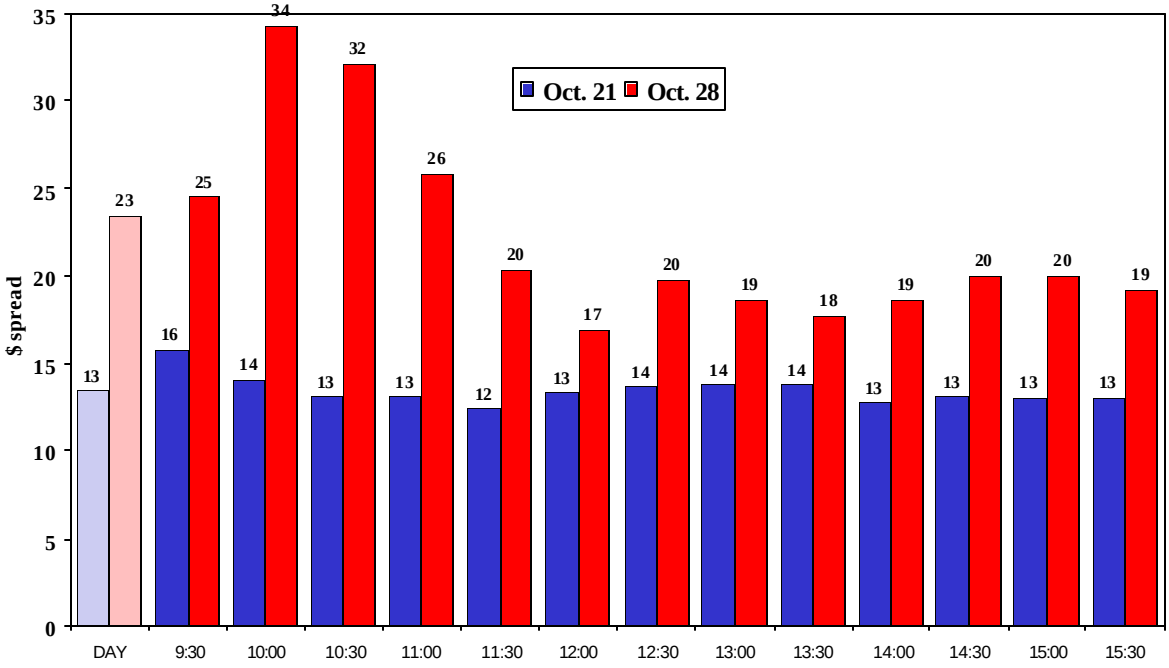
Time	Number of Trades	Action
350-Point Trading Halt (14:35:55-15:05:59)		
14:36:00 – 14:36:59	522	Move to "14:00:00 through first trading halt " interval
14:37:00 – 14:37:59	37	
14:38:00 – 14:38:59	2	
14:40:00 – 14:40:59	1	
550-Point Trading Halt (15:30:00-rest of the day)		
15:30:00 – 15:30:59	1,236	Move to "15:06:00 through second trading halt " interval
15:31:00 – 15:31:59	250	
15:32:00 – 15:32:59	80	
15:33:00 – 15:33:59	29	
15:34:00 – 15:34:59	10	
15:35:00 – 15:35:59	12	
15:36:00 – 15:36:59	7	
15:37:00 – 15:37:59	2	Drop from the sample (a total of 21 trades)
15:38:00 – 15:38:59	1	
15:39:00 – 15:39:59	2	
15:40:00 – 15:40:59	1	
15:41:00 – 15:41:59	2	
15:44:00 – 15:44:59	1	
15:47:00 – 15:47:59	1	
16:06:00 – 16:06:59	1	
16:20:00 – 16:20:59	1	
16:23:00 – 16:23:59	1	
16:31:00 – 16:31:59	1	
16:37:00 – 16:37:59	1	
16:40:00 – 16:40:59	1	
16:46:00 – 16:46:59	1	
16:47:00 – 16:47:59	2	
16:54:00 – 16:54:59	1	
17:03:00 – 17:03:59	1	

A1. Volume-weighted Average Spreads
Oct. 27 compared to Oct. 21



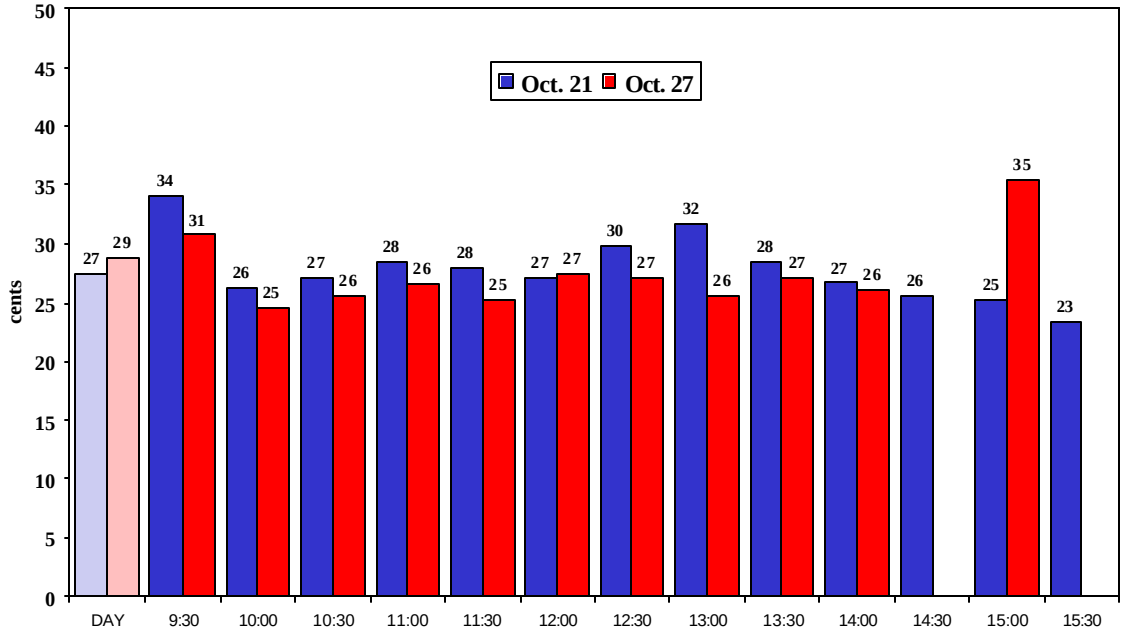
All NYSE-listed issues
Data source: NYSE daily CT and CQ files

A2. Volume-weighted Average Spreads
Oct. 28 compared to Oct. 21



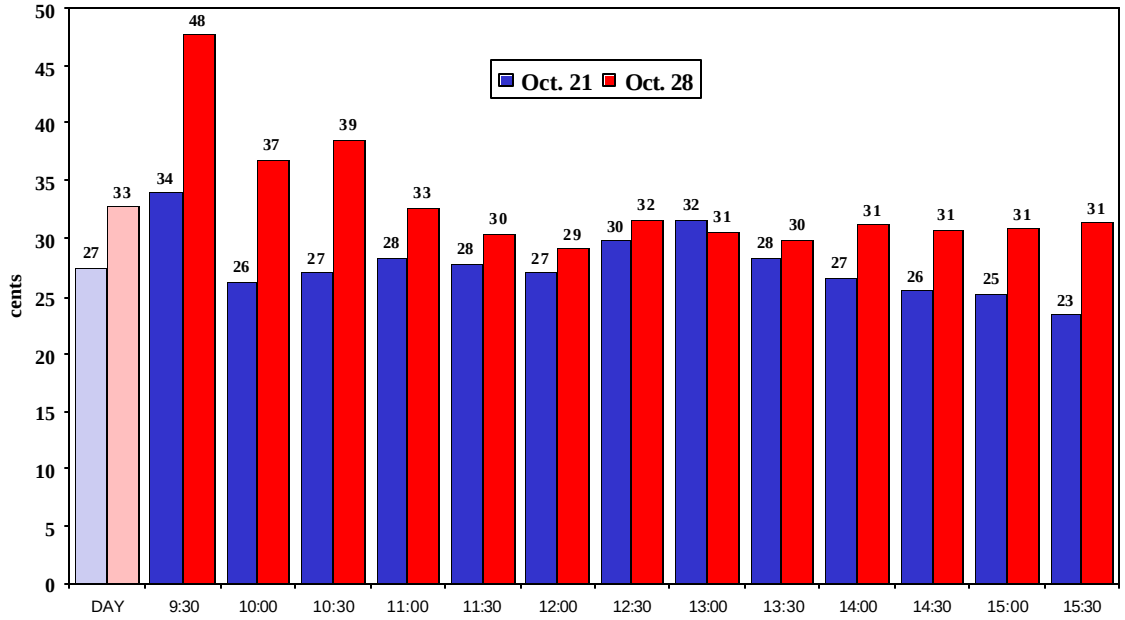
All NYSE-listed issues
Data source: NYSE daily CT and CQ files

A3. Average Quoted Spreads
Oct. 27 compared to Oct. 21



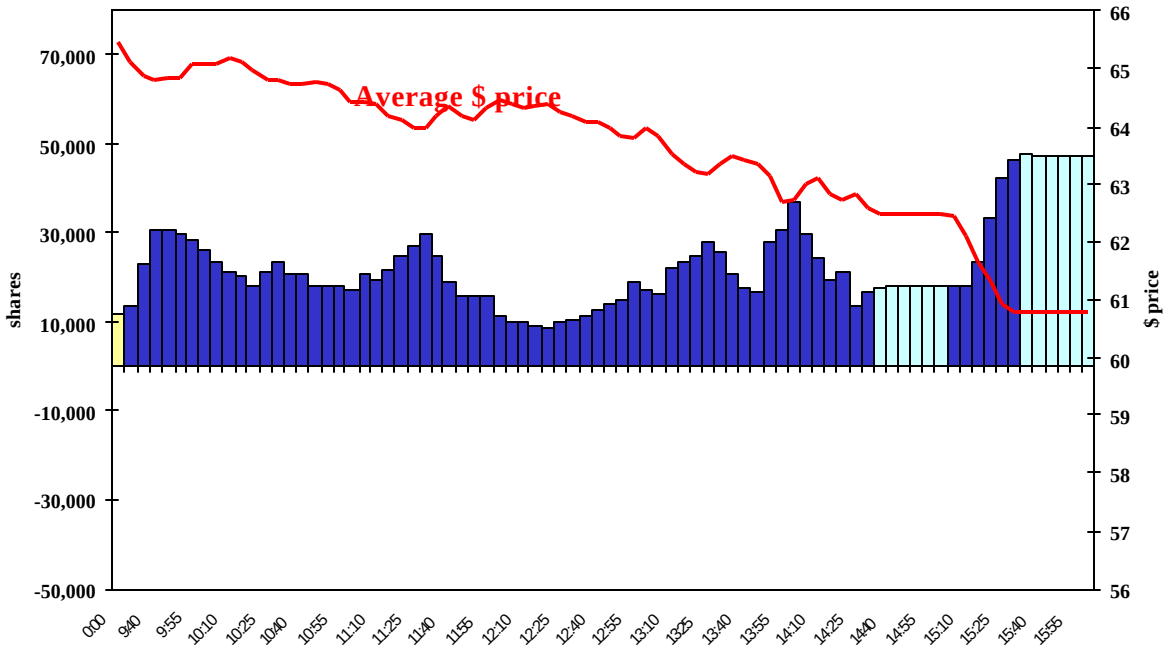
All NYSE-listed issues
Data source: NYSE daily CQ files

A4. Average Quoted Spreads
Oct. 28 compared to Oct. 21



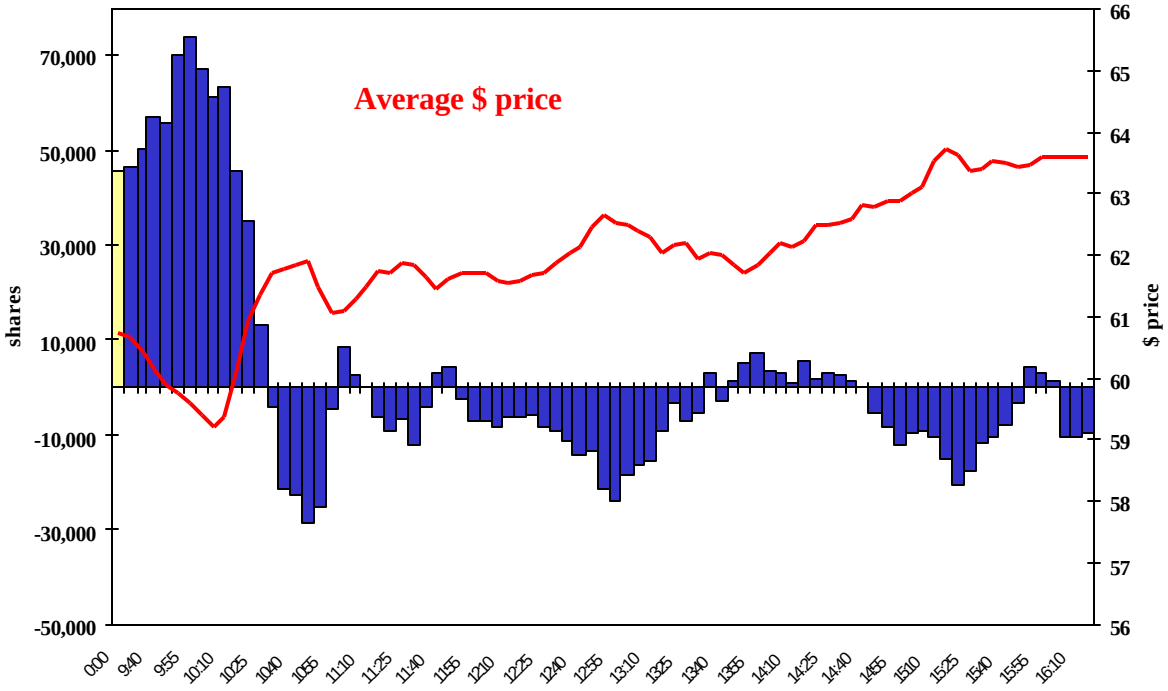
All NYSE-listed issues
Data source: NYSE daily CQ files

A5. Specialist Inventory per Stock (in shares)
30 DJIA Stocks, October 27 (form 81)



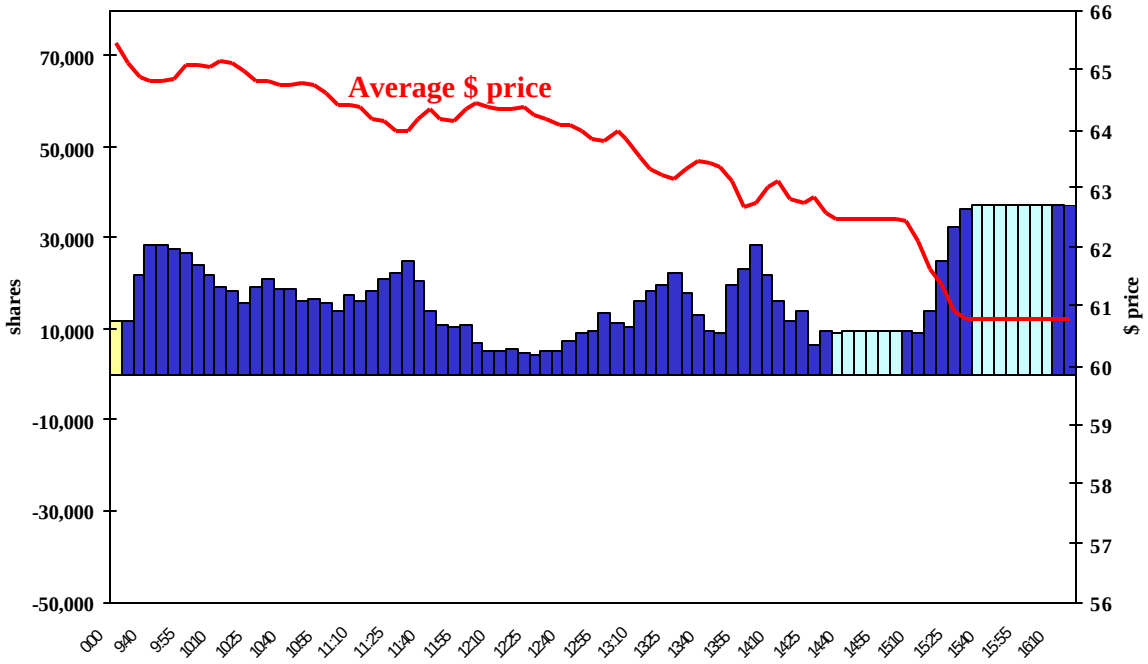
Data source: NYSE daily SPET files

A6. Specialist Inventory per Stock (in shares)
30 DJIA Stocks, October 28 (form 81)



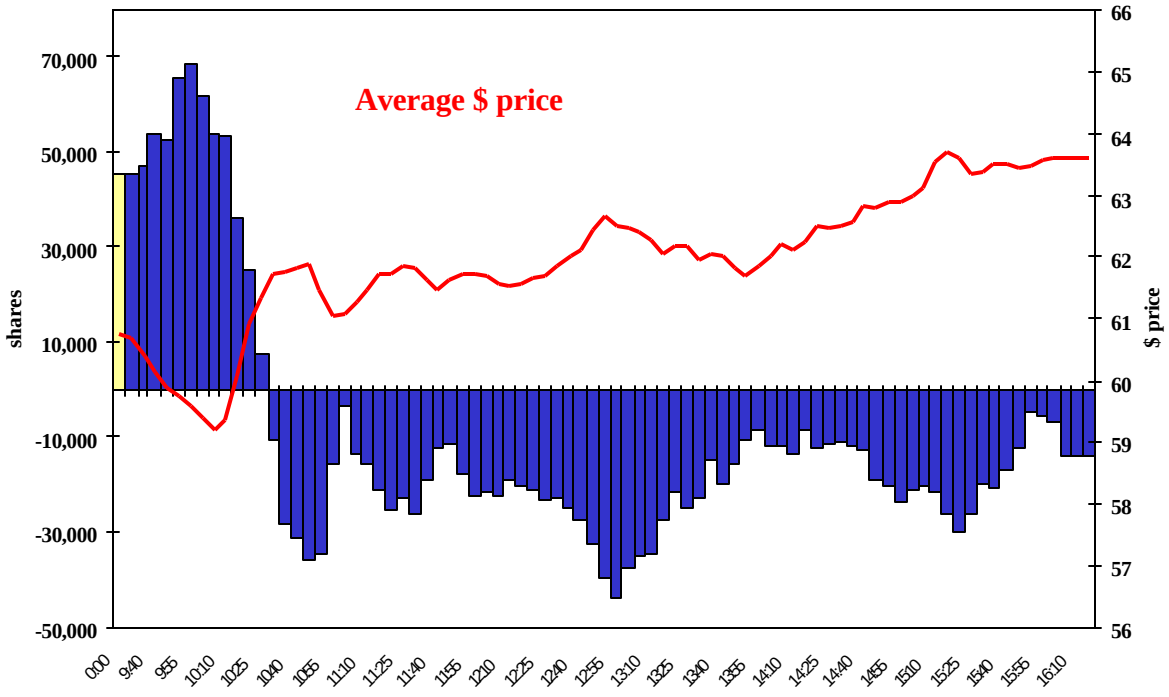
Data source: NYSE daily SPET files

A7. Specialist Inventory per Stock (in shares)
30 DJIA Stocks, October 27 (audit trail data)



Data source: NYSE daily SPET files

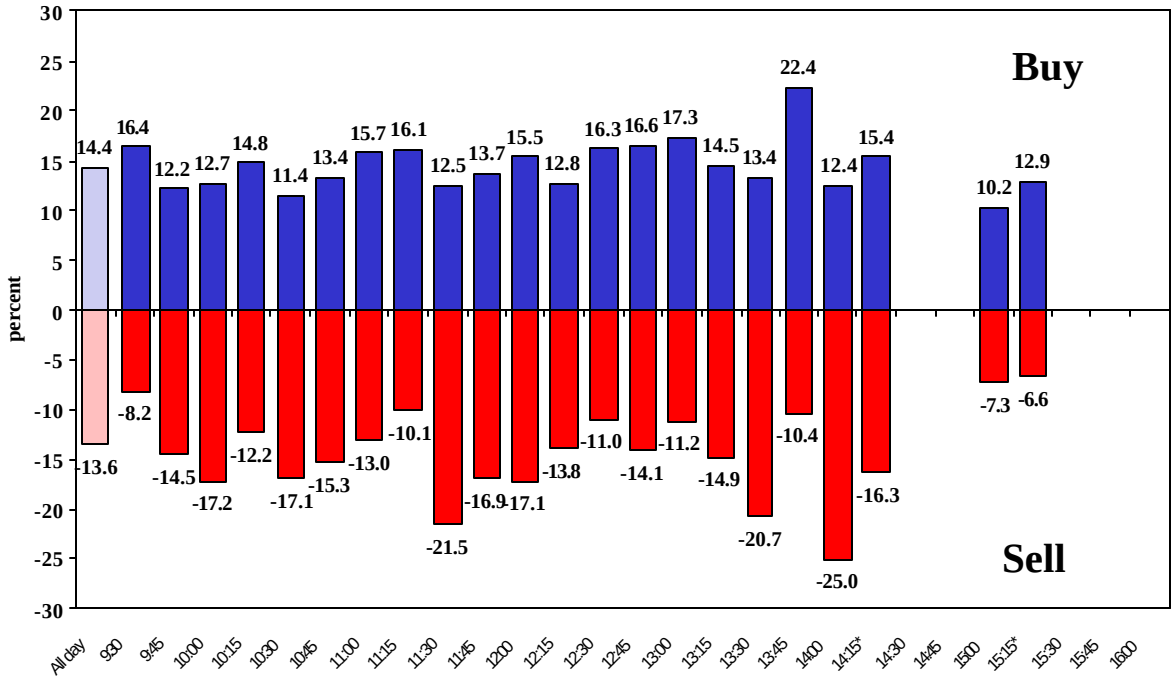
A8. Specialist Inventory per Stock (in shares)
30 DJIA Stocks, October 28 (audit trail data)



Data source: NYSE daily SPET files

A10. Specialist Buy and Sell Participation Rates

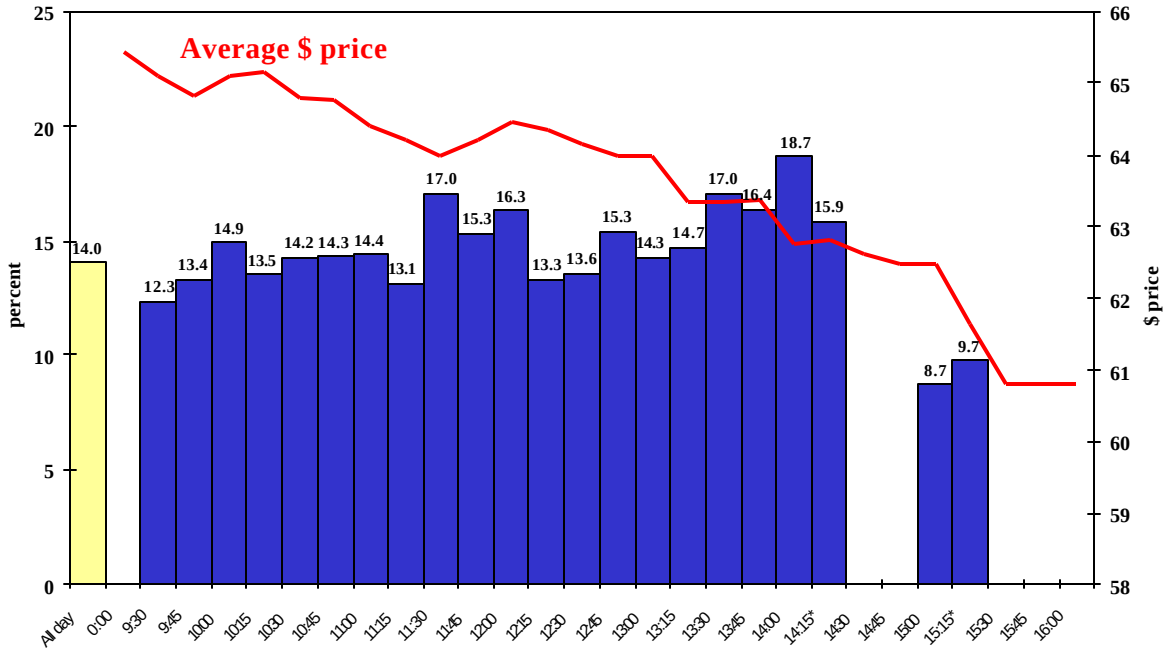
30 DJIA Stocks, October 27 (volume weighted, audit trail data)



Data source: NYSE daily SPET files

A9. Specialist Participation Rate

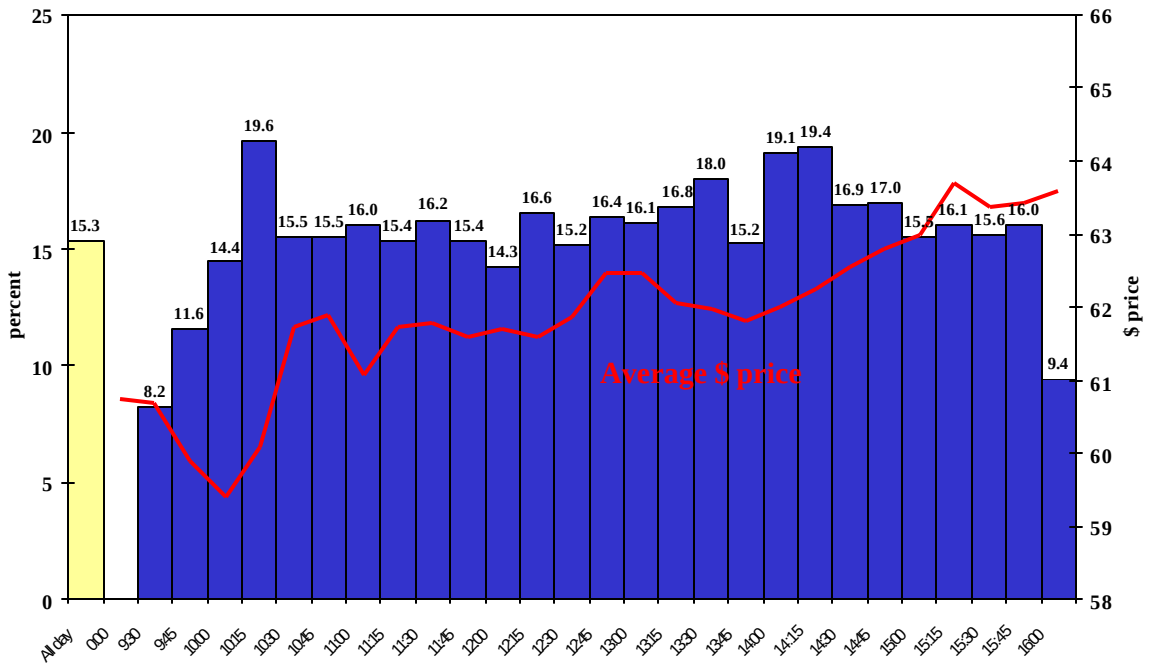
30 DJIA Stocks, October 27 (volume weighted, audit trail data)



Data source: NYSE daily SPET files

A11. Specialist Participation Rate

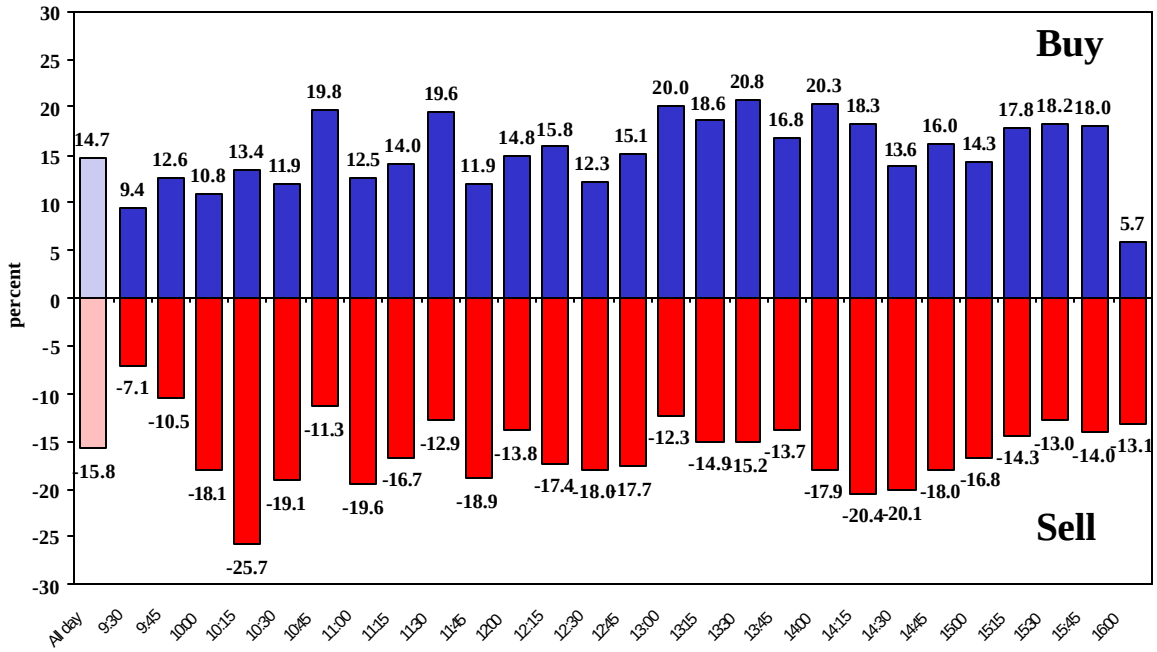
30 DJIA Stocks, October 28 (volume weighted, audit trail data)



Data source: NYSE daily SPET files

A12. Specialist Buy and Sell Participation Rates

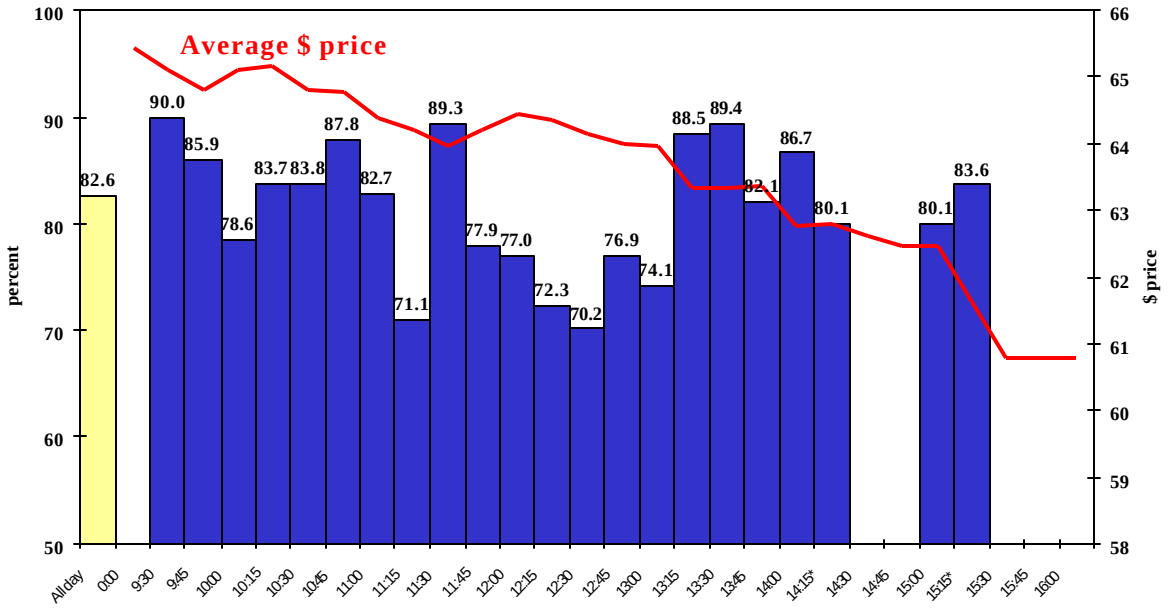
30 DJIA Stocks, October 28 (volume weighted, audit trail data)



Data source: NYSE daily SPET files

A13. Specialist Stabilization Rate

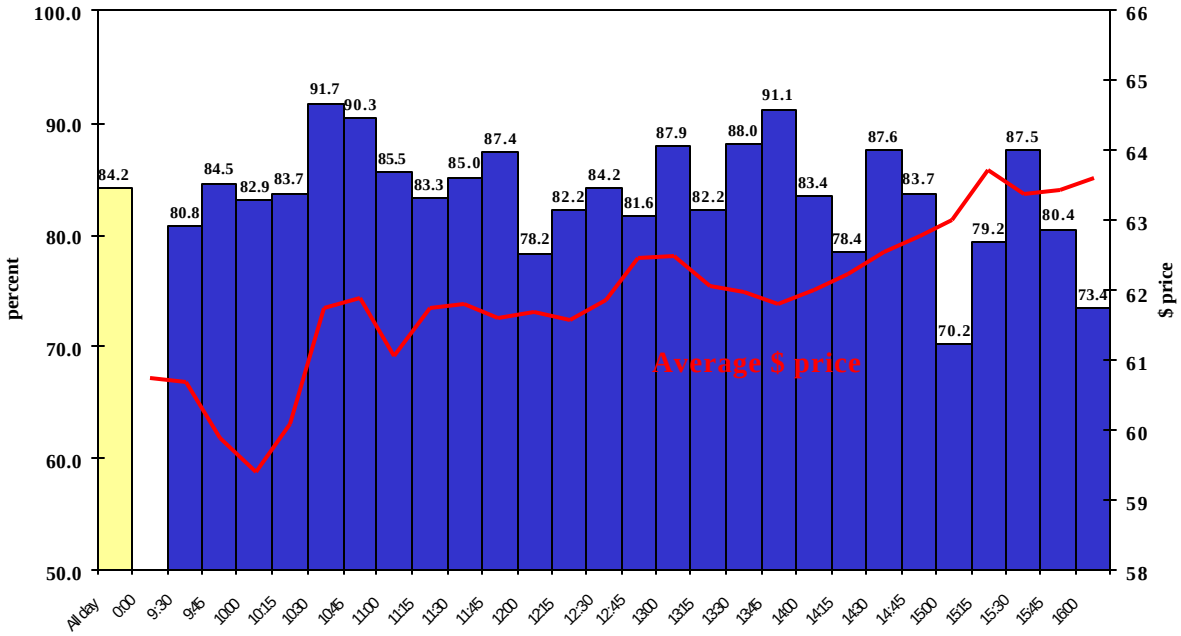
30 DJIA Stocks, October 27 (volume weighted, audit trail data)



Data source: NYSE daily SPET files

A14. Specialist Stabilization Rate

30 DJIA Stocks, October 28 (volume weighted, audit trail data)



Data source: NYSE daily SPET files