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# The trading profits of SOES bandits[1]

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**Abstract**

SOES bandits are individual investors who use Nasdaq's Small Order Execution System (SOES) for day trading. Their average profit per trade is small, but they trade dozens or hundreds of times per week. Bandits usually establish a position before most market-makers have updated their quotes, and lay off the position at favorable prices through Instinet or SelectNet. It is noteworthy that they trade profitably with market-makers despite having less information. Bandits keep the profits and bear the losses from their trades. Thus they have greater incentives to trade well than the employees of market-making firms. 

*JEL classification:* G14; D82; D83

*Keywords:* SOES; Nasdaq

## 1. Introduction

'SOES bandits' are individual investors who attempt to capitalize on short-term momentum in stock prices by executing trades through Nasdaq's Small Order Execution System (SOES). A SOES bandit typically trades while sitting in the office of a brokerage firm that caters expressly to bandits. In one corner of

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the bandit's screen, all dealer quote updates from a number of active Nasdaq stocks scroll by. When the bandit sees a stock with a lot of quote updates, he types in the stock's ticker symbol (or hits a function key if the stock is one that he or she follows closely). This brings all of the individual market-maker's quotes for that stock into another window of the bandit's screen. These quotes are arranged with the inside bid at the left and the inside ask at the right on the top line. Other dealer quotes are displayed below in order of their nearness to the inside quote. The dealer quotes are also color-coded, with the color, like the location, signifying the proximity of the quote to the inside quote. Dealer quotes are updated in real time on the bandit's screen.

By watching this screen the SOES bandit can identify and trade on price trends. Some bandits wear headphones that allow them to speak directly to the trading desk so they can act almost instantly when they think they observe a trend. Suppose that a bandit sees a few dealers raising their ask price in Microsoft above $85\frac{1}{4}$, but other dealers still quoting $85\frac{1}{4}$ ask. If it appears to the bandit that an upward price trend is developing, he calls to the trader to 'load Microsoft to buy at a quarter'. The trader then types in the Microsoft ticker symbol and any other information needed to submit the order. If it appears that the trend is continuing, the bandit will say to the trader 'buy Microsoft'. The brokerage firm's trader then buys 1000 shares of Microsoft instantly through SOES by clicking on a mouse. Trades are for 1000 shares because that is the maximum trade size allowed in SOES.

NASD rules prohibit individual bandits from initiating more than one position in the same stock within a five minute period. However, SOES bandits tell us that because there are so many of them attempting to execute trades with the same market-makers, the proportion of trades completed is only about 50%. The first order to reach a market-maker through SOES is executed instantaneously and at the quoted price. Others may be automatically held in the system for up to 90 s until a market-maker's quote allows execution of the order.

Bandits usually hold a position for only a few minutes. When the bandit feels the price trend is ending or reversing, he can trade out of the position through SOES in the same manner or by placing limit orders through Instinet or SelectNet. Instinet is a proprietary trading system owned and operated by Reuters that allows institutional investors to trade directly with each other. It is also used by market-makers. Trades that are executed through Instinet often take place at better prices than are available on Nasdaq, but Instinet trades are not executed instantly as are SOES trades. SelectNet is a system that allows an offer to buy or sell at a specified price to be sent electronically to all market-makers in the stock. Alternatively, the order can be directed toward a particular dealer. Orders entered through SelectNet are not executed automatically, and the SOES bandits have accused market-makers of refusing to honor quotes when trades were offered through SelectNet. The principle advantage of both

SelectNet and Instinet to SOES bandits is that they allow trades within the bid–ask spread.

We examine SOES bandit trading using data provided to us by two brokerage firms that cater to bandits. SOES bandit trading is of interest for several reasons. First, the trading profits of the bandits that we document here raises new questions about the efficiency of dealer markets. Market-makers lose money to SOES bandits despite an informational advantage. Bandits base their trading decisions on the quote updates of dealers and, occasionally, on public news announcements. Market-makers also have this information. In addition, market-makers know about the large orders they are working, and they have a sense of the large orders that others are working as a result of the calls they receive from other dealers. This information is not available to bandits. Market-makers also have continuous access to Instinet quotes. In contrast, one of our sample firms maintains a continual phone link to a correspondent broker who describes Instinet quotes verbally to the bandits.

Given their informational advantage, why do market-makers lose to bandits, and why do market-makers find it cheaper to lose to bandits than to hire additional traders to change quotes in response to the same information that the bandits use? One possibility is that it is simply more efficient for a bandit to monitor the quotes of 20 to 60 market-makers in a handful of stocks and charge them a small fee (the bandit's trading profits) to inform them that their quotes need updating than it is for each market-maker to separately hire employees to update their quotes. In this case, bandit's trading offers economies of scale because each bandit updates the quotes of many dealers. However, this explanation for bandit trading seems unlikely to us because there are over 2,000 SOES bandits and each active Nasdaq stock is followed by several of them.[2] In many cases there may be more bandits monitoring a stock than dealers making a market. Instead, we believe that if bandit trading against better-informed market-makers is profitable it is because there are agency problems in trading. If Merrill Lynch hires an additional trader to update quotes, the money saved from SOES bandit losses cannot be accurately measured and the trader will not be fully rewarded for spotting trends or for finding good trading opportunities on SelectNet. On the other hand, SOES bandits are risking their own capital and keeping their own profits. We believe this makes them inherently better at eliminating mispricings than market-makers.

A second reason for the interest in SOES bandit's trading is that bandits are frequently blamed for the wide bid–ask spreads and poor liquidity on Nasdaq. In a Washington Post article (Hinden, 1994) on February 7, 1994, Joseph Hardiman, president of the National Association of Securities Dealers (henceforth, NASD),

[2] This figure comes from a personal conversation with James Lee, President of the Electronic Traders Association, a group formed to promote the interests of SOES bandits.

said that 'SOES losses made market-makers gun shy, causing them to widen their price spreads' and that 'It reduced liquidity – the ease with which stocks can be traded'. Likewise, Kleidon and Willig (1995) claim that

> *As the prices of securities move up and down, the absence of perfect synchronization among market-makers implies that the quotes of one market-maker may become out of line with those of another, thereby creating an arbitrage opportunity, especially during periods of high price volatility … Narrower spreads increase the probability that quotes will become misaligned and therefore expose market-makers to greater risk of exploitation.*

This alleged link between SOES bandits, liquidity, and trading costs has led to intense regulatory interest in SOES trading. In response to market-maker's complaints, the NASD has made several attempts to prevent SOES trading. In 1988, the NASD barred member firms from executing trades by professional traders through SOES. Professional traders were defined as having five or more day trades executed through SOES on any trading day or as having a professional trading pattern. In 1993, the United States Court of Appeals threw out the professional trader rules as vague and arbitrary. The NASD then changed the maximum size SOES order from 1000 to 500 shares on a trial basis. However, the SEC did not allow this restriction to become a permanent feature of SOES and the maximum size SOES trade returned to 1000 shares in March 1995.

All of these regulatory changes took place without the benefit of any rigorous study of SOES bandit's trading. Our results suggest that the trading of SOES bandits differs from the way it is described in academic papers and the press. We find that SOES bandits make money only if they can close out positions within the spread through SelectNet or Instinet. Bandits who both initiate and close positions through SOES usually lose money. Also, the popular image of SOES bandits trading with the slowest and least alert market-maker is inaccurate. It appears that SOES bandits profit by purchasing before *most* dealers raise prices.

A third reason for examining SOES bandit's trading is that it provides insight into how traders keep prices in line in a dealer market with fragmented order flow. Nasdaq order flow is split among many dealers, and SOES bandits can profit if quotes of different dealers diverge. In addition to the fragmentation across dealers in the retail Nasdaq market, orders are split among the retail Nasdaq market, Instinet, and SelectNet. Instinet is the primary market for institutions while SelectNet is the market that dealers use to trade with each other or with brokerage firms. At any time, quoted prices in these three markets can differ.[3] SOES bandits provide a linkage between the three markets by

[3] New order handling rules for Nasdaq trades came into effect after the end of the sample period. These rules now require market-makers to display the same prices on Nasdaq that they display on Instinet. Because this rule does not apply to institutions who also use Instinet, differences in prices across the three markets have been reduced but not eliminated.

buying from (selling to) dealers in the retail Nasdaq market and selling to (buying from) institutional investors or other dealers in the other markets.

Finally, SOES bandits are interesting to study because they use information in price changes and trades to predict short-term price movements. They conduct technical analysis in real time and are able to make money from it. Studying their trading provides insights into how technical analysis can be used to predict price movements in a market with fragmented order flow.

Our results complement recent papers on the effect of SOES trading on the Nasdaq market. Harris and Schultz (1997) examine Nasdaq trading patterns around the January 31, 1994 change in SOES rules. This rules change reduced the maximum size SOES trade from 1000 shares to 500 shares. Individual market-maker's exposure was also reduced by electronically notifying dealers to update quotes after buying (selling) 1000 shares rather than the previous level of 5000 shares. Harris and Schultz (1997) show that prices increase subsequent to purchases of the maximum number of shares allowed in SOES and that prices drop after sell orders for the maximum number of shares that could be traded through SOES. When the January 1994 rule changes took place, the volume of trades from the maximum trade size allowed on SOES dropped dramatically, suggesting that market-makers' losses to SOES bandits also declined dramatically. However, Harris and Schultz (1997) find little evidence that quoted or effective spreads declined when the rules changed.

Laux (1995) examines trading around the March 1995 change in SOES rules that returned the maximum size SOES trade to 1000 shares. He provides some evidence that the costs of small non electronic trades declined and the costs of large non electronic trades increased when the maximum size SOES trade increased. As a whole, he finds little evidence of changes in the mean cost of trading around the rule change.

Battalio et al. (1997) examine volatility around trading of SOES bandits. There is some concern that SOES bandits increase volatility because they are momentum traders; they buy when a stock's price has been increasing and is expected to continue to increase and sell when a stock's price has fallen and is expected to continue falling. However, Battalio et al. (1997) show that trading by SOES bandits does not increase volatility, but instead concentrates price changes in shorter time periods. That is, SOES bandits make prices adjust more quickly.

The remainder of the paper is organized as follows. Section 2 describes the two unique data sets that we analyze in the paper. Section 3 provides an empirical description of the trading practices of SOES bandits. Section 4 offers a summary and conclusions.

## 2. Data

We use two distinct data sets in this paper. They consist of complete customer trading records for given sample periods from two different

brokerage firms that specialize in providing execution and clearing services to bandits.

A sophisticated reader could have several concerns about results reported from these proprietary data sets. Brokerage firms that cater to SOES bandits have been under pressure from the NASD for several years, and thus have an incentive to provide data that would place them in the most favorable light. One way to do this would be to 'cherry-pick' the sample periods to ensure a particular outcome. This is not the case with the data sets used here. In both cases, when asked for data the brokerage firms provided trading records for the period immediately following our request. A second concern is that the bandits could have altered the data in some way before giving it to us. We are confident this did not happen. Although the records of the two firms contain different types of data, they are broadly consistent with each other. Also, these are small firms that are unlikely to have the resources or the sophistication to engage in any large-scale data manipulation in the short time after the request and prior to providing the data to us. A third concern is that bandits who trade through these firms may not be representative of all SOES bandits. We do find some differences in the trading techniques of bandits that trade through the two firms, thus we would urge caution in generalizing the results of this paper to all SOES bandits.

The first data set consists of all trades from brokerage firm 'A' for the five consecutive trading days from November 30, 1995 to December 6, 1995. On a typical trading day, firm A accounts for about 0.5%–0.7% of Nasdaq volume. They are one of the larger bandit firms, but not the largest. The data from firm A consist of confirmation records from 10,642 trades. These records indicate if the trade was a buy or sell, the transaction price, the number of shares in the trade, a code for the identity of the trader, the date, and the time that the trade was posted. The time is of limited value because it is not the execution time of the trade. This data set is interesting because it provides information on the trading patterns of individual bandits.

We match up round-trip transactions from SOES bandits in the following manner. First, we exclude 28 of the 10,642 trades because they were for more than 1000 shares. Then, the first trade for each stock in each trader's account is paired with the subsequent trade of the opposite sign. If the bandit laid off part of the position through SelectNet or Instinet, the position may be unwound with two transactions of less than 1000 shares. This is unusual, but in these cases we search forward until we find all of the matching trades. Of the 10,614 trades of 1000 shares or less, we match 10,376 of the trades into 5188 round trips. The bandits use multiple trades to lay off positions in only 25 of these round trips. The remaining 238 trades are buy orders that could not be matched with sells or sells that could not be matched with buys.

These unmatched trades could be long-term investments made by bandits. Alternatively, these trades may be traders purchasing stock for 'hedge accounts'

to allow future sales. Bandits are prohibited from selling short through SOES. Firm A bandits circumvent this restriction by purchasing 1000 shares of each stock that they would like to sell short. These shares are placed in the bandit's hedge account. When the bandit believes that a stock will be moving down in the short-term, he uses SOES to sell shares from his hedge account. When the bandit believes the price momentum is over, he repurchases the stock through SelectNet, Instinet, or SOES.

The data set from brokerage firm 'B' consists of all trades for the two weeks from January 22, 1996 to February 2, 1996. These data consist of 9994 matched buy and sell trades or 4997 round trip transactions. For each trade we have the time of the trade, the trade price, the identity of the executing market-maker, the prevailing inside bid and ask quotes, the number of dealers at the inside bid, the number of dealers at the inside ask, and the method of execution (SOES, SelectNet, Instinet). It does identify the bandit making a trade.

The 10,376 matched trades represent 5188 round trip transactions by the SOES bandits who trade through brokerage firm A. The median value of the stock purchased by a firm A bandit in a transaction is \$55,550.00 while the mean value is \$58,434.38. The median round trip trading profit across all stocks and all SOES bandits is \$63.00 while the mean is \$72.48. The standard error is \$6.13, so, with 5188 observations the mean profit is significantly different from zero at any conventional confidence level. Commissions for active SOES traders are \$25 per trade or \$50 for a round trip at firm A. The mean profit after commissions is \$22.48, which is significantly different from zero at the 1% confidence level.[4]

The median value of transactions for bandits trading through firm B is \$30,375.00 while the mean value of their transactions is \$34,557.48. The median round-trip trading profit is \$0.00 and the mean profit is \$33.50. With a standard error of \$2.86, mean profits before commissions are significantly different from zero. We do not have commission data from firm B, but officials of the firm tell us that they charge 'less than \$25 per trade'.

Fig. 1 shows the distribution of profits on round trip transactions. The distribution of firm A bandit profits is shown with dark bars while the distribution of firm B bandit profits is depicted by clear bars. Several interesting patterns are revealed by this histogram. First, SOES trading is risky. About 35% of firm A's bandits' trades and about 30% of firm B's bandits' trades result in losses before commissions. Second, most profits or losses are small. Only about one quarter of the trades result in losses or gains of more than \$250. Successful bandits earn a living by taking eighths and quarters. Finally, profits of \$500 or more are much more common than losses of \$500 or more.

[4] This slightly overstates profitability because more than one commission will be charged to the bandit if more than one trade is used to lay off a position. However, we estimate that for Firm A bandits, about 99.5% of trades are laid off with one trade. We never observe Firm B bandits using more than one trade to lay off a position.

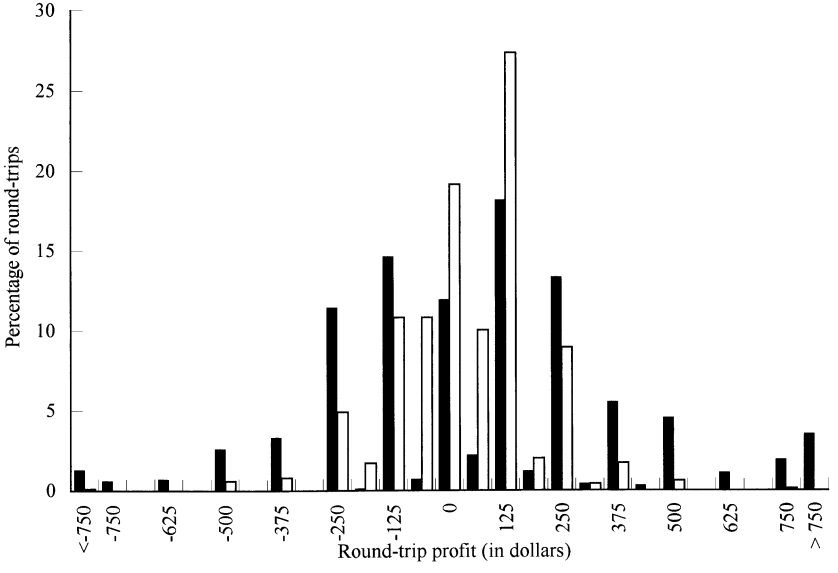


Fig. 1. The distribution of bandit's profits before commissions for round-trip transactions. Profits of bandits from firm A are depicted by solid bars. Profits of bandits from firm B are depicted by clear bars.

Differences in the trading techniques of bandits from the two firms are also visible in Fig. 1. Bandits from firm A have more large losses and more large profits than bandits from Firm B, who almost never made or lost more than $500 on a round-trip. Also, more of the round-trip profits of bandits from firm A are multiples of $125, meaning that these bandits are more likely to lay off positions using prices ending in eighths. In contrast, traders from Firm B have profits of $62.50 about 10% of the time. They seem to place more emphasis on trading out using prices ending in sixteenths of a dollar.

Bandits from both firms are more likely to use prices ending on odd-sixteenths to close out positions if the profit or loss is small. Large profits or losses will occur when the market is volatile, suggesting that bandits do not have the time to search for the best trade out price in a volatile market. When the market is volatile, other opportunities demand a bandit's attention and prevent him from taking the time to search for the best price.

All of the findings about SOES bandit profits are based on trading data for a five consecutive trading day period in November and December 1995 and a two week period in January and February 1996. To see if these weeks are typical periods, we obtained the high and low values for the Nasdaq Composite Index for each calendar week of 1995, for the five day sample period for firm A trades, and for the two weeks in 1996 for firm B trades. We then examine the ratio of the index high to the index low as a proxy for market volatility during

each week. The 55 ratios were then ranked from highest to lowest. The two weeks in 1996 had the 12th and 29th highest volatility. The five consecutive trading days during 1995 had the 38th highest volatility. Our sample periods appear to be typical weeks; they certainly are not outliers.

If bandits are making money, as our results show, they must be making money from counterparties. Some of the bandit positions are closed out on Instinet, where they could be trading with institutional investors. However, the great majority of positions are closed out through SelectNet or SOES by trading against market-makers. A sizeable proportion of the Instinet trades also are with market-makers. Thus, SOES bandits' profits come primarily from market-maker losses.

## 3. How Bandits trade

SOES bandits trade large active stocks. We obtain the previous year's Center for Research in Securities Prices (CRSP) size decile ranking for all of the stocks in all trades by firm A bandits and for 4502 of the 4997 stock trades by Firm B bandits (IPOs from early 1996 are not on the previous year's CRSP tape). For firm A bandits, 78% of the trades were of stocks in the largest CRSP size decile and 14.7% were of stocks in the second largest decile. Only 1.5% of the trades involved stocks in the smallest four deciles. For firm B bandits, 61% of trades were of stocks in the largest size decile and 26.8% were of stocks in the second largest decile. No trades involved stocks in the smallest four deciles. The size rankings include NYSE stocks. Size deciles would be even larger if we compared bandit stocks only against other Nasdaq stocks.

Table 1 shows the number of round-trip trades and the profit per trade for stocks that SOES bandits actively traded during this period. Panel A shows the number of round trip trades and the mean profit per trade for the 21 stocks traded most frequently by firm A bandits (two stocks tied for 20th in total trades). These 21 stocks account for 4193 (80.8%) of the total of 5188 round trips. Cisco Systems alone accounts for 725 round trip trades, and Sun Microsystems accounts for another 500. Mean profits before commissions are positive for 19 of the 21 stocks. Panel B shows the number of round trip trades and the mean profit per trade for the 20 stocks traded most frequently by firm B bandits.

A comparison of the trading of bandits from the two firms is difficult because the samples are from different time periods. Nevertheless, examination of Panel A and B suggests differences in the way that bandits trade at the two firms. First, average profits are smaller and less variable for firm B bandits. In addition, there are differences in the stocks that bandits trade at the two firms. Bandits at firm A concentrate their trading in the most active securities while bandits at firm B spread their trading more evenly across stocks. The 20 most heavily traded stocks account for only 1924 of the 4997 round-trip trades of firm B bandits. The

differences in the stocks traded by bandits at the two firms could reflect differences in the way that bandits are taught to trade or firm-specific knowledge about trading techniques and market-maker behavior that are passed among bandits at each brokerage firm. Differences in the ability to access Instinet or SelectNet may also lead bandits at different firms to specialize in a particular trading style.

### 3.1. Bandits specialize in a few stocks

Many SOES bandits specialize in trading a handful of stocks. One reason for specialization is that it is difficult to keep track of positions in many stocks simultaneously. In addition, bandits believe they develop expertise in the way some stocks are traded. They learn, for instance, which market-makers in a particular stock are the most likely to lead others in changing prices. Finally, trading in several stocks requires extra capital.

Table 1

*Panel A*: *Total round trips and the mean profit* (*in dollars*) *per round-trip before commissions for the* 21 *most commonly traded stocks for bandits from firm A. Mean profit and the number of round trip trades are calculated using trades of all SOES bandits who traded through Firm A. These stocks accounted for* 4193 *out of the* 5188 *round trips for firm A bandits.*

| Stock | Number of round-tips | Mean profit per round trip |
|---|---|---|
| Cisco systems | 725 | 87.58***$^{++}$ |
| Sun Microsystems | 500 | 58.13** |
| 3 Com | 387 | 79.35***$^{++}$ |
| Intel | 370 | 49.63*** |
| Microsoft | 360 | 63.01*** |
| Bay Networks | 288 | 20.82 |
| Applied Material | 197 | 26.13 |
| Dell computer | 164 | 76.21*** |
| Stratocom | 137 | 113.59***$^{+}$ |
| VLSI Technology | 127 | 54.59*** |
| Gandalf Technologies | 108 | 49.76 |
| Altera | 104 | 97.36*** |
| Oracle | 104 | 86.79*** |
| Lam Research | 97 | 93.04** |
| Quarterdeck Corp. | 85 | 138.96** |
| DSC Communications | 80 | 68.64*** |
| Sybase | 80 | 68.44*** |
| Komac | 75 | − 152.52**$^{++}$ |
| Iomega | 69 | − 100.54$^{+}$ |
| Adobe | 68 | 51.47 |
| Novellus Systems | 68 | 107.90 |
| All others | 995 | 117.36***$^{++}$ |

Table 1. Continued.

*Panel B: Total round trips and the mean profit in dollars per round trip before commissions for the 20 most commonly traded stocks for bandits from firm B. Mean profit and the number of round trip trades are calculated using the trades of all SOES bandits who traded through firm B. These stocks accounted for 1924 out of the 4997 round trips for firm B bandits.*

| Stock | Number of round-trips | Mean profit per round-trip |
|---|---|---|
| Cisco Systems | 136 | $17.00^{++}$ |
| Applied Material | 125 | 32.50*** |
| MCI Communications | 125 | 57.00*** |
| Bay Networks | 108 | 47.45*** |
| Apple Computer | 104 | 50.48*** |
| Informix | 104 | 41.47*** |
| LM Ericsson | 104 | $67.31^{***++}$ |
| Tellecommunications A | 103 | $16.38^{**+++}$ |
| Tellabs | 99 | 30.93 |
| Centocor | 96 | $15.62^{++}$ |
| Microsoft | 94 | 40.56*** |
| Oracle | 91 | 34.34*** |
| Circus Logic | 90 | 26.32 |
| Lam Research | 87 | $101.29^{***++}$ |
| Amgen | 84 | $75.15^{***++}$ |
| Adobe | 83 | $-37.65^{+++}$ |
| Altera | 78 | $13.62^{+}$ |
| 3 Com | 73 | 41.10*** |
| DSC Communications | 70 | $5.36^{++}$ |
| Starbucks | 70 | $10.71^{++}$ |
| All others | 3073 | $34.95^{***+++}$ |

*,**,*** Significantly different from zero at the 10%, 5%, and 1% levels.
$^{+,++,+++}$ Significantly different from \$50 at the 10%, 5%, and 1% levels.

Many bandits establish hedge accounts of 1000 shares in the stocks that they trade most frequently. The usual margin requirements apply to these accounts, therefore, bandits must pay at least half the cost of each 1000 share position. Maintaining a hedge account is not costly in the sense that hedge accounts do earn the return on each stock in the account that is not being traded. However, the capital required to purchase 1000 shares of several stocks can run into hundreds of thousands of dollars, a large amount for some individual bandits to raise. In addition, the preponderance of technology stocks among active Nasdaq issues makes it unlikely that the portfolio the bandit acquires in the hedge fund will be well diversified.

Evidence of specialization is depicted in Fig. 2a and b. These graphs depict the number of round trip trades made in each of the ten most popular bandit

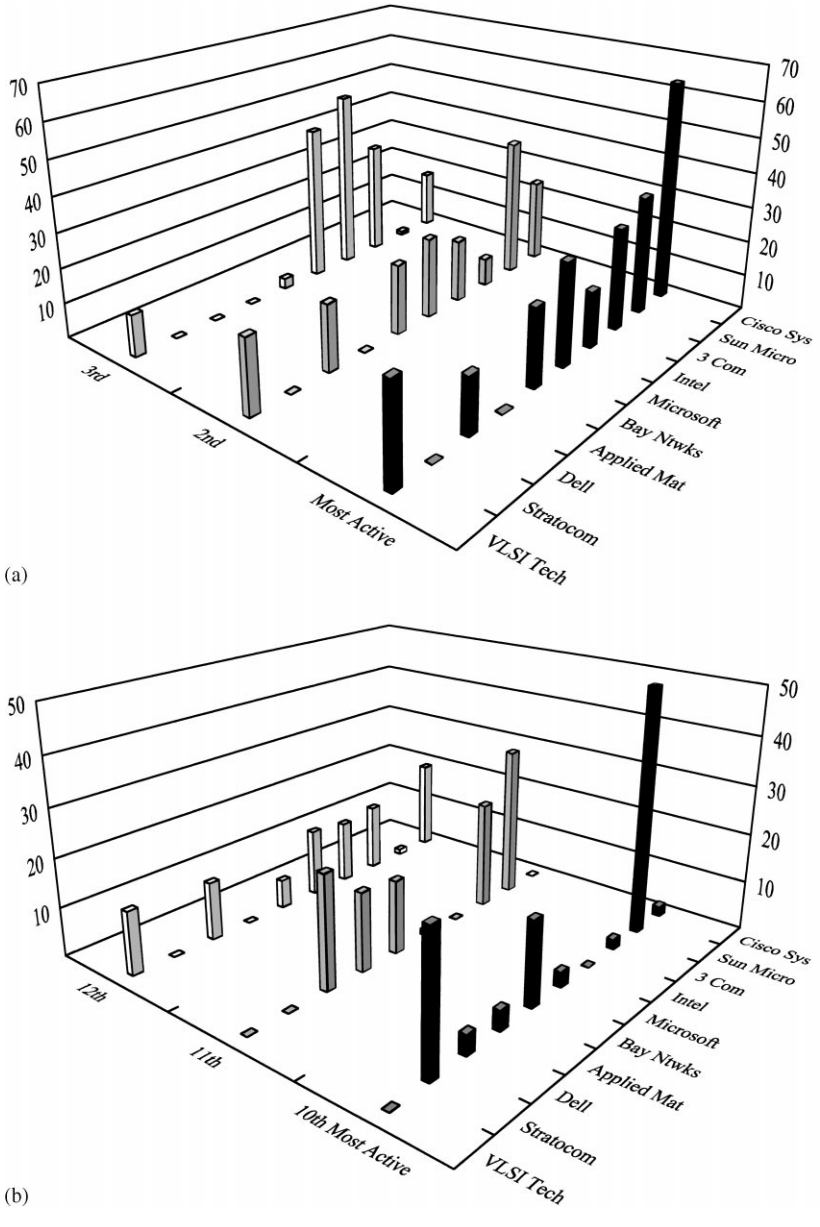


Fig. 2. (a) The number of round-trip transactions by the three most active traders at firm A in the ten stocks most frequently traded by all firm A bandits. (b) The number of round-trip transactions by the 10th, 11th, and 12th most active traders at firm A in the ten stocks most frequently traded by firm A bandits.

stocks by six of the bandits who trade through brokerage firm A. Fig. 2a shows the number of round-trip transactions by the three most active SOES bandits of firm A. The most active bandit had at least 15 round-trip transactions in eight of the ten most frequently traded stocks, but did not trade Applied Materials or Stratocom. The third most active trader did most of his trading in 3 Com, Intel, and Microsoft, and had at least 30 round-trip transactions in each of these stocks. He had almost no trades in Sun Microsystems even though that was the second most popular stock for other traders.

Fig. 2b depicts the trading activity of the 10th, 11th, and 12th most active bandits at Firm A. Here, among the less active traders, specialization is more evident. The 10th most active bandit had over 25 round-trip transactions in Stratocom, while the 11th and 12th most active (along with the three most active) had no trades at all. The 10th most active bandit had about 50 round-trip transactions in Sun Microsystems and almost none in Cisco Systems even though Cisco was more popular with other bandits.

A formal test for specialization involves calculating the number of trades for each bandit for each stock and using a chi-square test to determine if the distribution of trades in each stock differs from the expected values across bandits. We follow this procedure for all stocks and all bandits. The resulting Chi-square statistic of 34,555 with 8568 degrees of freedom allows us to reject the null hypothesis of no relation between the bandit identity and a stock's trading frequency at the 0.1% confidence level.

### *3.2. Bandit trading requires skill and some are better at it than others*

Table 2 provides data on the number of trades and the profitability of trades for bandits from firm A. Bandits are very active traders. The number of round-trips varies from one to 312 for the week. That is, the most active trader made about 120 trades *per day*. 19 of the bandits had more than one hundred round-trip trades during the five days. Mean profits varied substantially across bandits. Among the 34 bandits with 50 or more round trips, mean profit per round-trip before commissions ranged from $-\$17.96$ to \$220.78. Of the 69 bandits with one or more round trips, 52 were profitable before and 35 were profitable after commissions of \$25 per trade. The last two columns in Table 2 list the total profits before and after commissions for each bandit for the week. Profits before commissions is of interest because that is a measure of the cost of the bandit's trading to market-makers. On average, each bandit cost market-makers \$5450 during the week. Ten of the 69 bandits cost market-makers more than \$10,000 during the five days, four cost market-makers more than \$20,000, and one cost market-makers \$44,725. Profits after commissions, which represent a bandit's income, are much smaller but still average \$1690. Profits after commission are in excess of \$10,000 (\$5.2 million annually, if replicated every week) for six of the bandits and over \$29,000 for one of the bandits. Of course,

Table 2
The number of round-trips, mean and median profit per trade, and total profits before and after commissions for individual SOES bandits. Mean and median profits are calculated across all trades for all stocks. A *t*-test is used to determine if the mean profit is significantly different from zero and significantly different from round-trip commissions of $50. A sign rank test is used to determine if the median profit is significantly different from zero and $50.

| Bandit Number | Number round-trips | Mean profit per trade | Median profit per trade | Profits Before Commissions | Profits After Commissions |
|---|---|---|---|---|---|
| 67 | 312 | 143.35***$^{+++}$ | 250.00***$^{++}$ | 44,725 | $29,125 |
| 54 | 285 | 69.94*** | 125.00*** | 19,933 | 5,683 |
| 73 | 264 | 47.50** | 0.00 | 12,540 | − 660 |
| 97 | 253 | 23.72 | 63.00 | 6,001 | − 6,649 |
| 84 | 227 | 137.61***$^{++}$ | 0.00*$^{+++}$ | 31,237 | 19,887 |
| 24 | 224 | 131.59***$^{+++}$ | 125.00***$^{+++}$ | 29,476 | 18,276 |
| 87 | 220 | 57.69*** | 125.00***$^{+}$ | 12,692 | 1,692 |
| 74 | 213 | 14.38$^{+}$ | 0.00$^{++}$ | 3,063 | − 7,587 |
| 30 | 197 | 120.89***$^{+++}$ | 125.00***$^{+++}$ | 23,815 | 13,965 |
| 19 | 177 | 26.45 | 125.00 | 4,682 | − 4,168 |
| 80 | 172 | 82.11***$^{+}$ | 125.00***$^{++}$ | 14,123 | 5,523 |
| 101 | 167 | − 17.96$^{++}$ | − 125.00$^{+++}$ | − 3,000 | − 11,349 |
| 62 | 166 | 36.10 | 0.00 | 5,993 | − 2,309 |
| 5 | 159 | 21.86 | 125.00* | 3,476 | − 4,474 |
| 60 | 150 | 64.56*** | 125.00***$^{++}$ | 9,684 | 2,184 |
| 46 | 110 | 69.31*** | 125.00*** | 7,624 | 2,124 |
| 77 | 107 | 87.15*** | 125.00*** | 9,325 | 3,975 |
| 26 | 102 | 194.86* | − 125.00 | 19,876 | 14,776 |
| 11 | 100 | 130.00***$^{++}$ | 125.00***$^{+++}$ | 13,000 | 8,000 |
| 66 | 99 | 25.89 | 0.00 | 2,563 | − 2,387 |
| 13 | 91 | 108.48***$^{+}$ | 125.00***$^{++}$ | 9,872 | 5,322 |
| 29 | 85 | 20.60 | 125.00 | 1,750 | − 2,500 |
| 28 | 77 | 220.78** | 250.00** | 17,000 | 13,150 |
| 64 | 76 | 86.34 | 0.00 | 6,562 | 2,762 |
| 93 | 67 | 78.53* | 125.00 | 5,262 | 1,912 |
| 49 | 66 | 39.79 | 94.00 | 2,626 | − 674 |
| 55 | 64 | 48.36** | 63.00* | 3,095 | − 105 |
| 36 | 32 | 67.43* | 125.00* | 4,181 | 1,081 |
| 48 | 61 | 112.69 | 62.00 | 6,874 | 3,824 |
| 71 | 59 | 39.20 | − 125.00 | 2,313 | − 637 |
| 41 | 56 | 73.64*** | 125.00** | 4,124 | 1,324 |
| 47 | 53 | 154.49** | 62.50* | 8,188 | 5,538 |
| 15 | 52 | 64.90 | 0.00 | 3,375 | 775 |
| 12 | 51 | 122.55* | 125.00**$^{+}$ | 6,250 | 3,700 |
| 9 | 49 | − 34.45 | 0.00$^{++}$ | − 1,688 | − 4,138 |
| 89 | 41 | 99.10***$^{+}$ | 125.00***$^{++}$ | 4,063 | 2,013 |
| 25 | 38 | 245.05* | 125.00** | 9,312 | 7,412 |
| 3 | 37 | 20.27 | 0.00 | 750 | − 1,100 |
| 63 | 36 | 15.61 | 31.00 | 562 | − 1,238 |
| 69 | 35 | 35.34 | 0.00 | 1,237 | − 513 |
| 75 | 33 | − 26.55 | 0.00 | − 876 | − 2,526 |

Table 2. Continued.

| Bandit Number | Number round-trips | Mean profit per trade | Median profit per trade | Profits Before Commissions | Profits After Commissions |
|---|---|---|---|---|---|
| 104 | 30 | − 27.48 | − 125.00$^{++}$ | − 824 | − 2,324 |
| 7 | 29 | − 81.90$^{++}$ | 0.00$^{+}$ | − 2,375 | − 3,825 |
| 108 | 28 | − 21.18 | − 31.00$^{+}$ | − 593 | − 1,993 |
| 40 | 25 | 20.00 | 0.00 | 500 | − 750 |
| 21 | 21 | 65.48 | 125.00 | 1,375 | 325 |
| 17 | 20 | 246.90**$^{++}$ | 156.00***$^{++}$ | 4,938 | 3,938 |
| 34 | 20 | − 0.10 | 31.00 | − 2 | − 1,002 |
| 102 | 16 | 27.38 | 0.00 | 438 | − 362 |
| 79 | 15 | 16.67 | 0.00 | 250 | − 500 |
| 8 | 11 | − 56.82 | 125.00 | − 625 | − 1,175 |
| 14 | 10 | − 118.80$^{++}$ | − 62.50$^{+}$ | − 1,188 | − 1,688 |
| 78 | 9 | 111.11 | 125.00 | 1,000 | 550 |
| 22 | 8 | − 7.88 | 0.00 | − 63 | − 463 |
| 90 | 8 | 695.25**$^{+}$ | 437.50**$^{+}$ | 5,562 | 5,162 |
| 18 | 6 | 145.83 | − 62.50 | 875 | 575 |
| 99 | 6 | − 10.33 | − 31.00 | − 62 | − 362 |
| 16 | 5 | 0.00 | 0.00 | 0 | − 250 |
| 105 | 5 | 92.41 | − 112.44 | 462 | 212 |
| 27 | 4 | 281.25* | 312.50 | 1,125 | 926 |
| 106 | 4 | 93.75 | 125.00 | 375 | 175 |
| 31 | 3 | 83.33 | 125.00 | 250 | 100 |
| 39 | 3 | 104.33 | 125.00 | 313 | 163 |
| 23 | 2 | − 500.00 | − 500.00 | − 1,000 | − 1,100 |
| 65 | 2 | − 250.00 | − 250.00 | − 500 | − 600 |
| 109 | 2 | − 62.50 | − 62.50 | − 125 | − 225 |
| 52 | 1 | 0.00 | 0.00 | 0 | − 50 |
| 76 | 1 | 0.00 | 0.00 | 0 | − 50 |
| 107 | 1 | 250.00 | 250 | 250 | 200 |

*,**,*** Significantly different from zero at the 10%, 5%, and 1% levels.
$^{+,++,+++}$ Significantly different from \$50 at the 10%, 5%, and 1% levels.

some bandits lost money for the week after paying commissions. Four had losses of more than \$4000.

Another implication of the profits after commissions in Table 2 is that they represent the amount that market-makers would have to pay to employ bandits to keep their quotes updated for them. The profits before commissions represent the amount that the dealer would save by employing the bandit. The difference in profits before and after commissions averages \$3760 per week, and represents a loss to the bandit's broker that could be divided between the market-maker and the bandit. The continuing existence of these large potential gains to market-makers from employing traders to serve the same function as SOES bandits implies that market-maker employees cannot keep prices in line as well

as bandits. We believe this is because of agency costs. Market-maker employees do not receive all the profits or bear all the losses from their activities, so they will not work as hard or attentively as bandits.

Analysis of the total profits in Table 2 reveals a correlation of 0.737 between the total profits before commissions and the number of trades a bandit made. The correlation between total profits after commissions and the number of bandit trades is 0.365. Thus, much of the difference in total profits across bandits can be attributed to differences in the bandit's trading frequency. There is a positive correlation of 0.085 between the number of trades and the mean profit per trade. This is surprising because frequent trading means that the bandit may have more than one position open at once, and it is difficult to effectively trade more than one position at a time. When a bandit initiates a position and has no other positions open (3782 observations), mean expected profits before commissions are \$83.28. If the bandit already has one position open (1003 observations), profits average \$61.93. With two open positions (314 observations), mean profits are \$62.48 and with three open positions (92 observations), the mean profits from an additional position are only \$41.43. Thus the finding of a positive correlation between trading frequency and profits per trade suggests that the bandits who trade more frequently are more skillful than other bandits.

To test for differences in trading skills across bandits we first adjust for differences in the stocks that they trade. Table 3 reports results of analysis of variance tests of the effects of the stock and the bandit identity in determining profits from a trade. We conduct the analysis of variance using the trades of all bandits, the trades of bandits with 20 or more positions during the sample period, and the trades of bandits with 50 or more positions during the sample period. Results are similar in all three tests. In each test, the stock explains a significant portion of the variance of the trading profits. F-statistics for the stock are always significant at the 1% level. In each test, the bandit identity also explains a significant portion of the variance of trading profits. F-statistics for the bandit identity are always significant at the 1% confidence level. Thus, after adjustment for the stocks traded, there are significant differences in profits per trade across bandits. An interaction term between the bandit and the stock is never statistically significant.

The analysis of variance tests reported in Table 3 suggest that the differences in trading profits across bandits are greater than expected by chance or luck. However, our sample period is only five days long. A more reliable picture of differences in bandit skill requires a longer sample period that includes days with higher and lower volatility and trading volume.

### *3.3. Trading strategies*

To examine bandit trading strategies, we turn to data from firm B, which includes the time of the trade, the number of dealers at the inside bid and at the

Table 3
Analysis of variance for trading profits using the stock traded and the SOES bandit identity as explanatory variables. The data consists of the profits from 5188 round-trip transactions by 69 bandits who trade through firm A. All trades are from the five trading days from November 30, 1995 to December 6, 1995.

| | Sum of squares (millions) | Degrees of freedom | F-statistic (*p*-value) |
|---|---|---|---|
| | All bandits | | |
| Total | 842.9 | 5,082 | |
| Bandit | 18.9 | 66 | 1.80 (0.0001) |
| Stock | 42.8 | 121 | 2.22 (0.0001) |
| Bandit × Stock | 85.0 | 524 | 1.02 (0.3849) |
| | Bandits with 20 or more positions | | |
| Total | 812.0 | 4,930 | |
| Bandit | 11.5 | 45 | 1.69 (0.0066) |
| Stock | 42.3 | 115 | 2.31 (0.0001) |
| Bandit × Stock | 71.5 | 469 | 0.95 (0.7424) |
| | Bandits with 50 or more positions | | |
| Total | 739.6 | 4,544 | |
| Bandit | 10.2 | 33 | 1.98 (0.0007) |
| Stock | 41.8 | 105 | 2.54 (0.0001) |
| Bandit × Stock | 56.9 | 384 | 0.95 (0.7633) |

inside ask, the identity of the counterparty to the trade, and whether the trade was executed through SelectNet, SOES, or Instinet.

In Fig. 3 we plot the number of buy orders and number of sell orders by firm B traders for each 5 min period of the trading day. Firm B discourages its traders from using hedge accounts to allow defacto short sales. Thus all of firm B's bandit's positions are established with buy orders and all are closed with sell orders.

SOES bandits are day traders; they seldom hold a position overnight. Fig. 3 shows very few trades in the first few minutes after the opening. Bandits are not carrying over positions from the previous day that they trade at the open and bandits tell us that they do not like to trade before the 'market has established a direction'. Likewise, as the Firm B bandits close out positions at the end of the trading day, there are many sell orders but no buy orders. The number of buy orders per five minute period is much more volatile than the number of sell orders. This reflects the difference in the way that positions are established and

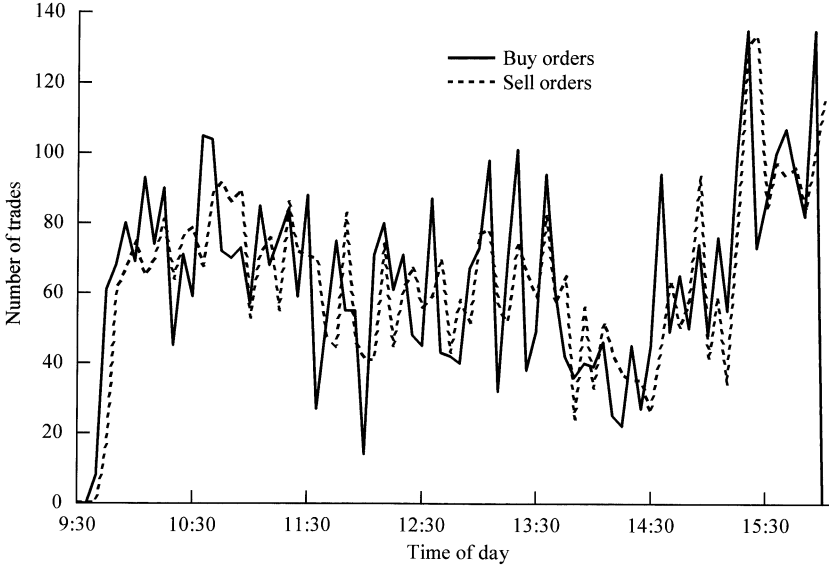


Fig. 3. The number of buy orders and sell orders for firm B bandits for each five minute period of the trading day during the two weeks from January 22, 1996 to February 2, 1996.

closed. Bandits establish a position quickly when they observe short-term trends. They lay off positions more slowly, searching for the best price on SelectNet and Instinet.

Bandits infer short-term price movements from market-maker quote updates and trades. Their trading strategies are often described as hitting the lone market-maker who has left his terminal for just a minute. However, the data suggest that bandits trade before *most* market-makers update quotes. Fig. 4 shows the distribution of the difference between the number of dealers at the inside bid and the number of dealers at the inside ask across all of the positions of bandits from Firm B. Dark bars show the number of dealers when the position is established by purchasing a stock while clear bars show the distribution when bandits sell or lay off a position. On some occasions bandits appear to pick off market-makers who are slow to update quotes. This is shown by the dark bars where the number of dealers at the bid exceeds the number at the ask. However, when bandits establish positions, there are usually more dealers at the inside *ask* than at the inside bid. The average number of dealers at the inside ask is 6.76 when bandits buy into a position. Thus, bandits are *not* picking off single dealers who are just a little slow in updating quotes. Bandit's trades precede the quote changes of *most* dealers.

Further evidence that bandits are not just picking off the slowest market-maker is that a number of trades to establish positions are usually observed at

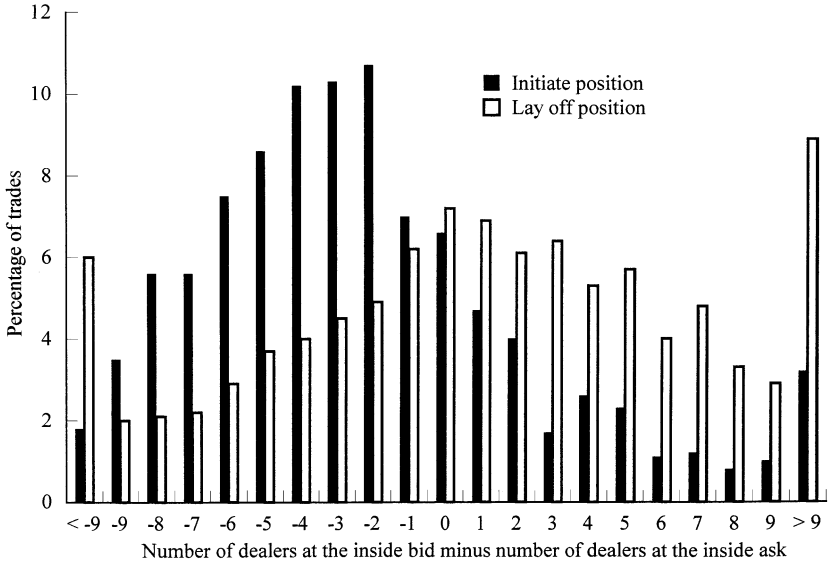


Fig. 4. The difference between the number of dealers at the bid and the number of dealers at the ask at the time that bandits from firm B initiated or traded out of positions. Solid bars show the distribution when bandits initiate positions and clear bars depict the distribution when bandits layoff a position.

about the same time. We define a 'cluster' of trades as three or more trades by bandits to establish positions in the same stock that occur within five seconds. Of the 4997 trades used by firm B's customers to establish positions, 4540 are part of a cluster of trades. In only one of the clusters was any single market-maker hit more than once by bandits establishing positions through SOES.

Traders at firm B tell us that this finding is not a surprise to them. A strategy they frequently employ is to look for early movement on one side of the market rather than waiting to catch traders who have been slow to adjust. That is, they buy when one or two reliable dealers raise their bids, not when there are only one or two slow dealers who have failed to raise their asks. We do not know whether this strategy is also followed by bandits who trade through other brokerage firms.

Bandits hold positions for very brief periods. For bandits who trade through firm B, the mean time between initiating and trading out of a position is 5 min and 36 s. The median time is three minutes and 26 seconds. Only one position in eight is held open for more than ten minutes. Fig. 5 shows trading profits before commissions by 20 s holding periods up to 15 min. There is an almost monotonic decline in trading profits as the position's holding period increases. If the holding period exceeds one minute and 20 s, mean profits start to decline. If the bandit holds a position more than five minutes he will, on average, lose money.

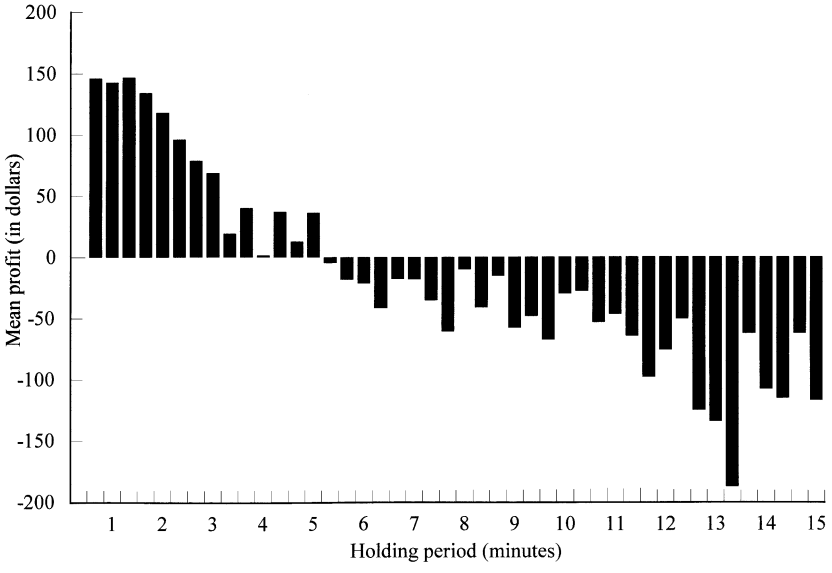


Fig. 5. Mean profit by 20 s holding period for all trades from firm B bandits for January 22, 1996 to February 2, 1996. The holding periods refer to the time if held to the end of the 20 s interval.

The difference between the number of dealers at the inside bid and the inside ask when bandits lay off positions, is analogous to the difference when bandits establish positions. Bandits tend to lay off positions when there are more dealers at the inside bid than the inside ask. They close positions when they feel a trend has run its course. The trigger for closing positions is when one or two reliable dealers move to lower ask prices, not when there is only one or two dealers left at the inside bid. Note that the imbalance in dealers is far less pronounced when SOES bandits are laying off positions than when they are establishing them. Bandits are concerned with trading out of positions with a favorable execution as well as watching for reversals of a trend.

While bandits almost always initiate positions using SOES, they prefer to lay off positions using SelectNet or Instinet. Of the 4994 positions established by traders from brokerage firm B, only 941 are closed out with a SOES trade. The remaining positions are laid off through SelectNet or Instinet. Table 4 shows how the prices at which firm B bandits lay off positions compare with the contemporaneous inside quotes. Of the 941 SOES trades in which bandits lay off positions, 937 are executed at the prevailing bid price.[5] This contrasts sharply

[5] We cannot tell for certain why the other four trades are executed at prices other than the bid. The most likely explanation is that the SOES orders were held up because there were others in the queue ahead of them and they were able to get slightly better prices than the quoted bid at the time the order was submitted.

Table 4
Number of layoffs by type of execution and location within the spread. Firm B bandits closed out 4994 positions from January 22, 1996 to February 2, 1997 by selling stock.

| Execution type | Sell price ⩽ bid | Bid < sell price < bid–ask midpoint | sell price = midpoint | Bid–ask midpoint < sell price < ask | Ask ⩽ sell price | Total |
|---|---|---|---|---|---|---|
| SelectNet | 48 | 243 | 1005 | 316 | 1625 | 3237 |
| Instinet | 32 | 60 | 366 | 118 | 240 | 816 |
| All non-SOES | 80 | 303 | 1371 | 343 | 1865 | 4053 |
| SOES | 937 | 0 | 2 | 0 | 2 | 941 |

Table 5
Profitability, duration, and number of trades by method of position lay-off for firm B's SOES bandits from January 22, 1996 to February 2, 1996.

| | SelectNet | Instinet | SOES |
|---|---|---|---|
| Number of trades | 3237 | 816 | 941 |
| Mean duration (seconds) | 219 | 523 | 581 |
| Mean profit | $85.98 | $19.26 | − $124.93 |
| Median profit | $125.00 | $0.00 | − $125.00 |
| 25th percentile | $0.00 | − $62.50 | − $250.00 |
| 75th percentile | $125.00 | $125.00 | $0.00 |

with the execution bandits get when trading out through SelectNet or Instinet. Over 90% of these trades (3670 of 4053) occur at or above the spread midpoint. In particular, over half of the SelectNet trades occur at the ask price. On average the effective half spread for bandits trading out through SelectNet or Instinet is − 4.2¢.

The favorable executions provided by SelectNet or Instinet are essential for profitable trading by SOES bandits. Table 5 shows the distribution of the profitability of SOES bandits' trades when positions are closed in different ways. When a SOES bandit lays off a position through SelectNet to a Nasdaq market-maker, his average profit before commissions is $85.98. Fewer than 25% of positions that are closed in this way lose money. When the position is laid off through Instinet, the mean profit is $19.26 and the median profit is zero. In contrast, when a bandit trades out through SOES, he loses $124.93 on average. Fewer than 25% of these trades result in a profit for the position.

The results suggest that bandits need to trade within quoted prices to make money. This is consistent with the results of Harris and Schultz (1997). They use clusters of three or more trades at the quoted price within 15 s as a proxy for

SOES bandit trading. They find that the bid–ask midpoint rises about 18¢ following a cluster of buy orders and falls by about the same amount following a cluster of sell orders. This is less than the mean bid–ask spread for their sample stocks.

It is interesting that market-makers complain about losses to SOES bandits but continue to voluntarily trade with them through SelectNet. An examination of the identities of market-makers on both sides of the trades shows that almost all of the dealers that SOES bandits use to establish positions trade out with the bandits on SelectNet. The ratio of SelectNet trades to SOES trades is smaller for the larger market-makers. For example, a regional firm, Montgomery Securities, executed 109 of our sample's SelectNet layoffs but was used to establish positions only 94 times. On the other hand, Morgan Stanley, one of the largest market-makers participated in 42 of the SelectNet trades in our sample but was hit 192 times by SOES bandits establishing positions.

As a formal test, we split the 161 dealers that participated in one or more trades in our sample into two groups of large and small dealers. We defined the large dealers as First Boston, Goldman Sachs, Herzog, Heine and Geduld, Lehman Brothers, Mayer Schweitzer, Merrill Lynch, Morgan Stanley, Nash Weiss, Salomon Brothers, Sherwood Securities, and Troster Singer. We defined all other market-makers as small dealers. Instinet trades were omitted, as were layoffs through SOES. We find that large dealers executed 849 SelectNet trades and were hit 1738 times by bandits establishing positions on SOES. Small dealers executed 2388 SelectNet trades and were hit 3259 times by bandits establishing positions. A Chi-square statistic of 66.69 with one degree of freedom means that we can reject equal proportions of SOES and SelectNet trades for large and small dealers at any conventional confidence level. It appears that bandits tend to buy from large market-makers on SOES and sell to small market-makers through SelectNet.

Our finding that SOES bandits receive such favorable executions when trading through SelectNet or Instinet has implications for other lines of empirical research on Nasdaq. In particular, effective spreads may be overstated if bandits can often lay off positions on the opposite side of the spread. This also suggests caution with other tests that involve assigning trades as buys or sells by comparing trade prices with contemporaneous quotes. Finally, these results provide a tantalizing but incomplete comparison of the prices available on Nasdaq with those available on Instinet and SelectNet. For investors who can take just a few minutes to execute a trade, these alternatives to Nasdaq appear to provide superior prices.

## 4. Summary and conclusions

The picture of a bandit that emerges from our study is that of a trader who intensely follows a handful of the most active Nasdaq stocks. He trades very

frequently and holds positions for only a few minutes. Bandits lose money almost as frequently as they make it, but manage a small average profit per trade. The successful bandit earns a living by making eighths and an occasional quarter dollar per share on trades.

Some of our findings are surprising. In particular, we find that bandits who trade with market-makers at quoted prices lose money. Thus, ignoring the costs of a trade, it appears that market-makers who trade with bandits only at their posted quotes make money from SOES bandits. To be profitable, bandits must close out positions using either SelectNet or Instinet. These systems, which are not commonly available to the investing public, allow bandits to close out positions at prices within the Nasdaq spread. Our results also refute the popular image of SOES bandits as picking off a distracted market-maker who is the last to update a quote. Instead, we find that SOES bandits buy when there are a number of dealers at the inside ask and only a handful of dealers have increased bid prices. In other words, SOES bandits trade before *most* market-makers update quotes. They are not just faster than the slowest market-maker, they are faster than the average market-maker.

The existence and profitability of SOES bandits raises new questions about the efficiency of different market structures. Bandits do not have any more information than the market-makers that they trade against and in many cases they have less information. But bandits still make money. In response, Nasdaq market-makers have expended considerable effort to eliminate SOES bandits through regulation. They have invested hundreds of thousands of dollars in proprietary software to update quotes when bandits trade against them. Why do not market-makers just hire traders to keep track of other dealer's quotes, Instinet quotes and SelectNet quotes and update their own prices in a more timely fashion?

We believe the answer is that market-makers are inherently less efficient at price discovery than are bandits. The reason is agency costs; bandits are trading for their own accounts, so they keep all their gains and bear all their losses. The compensation of traders employed by market-makers may depend on their performance, but to a much smaller degree. Thus, bandits have much greater incentive to concentrate on what they are doing, to follow stock prices closely, and to stay in front of their terminals than do market-maker employees. Unusually fast or skillful traders may find SOES trading to be more profitable than working for a Nasdaq market-maker.

The importance of these agency costs for market-making implies that individuals, trading their own accounts, may provide more efficient and more competitive market-making services than market-making firms that rely on employees to trade for them. Modern electronic news services and electronic order entry systems of the type used by SOES bandits allow individuals to act as dealers. The recent change in order handling rules that requires Nasdaq limit orders to be displayed may be an important first step in this direction. Firm B's

Bandits tell us that they are already trying limit order trading strategies as a supplement to their SOES trading.

## References

Battalio, R., Hatch, B., Jennings, R., 1997. SOES trading and market volatility. Journal of Financial and Quantitative Analysis 32, 225–238.

Harris, J., Schultz, P., 1997. The Importance of firm quotes and rapid executions: Evidence from the January 1994 change in SOES. Journal of Financial Economics 45, 135–166.

Hinden, S., 1994. Nasdaq's big guns send trading bandits packing. Washington Post, February 7, 1994.

Kleidon, A., Willig, R., 1995. Why do Christie and Schultz infer collusion from their data? Unpublished working paper. Cornerstone Research, Menlo Park, CA.

Laux, P., 1995, Nasdaq trading costs, SOES rules, and Nasdaq electronic trading: an assessment using audit trail data. Unpublished working paper. Case Western Reserve University, Cleveland, OH.