Conflict of Interest and Execution Quality of Futures Floor Traders

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Abstract

We study the quality of customer trades executed by futures floor traders and, in particular, by dual traders (floor traders who trade both for their own accounts and for customers on the same day). In the S&P 500 futures, we show that active dual traders provide inferior execution of customer trades relative to their personal trades and relative to pure brokers, even after controlling for differences in trade size, volatility, and volume. We find that part of active dual traders' price advantage over customers is compensation for providing liquidity when trading for their own accounts, while the remaining part is the value of observing the customer order flow. We further show that personal and customer trades (in particular, large customer trades) of active dual traders are correlated, consistent with dual traders mimicking, frontrunning or misallocating customer trades. After a regulatory restriction on dual traders' personal trading, dual customers receive similar execution to other customers, and there is no correlation between the personal and customer trades of dual traders.

In this paper, we study the quality of customer trade execution by futures floor traders, focusing in particular on dual traders---floor traders who trade both for their own accounts and for customers on the same day. As highly active traders using their personal accounts, dual traders are valued by exchanges for their contribution to liquidity but, as agents for customers, they are also suspected of acting against the best interests of their customers. U.S. regulators had previously proposed a ban on dual trading for all futures contracts, although the ban was never implemented. Currently, with some exceptions, dual trading is allowed in most futures markets.[1]

Our study focuses on the relation between personal trading and customer execution by dual traders of different activity levels, using a detailed transactions data identifying the personal and customer trades of each futures floor trader. We define a floor trader as a dual trader if he trades both for himself and for customers on the same day at least once in the sample. Dual traders are then sorted into two groups, more and less active, by the number of days each group is actively dual trading. More and less active dual traders may have different incentives to provide good execution to customers. Active dual traders may have superior trading skills and provide above-average execution to customers. On the other hand, active dual traders may have greater opportunities to mimic (trade after), frontrun (trade before) or misallocate customer trades, and consequently provide inferior execution.[2] If dual traders mimic or frontrun informed customers, then their personal trades

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[1] Congress passed the Futures Trading Practices Act 1992, which required the Commodity Futures Trading Commission (CFTC) to establish rules for banning dual trading in all active futures markets. A proposal to lift the ban is in the Commodity Futures Modernization Act 2000 being debated in the House and Senate. Dual trading is currently restricted by the Chicago Mercantile Exchange (CME) for some contracts, mostly those with a high level of past trading activity.

[2] The CME recently restricted dual trading to l0 percent of a trader's daily trading in the Nasdaq 100 pit, leading to speculation of frontrunning in the pit and calls for investigation from legislators (Futures, September 2000). The General Accounting Office (GAO, 1989a, 1989b) reported that broker's trading resulted in futures customers receiving worse prices than existing best bids and offers.

aggravate the adverse selection problem of market makers and may widen the bid-ask spread for customers (Fishman and Longstaff, 1992). Dual traders may also frontrun large uninformed trades that are broken up, increasing these customers' expected execution costs (Madhavan, 1995). With misallocation, a dual trader allocates ex-post a trade at a better price to his own account and a trade at an inferior price to customers.[3]

Our initial sample is the S&P 500 index futures for May and June of 1987. We find that more active dual traders specialize in dual trading, in the sense that most of their active days are dual trading days, rather than days when they trade *only* for customers or *only* for themselves. We show that these active dual traders provide inferior execution of customer trades, relative to their own trades and relative to pure brokers, even after controlling for trade size, volatility, and volume.

Dual traders may provide liquidity to customers by buying at the bid price and selling at the ask price for their own accounts, while buying at the ask and selling at the bid for customers. Thus, as compensation for supplying liquidity, dual traders may receive better prices for their own accounts relative to customers. We test whether dual traders' profits per contract are similar to those of other liquidity providers, and find that active dual traders make higher profits per contract relative to locals (floor traders who trade exclusively for themselves) and relative to their *own* local trading days. Hence, the liquidity hypothesis cannot fully explain dual traders' price advantage, nor why customers of dual traders receive inferior execution relative to customers of pure brokers.

Through their personal trading, dual traders may profit from either payoff or non-payoff private

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[3] The CFTC recently charged a broker for "fraudulently allocating trades among his personal account and his three customer accounts to his benefit and to the detriment of his customers." The broker entered orders, but not account numbers, to the trading floor. When the orders were filled, they were allocated either to the broker's account or his three customer accounts, depending on fill quality (CFTC Enforcement Action 4023-97; CFTC Docket No. 97-8).

information reflected in the customer order flow.[4] We find some evidence that active dual traders' customer trading volume in the first two hours of trading is a determinant of their profits for the remainder of the day. More important, we show that the personal and customer trades of dual traders are correlated, and that the correlation is stronger for large-sized customer trades. Although the correlation could reflect dual traders mimicking or frontrunning of informed trades, our evidence shows that dual traders' customers are *not* successful market timers, suggesting that customers may be uninformed. Our tests do not rule out frontrunning of large uninformed trades or misallocation as potential explanations for the correlation.[5] These explanations are also consistent with the result that customers of dual traders receive worse prices than brokers' customers do.

We also study the S&P 500 futures from April to July of 1991. The CME restricted dual trading through the so-called Top-step rule of June 22 1987, which prevented dual traders from using the top step of the pit for *personal* trading.[6] After the restriction, execution prices for dual traders' customers are similar to brokers' customers and to dual traders' personal trades. Further, dual trading profits are similar to locals' profits. Finally, personal and customer trades of dual traders are not correlated. Hence, following the Top-step rule, the ability of dual traders to profit from the customer order flow appears to be reduced, perhaps because traders use the top step to observe the inflow of customer orders into the pit.[7] Our result that execution quality of customer trades improved after the Top-step rule is consistent with evidence in Locke and Venkatesh (1997).

Finally, we study the Japanese Yen futures for May and June 1987. Similar to the S&P 500

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[4] Cao and Lyons (1999) examine non-payoff private information reflected in the past order flow. Lyons (1995) finds evidence of non-payoff information for FX markets.

[5] Misallocation implies a correlation when, for example, a dual trader executes a personal and a customer purchase and then allocates them ex-post based on price.

[6] CME's Rule 541 states: "A member, who has executed an S&P 500 futures contract order while on the top step of the S&P 500 futures pit, shall not thereafter on the same day trade S&P 500 futures contract for his own account."

1987, active dual traders in the Yen specialize in dual trading and receive better prices for their own trades than customers do. In contrast to the S&P 500 1987, however, customers of dual traders and brokers receive similar execution and personal trading profits of dual traders and locals are also similar. Further, there is no correlation between dual traders' personal and customer trades. Thus, all of dual traders' price advantage in the Yen appears to be compensation for providing liquidity. Trading activity in the Yen futures is small compared to the S&P 500 futures and the Yen spot market, and this may limit dual traders' opportunities to profit from the customer order flow.

The CFTC (1989), Fishman and Longstaff (1992) and Chang and Locke (1996) compare execution quality of customer trades by dual traders and pure brokers, and trading profits of dual traders and locals. Chang and Locke (1996) examine whether dual traders in the aggregate follow mimicking strategies, by regressing the relative personal trading imbalance of dual traders on the relative customer-trading imbalance. We, on the other hand, estimate whether the trade direction of an *individual* dual trader is correlated with the direction and volume of his customer trades, after controlling for factors that may determine the trading decisions of both customers and dual traders. Our tests of market timing skills and whether dual traders predict profitable trading days are new to the dual trading literature.

While we focus on dual traders' aggregate activity level, Chang and Locke (1996) and Locke, Sarkar and Wu (1999) categorize dual traders according to their mix of personal and customer trades. They argue that dual traders with a high ratio of customer to personal trading are more prone to conflicts of interest (Chang and Locke, 1996) or have poor trading skills (Locke at al., 1999). We show that dual traders with extensive customer *and* personal trading provide the worst execution of

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[7] The FBI sting operation in 1989 to uncover frontrunning in the Chicago futures pits could be another factor.

customer trades and make the most personal trading profits.

Theoretical models suggest that dual trading may decrease liquidity. In Roell (1990), dual trading benefits those uninformed traders whose orders are observed by the broker. In Fishman and Longstaff (1992), dual traders mimic or frontrun the trade direction of highly informed customers. In Sarkar (1995), dual traders reduce liquidity by mimicking informed orders and offsetting uninformed orders but they also add liquidity through their proprietary trading.

The rest of the paper is organized as follows. Section one describes the data and presents descriptive statistics. Section two compares execution quality of dual traders and pure brokers. Section three studies profits of dual traders and locals. Section four examines whether dual traders benefit from the customer order flow. Section five analyzes market-timing skills of customers and floor traders. Section six concludes.

1. Data and Descriptive Statistics

We use the Computerized Trade Reconstruction data provided by the CFTC for the CME's S&P 500 index futures and the Japanese yen futures for 35 trading days from May 1 to June 1987. We also study the S&P 500 index futures for the period April 1 to June 28, 1991, a total of 64 trading days. For each trade, the data provides the customer type, the trade type, the number of contracts traded, the trade price, and a buy-sell indicator with all variables dated by 30-minute brackets or intervals for the 1987 data, and 15-minute brackets for the 1991 data. The customer types are indicated by the Customer Type Indicator (CTI) 1 (trades executed for floor traders' own accounts) and CTI 4 (trades for outside customers). Most trades fall under these two categories.[8]

[8] The others are CTI 2 (trades for a clearing member's house account) and CTI 3 (trades for another member present on the exchange floor).

Our Japanese yen sample has 173,771 trades and 351 traders, with an average daily trading volume of almost 27,000 contracts. The S&P 500 sample contains 1,296,769 trades and 957 traders in 1987, with an average daily volume of almost 122,000 contracts. For 1991, the S&P 500 sample has 1,616,726 trades and 651 traders, and an average daily volume of more than 74,500 contracts.

To construct the dual and nondual floor trader samples, we calculate x_{it} = (personal trading volume)/(total trading volume) for trader i on day t. Depending on the value of x_{it}, we define day t as a dual trading day, a local trading day, or a broker trading day for trader i. Day t is a dual trading day for floor trader i if x_{it} is in the closed interval [0.02, 0.98], a local trading day if $x_{it} > 0.98$, and a broker trading day if $x_{it} < 0.02$.[9] We define a dual trader as a floor trader with at least one dual trading day in the sample period. Thus, the dual trader sample consists of the dual trading days, local trading days, and broker trading days of dual traders.[10] A local is a floor trader with *only* local trading days in the sample. A broker is a floor trader with *only* broker trading days in the sample. We use the terms *broker* and *pure broker* interchangeably.

A. Activity of Dual and Nondual Floor Traders

Table 1 provides information on the activities of dual and nondual floor traders. In 1987, for both the Yen and the S&P 500, the average dual trader is more active than the average floor trader and spends most of his days in dual trading. For the S&P 500 futures 1987, for example, the average dual trader is active for almost 28 days, compared to 18 days for the average floor trader; and spends

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[9] Since there is no legal definition of dual trading, we define it endogenously, as the exchanges do. The 2-percent filter allows for error trading. When a broker makes a mistake in executing a customer order, the trade is placed into an error account as a trade for the broker's personal account. The broker may then offset the error with a trade for the error account. Chang, Locke, and Mann (1994) state that a value of 2 percent for error trading seems reasonable based on their conversations with CFTC and exchange staff.

[10] While we could also categorize a floor trader as a dual trader *only* on the days he is dual trading, our broader definition

16 of these 28 days in dual trading. In the S&P 500 1991, by contrast, although the average dual trader continues to be more active than the average floor trader is, he spends only about 5 of his 60 active days in dual trading.

Table 2 reports activity on dual and nondual trading days of floor traders. For all trading days, aggregate activity (number of trader days, trades and total volume) is substantially lower for the Yen. On dual trading days, aggregate activity is highest for the S&P 500 1987. For example, while total volume on dual trading days is more than 1.9 million for the S&P 500 1987, it is less than 400,000 for the Yen and the S&P 500 1991. Between 1987 and 1991, aggregate activity in the S&P 500 shifts from dual days to broker days. For example, the number of trades on dual days falls from almost 550,000 in 1987 to about 75,000 in 1991 while it increases on broker days from about 104,000 in 1987 to more than 600,000 in 1991. Consistent with this shift, volume and trades per trader day on dual days are highest in 1987 and lowest in 1991.

B. Dual Traders of Different Activity Levels

We divide dual traders into two groups by the number of their dual trading days in sample. The more active group is composed of those in the highest 50th percentile of dual trading days, and the less active group are those in the lowest 50th percentile of dual trading days. With this procedure, more (less) active dual traders for the S&P 500 1987 are those with at least (less than) 18 dual trading days in the sample. The cut-off numbers for active dual traders in the S&P 500 1991 and the Yen are 3 and 7 dual trading days, respectively. The relatively low cut-off in 1991 reflects the fact that the average dual trader is dual trading for only 5 days in sample (see Table 1).

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allows a determination as to whether the behavior of a dual trader is related specifically to dual trading.

Table 3 shows descriptive statistics for the two groups of dual traders. In 1987, active dual traders in the S&P 500 specialize in dual trading. For example, more active dual traders in the S&P 500 have 3,264 dual trading days out of 4,030 total trading days, an 80 percent share. In contrast, less active dual traders in the S&P 500 are more like locals, since about 60 percent of their days are local trading days. Active dual traders in the S&P 500 1991 do *not* specialize in dual trading, spending only 13 percent of their days in dual trading. Active dual traders in the Yen also specialize in dual trading, with almost 60 percent of their days spent in dual trading. In the Yen, the less active dual traders are more like brokers, since about 53 percent of their days are broker trading days.

2. Execution Quality of Customer Trades by Dual Traders and Brokers

Dual traders may trade for themselves and for customers on dual trading days. On other days, they may trade only for customers, just like pure brokers. For each trading bracket, and for buys and sells separately, we compute the volume-weighted average price of customer trades of brokers, dual traders' customer trades and personal trades on their dual trading days, and dual traders' customer trades on their broker trading days. We then calculate the difference in prices between dual traders' customer trades on dual trading days and the other trades. Extreme observations (i.e. mean absolute price differences exceeding $125 for the Yen and $250 for the S&P 500, about 10 times the minimum tick or price change in each contract) are deleted.[11] We use a paired *t* test to infer whether the mean price differences are significantly different from zero.

Table 4 reports the mean and median price differences in dollars for all dual traders and for the more and less active dual trader groups. Since the price differences are found to be similar for buys

[11]To obtain the nominal dollar value for the S&P 500 futures, we multiply the price, quoted in dollars per index point, by

and sells, we aggregate the buy and sell results for presentation purposes. A *positive* (*negative*) number indicates that customers of dual traders on dual trading days receive *worse* (*better*) prices relative to dual traders' personal trades and relative to other customers. For the S&P 500 1987, dual traders buy at a lower price and sell at a higher price for their own accounts relative to their customers, and the difference is significant at the 0.01 percent level. This result also holds for the more active dual traders whose mean price advantage is about $22 (more than 4/5 of a tick). Less active dual traders have a lower, but statistically significant, price advantage (about $13) over their customers. For the S&P 500 1991, active dual traders' price advantage (about $5) is substantially reduced from 1987 and not significant at a 5 percent level. Moreover, there is no price advantage for less active dual traders. For the Yen, there is evidence of price advantage for active dual traders (about $8 or 2/3 of a tick), but not for less active dual traders.

Table 4 further shows that, in the S&P 500 1987, customers of dual traders on dual trading days receive worse prices compared to customers of pure brokers, and the magnitude of the price difference is similar to that between dual traders' personal and customer trades. This result also holds for the more and less active dual traders. In the other two contracts, all customers receive similar execution. Finally, there is no *robust* evidence that prices received by dual traders' customers on dual and broker trading days are different. For example, the evidence is present in the all-dual-trader sample for the S&P 500 1987, but not for more and less active dual traders.

Higher trade size, volatility and volume may increase the difficulty of executing customer trades relative to personal trades. Recall from Table 2 that, for dual trading days in the Yen, volume and trade size are lower while volatility is higher for own account trades relative to customer trades.

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500. For the Yen futures price, quoted in dollars per 100 yens, we multiply the price by 125,000 yens.

For dual trading days in the S&P 500 1987, volume and volatility are lower but trade size is higher. Thus, it is not apparent that differences in size, volume or volatility account for the observed price differences. Similar remarks apply for customer trades on dual and broker trading days.

To formally examine the effect of these factors on the price differences, we sort trading brackets into four groups based on the trade size, volume, and volatility of dual traders' customer trades and own account trades in each bracket. For the trade size factor, one group contains brackets with the largest trade size (the highest 25th percentile) of dual traders' personal and customer trades, the next group has brackets in the 50th to 75th percentile, and so on. Groups are formed in a similar way for the other factors. For each group of brackets, we repeat the tests carried out in Table 4. We proxy volatility by the standard deviation of the *buy* prices only, to account for the bid-ask bounce.

The results are in Table 5. A positive (negative) difference indicates that dual traders' customers on their dual trading days receive a worse (better) price relative to dual traders' own trades; or relative to brokers' customers. The results show that after controlling for size, volatility, and volume, dual traders continue to receive better prices for themselves than for their customers in both the Yen and the S&P 500 1987, but not in the S&P 500 1991. Dual traders in 1987 receive better prices for their personal trades in every group, and in most cases the difference is significant at a 0.01 percent level. The price differences are greater for the highest trade size, volatility, and volume groups for the S&P 500 1987, indicating that these trades may be more difficult to execute. However, even for the smallest size, volume or volatility group, the mean price advantage for dual traders is at least $12. In the Yen, the price differences are similar for the different groups. For the S&P 500 1991, the price difference is statistically insignificant for all groups except one.

Table 5 also shows that, after controlling for trade size, volatility, and volume, customers of dual traders in the S&P 500 1987 continue to receive worse prices on dual trading days relative to

customers of pure brokers. Although the price differences tend to be greater for the highest trade size and volatility groups, they are highly significant for every group. There is no significant difference in customer trade prices of dual traders and brokers for the other contracts.

To check for robustness, we sort trading brackets into three or five groups, instead of four. We also use different proxies for the volatility measure, such as the difference between the maximum and minimum prices in a trading interval. The results remain qualitatively similar. In summary, active dual traders in the S&P 500 1987 provide poor execution for their customers, relative to both pure brokers and their own trades, even after controlling for trade size, volatility, and volume. In the S&P 500 1991, execution quality is similar for customer trades of dual traders and pure brokers, and for customer and personal trades of dual traders. In the Yen, customers of dual traders receive prices similar to customers of pure brokers, but worse than dual traders' own trades.

Customer order characteristics for brokers and dual traders may be different and trade size, volatility, and volume may not fully control for this difference. However, as discussed in the conclusion, customers have limited control over who executes their orders and so it is unclear why the orders should be different. Another possibility is that brokerage firms seek out floor traders with a reputation for superior trading skills to execute "difficult" orders and these skilled traders may be more likely to dual trade. But our later results suggest that dual traders do not have better trading skills than locals do. Specifically, in the next section, we show that per contract trading profits of dual traders on *local* trading days are similar to that of locals (Table 6), and in section 5B, we show that dual traders and locals have similar market timing skills (Table 10).

3. Trading Profits of Dual Traders and Locals

Kuserk and Locke (1993), Silber (1984) and Smidt (1985) provide evidence that locals behave

as if they are market makers. So, if dual traders' price advantage is compensation for providing liquidity, then the realized bid-ask spread for dual traders and locals should be similar. If dual traders' profits are also related to the customer order flow, then profits on their dual trading days may be higher than on their local trading days.

Dual traders' per contract profits are approximately the difference between the average buy and sell prices on their personal trades, and thus a proxy for the realized bid-ask spread.[12] We calculate floor traders' aggregate profits on a daily basis by subtracting the value of purchases from the value of sales for each trader, with imbalances valued at the daily settlement prices of the CME (i.e., marked-to-market). Aggregate daily profits are divided by the number of round-trip transactions for each floor trader to obtain daily profits per contract. We find that the distribution of profits is highly skewed, and so we focus on the *median* profits per contract, and use the *z* statistic to test for differences in median profits.

Table 6 reports per contract trading profits (in dollars) of locals and of dual traders on their dual and local trading days. We find that, for the S&P 500 1987, dual traders' median on their dual days are higher than on their local days and also higher than locals' profits. The difference is about $8.50, or roughly 1/3 of the tick, in both cases and highly significant. The same results hold for more active dual traders, but not for less active dual traders. In contrast, for the S&P 500 1991, the median profits of dual traders on their dual days are similar to their local day profits and to locals' profits. For the Yen, active dual traders' median profits on their dual days are higher than on their local days and higher than locals' profits, but only by about $2.50, or roughly 1/5 of the tick, in both cases.

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[12]The calculation of per contract profits includes an assumption about how end-of-day inventories are valued and, hence, it is not *exactly* equal to the difference between the daily averages of buy and sell prices. However, the value of ending inventory is generally small. For example, in the S&P 500 1987, the median value of end-of-day inventory of locals and dual

Recalling Table 2, we note some difference in the trade size, volatility, and volume of own account trades on dual trading days and on local trading days. To examine the effect of these factors on profits, we compute trade size, volatility, and volume of dual traders' personal trades and locals' trades on a daily basis and combine *trader days* into four groups for each factor. For each group, Table 7 shows the *difference* in median profits of dual traders on their dual days with their local days and with locals' profits. A positive (negative) number indicates that dual day profits of dual traders are higher (lower) in both cases. In the S&P 500 1987, for every group, median profits are higher for dual traders compared to locals and higher on their dual days than on their local days. The profit differences are mostly on the order of $7 to $11, and generally significant at the 0.01 percent level. The differences are largest for the largest size, volatility, and volume groups but they remain substantial for the smaller groups. Profit differences are not significant for the S&P 500 1991. Finally, for the Yen, the profit difference is not significant for 9 of the 12 groups.

We conclude that, for the Yen, dual traders' price advantage over their customers can be explained as compensation for providing liquidity. After controlling for trade size, volume and volatility, dual traders' profits are statistically similar to locals' profits, and of comparable magnitude to their price advantage over customers. For the S&P 500 1987, however, active dual traders have higher profits than locals *and* have higher profits on their dual days than on their local days and so their price advantage is only partially explained as compensation for providing liquidity.

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traders is zero for every sample day; and the mean value of end-of-day inventory is less than one-half of one percent of daily profits. Similar remarks apply to the other contracts.

4. The Dependence of Dual Trader Profits on Customer Order Flow

The additional profits of dual traders on their dual trading days may reflect the value of observing the customer order flow. Active dual traders' customer volume is a large share of market volume (about 27 percent for the S&P 500 1987, for example). If their profits are correlated with market volume, then observing the customer order flow may help dual traders anticipate profitable trading opportunities better compared to locals, who have no direct knowledge of customer orders. This idea is explored in section *A*. In section *B*, we examine whether dual traders' personal and customer trades are correlated.

A. Does Customer Order Flow Predict Dual Trader Profits?

A dual trader does not have to announce at the beginning of the day whether or not he will be a dual trader. Rather, this is a business decision that he makes based on the customer order flow over the course of the day. We assume that a dual trader uses information from the first two hours of trading to predict profits per contract for the remaining five hours of the trading day. The assumption seems reasonable since the correlation in the first two hours' volume and later volume is quite high (about 0.32 for the S&P 500 1987, for example) and, further, around 75 percent of daily profits are generated in the final 5 hours of the trading day.

We assume that a dual trader's profit prediction is based on public information (number of market makers, market volatility and net market volume) and his private information (volatility and volume of customer trades). The number of market makers is a proxy for the degree of dealer market competition.[13] We include the dual trader's first two hours' profits to capture possible reversals or

[13] Our prediction model is broadly consistent with theory. In Sarkar (1995), for example, dual trading profits are increasing

continuations in intra-day profit patterns. For dual trader *i* on day *t*, we have:

$$\textit{Last 5 Hours' Profit per Contract}_{it} = a_0 + a_1\ \textit{First 2 Hours' Net Market Volume}_t$$
$$+ a_2\ \textit{First 2 Hours' Market Volatility}_t + a_3\ \textit{Number of Market Makers in First 2 Hours}_t$$
$$+ a_4\ \textit{First 2 Hours' Profit per Contract}_{it} + a_5\ \textit{First 2 Hour's Own Customer Trading Volume}_{it}$$
$$+ a_6\ \textit{First Two Hour's Own Customer Volatility}_{it} + e_{it} \qquad (1)$$

The net market volume is the market volume less the dual trader's customer volume. Market (customer) volatility is the standard deviation of market (customer) buy prices. When buy prices are missing, we use sell prices. The number of market makers is the number of floor traders trading for their personal accounts. For the first two hours' aggregate profits, inventory imbalances are valued at the average price of the last trading bracket in this two-hour period. For the last five hours' aggregate profits, the ending inventory value in the first two-hour period is carried over and marked-to-market at the CME settlement price. Any additional inventory imbalance during the final five-hour session is also marked-to-market in similar fashion. This procedure ensures that the sum of the first two and last five hours' aggregate profits equal the daily aggregate profits, as calculated earlier. Per contract profits equal aggregate profits divided by the number of round-trip trades, as before.

Model (1) is estimated separately for more active dual traders and locals. We omit less active dual traders due to insufficient observations. Locals do not have customers, so only variables in the public information set and lagged profits are used as explanatory variables. The estimation method is the Generalized Method of Moments (GMM) technique of Hansen (1982).

Panel A of Table 8 shows results for active dual traders and locals. Only the customer volume

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in the customer volume and volatility. The number of market makers determines profits if we consider inter-dealer trading (see Naik, Neuberger and Viswanathan, 1999).

is significant for dual traders' profits in the S&P 500 1987, whereas both market and customer volume are significant for dual traders in the Yen and the S&P 500 1991. This suggests that dual traders in the S&P 500 1987 are more dependent on *customer* order flow for profits, compared to the other contracts. Initial volume and subsequent profits are positively related in 1987, but negatively related in 1991. Volatility is significantly related to future profits for the Yen and the S&P 500 1991, but not for the S&P 500 1987. For all contracts, initial and later profits of dual traders are negatively correlated. For locals, the number of market makers is the only significant determinant of daily profits and, that too, only for the S&P 500 1987. The regressions explain little of the variation in daily profits for either dual traders or locals, as shown by the low adjusted R-square for all contracts.

How successful is dual traders' profit prediction model ex-post, relative to locals? For each dual trader and local, we divide trading days into *high expected* and *low expected* profit days, where expected profit is the fitted value of the per contract profit using regression (1). High (low) expected profit days are those for which expected profits of locals and dual traders are in the highest (lowest) 50th percentile of expected daily profits. In Panel B of Table 8, we report *actual* median profits for the final 5 hours of trading on high and low expected profit days. The results show that, although actual median profits are generally greater on high-expected profit days, the *difference* in median profits between dual traders and locals is similar on high and low expected profit days. For example, the profit difference between dual traders and locals in the S&P 500 1987 is about $14 on high expected profit days and $14.50 on low expected profit days, and both differences are significant. Thus, the higher profits of dual traders, relative to locals, cannot be explained by a superior ability to predict profitable trading opportunities.

As robustness checks, we estimate a different model, where today's profit prediction is based

on the last two hours' trading of the previous day. We also use total instead of per contract profits. Both variations lead to qualitatively similar results. Further, the correlation between initial volume and subsequent profits is *not* due to a correlation between initial volume and subsequent volatility since the latter correlation is low (less than 9 percent for the S&P 500 1987, for example). Hence, knowledge of customer order flow, in and of itself, appears to be valuable for dual traders' profits. In the next section, we explore how dual traders may profit from knowledge of customer order flow.

B. Are Personal and Customer Trades of Dual Traders Correlated?

As argued in the introduction, personal and customer trades of a dual trader may be correlated if the dual trader mimics, frontruns or misallocates his customers' trades. We estimate *for each dual trader* the correlation between purchase/sales by the dual trader for his own account and for his customers using a Probit regression. Relative to the probability of selling, the probability of a dual trader *i* buying for own account in trading bracket *t* is:

$$\begin{aligned} \textit{Probability(Dual buy for own account)}_{it} = {} & a_0 + a_1\, BS_{it} + a_2\, SV_{it} + a_3\, Dummy1^{*}\, BS_{it} \\ & + a_4\, Dummy2^{*}\, BS_{it} + a_5\, Dummy1^{*}Dummy2^{*}\, BS_{it} + \textit{Lagged variables}_{it} + e_{it} \end{aligned} \qquad (2)$$

Define the signed volume in a bracket as the buy minus the sell volume. The buy/sell indicator for a bracket is zero (two) when the signed volume is negative (positive), and one if the signed volume is zero. *BS* is the buy/sell indicator for dual customers and *SV* is the signed dual customer volume in units of 100 contracts. *Dummy1* is one for large dual customer trades (i.e., those in the top 10 percentile of trade sizes) and 0 otherwise. *Dummy2* is one for the final trading hour and 0 otherwise. The *lagged variables* control for common factors that may explain the buy/sell decisions of dual traders and customers. They are lags of changes in the market price (per $10,000 of contract value), changes in *BS* and changes in the signed volume of dual and *aggregate* customer trades.

An increase in *BS* from zero to two indicates that dual customers switch from selling to buying. If this increases the probability of a dual trader buying for own account then the estimate of a_1 is positive, indicating a correlation in the *direction* of customer and personal trades of dual traders. The estimate of a_2 is positive if the *volume* of a customer buy increases the probability of a dual trader buying for his own account. If large customer trades are more likely to be correlated with dual traders' personal trades, then the estimate of a_3 is positive. If dual traders are reluctant to carry overnight positions, then there may not be a correlation in the final trading hour, and the estimate of a_4 will not be positive. If there is no correlation for large customer trades in the last trading hour, then the estimate of a_5 will also not be positive.

Results from estimating (2) for active dual traders are given in Table 9 in the column labeled *Model 1*. Results for less active dual traders are omitted since there are few observations. Estimates of most lagged variables are not significant and so, for brevity, we only present results for the significant ones (lagged price change and the lagged *BS*). The Pearson chi-square indicates that the model is not rejected for any of the contracts. For more active dual traders in the S&P 500 1987, there is strong evidence of correlation in the direction of dual traders' personal with customer trades, and with large customer trades in particular. A customer buy increases the probability of a dual trader buy for personal account by four percent, and the probability increases a further 10 percent if the customer buy order is large. Both estimates are significant at a less than one-percent level. There is also evidence that a higher customer buy volume increases the probability of a dual buy. In the final trading hour, a large customer buy has no effect on the probability of a dual buy and a smaller customer buy reduces the probability. A past increase in the market price reduces the probability of a dual buy currently, and a past dual customer buy increases it, but these effects are not significant.

In the Yen, there is evidence of correlation for small customer trades in the very last trading

hour but not for large customer trades. In the S&P 500 1991, there is weak evidence (*p* value exceeding 9 percent) of correlation in the direction of trades, and stronger evidence that customer volume is correlated with dual traders' buy/sell decision.

We repeat the analysis after replacing the dependent variable in (2) with the buy/sell indicator for a dual trader's personal trades. We use an accelerated failure time model, assuming a logistic distribution for the failure time.[14] This method allows efficient estimates when the dependent variable is discrete. The results, reported in Table 9 under the column-heading *Model 2*, support the earlier evidence of correlation in the direction of personal and customer trades, and large customer trades in particular, for more active dual traders in the S&P 500 1987. There is no evidence of correlation in the trade direction for any other contract. For the Yen, there is continuing evidence of correlation for small customer trades in the last hour. For the S&P 500 1991, there is only weak evidence that higher customer buy volume increases the probability of a dual buy.

Since *BS* is correlated with *SV*, we re-estimated the models without *SV***.** We also re-estimated *Model 2* after deleting values of zero for the buy-sell indicator (i.e., brackets with equal buy and sell volumes). In all cases, we obtained qualitatively similar results.

5. Are Customers and Dual Traders Successful Market Timers?

A. Market Timing by Customers

The correlation in dual traders' personal and customer trades could reflect mimicking or frontrunning of informed customers. Customers with information may systematically buy (sell) before

[14] Estimates from the logistic distribution are robust since they have bounded influence functions. An influence function measures the difference in standard deviation units between estimates with and without a observation.

a price rise (fall). We use the Henriksson and Merton (1981) [HM] nonparametric test to evaluate customers' success in market timing. The HM analysis is based on the idea that a perfect market timer effectively holds a put option on the underlying asset. When the market is up, the perfect timer is fully invested in the risky asset and, when the market is down, the perfect timer is holding the riskless asset. Pesaran and Timmermann (1994) show that the HM nonparametric test is equivalent to Fisher's exact test of a two-by-two matrix.

To implement the test, we construct a unique price measure and a buy/sell indicator for each bracket. The price for a bracket is the (unsigned) volume-weighted price of all transactions in that bracket. The buy-sell indicator is based on the signed volume for the dual traders' own accounts. We omit outcomes where the prices do not change between brackets or the signed volume is zero in a bracket. Table 1 illustrates the two-by-two matrix. The row outcomes are whether the price measure decreases or increases from the current bracket to the next. The column outcomes are whether the signed volume in the *current* bracket is positive or negative.

	Sell now	**Buy now**
Price falls	Sell prior to price fall	Buy prior to price fall
Price rises	Sell prior to price rise	Buy prior to price rise

Table 1: Two-by-two Matrix for Market Timing Test

The null hypothesis is no association between the row and column variables. For two-by-two tables, Fisher's Exact test estimates the probability of observing a table with at least as much evidence of association as the one actually observed, given the null hypothesis is true. The hyper geometric

probability, q, of every possible table is computed, and the p-value is defined as PROB = Σ_A q. For right-tailed tests, A is the set of tables where the frequency in the (1,1) cell is greater than or equal to that of the observed table. In Table 1, the (1,1) cell represents the event that the floor trader sells and the price falls subsequently. We count a trader as successful if the right-tailed test shows a p-value less than 10 percent.

Panel A of Table 10 reports results for all customers, large dual customers (defined as dual customer trades in the top 10 percentile of trade sizes) and small dual customers. The p value corresponding to Fishers' exact test shows no evidence of market timing ability for any type of customers, other than small dual customers in the S&P 500 1991. The conditional probabilities of buying before a price rise or selling before a price decline are around 50 percent. Thus, the evidence is consistent with dual customers in the S&P 500 1987 or the Yen being uninformed.

B. Market Timing by Dual Traders and Locals

Dual traders may have higher profits compared to locals because they are more successful in timing the market. Manaster and Mann (1996) argue that futures market makers have informational advantages that enable them to adjust inventory in anticipation of favorable price movements. If the ability to time markets is related to the customer order flow, then dual traders may be more successful in market timing on dual rather than local trading days. We use Fisher's Exact test to estimate a floor trader's market timing ability. Panel B of Table 10 reports the percent of locals, and dual traders on their dual and local trading days, that are successful market timers, with the number of floor traders evaluated in parenthesis. We do not perform tests for local days of more active dual traders due to insufficient observations. We find that the percent of successful market timers range from 15 to 20 percent for all contracts and floor trader types. The results show that locals are at least as successful

in timing the market as are dual traders.

To check the robustness of our results, we use two other tests to determine market timing ability. The Pearson chi-square statistic involves the difference between the observed and expected cell frequencies in Table 1 (Feinberg, 1977). Finally, we define a *t* test based on a normal approximation, derived by HM, to the hyper geometric distribution. The approximation is valid for large samples or when the frequencies of price increases and decreases are not too different. We do not find evidence of superior market timing ability by customers or dual traders under these two additional tests.

6. Conclusion

We find that relatively active dual traders in the S&P 500 futures markets, who specialize in dual trading, provide inferior execution of customer trades relative to pure brokers and relative to their personal trades. These results hold even after we control for differences in trade size, volume and volatility. While part of dual traders' price advantage is explained as compensation for providing liquidity when trading for their personal accounts, the remaining part appears to reflect the value of dual traders' customer order flow. In particular, personal and customer trades (especially large customer trades) of dual traders are correlated, consistent with dual traders mimicking or frontrunning informed customers. However, we do not find evidence that dual traders' customers have market timing skills, suggesting that customers may not be informed. Our tests do not rule out frontrunning of large uninformed trades or misallocation as a possible source of dual trader profits. After a restriction on dual traders' personal trading, dual customers receive similar execution to other customers, and there is no correlation between the personal and customer trades of dual traders.

Can futures customers prevent poor execution by dual traders? One possibility is that customers specify their orders *not* go to a dual trader. Customers' choice is limited, however, since independent floor traders who are free to dual trade execute most customer orders. Large customers can request order execution by the brokerage firm's trading desk instead of independent traders, but the desk's trading capacity may be insufficient during active markets. Alternatively, dual traders may compensate informed customers for poor execution by offering lower commission fees (Fishman and Longstaff, 1992), by paying for information (Naik, Neuberger and Viswanathan, 1999), or by providing facilitation services (Aitken, Garvey and Swan, 1994).

Another way customers may receive better quality execution and mitigate potential trading abuses is by executing trades via electronic systems, which provide superior audit trails and enable easier detection of abuses such as frontrunning. For exchange-traded futures, most trading outside of the U.S. is already done electronically and, even in the U.S., the share of electronic systems in futures trading volume is growing rapidly (Sarkar and Tozzi, 1998). Our study suggests that the potential benefits of electronic systems in U.S. futures markets could be substantial.

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Table 1
Activity of Floor Traders in the S&P 500 and Japanese Yen Futures Pits

"Locals (brokers)" refers to floor traders who trade exclusively for their own (customer) account during the sample period. "Dual traders" refer to floor traders who trade both for their own account and for customers on at least one day during the sample period. The sample period is 35 days from May 1 to June 19, 1987 for the Japanese Yen futures and the S&P 500 futures and 64 days from April 1 to June 28, 1991 for the S&P 500 futures.

	Japanese Yen 1987				S&P 500 1987				S&P 500 1991			
	Locals	Brokers	Dual traders	All floor traders	Locals	Brokers	Dual Traders	All floor traders	Locals	Brokers	Dual Traders	All floor traders
Number of traders	157	130	64	351	505	213	239	957	396	146	109	651
Number of trading days	1,480	707	1,609	3,796	9,586	1,029	6,650	17,265	14,028	1,368	6,525	21,921
For own account only	1,480	---	378	1,858	9,586	---	1,939	11,525	14,028	---	3,072	17,100
For customer only	---	707	539	1,246	---	1,029	895	1,924	---	1,368	2,925	4,293
For both	---	---	692	692	---	---	3,816	3,816	---	---	528	528
Number of active days per trader	9.43	5.44	25.14	10.81	18.98	4.83	27.82	18.04	35.42	9.37	59.86	33.67
For own account only	9.43	---	5.91	5.29	18.98	---	8.11	12.04	35.42	---	28.18	26.27
For customer only	---	5.44	8.42	3.55	---	4.83	3.75	2.01	---	9.37	26.84	6.59
For both	---	---	10.81	1.97	---	---	15.96	3.99	---	---	4.84	0.81
Number of active traders per day	43	21	47	108.46	274	30	192	493.29	219.19	21.38	101.95	342.52
For own account only	43	---	11	53.09	274	---	56	329.29	219.19	---	48.00	267.19
For customer only	---	21	16	35.60	---	30	26	54.97	---	21.38	45.70	67.08
For both	---	---	20	19.77	---	---	110	109.03	---	---	8.25	8.25

Table 2
Dual and Nondual Trading Days in the S&P 500 and Japanese Yen Futures Pits

"Broker (local) trading days" refers to days on which floor traders trade exclusively for their own (customer's) account. "Dual trading days" refers to days when floor traders trade both for their own accounts and for customers. Volatility is the standard deviation of buy prices, in dollars. The sample period is 35 days from May 1 to June 19, 1987 for the Japanese Yen futures and the S&P 500 futures and 64 days from April 1 to June 28, 1991 for the S&P 500 futures.

	Japanese Yen 1987				S&P 500 1987				S&P 500 1991			
	Broker trading days	Local trading days	Dual trading days	All trading days	Broker trading days	Local trading days	Dual trading days	All trading days	Broker trading days	Local trading days	Dual trading days	All trading days
Number of trader days	1,246	1,858	692	3,796	1,924	11,525	3,816	17,265	4,293	17,100	528	21,921
Number of trades	26,004	73,356	74,411	173,771	103,599	644,093	549,077	1,296,769	612,074	929,764	74,888	1,616,726
Trades per trader day	20.87	39.48	107.53	45.78	53.85	55.89	143.89	75.12	142.57	54.37	141.83	73.75
For own account	---	39.48	38.88	26.41	---	55.89	39.81	46.11	---	54.37	13.51	42.74
For customer	20.87	---	68.65	19.37	53.85	---	104.08	29.01	142.57	---	128.32	31.01
Total volume	168,870	389,542	384,738	943,150	494,520	1,845,925	1,929,113	4,269,558	2,118,345	2,382,556	264,342	4,765,243
Volume per trader day	135.53	209.66	551.98	248.46	257.03	160.17	505.53	247.30	493.44	139.33	500.65	217.38
For own account	---	209.66	176.91	134.87	---	160.17	156.69	141.55	---	139.33	46.66	109.81
For customer	135.53	---	379.07	113.59	257.03	---	348.84	105.75	493.44	---	453.99	107.57
Average trade size	6.5	5.31	5.17	5.43	4.77	2.87	3.51	3.29	3.46	2.56	3.53	2.95
For own account	---	5.31	4.55	5.11	---	2.87	3.94	3.07	---	2.56	3.41	2.57
For customer	6.5	---	5.52	5.87	4.77	---	3.35	3.65	3.46	---	3.57	3.47
Volatility of prices	154.25	131.67	141.66	140.87	533.89	571.86	528.41	568.48	566.43	556.42	556.81	561.53
For own account	---	131.67	142.57	137.00	---	571.86	509.85	567.46	---	556.42	529.71	556.35
For customer	154.25	---	136.65	143.49	533.89	---	534.39	534.57	566.43	---	554.20	565.84

Table 3
Dual Traders of Different Activity Levels in the S&P 500 and Japanese Yen Futures Pits

Less (more) active dual traders are those dual trading at most (more than) 7 days in the Yen futures, 18 days in the 1987 S&P 500 futures, and 3 days in the 1991 S&P 500 futures. "Broker (local) trading days" refers to days on which floor traders trade exclusively for their own (customer's) account. "Dual trading days" refers to days when floor traders trade both for their own accounts and for customers. The sample period is 35 days from May 1 to June 19, 1987 for the Japanese Yen futures and the S&P 500 futures and 64 days from April 1 to June 28, 1991 for the S&P 500 futures.

	Japanese Yen 1987			S&P 500 1987			S&P 500 1991		
	Local trading days	Broker trading days	Dual trading days	Local trading days	Broker trading days	Dual trading days	Local trading days	Broker trading days	Dual trading days
More active dual traders									
Number of traders	27	27	32	95	102	120	47	43	47
Number of trader days	172	233	623	342	424	3,264	1136	1751	429
Volume per trader day	101.59	437.74	601.54	107.11	358.33	529.78	50.87	569.49	530.95
For own account	101.59	---	186.54	107.11	---	149.49	50.87	---	42.94
For customers	---	437.74	415.00	---	358.33	380.29	---	569.49	488.01
Trades per trader day	28.20	76.88	116.50	33.91	973.26	153.95	22.78	174.20	149.68
For own account	28.20	---	41.19	33.91	---	39.47	22.78	---	12.69
For customers	---	76.88	75.31	---	973.26	114.48	---	174.20	136.99
Less active dual traders									
Number of traders	25	29	32	115	83	119	60	37	62
Number of trader days	206	306	69	1843	753	552	1936	1174	99
Volume per trader day	229.56	45.72	144.70	133.53	23.61	362.15	102.01	527.07	369.34
For own account	229.56	---	90.00	133.53	---	199.28	102.01	---	62.75
For customers	---	45.72	54.70	---	23.61	162.88	---	527.07	306.59
Trades per trader day	50.02	8.51	26.61	46.99	49.08	84.40	44.51	173.00	107.87
For own account	50.02	---	18.06	46.99	---	41.79	44.51	---	17.10
For customers	---	8.51	8.55	---	49.08	42.61	---	173.00	90.77

Table 4
Difference in Prices of Customer Trades by Dual Traders and Brokers
For Dual Traders of Different Activity Levels

For each dual trader group, we report (in dollars) the price difference in a bracket between trades for dual traders' customers on dual trading days and (1) trades for dual traders' own accounts; (2) trades for dual traders' customers on broker days; and (3) trades for customers of brokers. A *positive* (*negative*) difference indicates that dual traders' customers on dual trading days receive a *worse* (*better*) price relative to each of the other types of trades. Less (more) active dual traders are those dual trading at most (more than) 7 days in the Yen futures, 18 days in the 1987 S&P 500 futures, and 3 days in the 1991 S&P 500 futures. *P* values correspond to a paired *t* test for whether the mean price difference is significantly different from zero. Estimates significant at the five- percent level or less are in bold. The sample period is 35 days from May 1 to June 19, 1987 for the Japanese Yen futures and the S&P 500 futures and 64 days from April 1 to June 28, 1991 for the S&P 500 futures.

	Japanese Yen 1987 Trades for dual traders' customers on dual trading days and			S&P 500 1987 Trades for dual traders' customers on dual trading days and			S&P 500 1991 Trades for dual traders' customers on dual trading days and		
	trades for dual traders' own accounts	trades for dual traders' customers on broker days	trades for customers of brokers	trades for dual traders' own accounts	trades for dual traders' customers on broker days	trades for customers of brokers	trades for dual traders' own accounts	trades for dual traders' customers on broker days	trades for customers of brokers
All dual traders									
Mean	**7.83**	1.98	2.01	**20.85**	**9.21**	**21.60**	**5.24**	1.88	-0.49
Median	**8.11**	1.90	1.13	**21.15**	**5.20**	**21.63**	**5.84**	2.16	-0.16
P value	**0.0001**	0.0884	0.3193	**0.0001**	**0.0034**	**0.0001**	**0.0278**	0.1981	0.7639
Number of brackets	**896**	843	603	**958**	**879**	**878**	**1848**	3153	3033
More active dual traders									
Mean	**7.70**	**2.63**	2.24	**21.66**	5.55	**21.54**	5.09	1.07	0.78
Median	**7.75**	**1.28**	1.29	**21.66**	5.15	**21.80**	5.55	0.28	0.08
P value	**0.0001**	**0.0236**	0.2643	**0.0001**	0.1004	**0.0001**	0.0561	0.4711	0.6385
Number of brackets	**898**	**816**	600	**959**	824	**879**	1552	3149	2992
Less active dual traders									
Mean	6.92	-2.17	-6.39	**12.78**	6.27	**8.77**	3.76	-2.00	**-6.53**
Median	8.92	-1.28	-1.64	**10.90**	5.77	**8.16**	8.26	-2.83	**-6.71**
P value	0.1372	0.7050	0.1744	**0.0004**	0.0937	**0.0142**	0.5760	0.4857	**0.0276**
Number of brackets	93	85	114	**816**	794	**821**	244	1124	**1089**

Table 5
Difference in Prices of Customer Trades by Dual Traders and Brokers For Trading Brackets Sorted by Trade Size, Volume, and Volatility

We sort trading brackets into four groups by trade size, volume, and volatility. For each group, we report (in dollars) the mean price difference in a bracket between (1) dual traders' own and customer trades on dual trading days; and (2) trades for brokers' customers and dual traders' customers on dual trading days. A *positive* (*negative*) difference indicates that dual traders' customers on dual trading days receive a *worse* (*better*) price relative to each of the other types of trades. Volume is the number of contracts traded, and volatility is the standard deviation of buy prices. *P* values correspond to a paired *t* test for whether the mean price difference is significantly different from zero. Estimates significant at the five- percent level or less are in bold. The sample period is 35 days from May 1 to June 19, 1987 for the Japanese Yen futures and the S&P 500 futures and 64 days from April 1 to June 28, 1991 for the S&P 500 futures.

	Japanese Yen 1987		S&P 500 1987		S&P 500 1991	
	Dual traders' own and customer trades	Customer trades of brokers and dual traders	Dual traders' own and customer trades	Customer trades of brokers and dual traders	Dual traders' own and customer trades	Customer trades of brokers and dual traders
Smallest trade size group	**8.95**	1.59	**16.04**	**12.59**	**11.49**	0.26
P value	**0.0001**	0.6662	**0.0001**	**0.0174**	**0.0143**	0.9307
No. of brackets	**224**	161	240	220	**440**	778
Trade size group 2	**8.91**	-1.21	**21.60**	**21.59**	-5.94	-3.40
P value	**0.0001**	0.7723	**0.0001**	**0.0001**	0.2286	0.3042
No. of brackets	**224**	136	239	219	405	737
Trade size group 3	**7.21**	-0.94	**19.31**	**29.82**	5.43	3.26
P value	**0.0001**	0.8071	**0.0001**	**0.0001**	0.2347	0.3272
No. of brackets	**224**	152	240	220	493	761
Highest trade size group	**6.24**	8.21	**26.49**	**22.41**	8.54	-2.21
P value	**0.0019**	0.0663	**0.0001**	**0.0004**	0.0766	0.5386
No. of brackets	**224**	154	239	219	510	757
Smallest volume group	**6.43**	2.32	**11.66**	**22.41**	2.02	-0.35
P value	**0.0001**	0.5008	**0.0006**	**0.0001**	0.6730	0.9114
No. of brackets	**227**	178	240	220	383	753
Volume group 2	**8.21**	4.12	**21.14**	**15.83**	6.40	-3.24
P value	**0.0001**	0.3378	**0.0001**	**0.0107**	0.1996	0.3015
No. of brackets	**223**	148	239	219	411	761
Volume group 3	**6.20**	-0.73	**16.70**	**18.70**	3.89	-0.85
P value	**0.0004**	0.8747	**0.0004**	**0.0004**	0.4142	0.8007
No. of brackets	**223**	127	240	220	490	751
Highest volume group	**10.50**	1.89	**33.97**	**29.47**	7.74	2.43
P value	**0.0001**	0.6394	**0.0001**	**0.0001**	0.0839	0.4834
No. of brackets	**223**	150	239	219	564	768

Continuation of Table 5

Smallest volatility group	**8.44**	0.55	**15.91**	**13.96**	5.43	-0.96
P value	**0.0001**	0.8366	**0.0001**	**0.0007**	0.1899	0.7113
No. of brackets	**224**	197	**240**	220	392	760
Volatility group 2	**6.49**	-4.42	**20.29**	**19.33**	4.87	0.90
P value	**0.0001**	0.2267	**0.0001**	**0.0003**	0.2336	0.6419
No. of brackets	**224**	128	239	219	466	752
Volatility group 3	**9.56**	-1.28	**20.95**	**24.68**	8.56	-3.21
P value	**0.0001**	0.7641	**0.0001**	**0.0001**	0.0664	0.1519
No. of brackets	**224**	128	240	220	498	761
Highest volatility	**6.81**	**12.23**	**26.28**	**28.45**	2.07	2.44
P value	**0.0092**	**0.0271**	**0.0001**	**0.0001**	0.7144	0.5487
No. of brackets	**224**	**150**	239	219	492	760

Table 6
Personal Trading Profits Per Contract of Dual Traders and Locals For Dual Traders of Different Activity Levels

For each dual trader group, we report the profits per contract (in dollars) of dual traders on their dual and local trading days, and of locals. Less (more) active dual traders are those dual trading at most (more than) 7 days in the Yen futures, 18 days in the 1987 S&P 500 futures, and 3 days in the 1991 S&P 500 futures. The *z*-statistic tests whether the median personal trading profits are the same for locals and dual traders on their dual trading days, and for dual traders on their dual and local trading days. *P* values are in parenthesis. Estimates significant at the five-percent level or below are in bold. The sample period is 35 days from May 1 to June 19, 1987 for the Japanese Yen futures and the S&P 500 futures and 64 days from April 1 to June 28, 1991 for the S&P 500 futures.

	Japanese Yen 1987			S&P 500 1987			S&P500 1991	
	Trader days	Mean	Median	Trader days	Mean	Median	Trader days	Mean	Median
Locals	1480	-1.80	6.19	9586	17.68	16.43	17628	6.03	15.91
All dual traders									
Dual trading days (**1**)	692	8.31	8.72	3816	24.94	25	528	24.78	15.00
Local trading days (**2**)	378	0.07	5.58	1939	33.09	16.45	3072	-1.59	14.74
Median profit difference									
Test for **(1)** and (**2**)		***Z*=2.95**	***p*=0.0033**		***Z*=7.44**	***p*=0.0001**		*Z*=-0.35	*p*=0.7238
Test for **(1)** and locals		***Z*=2.67**	***p*=0.0076**		***Z*=10.60**	***p*=0.0001**		*Z*=-0.13	*p*=0.9000
More active dual traders									
Dual trading days (**3**)	623	9.31	8.75	1415	27.14	26.29	429	19.00	16.87
Local trading days (**4**)	172	17.72	6.16	233	60.84	17.33	1136	-16.53	12.67
Median profit difference									
Test for (**3**) and (**4**)		***Z*=2.05**	***p*=0.0406**		***Z*=3.05**	***p*=0.0023**		*Z*=0.70	*p*=0.4866
Test for (**3**) and locals		***Z*=2.83**	***p*=0.0046**		***Z*=11.07**	***p*=0.0001**		*Z*=0.15	*p*=0.8820
Less active dual traders									
Dual trading days (**5**)	69	-0.69	6.25	552	11.94	19.83	99	49.83	8.70
Local trading days (**6**)	219	-14.66	5.10	1706	29.31	16.22	1936	7.17	15.00
Median profit difference									
Test for (**5**) and (**6**)		*Z*=-0.73	*p*=0.4660		*Z*=1.37	*p*=0.1704		*Z*=-0.92	*p*=0.3565
Test for (**5**) and locals		*Z*=-0.13	*p*=0.8977		*Z*=1.40	*p*=0.1613		*Z*=-1.31	*p*=0.1901

Table 7
Personal Trading Profits Per Contract of Dual Traders and Locals For Days Sorted by Trade Size, Volume, and Volatility

We sort trading days into four groups by the trade size, volume, and the volatility of the personal trades of locals and dual traders. For each group, we report (in dollars) the difference in median profits per contract of dual traders on their dual trading days and (1) locals, in the column labeled *Dual traders and locals*; and (2) on their own local trading days, in the column labeled *Dual and local trading days*. A *positive* (*negative*) number indicates *higher* (*lower*) profits for dual traders on their dual trading days. Volume is the daily number of contracts traded. Volatility is the daily standard deviation of buy prices. *P* values correspond to a Z test for whether the median differences in profits are significantly different from zero. Estimates significant at the five percent or below are in bold. The sample period is 35 days from May 1 to June 19, 1987 for the Japanese Yen futures and the S&P 500 futures and 64 days from April 1 to June 28, 1991 for the S&P 500 futures.

	Japanese Yen 1987		S&P 500 1987		S&P 500 1991	
	Dual traders and locals	Dual and local trading days	Dual traders and locals	Dual and local trading days	Dual traders and locals	Dual and local trading days
Smallest trade size group						
Difference in profits	2.33	1.20	**10.97**	**10.76**	**-14.78**	-8.30
P value	0.1441	0.6007	**0.0001**	**0.0001**	**0.0086**	0.7855
Z statistic	1.46	0.52	**7.24**	**4.54**	**-2.63**	-0.27
Trade size group 2						
Difference in profits	**4.50**	**6.21**	**3.97**	**5.76**	6.06	-10.74
P value	**0.0401**	**0.0034**	**0.0019**	**0.0006**	0.6888	0.2687
Z statistic	**2.05**	**2.93**	**3.11**	**3.42**	0.40	-1.11
Trade size group 3						
Difference in profits	0.30	2.68	**9.85**	**5.78**	-19.19	6.17
P value	0.6353	0.1481	**0.0001**	**0.0129**	0.0507	0.5065
Z statistic	0.47	1.45	**4.90**	**2.49**	-1.96	0.66
Highest trade size group						
Difference in profits	3.24	4.09	**14.78**	**19.03**	8.65	-12.50
P value	0.2128	0.3020	**0.0001**	**0.0001**	0.1361	0.1245
Z statistic	1.25	1.03	**6.84**	**5.89**	1.49	-1.54
Smallest volume group						
Difference in profits	1.59	1.65	**5.43**	**8.33**	-8.05	-7.65
P value	0.4728	0.5367	**0.0001**	**0.0001**	0.2210	0.2793
Z statistic	0.72	0.62	**4.44**	**4.14**	-1.22	-1.08
Volume group 2						
Difference in profits	2.68	4.32	**9.95**	**6.15**	-15.20	9.43
P value	0.3626	0.1255	**0.0001**	**0.0019**	0.1183	0.5737
Z statistic	0.91	1.53	**5.15**	**3.11**	-1.56	0.56
Volume group 3						
Difference in profits	3.23	**3.98**	**9.85**	**9.58**	-16.30	-9.86
P value	0.0763	**0.0385**	**0.0001**	**0.0004**	0.4348	0.6859
Z statistic	1.78	**2.07**	**6.44**	**3.51**	-0.78	-0.45
Highest volume group						
Difference in profits	1.78	5.68	**14.78**	**16.49**	8.01	-7.33
P value	0.4024	0.2122	**0.0001**	**0.0001**	0.3329	0.3294
Z statistic	0.84	1.25	**5.93**	**5.36**	0.97	-0.98

Continuation of Table 7

Smallest volatility group						
Difference in profits	2.00	1.12	**7.69**	**6.73**	-0.51	-0.36
P value	0.4399	0.4424	**0.0001**	**0.0001**	0.8973	0.8870
Z statistic	0.77	0.77	**5.94**	**3.80**	-0.13	-0.14
Volatility group 2						
Difference in profits	**3.33**	**6.04**	**6.87**	**6.30**	-15.00	-13.70
P value	**0.0233**	**0.0130**	**0.0001**	**0.0021**	0.0750	0.0799
Z statistic	**2.27**	**2.48**	**4.53**	**3.08**	-1.78	-1.75
Volatility group 3						
Difference in profits	-0.71	2.80	**10.05**	**7.01**	-8.90	0.00
P value	0.8561	0.2237	**0.0001**	**0.0003**	0.3065	0.8944
Z statistic	-0.18	1.22	**5.25**	**3.62**	-1.02	0.13
Highest volatility group						
Difference in profits	**5.09**	5.01	**15.34**	**19.38**	4.36	-6.62
P value	**0.0174**	0.1211	**0.0001**	**0.0001**	0.6985	0.6030
Z statistic	**2.38**	1.55	**5.71**	**6.37**	0.39	-0.52

Table 8
Customer Order Flow and Dual Trader Profits

In Panel A, we estimate the following regression for active dual trader *i* on day *t*:

$$\textit{Last 5 Hours' Profit per contract}_{it} = a_0 + a_1\ \textit{First 2 Hours' Net Market Volume}_{it} + a_2\ \textit{First 2 Hour's Market Volatility}_{it} + a_3\ \textit{Number of market makers in first 2 trading hours} + a_4\ \textit{First 2 Hours' Profit per Contract}_{it} + a_5\ \textit{First 2 Hour's Own Customer Volume}_{it} + a_6\ \textit{First 2 Hour's Own Customer Volatility}_{it} + e_{it}$$

Locals predict profits based on market information and lagged profits only. The estimation method is the Generalized Method of Moments (GMM). *P* values are in parenthesis. In panel B, we report actual median profits (for the last 5 hours of trading) on days with high and low *expected* profits (the fitted value from 1). High (low) expected profit days are those with expected profits in the highest (lowest) 50th percentile of expected profits. Active dual traders are those dual trading more than 7 days in the Yen futures, 18 days in the 1987 S&P 500 futures and 3 days in the 1991 S&P 500 futures. Estimates significant at the five-percent level or below are in bold. The sample period is 35 days from May 1 to June 19, 1987 for the Japanese Yen futures and the S&P 500 futures and 64 days from April 1 to June 28, 1991 for the S&P 500 futures.

	Japanese Yen 1987		S&P 500 1987		S&P 500 1991	
Panel A: Profit Prediction of Dual Traders and Locals						
	Dual traders	Locals	Dual traders	Locals	Dual traders	Locals
Intercept	**49.40**	-1.43	**-25.45**	**125.28**	**626.23**	-0.06
	(0.0376)	(0.9711)	**(0.0001)**	**(0.0001)**	**(0.0001)**	(0.9993)
Net market volume in first two trading hours	**0.004**	-0.01	-0.00	**0.01**	**-0.05**	0.01
	(0.0228)	(0.1302)	(0.8145)	**(0.0481)**	**(0.0033)**	(0.1605)
Market volatility in first two trading hours	**-1.00**	0.22	0.01	0.00	**2.15**	-0.10
	(0.0001)	(0.2986)	(0.1985)	(0.7354)	**(0.0001)**	(0.5660)
Number of market makers in first two trading hours	0.31	0.63	0.94	**-0.79**	**-5.51**	-0.23
	(0.6152)	(0.6397)	(0.1138)	**(0.0107)**	**(0.0001)**	(0.7019)
Profits per contract in first two trading hours	**-0.29**	0.08	**-0.35**	-0.00	**-0.05**	0.05
	(0.0001)	(0.2015)	**(0.0016)**	(0.9483)	**(0.0001)**	(0.1000)
Dual customer volume in first two trading hours	**0.11**	---	**0.75**	--	**-0.39**	---
	(0.0001)		**(0.0001)**		**(0.0001)**	
Dual customer volatility in first two trading hours	**-0.51**	---	0.02	---	0.12	---
	(0.0001)		(0.8124)		(0.2687)	
Adjusted R-square	5.41	-0.06	0.58	0.01	-0.16	0.00
Number of trader days	398	1,480	2,715	9,586	232	14,028
Panel B: Actual and Expected Profits of Dual Traders and Locals						
	High expected profit days	Low expected profit days	High expected profit days	Low expected profit days	High expected profit days	Low expected profit days
Active dual traders	6.87	6.25	25.00	21.93	0.00	0.00
Locals	8.20	3.42	11.03	7.43	11.00	12.50
Difference in median profits	-1.33	**2.83**	**13.97**	**14.50**	-11.00	**-12.50**
(P value)	(0.6250)	**(0.0029)**	**(0.0001)**	**(0.0001)**	(0.3725)	**(0.0001)**

Table 9
Are Dual Traders' Personal and Customer Trades Correlated?

Model 1 estimates *for each active dual trader* the following Probit regression. Relative to the probability of selling, the probability of a dual trader *i* buying for own account in trading bracket *t* is:

$$Probability(Dual\ buy\ for\ own\ account)_{it} = a_0 + a_1 BS_{it} + a_2\ SV_{it} + a_3 Dummy1^* BS_{it} + + a_4 Dummy2^* BS_{it} + a_5 Dummy1^* Dummy2^* BS_{it} + Lagged\ variables_{it} + e_{it}$$

The buy/sell indicator for a bracket is equal to zero (two) if the signed volume (the buy volume minus the sell volume) is negative (positive) and one if the signed volume is zero. **BS** is the buy/sell indicator for a dual customer; and **SV** is the signed dual customer volume in units of 100 contracts. *Lagged variables* are changes in the market price (per $10,000 of contract value), changes in **BS**, changes in **SV**, and changes in the buy/sell indicator and signed volume of *aggregate* customer trades. However, for brevity, only results for the lagged price change and lagged **BS** are presented. *Dummy*1 is one for large dual customer trades (i.e., those in the top 10 percentile of trade sizes) and 0 otherwise. *Dummy*2 is 1 for the final trading hour and 0 otherwise. A Pearson chi-square test is computed for the model's goodness of fit. In **Model 2**, the dependent variable is the buy/sell indicator for a dual trader's personal trade. We use an accelerated failure time model, assuming a logistic distribution for the failure time. *P*-values are in parentheses. Estimates significant at the ten-percent level or below are in bold. Active dual traders are those dual trading more than 7 days in the Yen futures, 18 days in the 1987 S&P 500 futures and 3 days in the 1991 S&P 500 futures. The sample period is 35 days from May 1 to June 19, 1987 for the Japanese Yen futures and the S&P 500 futures and 64 days from April 1 to June 28, 1991 for the S&P 500 futures.

	Japanese Yen 1987		S&P 500 1987		S&P 500 1991	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Intercept	**1.11** **(0.0018)**	**1.02** **(0.0001)**	6.11 (0.9945)	**0.99** **(0.0001)**	2.17 (0.3959)	**0.94** **(0.0001)**
Buy/sell indicator of dual customers **BS**	-0.03 (0.3905)	-0.01 (0.6270)	**0.04** **(0.0092)**	**0.01** **(0.0617)**	**0.11** **(0.0919)**	0.03 (0.4178)
Large trade dummy***BS**	0.01 (0.8809)	-0.00 (0.9335)	**0.10** **(0.0005)**	**0.03** **(0.0544)**	0.16 (0.1273)	0.08 (0.1371)
Signed volume of dual customers **SV**	-0.09 (0.1870)	-0.03 (0.2984)	**0.05** **(0.0481)**	0.00 (0.9738)	**0.28** **(0.0264)**	**0.10** **(0.0903)**
Last trade hour dummy***BS**	**0.23** **(0.0140)**	**0.13** **(0.0129)**	**-0.05** **(0.0577)**	0.00 (0.8897)	0.21 (0.3308)	0.06 (0.6246)
Last trade hour dummy*Large trade dummy***BS**	0.19 (0.4987)	0.19 (0.2115)	-0.09 (0.2496)	-0.01 (0.6910)	-0.58 (0.1654)	-0.13 (0.5285)
Lag of **BS**	-0.01 (0.8343)	-0.00 (0.8693)	0.02 (0.1327)	0.00 (0.7766)	0.06 (0.2925)	0.02 (0.4879)
Lag of price change	**-0.03** **(0.0051)**	**-0.02** **(0.0008)**	-0.12 (0.6755)	-0.03 (0.8257)	-0.22 (0.7963)	-0.47 (0.3411)
Pearson's Chi-square (Prob > chi-square)	5606 (0.4636)	--- ---	36144 (0.5223)	--- ---	1711 (0.3561)	--- ---
Number of brackets	2,823	2,823	18,245	18,245	856	856

Table 10
Market Timing Skills of Customers, Dual Traders and Locals

Market timing skill is the ability to systematically buy (sell) before a price increase (decrease). We count the number of times customers and floor traders buy or sell during a trading bracket when the price increases or decreases subsequently, and tabulate the outcomes in a two-by-two table. The Exact Fisher test evaluates the probability of observing a particular two-by-two table. In Panel A, we report *p* values for tests of customers' market timing skills. In Panel B, we report the percent of locals and dual traders successful under the Exact Fisher test, with of the total number of traders evaluated in parenthesis. Less (more) active dual traders are those dual trading at most (more than) 7 days in the Yen futures, 18 days in the 1987 S&P 500 futures and 3 days in the 1991 S&P 500 futures. The sample period is 35 days for the Yen and the S&P 500 from May 1 to June 19, 1987 and 64 days for the S&P 500 from April 1 to June 28, 1991.

	Japanese Yen 1987			S&P 500 1987			S&P 500 1991		
Panel A: Timing Success of Customers									
	Conditional probability of		p value for Exact Fisher test	Conditional probability of		p value for Exact Fisher test	Conditional probability of		p value for Exact Fisher test
	Buy on up	Sell on down		Buy on up	Sell on down		Buy on up	Sell on down	
All customers	46	48	0.895	53	50	0.302	50	53	0.125
Large dual customers	49	47	0.793	54	47	0.423	54	47	0.538
Small dual customers	45	49	0.715	43	47	0.989	51	57	0.089
Panel B: Timing Success of Dual Traders and Locals									
	Conditional probablity of		% successful (number evaluated)	Conditional probablity of		% successful (number evaluated)	Conditional probablity of		% successful (number evaluated)
	Buy on up	Sell on down		Buy on up	Sell on down		Buy on up	Sell on down	
Locals	42	56	15 (33)	49	50	16 (220)	29	73	17(271)
More active dual traders on dual days	44	61	15 (26)	52	52	14 (81)	35	70	3.5(30)
Less active dual traders on dual days	---	---	---	---	---	---	28	75	0 (32)
on local days	---	---	---	54	49	20 (35)	26	76	9 (58)