KRANNERT GRADUATE SCHOOL OF MANAGEMENT

Purdue University
West Lafayette, Indiana

An Examination of Own Account Trading by Dual Traders in Futures Markets

by

Sugato Chakravarty
Kai Li

Paper No. 1156
Date: April 2002

Institute for Research in the
Behavioral, Economic, and
Management Sciences

An Examination of Own Account Trading By Dual Traders in Futures Markets

Sugato Chakravarty*
Purdue University
West Lafayette, IN 47907

Kai Li
University of British Columbia
Vancouver, Canada V6T 1Z2

Current Version: April 2002

Abstract

Using proprietary audit trail transaction data compiled by the Commodity Futures Trading Commission, we investigate, at the individual trader level, (1) the *timing* and (2) the *determinants* of dual traders' personal trades. Our analysis reveals an absence of any trade timing by dual traders in relation to the execution of their customers' orders. Further examination employing correlation statistics and time series regressions provides strong support for the proposition that dual traders supply liquidity and actively manage inventory. Even after simultaneously controlling for factors representing information, liquidity supply and inventory control, within a multivariate regression framework, liquidity supply and inventory control remain as the determinants of dual traders' personal trades. Overall, the emergent profile of a dual trader is that of an uninformed trader performing complimentary tasks of liquidity provision and personal inventory management. These results survive extensive robustness checks, question the assumptions underpinning the extant theoretical research and have important policy implications.

Keywords: dual trading, front running, informed trader, inventory, liquidity
JEL Classification: G20, G28
Address: *Chakravarty—Phone: (765) 494-6427; Fax: (765) 494-0869; Email: sugato@purdue.edu*
Li—Phone: (604) 822-8353; Fax: (604) 822-4695; Email:kai.li@commerce.ubc.ca

---

* Corresponding author. We thank two anonymous referees for their comments, Steve Mann for providing the data, and Peter Locke for clarifying institutional details. We also thank Doron Avramov, Murray Carlson, David Denis, Mike Fishman, Gerry Garvey, Rob Heinkel, Alexander Kempf, Alan Kraus, John McConnell, N.R. Prabhala, Asani Sarkar, Avanidhar Subrahmanyam (Subra), Raman Uppal, and seminar participants at Purdue University, York University, and the Chicago Board of Trade 13th Annual European Futures Research Symposium in Scotland, for various comments and suggestions on the present, and earlier, versions of the paper. Marta Sue Foth and Yang Wu prepared the tables, Joshua Slive provided valuable editorial help, and Longkai Zhao provided excellent research assistance during the revision of the paper. We also thank the Futures Industry Institute for providing us with the daily settlement price data. Chakravarty acknowledges financial support from the Purdue Research Foundation and Li acknowledges financial support from the Social Sciences and Humanities Research Council of Canada and the Bureau of Asset Management at UBC. The usual disclaimer applies.

An Examination of Own Account Trading By Dual Traders in Futures Markets

Abstract

Using proprietary audit trail transaction data compiled by the Commodity Futures Trading Commission, we investigate, at the individual trader level, (1) the *timing* and (2) the *determinants* of dual traders' personal trades. Our analysis reveals an absence of any trade timing by dual traders in relation to the execution of their customers' orders. Further examination employing correlation statistics and time series regressions provides strong support for the proposition that dual traders supply liquidity and actively manage inventory. Even after simultaneously controlling for factors representing information, liquidity supply and inventory control, within a multivariate regression framework, liquidity supply and inventory control remain as the determinants of dual traders' personal trades. Overall, the emergent profile of a dual trader is that of an uninformed trader performing complimentary tasks of liquidity provision and personal inventory management. These results survive extensive robustness checks, question the assumptions underpinning the extant theoretical research and have important policy implications.

Keywords: dual trading, front running, informed trader, inventory, liquidity
JEL Classification: G20, G28

1. Introduction

Dual trading is an age-old custom in futures markets whereby some floor traders are allowed to trade both for themselves and for their customers.[1] This seemingly innocuous practice has attracted the attention of researchers and regulators alike, in light of ongoing Congressional debate on imposing personal trading restrictions on dual traders. An excerpt from Bloomberg news wire release, July 22, 1999, titled "Regulators to Decide Personal Trading by Futures Brokers" reads, in part, as follows:

> *U.S. regulators are gearing up to decide soon whether to limit a common trading practice on futures exchanges in Chicago that some critics say raises the potential for brokers to cheat their customers. ......(If these trading limits are imposed) "We will lose some of our brokers, who say they need to supplement their income by trading for themselves as well as their customers," said Jim Sutter, who manages Cargill Inc.'s oilseeds and grain futures trading on the Exchange.*

The supporters of the ban on dual trading argue that these floor traders are in a position to front run their customers' orders. An FBI sting operation at the Chicago Board of Trade (CBOT) and the Chicago Mercantile Exchange (CME), in late 1988 and early 1989, concluded that brokers (including dual traders) were cheating customers, leading to dozens of arrests and a 1992 government ban on dual trading in major futures contracts. Interestingly, Congress banned the practice of dual trading but then left the door open by telling regulators they could decide on when to enforce the ban. Opponents of the ban claim (see Grossman (1989)) that some brokers affected by the ban might exit the market, resulting in illiquid markets and higher trading costs for investors.

We contribute to this debate—which ultimately boils down to whether dual traders should be allowed to enjoy the privilege of own account trading along with their normal brokering activities—by investigating two related questions not addressed by the extant empirical literature. Specifically, we examine (1) the *timing* of a dual trader's personal trades, in

[1] The Chicago Mercantile Exchange Rulebook defines dual trading as: *The term "dual trading" shall mean trading or placing an order for one's own account, an account in which one has a direct or indirect financial interest or an account which one controls, in any contract month in which such person previously executed, received or processed a customer order on the Exchange floor during the same Regular Trading Hours session.*

relation to the execution of his customers' orders; and (2) the *determinants* of his personal trading decision. Existing research suggests the possible candidates driving dual traders' personal trading are information, liquidity supply, and inventory control.[2]

Trade-timing issues have not been addressed in the dual trading literature, possibly due to the paucity of appropriate data, while an analysis of the determinants of a dual trader's personal trading decision, within a multivariate regression framework, is also absent. The focus, in contrast, has largely been to examine the correlation between trade-related characteristics and each of the above-mentioned factors, in isolation of the others, for a cross-section of dual traders.

The CME definition of dual trading (see footnote 1), coupled with the results of existing research, provide testable implications related to information, liquidity supply and inventory control in terms of the timing/direction of dual traders' personal trades vis-à-vis the execution of their customers' orders. Thus, for example, dual traders could become informed after observing their customers' orders and/or by knowing something about their customers' motives for trading. They could then take advantage of this information by trading on their own account—either ahead of or following the execution of their customers' orders. Consequently, a simple test of whether dual traders are informed traders is to examine the existence (and direction) of causality between a dual trader's personal trades and his customers' trades. Similarly, a test of the liquidity-supplying role of dual traders is to investigate whether their own account trades are always in opposite direction of their customers' trades. Finally, a test of the inventory-rebalancing hypothesis is to examine if dual traders' own account trading make their inventory revert rapidly to a constant level (i.e., if their inventory is mean-reverting).

Our data are time series of audit trails at the CME during the first half of 1992 compiled by the Commodity Futures Trading Commission (CFTC) providing information on trade time, price, quantity, trade direction (buyer or seller) and the trader's identification. They are used internally by the CFTC for regulation and enforcement purposes.

On performing tests of causality (in the Granger (1980) sense), on a trader-by-trader basis,

---

[2] See, for example, Grossman (1989), Roell (1990), Fishman and Longstaff (1992), Smith and Whaley (1994), Chakravarty (1994), Chang, Locke and Mann (1994), Sarkar (1995), Chang and Locke (1996), Manaster and Mann (1996), and Locke, Sarkar and Wu (1999).

we find an absence of dual traders' personal volume either (Granger) causing their customers' volume or vice versa. This result survives a battery of robustness checks performed on various partitions of the data. We also test for, and reject, the possibility of inter-dealer collusion with regard to front running and piggybacking.

In the spirit of the CFTC's original inquiry into the fraudulent practices at the CME in 1989 (see, for example, CFTC (1989)), we investigate the *direction* of a dual trader's personal trades in relation to his customers' trades and find that there is significant negative correlation between dual traders' own account trades and those of their customers. Thus, dual traders appear to be liquidity suppliers. Our tests further reveal that dual traders are significant liquidity providers during times of large price swings and when other liquidity suppliers (such as locals[3]) are in short supply. They may also have a more important liquidity-providing role in relatively lower volume futures pits. Additionally, we find strong evidence of rapid mean reversion in the personal inventory of individual dual traders in our sample.

Finally, we examine the determinants of a dual trader's decision to trade for his own account, after simultaneously controlling for information, liquidity supply, inventory control behavior, and other factors considered relevant by the extant literature. We find that a dual trader's decision to trade for his own account is determined mainly by liquidity supply and inventory control reasons. The result that dual traders both provide liquidity and control personal inventory is, in essence, opposite sides of the same coin—one requiring a dual trader to move away from his desired inventory position (through liquidity supply), the other fueling the need to revert back toward his desired inventory position (through inventory control).[4] Our results call into question the notion that dual traders are informed traders capable of misusing their information for private gain. This may assuage the concerns of regulators when determining the prevalence and/or the seriousness of such offenses.

Our research builds on the work of Fishman and Longstaff (1992, henceforth FL) who develop a dual trading model based on the assumption that a broker has imperfect, though

[3] Locals are a group of futures floor traders who supply liquidity and rarely hold open positions overnight. Their liquidity-providing role also earns them the title of market makers.

[4] We thank an anonymous referee for providing this intuition.

better, information (relative to other floor traders) about whether his customer is making an informed or an uninformed trade. Upon testing the implications of their model with transaction data similar to ours, FL find that the personal trading profits of dual trading brokers are significantly higher than those of other floor traders; the personal trading profit of a given floor trader is higher on days when he is dual trading than on other days; and the customers of dual trading brokers earn higher profits than the customers of non-dual trading brokers. From these results, FL infer that dual traders are informed traders and that the higher trading profits of dual traders are due to the information conveyed by their customers' orders rather than to dual traders' superior trading skills. Our study differs from FL in several ways that may account for the differences in findings. First, we provide a trader-by-trader examination of the trading behavior of dual traders vis-à-vis the execution of their customers' orders. Second, while FL study a single contract, soybean, over 15 randomly selected days, we study a wide variety of contracts over a six-month period. Third, the soybean contract examined in FL trades at the CBOT, while our contracts trade at the CME. Finally, the sample period in FL pre-dates the FBI sting operation in 1989, while our study is conducted on contracts traded well after the FBI investigation.

The remainder of the paper is organized as follows. Section 2 reviews the related literature while Section 3 discusses the data. Section 4 examines the direction of causality between dual traders' personal trades and their customers' trades, using a trader-by-trader approach. Section 5 examines the liquidity-providing role of dual traders, while Section 6 investigates dual traders' inventory management practice. Section 7 examines the determinants of dual traders' personal trades under a multivariate regression framework. Section 8 concludes. An appendix detailing the dual traders used in the analyses is omitted for brevity, but is available on request.

2. Related Literature

The theoretical literature on dual trading starts with the basic assumption that dual traders are informed traders and then investigates the effects of their trading strategies (through piggybacking and/or front running) on market liquidity and the informativeness of prices (see, for example, Grossman (1989), Roell (1990), Fishman and Longstaff (1992), Chakravarty (1994), and Sarkar (1995)). While providing numerous valuable insights, this literature is unable to provide any guidance on the fundamental question of whether dual traders are informed traders to begin with—a primary focus of the current research.

The empirical literature on dual trading can be classified into two main themes. The first theme focuses on the liquidity effects of various dual trading restrictions imposed on the futures markets.[5] For example, Smith and Whaley (1994) find that the effective bid-ask spread increases and trading volume decreases as a result of restrictions on dual trading in the S&P 500 futures contract. Chang, Locke and Mann (1994) examine changes in the trading behavior of the CME floor traders since the implementation of Rule 552, and conclude that dual traders possess valuable skill and information related to the particular commodity they are trading. Chang and Locke (1996) analyze dual trading on futures contracts restricted by the CME Rule 552 and report that dual traders are superior brokers and find no evidence of informational advantage in dual traders' personal trading. Locke, Sarkar and Wu (1999) examine whether aggregate liquidity measures are appropriate indicators of trader welfare in markets with multiple dealers possessing heterogeneous skills. They find that dual trading restrictions, while hurting skilled dual traders and their customers, have little impact on market depth.

The second theme of the empirical literature examines a cornucopia of issues related to the microstructure of futures markets. Manaster and Mann (1996), for example, use futures transaction data to investigate cross-sectional relationships between market maker inventory positions and their trading activity. The authors find that competitive market makers at the CME appear to actively manage their inventory and learn from customer trades and conjecture that there are heterogeneous information advantages possessed by market makers. Ferguson and Mann (2001) examine customer transaction costs at the CME and report that the bid-ask spreads are U-shaped over the trading day. Finally Locke and Mann (1999) explore behavioral explanations of own account trading by dual traders. In sum, the extant empirical literature too is unable to answer our central question: what are the determinants of personal trading by dual

[5] Examples of such restrictions include the "top-step rule" implemented by the CME on the S&P 500 futures contract in June 1987, and the imposition of CME Rule 552 on all high volume futures contracts effective May 1991.

traders? Whether it is information, liquidity provision, or inventory control that drives the personal trading decision of dual traders is ultimately an empirical question and should be analyzed within a unified framework—as we do. Additionally, almost all existing empirical studies perform cross-sectional analyses across dual traders.[6] In contrast, the questions we address necessitate a trader-by-trader analysis. Finally, most empirical studies cited above examine the merits (and pitfalls) of dual trading using futures contracts subject to various dual trading restrictions. We, conversely, examine only those futures contracts that permit unrestricted dual trading. Given that the current policy debate centers on whether a ban on dual trading would reduce market liquidity, our approach has the potential of providing policy makers some guidance in that regard.

Our study, however, is closely related to, and extends Fishman and Longstaff (1992). FL begin with a stylized model designed to capture the intuition that a broker knows more about his customers and their motives for trading relative to other floor traders. The broker can then use this informational advantage by mimicking the trades of those he thinks are likely to be informed. The model provides testable implications regarding the trading profits of futures market participants. Specifically, (1) the expected trading profits of dual traders should be higher when they dual trade (i.e., trade after executing their customers' orders) than when they trade exclusively for their own account (i.e., behave as "locals"); and (2) customers should earn higher expected trading profits when their broker dual trades than when he trades exclusively for his customers (i.e., he is a pure broker). The data FL explore are intra-day transaction records in the soybean futures, one of the most actively traded futures contracts at the CBOT, for 15 randomly selected trading days during the last quarter of 1988. By computing the daily trading profits of dual traders and their customers and examining the relationship between dual trading and trading profitability, FL test and find support for their hypotheses. While the empirical analysis in FL involves computing and comparing daily trading profits of (a) locals

[6] Locke, Sarkar and Wu (1999), in fact, suggest that traders could be heterogeneous with respect to trading skills, and that the aggregate measures of trading costs, such as average bid-ask spreads, could be misleading. Consistent with the above, they develop a theoretical model based on dealer heterogeneity. Curiously, however, their empirics are then based on analyses of pooled trader groups (i.e., they perform cross-sectional analyses). Fishman and Longstaff (1992) is the only known exception examining the trading histories of the most/least profitable traders in their sample.

and dual traders; (b) dual traders on their dual trading and non-dual trading days; and (c) dual traders' customers on days when the dual trader did (did not) trade for his own account, our approach consists of an intra-day examination of sequences of signed customer and personal trading volumes of dual traders, on a trader-by-trader basis. In addition, as discussed in the introduction, there are also important differences in the data (one very liquid CBOT futures contract versus eight CME futures contracts of varying liquidity) and sample periods (before versus after the FBI investigation) over which these two empirical analyses are implemented.

3. Data

Our data consist of audit trail transaction records of eight futures contracts traded at the CME during the first six months of 1992. The contracts are live cattle, hogs, pork bellies, feeder cattle, lumber, Canadian dollars, T-bills, and S&P 400. The two million plus transaction records provide a detailed look at the complete trading history of all floor traders in these eight futures pits. We supplement the above data with the daily settlement price data to calculate trading profits (defined in Section 4).

3.1. Contract selection and data characteristics

The reason for restricting our attention to these eight futures contracts is that, since May 1991, the CME Rule 552 explicitly prohibits dual trading activities in the most active contracts on the Exchange. According to Chang, Locke and Mann (1994), all the major currency contracts are affected by the rule. Given that our goal is to study a dual trader's own account trading, we examine only contracts that allow *unrestricted* dual trading.

The audit trail data record each transaction twice, once for each party to a trade. An exchange algorithm, called the computerized trade reconstruction, uses each trader's independently reported sequence of trades, in conjunction with the time and sales data, to time each trade within a minute. Since some timing errors are likely, we perform our analysis in five-minute time intervals. For robustness, we also replicate all subsequent analyses with various time intervals, greater or less than five minutes, and obtain similar results.

In addition to trade time, the audit trail records provide price, quantity, specifics of the contract, and the trader's identification.[7] Unique to this data, each record also specifies the trade direction and a classification of the customer types on each side of a trade. There are four customer type indicators (CTI), labeled 1 through 4. The CTI 1 trades are market making trades for personal account (39% of the volume); CTI 2 trades are trades executed for the account of the trader's clearing member (6.2% of the volume); CTI 3 trades are trades executed for the account of any other Exchange member (5.7% of the volume); and CTI 4 trades are the trades of outside customers (49.1% of the volume). These numbers are consistent with the statistics reported in Chang and Locke (1996), and Manaster and Mann (1996). While we report results based on transactions in contracts of *all* maturities, we also replicate our analyses with transactions in the nearest maturity contracts only, at any point in time, and find that our results remain virtually unchanged.

3.2. *Trader classification*

Our definitions of a dual trading day and dual traders follow Locke, Sarkar and Wu (1999). We calculate a trading ratio d as the proportion of a floor trader's personal trading (CTI 1) volume over the sum of his personal (CTI 1) and his customers' (CTI 4) trading volumes for each day he is active. For each floor trader, a trading day is a local day if $d > 0.98$, a broker day if $d < 0.02$, and a dual trading day if d lies on the closed interval [0.02, 0.98]. When a broker makes a mistake in executing a customer order, the trade is placed into an error account as a trade for the corresponding broker's personal account. Thus, the 2% filter is used to allow for the possibility of error trading and appears reasonable based on communications with the CFTC. As a robustness check, we also replicate all subsequent analyses, successively, with 0%, 5%, and 10% filter rules.[8] Upon re-estimation, our results remain qualitatively similar in each case.

A floor trader with at least one dual trading day in the sample is defined as a dual-trader. The criterion for a specific floor trader to be included in our sample as an active dual

[7] To protect trader privacy, however, the CFTC maps each trader's Exchange badge number to a randomly selected number unique to the trader.

[8] That is, for each floor trader, a trading day is a broker trading day if the fraction of personal trading volume is $d = 0$ ($d < 0.05, 0.10$ using the 5%, 10% filters, respectively), and a dual trading day if d lies in the interval (0, 1) (in the closed intervals [0.05, 0.95], [0.10, 0.90] using the 5%, 10% filters, respectively).

trader is that the number of his dual trading days exceeds 50, out of a maximum of 126 trading days during the first six months of 1992. With this filter, we obtain a total of 101 active dual traders in our sample across the eight futures contracts. Of these, the live cattle contract has the largest number (40) of active dual traders, while the S&P 400 contract has only one active dual trader. These 101 traders account for well over half the total volume in our original data. The remaining dual traders trade only sporadically and, hence, do not provide us with enough observations to conduct tests with any degree of power. Also, given the sporadic nature of their trades, it is questionable if they can tell any story whatsoever. Thus, these dual traders and their trades are excluded from the sample. To ensure that the peculiarities of our sample selection do not drive the results, and the conclusions reached from analyzing the 101 dual traders are representative of the market as a whole, we also experiment with varying cutoff values below 50 dual trading days, to include progressively more dual traders in our sample. Upon re-estimation of our model in each case, the results remain similar and our conclusions unchanged.

We perform a robustness check to ensure that our sample of dual traders behaves distinctly on their dual trading days from two other important classes of futures floor traders: locals and brokers. The former trade solely for their personal account while the latter never trade on their personal account. We obtain fractions of the transaction volume contributed by these different types of traders. Thus, in every five-minute time interval of a particular trading day, we aggregate the volume of traders who are making market on that day as *local volume;* the volume of traders who are brokering on that day as *broker volume;* and the volume of traders who are dual trading on that day separately into *dual trader personal volume* and *dual trader customer volume.*[9] We then compute the volume fractions contributed by locals, brokers and dual traders. We find that, on aggregate, dual traders appear to play a less significant role as liquidity suppliers than locals. For example, the mean faction of *dual trader personal volume* ranges from 0.0500 for S&P 400 to 0.1781 for T-bills futures, while the mean fraction of *local volume* ranges from 0.2566 for Canadian dollars to 0.4077 for lumber futures. Thus, except for

[9] The classification of futures traders into dual traders, locals, and brokers is based on traders' trading practice on a particular trading day. Hence, these traders could (and do) change their roles from day to day.

Canadian dollars futures, the fraction of *market volume* contributed by dual traders is less than half that contributed by locals. Dual traders, however, appear to execute more customer volume (as brokers) than pure brokers in all contracts except for feeder cattle and S&P 400 futures. The mean fraction of *dual trader customer volume* ranges from 0.1528 for S&P 400 to 0.4713 for Canadian dollars futures, while the mean fraction of *broker volume* ranges from 0.0654 for lumber to 0.4759 for S&P 400 futures. In sum, dual traders, on their dual trading days, appear to behave very distinctly from their days of acting as pure locals or as pure brokers.

4. Dual Trading and Information

The CME trading rules define piggybacking and front running in terms of the *timing* of a dual trader's personal trades relative to his customers' trades (see footnote 1). This is because one way for dual traders to become informed is by observing their customers' orders and from knowing something about their customers' trading motives. The dual traders could then conceivably take advantage of this information by either trading ahead of or trading after executing their customers' orders. It, therefore, follows that any evidence of causality between a dual trader's personal trades and his customers' trades is consistent with evidence that dual traders may become informed through observing their customers' orders. To see if such causality exists, we set up simple tests, following Granger (1980), on a trader-by-trader basis. The specific empirical models used are discussed below.

4.1. *Tests of piggybacking/front running*

We define *personal netbuy* as the difference between a dual trader's buy volume and his sell volume on personal account in time interval t, and *customer netbuy* as the difference between a dual trader's customer buy volume and his customer sell volume in time interval t. The null hypothesis to examine if a dual trader's personal trades *follow* his customers' trades involves running the following Granger-type regression using all (customer and personal) trades of each dual trader in our sample:

$$\begin{aligned} \textit{Personal Netbuy}_t = a_0 + a_1\,\textit{Customer Netbuy}_{t-1} + \ldots + a_J\,\textit{Customer Netbuy}_{t-J} \\ + b_1\,\textit{Personal Netbuy}_{t-1} + \ldots + b_J\,\textit{Personal Netbuy}_{t-J} + u_t, \qquad (1) \end{aligned}$$

and testing $a_1 = \ldots = a_J = 0$.

Similarly, the null hypothesis to examine if a dual trader's personal trades *precede* his customers' trades involves running the following regression:

$$Customer\ Netbuy_t = a_0 + a_1\, Customer\ Netbuy_{t-1} + \ldots + a_J\, Customer\ Netbuy_{t-J} + b_1\, Personal\ Netbuy_{t-1} + \ldots + b_J\, Personal\ Netbuy_{t-J} + v_t, \qquad (2)$$

and testing $b_1 = \ldots = b_J = 0$.[10]

Equations (1)-(2) are time series regressions which we estimate using the asymptotically robust Generalized Method of Moments (GMM), proposed by Hansen (1982) in order to minimize autocorrelation and heteroscadasticity related problems in the error terms. Fortunately, GMM requires very weak assumptions on the error terms—only that they have well defined unconditional moments, including when the moments are conditionally varying. To implement the Granger tests, we use the Wald Chi-squared test statistic with degrees of freedom equal to the number of lags J. For robustness, the causality tests are conducted with J = 1, 3, and 5.

Since we have 101 sets of regression estimates for each regression specification, we report the results in the following way. Table 1 Panel A reports the Granger causality test results by providing the number of dual traders in each contract for whom the null hypothesis of no piggybacking is rejected at the 5% significance level. Across all contracts, we find that only about 10% of the dual traders in our sample trade personally immediately following execution of their customers' trades. In Panel B, there is even weaker evidence of dual traders trading personally ahead of their customers' orders. Less than 10% of the dual traders' personal trades precede their customers' trades in any economically significant way. Note that while the above discussion pertains to all personal and customer trades of the dual traders in our sample, for robustness, we re-estimate equations (1) and (2) using subsets of a dual trader's personal trades: those that have the same trade direction as his customers' trades (estimated once for the

[10] Note that our empirical setup implicitly assumes that dual traders are myopic. This may seem contradictory to Kyle (1985), where the *single* informed trader is assumed to have long-lived private information. However, in an extension of the basic Kyle framework, Holden and Subrahmanyam (1992) argue that Kyle's assumption of a single informed trader is too strong and show that in a world of *multiple* informed traders, competition causes most of the informed traders' common private information to be revealed immediately. This argues for informed traders with short-lived private information as we have assumed in our empirical setting. Additionally, Ito, Lyons and Melvin (1998), and Locke and Mann (1999) find that the information sources associated with floor trader profitability are undoubtedly order-flow related, and, thus, of short duration.

buy trades and once for the sell trades). Here too, the results are qualitatively similar to those reported above and there is no strong evidence of dual traders either front running or following their customers' trades in any economically significant way.

In sum, by equating a dual trader's propensity to trade personally after his customers to piggybacking and his propensity to trade personally ahead of his customers' orders to front running, a trader-by-trader analysis indicates that neither piggybacking nor front running is an economically significant phenomenon.

4.2. *Tests of piggybacking/front running on profitable customer trades*

An underlying assumption of the Granger tests performed above is that all customer trades have equal information content—or that all customer trades are equally beneficial to piggyback or front run on. But we know that customer trades come in many flavors. Some are passive orders triggered by price movements while others are high priority market orders that need to be worked on the floor of the Exchange. It is, therefore, reasonable to expect that the latter may contain more information than the former and may result in more frequent piggybacking/front running. To the extent that the more informative customer trades also lead to higher trading profits for the customer, we identify the informed customer trades, based on ex-post profitability, and examine whether piggybacking/front running is associated with such customer trades.

Following Fishman and Longstaff (1992) we define the ex-post trading profit of a dual trader's customers in time interval t on day d as

$$\pi_{t,d} = \textit{Buy Volume}_{t,d} \times (\textit{Settlement Price}_d - \textit{Purchase Price}_{t,d}) + \textit{Sell Volume}_{t,d} \times (\textit{Sale Price}_{t,d} - \textit{Settlement Price}_d). \qquad (3)$$

A profitable buy trade (sell trade) is made when the purchase (sale) price is below (above) the day's settlement price. Using equation (3), we compute the profit associated with each customer trade in a five-minute interval. If the sum of these profits is positive, the corresponding *customer netbuy*, for that time interval t, is retained. We use this subset of observations to carry out tests on piggybacking/front running.[11] For brevity we do not present

[11] Note that through the current and subsequent refinements, the number of dual traders examined in each contract does not change. The only difference is the (reduction in the) number of time series observations for each dual trader.

these results formally or those corresponding to subsequent robustness checks. All results are, however, available on request.

Using the subset of the data described above, we find that a very small number of dual traders trade personally either immediately following or immediately preceding the execution of their customers' trades. For example, employing the 1-lag (3- and 5-lags) Granger regression, in the live cattle contract, only 2 (2 and 3, respectively) dual traders are found to be piggybacking; in the feeder cattle contract, none (1 and 1, respectively) of the dual traders appears to be front running. Upon further retaining only those observations of *customer netbuy* associated with time intervals when the customer net trading profit is greater than the average profit for that day, we find little evidence of dual traders either piggybacking or front running and our earlier conclusions appear robust. Overall, we do not find dual traders behaving differentially to profitable customer trades relative to all customer trades.

4.3. *Tests of piggybacking/front running on customer trades with superior execution*

It is also possible that a dual trader's personal trades could be closely associated with only those of his customer trades that he executes at "desirable prices." To see if this is indeed the case, we classify dual traders' customer trades using the "execution skill" measure introduced by Manaster and Mann (1996). In particular, we compute the execution skill associated with a given dual trader's customer trades as the difference between the volume-weighted mean sale price (or purchase price) of a dual trader's customers (CTI 4 trades), and the volume-weighted mean sale price (or purchase price) of all trades, during each five-minute interval. Thus, for all customer buys, in time interval t, execution skill is positive (negative) if a dual trader executes his customer trades at a price lower (higher) than the average purchase price for all trades in that time interval. Likewise, for all customer sells, execution skill is positive (negative) if a dual trader executes his customers' trades at a price higher (lower) than the average sale price for all trades in that time interval. When a dual trader executes both buy and sell transactions for his customers, in time interval t, skill is computed as a volume-weighted measure of purchase- and sale-price skills. If the skill measure is positive, the corresponding *customer netbuy,* for that time interval t, is retained. Upon performing Granger causality tests with this subset of observations, we find very little evidence of dual traders either front running or following such customer orders with personal trades. In other words, there is no relationship between well-executed customer trades and a dual trader's personal trades. Upon further refining the sample to retain only those observations of *customer netbuy* associated with time intervals when the skill measure is greater than the average skill for that day, the results from causality tests remain virtually identical to those discussed above.

Finally, Manaster and Mann (1996) show that futures floor traders usually maintain a zero inventory position at the end of the trading day. Hence, sales on personal account (i.e., inventory reducing behavior) by futures floor traders might be related to inventory control effects, discussed later in the paper. By the same token, however, inventory-increasing trades, that take these traders away from their preferred position, might be information driven. We, therefore, investigate piggybacking/front running using dual traders' inventory-increasing trades only and find there are even fewer dual traders using their buy trades to piggyback or front run. Overall, we do not find any evidence to suggest that the inventory-increasing trades of dual traders are motivated by either piggybacking or front running, i.e., information driven.

4.4. *Dual trader profitability*

We delve deeper in our attempt to detect significant piggybacking/front running in our sample of dual traders by comparing the trading profits of those dual traders identified, in Table 1, to be either piggybacking or front running their customers' orders, to the trading profits of those dual traders who do neither. If there were significant correlation between dual traders who either piggyback or front run and dual traders who make the highest profits, we would have uncovered circumstantial evidence linking dual traders to informed trading.

While there appears to be some weak support for the notion that dual traders who indulge in either activity also end up making higher profits, the evidence is far from (statistically or economically) significant. In the live cattle and pork bellies contracts, for example, we find no statistically significant difference in the average (as well as median) profit between dual traders who piggyback or front run to those who do not indulge in either activity. In the live hogs contract, out of 15 eligible dual traders, only 2 (1) dual trader(s) appear to be piggybacking (front running) his customers and making significantly higher profits than those 13 (14) who do not piggyback (front run). Once again, our original message appears to hold: there is no evidence to suggest dual traders piggyback or front run in any economically significant way.

4.5. *Trading through collusion*

Even though we have shown that own account trading by dual traders, either ahead of or following the execution of their customers' orders, is not prevalent at an individual trader level, it is possible that some of these floor traders could act collusively to execute trades on others' behalf. Thus, for example, one trader may trade on behalf of his friend who has the (illegal) information. Any reasonable test of causality between a trader's personal trades and those of his customers has to account for such a possibility. Fortunately, our data allow us to identify a floor trader's trades executed on behalf of other traders (CTI 3 trades). The data do not, however, provide us with details about which particular trader a CTI 3 trade is executed for. Consequently, we define *member netbuy* as the difference between all CTI 3 buy and all CTI 3 sell trades on Exchange members' account in time interval t, and examine causality between *member netbuy* and *customer netbuy* on a trader-by-trader basis. Notice that by linking individual dual trader-specific customer trades (*customer netbuy*) with aggregated (by necessity) member-for-member trades (*member netbuy*), we actually skew the tests toward finding piggybacking or front running through collusion.[12] In spite of this, we do not find any significant correlation between *member netbuy* and either lead or lagged *customer netbuy*. Thus, the evidence does not indicate any presence of broker complicity to execute personal trades on each other's behalf. Moreover, an inspection of the total CTI 3 volume on a contract-by-contract basis reveals that it averages about 5% of the total volume (and of the total transaction frequency). As a result, any trade through broker complicity, not picked up by our tests, is unlikely to be economically significant.

In summary, there is little evidence to suggest that dual traders either trade ahead of or trade following execution of their customers' orders—either on their own or through other floor traders.

---

[12] To see this, consider the following example. Assume that dual traders *A* and *B* purchase a futures contract for some Exchange members (CTI 3 trades) at time t. A third dual trader, *C*, totally unrelated to *A* and *B*, purchases the same contract for his customers (CTI 4 trades) in the following period. A test using aggregated trading volume measures would then indicate strong positive correlation between dual traders' member-for-member trades in time period t and their customer trades in time period t+1. A possible implication of such a finding could be that (collusive) front running exists in the contract when, in fact, there is none.

5. Dual Trading and Liquidity Supply

One argument against the ban on dual trading is that some of the dual traders affected by the ban might exit the market due to an inability to supplement their income from brokering, by trading for themselves. Their exit could result in illiquid markets and higher trading costs. In this section, we investigate the liquidity-supplying role of dual traders in our sample.

The original enquiry by the CFTC into the practices at the CME in 1989 focused on the issue of the direction of dual traders' personal trades vis-à-vis the direction of their customers' trades.[13] In the same spirit, we too investigate the direction of a dual trader's personal trades in relation to trades of other market participants as follows. We define, *other personal netbuy* as the difference between (a) the remaining CTI 1 buy trades (excluding CTI 1 buy trades made by the dual trader of interest), and (b) the remaining CTI 1 sell trades (excluding CTI 1 sell trades made by the dual trader of interest) in time interval t. *House netbuy* is defined as the difference between all CTI 2 buy and all CTI 2 sell trades on house account in time interval t. In essence, *personal netbuy* (defined in Section 4.1) represents liquidity supplied by the dual trader, while *house netbuy, member netbuy* (defined in Section 4.5) and *customer netbuy* (defined in Section 4.1) capture the demand for liquidity by market participants, other than dual traders, in time interval t. By decomposing order flow into its separate components, as above, we are able to isolate the liquidity-supplying role of dual traders.

We compute correlations between *personal netbuy* and the four other netbuy measures defined above. If dual traders were liquidity providers, we would expect them to be buying when the rest of the market (excluding other dual traders) is selling and vice versa, leading to negative and significant correlations between *personal netbuy* and *house netbuy,* between *personal netbuy* and *member netbuy,* and between *personal netbuy* and *customer netbuy*. Table 2 provides the results.

The correlations between *personal netbuy* and *other personal netbuy* in Table 2 Panel A are almost always positive, indicating that dual traders on the Exchange usually trade in the same

---

[13] Also see "Traders are Indicted for Running the Pits by Their Own Rules," WSJ, Aug. 3, 1989, p.1.

direction. The correlations between *personal netbuy* and *house netbuy* in Panel B, and between *personal netbuy* and *member netbuy* in Panel C are also positive most of the time, indicating that trades on house account (CTI 2) and Exchange member-for-member trades (CTI 3) are usually in the same direction as trades by the dual trader of interest. The correlations between *personal netbuy* and *customer netbuy* in Table 2 Panel D are predominantly negative and statistically significant, indicating that dual traders' personal trades appear to accommodate liquidity demand from their customers. For example, the mean Pearson correlation coefficients range from -0.1223 for live cattle to -0.2961 for T-bills futures. The results using the Spearman rank correlation measure are very similar and, therefore, not presented.

5.1. *Dual trading and liquidity supply across contracts*

We also compare the liquidity-providing role of dual traders across contracts. Note that our set of contracts encompasses the highly active commodity futures such as live cattle and live hogs, as well as the less active financial futures such as Canadian dollars and T-bills. It is useful to investigate if liquidity supply by dual traders is more significant in the lower volume pits. We conduct both t-tests (parametric) and Wilcoxon signed rank (non parametric) tests on the correlations between *personal netbuy* and *customer netbuy* from different contracts in Table 2 Panel D. Among the eight contracts examined, the most (least) actively traded contract is live cattle (S&P 400); hogs, Canadian dollars, pork bellies, T-bills, feeder cattle, and lumber all have intermediate trading activities.[14]

Several noteworthy results emerge from our pair-wise comparisons across these contracts. First, as expected, we find that in the most actively traded agricultural contracts—like live cattle and hogs—the liquidity-providing role of dual traders is statistically less significant than that of dual traders in the less active contracts. Second, the liquidity-providing role of dual traders in the less active financial contract, T-bills, is statistically more significant than that of dual traders in the agricultural contracts. Third, among dual traders in the

[14] In low activity contracts, we find (not reported) that there are fewer time intervals containing CTI 2 and CTI 3 trades. Consequently, these pits are likely to exhibit stronger and negative correlation between *personal netbuy* and *customer netbuy*. This is, however, not a problem, as it simply illustrates the importance of liquidity supply by dual traders in these contracts. Thus, for example, if there is only one trade by a customer trading against a dual trader in time interval t, then the correlation is -1 — indicating that the dual trader supplies liquidity perfectly. We thank an anonymous referee for providing this insight.

moderately active agricultural contracts pork bellies, feeder cattle, and lumber, we do not find any significant difference in their liquidity-providing role. In sum, we find that, in addition to being liquidity providers overall, dual traders may have a more important liquidity-providing role in lower volume pits.

5.2. *Dual trading and liquidity supply under market stress*

To investigate the robustness of dual traders' liquidity-providing role, we explore whether there are differences when the supply of liquidity is more likely to be strained: times when there are large price changes or when there are fewer locals in the market. Accordingly, we compute correlations between *personal netbuy* and *customer netbuy* during times when there are "large" price swings. We define a price swing as large when the absolute price change, in time interval t, exceeds the sample average of absolute price changes in a given contract for that day. If dual traders were liquidity providers during times they are needed most, we should expect to see stronger negative and statistically significant correlations between these two signed order flows.

We find that almost all correlations are negative and most of them are statistically significant, indicating that dual traders' personal trades tend to be liquidity providing. However, both parametric and non-parametric tests reveal that the difference between the current set of correlations and correlations in Table 2 Panel D (the baseline case) is not statistically distinct. Thus, dual traders appear to be at least as strong a liquidity provider during times of large price swings as they are in any situation.

Next, we compute correlations between *personal netbuy* and *customer netbuy* during times when there are "fewer" locals on the market providing liquidity. We define a market to have fewer locals when the number of locals, in time interval t, is below the sample average of the number of locals in a given contract for that day. If dual traders were liquidity providers at times when fewer locals are present, we would expect to see stronger (and statistically significant) negative correlations between these two signed order flows. In fact, we do find evidence that dual traders' personal trades tend to be liquidity providing. However, upon conducting both t-tests and Wilcoxon signed rank tests on the difference between the current set of correlations and those in Table 2 Panel D (the baseline case), we find that the current set of correlations is numerically more negative, but not statistically distinct, from the correlations in the baseline case. That is, dual traders' role as liquidity suppliers appears to be at least as strong when other liquidity suppliers (such as locals) are in short supply.

6. Dual Trading and Inventory Control

Inventory control models predict (see O'Hara (1995) for a summary of the relevant literature) that market makers manage inventory risk by adjusting bid and ask prices and, over time, their inventory levels revert to a constant level. Manaster and Mann (1996) report a similar behavioral pattern by locals in the futures market. But liquidity provision and inventory control are opposite sides of the same coin. If liquidity supply leads to an increase in personal inventory, then the need to revert back to desired levels will naturally prompt the opposite, or inventory control, behavior. We have already uncovered evidence of liquidity supply behavior by the dual traders in our sample. In the current section, we investigate the possible existence of mean reversion in inventory by these dual traders. Consistent with Fishman and Longstaff (1992), and Manaster and Mann (1996), we assume that all traders begin the trading day with a zero inventory position.[15]

Accordingly, we compute *inventory* as a dual trader's own account buy trades minus his own account sell trades, cumulated from the beginning of a trading day to time interval t, assuming that a dual trader only has full control of his own account trades.

We consider a simple time series model of inventory behavior in which the change in inventory at time interval t, $\Delta inventory_t$, is regressed on $inventory_{t-1}$. The model is estimated daily for each dual trader in our sample. We find that dual traders show a strong desire for balancing inventory in their personal trades. The median coefficient on $inventory_{t-1}$ ranges from -0.48 for S&P 400 to -0.23 for feeder cattle futures. That is, the S&P 400 (feeder cattle) dual trader, in a typical trading day, reduces his inventory by 48% (23%) in a given time period relative to his inventory in the previous time period. It also appears that inventory does not follow a random walk—the null hypothesis of inventory containing a unit root is rejected overwhelmingly at the

[15] Note that while Fishman and Longstaff (1992) do not consider the inventory control behavior of dual traders, Manaster and Mann (1996) only do so for locals and not for dual traders.

5% level[16]—but, instead, exhibits very rapid mean reversion. Moreover, we also examine the contemporaneous relationship between trades and inventory and find that most of the correlations between $inventory_{t-1}$ and trades at time period t are negative and significant. The implication is that the most active sellers are traders with long positions, and the most active buyers are traders with short inventory positions. Our results are consistent with the intuition of the inventory control literature in general, and with Manaster and Mann (1996) in particular.

Overall, there appears to be a strong inventory control effect in personal trading by our sample of dual traders, complementing their liquidity-supplying role identified in Section 5.

7. Determinants of Dual Traders' Personal Trades

In this section, we examine the determinants of dual traders' personal trades. Our investigation is motivated, on the one hand, by regulators' concerns about whether dual traders should be allowed to trade on their own account and, on the other hand, by a literature that has chosen to examine the various facets of dual trading in isolation. Unfortunately, the latter approach limits our understanding of what fundamentally distinguishes a dual trader from other floor traders like pure brokers or locals. It is also likely that the magnitude of some of the effects, pertaining to dual trading, we have examined in isolation could become more or less prominent, once we control for other determinants of the same phenomenon.

Toward this end, the dependent variable, *personal netbuy*, in our multivariate analysis reflects the one characteristic that distinguishes a dual trader from a pure broker—his ability to trade on his own account. Our choice of a parsimonious set of exogenous variables is guided by the existing literature (including the current research) that suggests that measures of information, liquidity provision, and inventory control are possible determinants of a dual trader's personal trading volume.

As discussed before, information-related variables are captured through inclusion, in the regression model, of a dual trader's *customer netbuy* during time intervals t-3 up to t-1, *NLAG1 - NLAG3*, and those in lead periods t+1 to t+3, *NLEAD1 - NLEAD3*. The lagged (lead) variables should capture the case where a dual trader may trade personally after (before) executing his

[16] We test for unit roots using the Phillips-Perron test statistic (Perron (1988)).

customers' orders.

The potential conflict of interest between a dual trader's role as a broker and his role as a local is the main argument in favor of a ban on dual trading. The opponents of the ban, however, argue that the cost associated with this conflict of interest has to be traded off against the added liquidity provided by dual traders. We, therefore, examine the relationship between a dual trader's personal trading and his liquidity-providing role by including, *customer netbuy,* as a measure of liquidity demand by the customers of dual traders in time interval t.[17] We include *inventory* to control for dual traders' inventory management practice.

In summary, our multivariate analysis involves running the following regression:

$$\begin{aligned} \textit{Personal Netbuy}_t &= a_0 + a_1 \textit{Inventory}_{t-1} + a_2 \textit{Customer Netbuy}_t + a_3 \textit{NLAG1} \\ &+ a_4 \textit{NLAG2} + a_5 \textit{NLAG3} + a_6 \textit{NLEAD1} + a_7 \textit{NLEAD2} + a_8 \textit{NLEAD3} + e_t, \qquad (4) \end{aligned}$$

on a trader-by-trader basis across the eight futures contracts in the sample. We employ the Generalized Method of Moments (GMM) technique to obtain autocorrelation- and heteroscedasticity-adjusted regression coefficient estimates.

Since we have 101 separate sets of coefficient estimates, one for each dual trader in our sample, we present, in Table 3, the numbers of positive and negative coefficients, as well as the numbers of positive and statistically significant and negative and statistically significant coefficient estimates, respectively, at the (one-sided) 5% level. We also report the average GMM coefficient estimates across traders in the same contract.

Consistent with our earlier results, we find sporadic evidence of dual traders' personal trades following their customers' trades. While there are cases where the coefficients on *NLAG1* - *NLAG3* are positive and statistically significant across the contracts examined, the evidence is weak at best. There is similarly weak evidence to support the idea that dual traders' personal trades precede their customers' trades. Specifically, the coefficients on *NLEAD1* - *NLEAD3* are positive and statistically significant for only a few dual traders across all contracts.

We, however, find strong association between a dual trader's personal trading and *customer netbuy,* our proxy for liquidity demand by the customers of dual traders. The

---

[17] We also repeat our analysis by replacing *customer netbuy* with a variable combining *house netbuy* with *customer netbuy,* and re-estimating the regression given by equation (4). We get results similar to those reported here.

coefficient on *customer netbuy* is negative and statistically significant for almost all of the dual traders in the sample, indicating that dual traders meet their customers' net buy (sell) demands by selling from (buying into) their personal account. Finally, a dual trader also appears to trade on his own account to actively manage his inventory. The coefficient on *inventory* is negative and statistically significant for most of the traders in the eight contracts. That is, a dual trader buys on personal account when his inventory position is negative, and sells when it is positive.

To ensure the robustness of our findings, we re-estimate equation (4) with various extensions/modifications. Thus, for example, we include additional conditioning variables such as the lagged *personal netbuy*, an execution skill variable (as defined in Manaster and Mann (1996)), a trade timing dummy (as suggested in Walsh and Dinehart (1991), and Ferguson and Mann (2001)), a measure for market volatility (as in Manaster and Mann (1996)), and *customer netbuy* back to time interval *t-8* and forward to time interval *t+8*. It is also possible that dual traders might possess valuable private information beyond that gleaned from observing their customers' orders, due to their innate trading skills, including years of experience both as a broker and as a dealer. If so, personal trading based on such information should result in systematic trading profits for the dual trader. Since this private information, if present, is unobservable, we re-estimate (4) with a suitable information proxy.[18] In each case, our main conclusions remain unchanged.

In sum, the two significant factors driving dual traders' own account trading, after controlling for all other reasonable measures, appear to be liquidity provision and inventory control.

---

[18] The information proxy is constructed as follows. Consider the following regression

$$\pi_t = p_0 + p_1 NLAG1 + p_2 NLAG2 + p_3 NLAG3 + w_t,$$

where π_t is the ex-post trading profit of a dual trader in time interval t. Notice, in the above equation, w_t, by construction, is orthogonal to the customers' net buy volumes and represents the component of dual trader's trading profit not attributed to customer information. We, therefore, use this residual as a proxy for information that a dual trader may have over and above that from observing his customers' trades. A significant association between a dual trader's *personal netbuy* and the residual w_t would imply that the dual trader is an informed trader, possessing information over and beyond that gleaned from observing his customers' orders.

8. Concluding Summary

Using detailed and proprietary audit trail transaction data compiled by the CFTC, we seek to investigate, at the individual trader level, the *timing* of dual traders' personal trades relative to the execution of their customers' orders and the *determinants* of their personal trades. Our analysis reveals a surprising absence of any trade timing by dual traders vis-à-vis the execution of their customers' orders. Further examination employing correlation statistics and time series regressions provides strong support for dual traders as liquidity suppliers and for their inventory control behavior. We also perform individual trader-by-trader regressions of own account trading on factors representing information, liquidity supply and inventory rebalancing, and find that the main reasons for own account trading by dual traders are liquidity supply and inventory rebalancing.

Our research extends the seminal work of Fishman and Longstaff (1992) who find evidence consistent with dual traders being informed traders. While our results differ from theirs, the divergence in results can be reasonably ascribed to major differences in the data and time periods over which the two investigations are carried out: FL's investigation is based on an actively traded contract listed at the CBOT over a period just *before* the FBI launched a Federal investigation into fraudulent trading practices at Chicago futures exchanges, while ours is based on futures contracts of varying trading activities listed at the CME over an extended period *after* the FBI operation.

The current investigation follows on the heels of a renewed legislative interest in whether to curb, and ultimately to ban, the privilege enjoyed by dual traders in the futures markets both to trade on their personal account and to execute their customers' orders. A central argument for banning dual trading is that dual traders are informed traders, front running their customers' orders for private gain. We find no evidence to support such claims. In fact, the emergent profile of a dual trader is that of an uninformed trader trading primarily for liquidity provision and inventory rebalancing. Regulators will, therefore, need to proceed with caution before implementing any restrictions on own account trading by dual traders.

References

Chakravarty, Sugato, 1994, Should actively traded futures contracts come under the dual-trading ban? *Journal of Futures Market* 14, 661-684.

Chang, Eric C., Peter R. Locke, and Steven C. Mann, 1994, The effect of CME Rule 552 on dual traders, *Journal of Futures Market* 14, 493-510.

Chang, Eric C., and Peter R. Locke, 1996, The performance and market impact of dual trading: CME Rule 552, *Journal of Financial Intermediation* 5, 23-48.

Commodity Futures Trading Commission, 1989, Economic analysis of dual trading on commodity exchanges, Report prepared by the Division of Economic Analysis with Technical Support from the Office of Information Resources Management (November).

Ferguson, Mike, and Steven C. Mann, 2001, Execution costs and their intraday variation in futures markets, *Journal of Business 74*, 125-160.

Fishman, Michael J., and Francis A. Longstaff, 1992, Dual trading in futures markets, *Journal of Finance* 47, 643-671.

Granger, Clive W.J., 1980, Tests for causation—a personal viewpoint, *Journal of Economic Dynamics and Control* 2, 329-352.

Grossman, Sanford J., 1989, An economic analysis of dual trading, Rodney L. White Center for Financial Research Paper 33-89, The Wharton School, University of Pennsylvania.

Hansen, Lars, 1982, Large sample properties of generalized method of moments estimators, *Econometrica* 50, 1029-1084.

Holden, Craig W., and Avanidhar Subrahmanyam, 1992, Long-lived private information and imperfect competition, *Journal of Finance* 47, 247-270.

Ito, Takatoshi, Richard K. Lyons, and Michael T. Melvin, 1998, Is there private information in the FX market? The Tokyo experiment, *Journal of Finance* 53, 1111-1130.

Kyle, Albert S., 1985, Continuous auctions and insider trading, *Econometrica* 53, 1315-1335.

Locke, Peter R., and Steven C. Mann, 1999, Do professional traders exhibit loss realization aversion? working paper, Texas Christian University.

Locke, Peter R., Asani Sarkar, and Lifan Wu, 1999, Market liquidity and trader welfare in multiple dealer markets: Evidence from dual trading restrictions, *Journal of Financial and Quantitative Analysis* 34, 57-88.

Manaster, Steven, and Steven C. Mann, 1996, Life in the pits: Competitive market making and inventory control, *Review of Financial Studies* 9, 953-975.

O'Hara, Maureen, 1995, *Market Microstructure* (Blackwell Publishers, Cambridge, MA).

Perron, Pierre, 1988, Trends and random walks in macroeconomic times series, *Journal of Economic Dynamics and Control* 12, 297-332.

Roell, Ailsa, 1990, Dual capacity trading and the quality of the market, *Journal of Financial Intermediation* 1, 105-124.

Sarkar, Asani, 1995, Dual trading: Winners, losers and market impact, *Journal of Financial Intermediation* 4, 77-93.

Smith, Tom, and Robert E. Whaley, 1994, Assessing the costs of regulation: The case of dual trading, *Journal of Law and Economics* 37, 329-336.

Walsh, Michael J., and Stephen J. Dinehart, 1991, Dual trading and futures market liquidity: An analysis of three Chicago Board of Trade contract markets, *Journal of Futures Markets* 11, 519-537.

Table 1: Dual Trading and Information

This table examines the information source of dual traders. We investigate the direction of causality between dual traders' personal trades and their customer trades. The criterion for a specific floor trader to be included in our sample as an active dual trader is that the number of his dual trading days exceeds 50, out of a maximum of 126 trading days during the first six months of 1992. Number of traders gives the number of dual traders examined in each contract. We implement the Granger causality test on a trader-by-trader basis. For robustness, the Granger causality test is conducted at 1, 3, and 5 lags using GMM and the Wald Chi-squared test statistic. Beneath each null hypothesis, the cell gives the number of traders in each contract that reject the null at the 5% level.

	Live Cattle	Hogs	Pork Bellies	Feeder Cattle	Lumber	Canadian Dollars	T-bills	S&P 400
Number of traders	40	15	18	4	10	7	6	1
	Panel A: H_0: Dual trader's customer trades do not cause dual trader's personal trades (piggybacking)							
One lag	9	2	2	0	1	0	0	0
Three lags	6	1	1	0	1	0	0	0
Five lags	6	0	6	1	1	0	0	0
	Panel B: H_0: Dual trader's personal trades do not cause dual trader's customer trades (front running)							
One lag	1	2	3	1	2	1	0	0
Three lags	4	1	1	2	0	1	0	0
Five lags	3	1	1	1	1	1	1	0

Table 2: Dual Trading and Liquidity Supply

This table examines the liquidity-providing role of dual traders by focusing on the pairwise Pearson correlations between (1) *personal netbuy* and *other personal netbuy* (CTI 1 trades, Panel A); (2) *personal netbuy* and *house netbuy* (CTI 2 trades, Panel B); (3) *personal netbuy* and *member netbuy* (CTI 3 trades, Panel C); and (4) *personal netbuy* and *customer netbuy* (CTI 4 trades, Panel D). We define, *personal netbuy*, as the difference between a dual trader's buy volume and his sell volume on personal account in time interval t, and use it to represent liquidity supplied by the dual trader. *Other personal netbuy* is the difference between (a) the remaining CTI 1 buy trades (excluding CTI 1 buy trades made by the dual trader of interest), and (b) the remaining CTI 1 sell trades (excluding CTI 1 sell trades made by the dual trader of interest) in time interval t. *House netbuy* is the difference between all CTI 2 buy and all CTI 2 sell trades on house account in time interval t. *Member netbuy* (CTI 3 trades) and *customer netbuy* (CTI 4 trades) are defined similarly. The criterion for a specific floor trader to be included in our sample as an active dual trader is that the number of his dual trading days exceeds 50, out of a maximum of 126 trading days during the first six months of 1992. Number of traders gives the number of dual traders examined in each contract. All correlations are computed on a trader-by-trader basis and the summary statistics of these correlations in terms of mean, median, minimum, and maximum are provided. # *significant corr.* provides the number of traders in each contract with significant correlation at the 5% level.

	Live Cattle	Hogs	Pork Bellies	Feeder Cattle	Lumber	Canadian Dollars	T-bills	S&P 400
Number of traders	40	15	18	4	10	7	6	1
				Panel A: correlation (*Personal Netbuy, Other Personal Netbuy*)				
Mean	.0568	.0474	.1048	.0680	.0904	.1103	.0692	.0291
Median	.0492	.0444	.0753	.0526	.0770	.1118	.0613	.0291
Min	-.0603	-.0413	.0043	-.0774	.0335	.0547	.0149	.0291
Max	.1830	.1698	.3298	.2442	.1581	.1855	.1464	.0291
# significant corr.	23	9	13	4	7	7	4	0
				Panel B: correlation (*Personal Netbuy, House Netbuy*)				
Mean	.0110	.0134	.0438	-.0092	-.0184	.0589	.0912	.0704
Median	.0130	.0023	.0382	-.0050	-.0160	.0419	.0913	.0704
Min	-.0750	-.0311	-.0150	-.0451	-.0669	.0374	.0108	.0704
Max	.0985	.1277	.2211	.0182	.0252	.0976	.1811	.0704
# significant corr.	12	5	5	1	1	7	5	1

Table 2 continued

	Live Cattle	Hogs	Pork Bellies	Feeder Cattle	Lumber	Canadian Dollars	T-bills	S&P 400
Number of traders	40	15	18	4	10	7	6	1
Panel C: correlation (*Personal Netbuy, Member Netbuy*)								
Mean	.0217	.0260	.0381	.0144	.0467	.0145	.0555	.0072
Median	.0178	.0162	.0306	.0166	.0485	.0131	.0523	.0072
Min	-.0508	-.1086	-.0466	-.0102	-.0029	-.0018	.0370	.0072
Max	.1057	.1230	.2039	.0345	.0974	.0421	.0776	.0072
# significant corr.	6	6	8	0	4	1	3	0
Panel D: correlation (*Personal Netbuy, Customer Netbuy*)								
Mean	-.1223	-.1415	-.2208	-.2202	-.2011	-.2368	-.2961	-.1752
Median	-.1168	-.1092	-.1656	-.1304	-.1797	-.2745	-.2649	-.1752
Min	-.2708	-.3627	-.5225	-.6302	-.3348	-.3174	-.5780	-.1752
Max	.0129	-.0017	-.0654	.0103	-.1421	-.1246	-.1352	-.1752
# significant corr.	36	14	18	2	10	7	6	1

Table 3: Determinants of Dual Traders' Own Account Trading

This table provides an overview of GMM estimates of a dual trader's own account trading equation (4) across our sample of 101 dual traders in eight futures contracts. The criterion for a specific floor trader to be included in our sample as an active dual trader is that the number of his dual trading days exceeds 50, out of a maximum of 126 trading days during the first six months of 1992. For each futures contract, the first row gives the average coefficient estimates. The second row gives the numbers of positive (+) and negative (-) coefficient estimates, and in parentheses the numbers of significantly positive and significantly negative coefficient estimates, respectively, at the 5% level in a one-tailed test. The dependent variable is a dual trader's *personal netbuy*, defined as the difference between a dual trader's buy volume and his sell volume in time interval t. *Inventory* is the cumulative difference between a dual trader's own account buy trades and his own account sell trades, from the beginning of a trading day to time interval t-1. *Customer netbuy* is the difference between a dual trader's customer buy volume and his customer sell volume in time interval t and is the liquidity proxy. *NLAG1* - *NLAG3* are a dual trader's *customer netbuy* in time intervals t-1 up to t-3; and *NLEAD1* - *NLEAD3* are a dual trader's *customer netbuy* in time intervals t+1 up to t+3. These lead and lag variables are the information proxies.

	Intercept		*Inventory*		*Customer Netbuy*		*NLAG1*		*NLAG2*		*NLAG3*		*NLEAD1*		*NLEAD2*		*NLEAD3*	
	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
Live Cattle	.0368		-.0526		-.0109		.0095		.0160		.0098		.0088		.0167		-.0022	
	19	21	2	38	1	39	17	23	24	16	20	20	25	15	25	14	19	21
	(3)	(2)	(1)	(33)	(0)	(29)	(5)	(5)	(4)	(1)	(2)	(3)	(4)	(0)	(5)	(0)	(2)	(1)
Hogs	.0399		-.0577		-.0229		.0044		.0046		-.0066		.0067		.0038		.0008	
	7	8	1	14	0	15	9	6	7	8	4	11	9	6	8	7	6	9
	(2)	(1)	(0)	(13)	(0)	(14)	(2)	(1)	(2)	(1)	(0)	(1)	(2)	(1)	(1)	(0)	(0)	(0)
Pork Bellies	-.0870		-.0770		-.0374		-.0055		-.0010		.0097		.0081		.0192		-.0040	
	4	14	0	18	0	18	5	13	7	11	12	6	14	4	12	6	13	5
	(0)	(3)	(0)	(18)	(0)	(18)	(0)	(2)	(0)	(1)	(1)	(0)	(3)	(0)	(4)	(2)	(1)	(0)
Feeder Cattle	.0297		-.0481		-.0847		-.0218		-.0222		-.0110		-.0080		.0172		.0162	
	4	0	1	3	1	3	0	4	1	3	3	1	2	2	4	0	3	1
	(0)	(0)	(0)	(3)	(0)	(3)	(0)	(0)	(1)	(0)	(0)	(0)	(0)	(1)	(0)	(0)	(0)	(0)
Lumber	-.0146		-.1408		-.0244		-.0025		-.0042		-.0049		-.0017		.0054		-.0021	
	4	6	0	10	0	10	3	7	5	5	2	8	5	5	5	5	5	5
	(0)	(1)	(0)	(9)	(0)	(10)	(1)	(1)	(0)	(3)	(0)	(1)	(1)	(0)	(0)	(0)	(1)	(1)
Canadian Dollars	-.0214		-.0465		-.0380		-.0008		-.0010		-.0028		.0019		.0013		-.0001	
	3	4	0	7	0	7	3	4	3	4	1	6	6	1	5	2	4	3
	(0)	(1)	(0)	(7)	(0)	(7)	(0)	(1)	(0)	(1)	(0)	(1)	(2)	(1)	(1)	(0)	(0)	(0)
T-bills	.0042		-.0338		-.0615		.0053		.0073		-.0016		.0031		.0094		-.0008	
	2	4	0	6	0	6	4	2	3	3	2	4	4	2	4	2	3	3
	(1)	(1)	(0)	(5)	(0)	(6)	(0)	(0)	(1)	(0)	(1)	(0)	(0)	(0)	(2)	(0)	(0)	(0)
S&P 400	-.0370		-.1966		-.0156		-.0035		.0112		.0087		-.0037		-.0137		.0020	
	0	1	0	1	0	1	0	1	1	0	1	0	0	1	0	1	1	0
	(0)	(0)	(0)	(1)	(0)	(1)	(0)	(0)	(0)	(0)	(1)	(0)	(0)	(0)	(0)	(1)	(0)	(0)

ADDITIONAL INSTITUTE PAPERS AVAILABLE FROM THE KRANNERT GRADUATE SCHOOL OF MANAGEMENT

-1995-

1069 Sugato Chakravarty and John J. McConnell, AN ANAYLSIS OF PRICES, BID/ASK SPREADS, AND BID AND ASK DEPTH SURROUNDING IVAN BOESKY'S ILLEGAL TRADING IN CARNATION'S STOCK.

1070 John J. McConnell and Henri Servaes, EQUITY OWENERSHIP AND THE TWO FACES OF DEBT.

1071 Kenneth J. Matheny, REAL EFFECTS OF MONETARY POLICY IN A 'NEOCLASSICAL' MODEL: THE CASE OF INTEREST RATE TARGETING.

1072 Julie Hunsaker and Dan Kovenock, THE PATTERN OF EXIT FROM DECLINING INDUSTRIES.

1073 Kessan Joseph, Manohar U. Kalwani, THE IMPACT OF ENVIRONMENTAL UNCERTAINTY ON THE DESIGN OF SALESFORCE COMPENSATION PLANS.

1074 K. Tomak, A NOTE ON THE GOLDFELD QUANDT TEST

1075 Alok R. Chaturvedi, SIMDS: A SIMULATION ENVIRONMENT FOR THE DESIGN OF DISTRIBUTED DATABASE SYSTEMS

1076 Dan Kovenock and Suddhasatwa Roy, FREE RIDING IN NON-COOPERATIVE ENTRY DETERRENCE WITH DIFFERENTIATED PRODUCTS

1077 Kenneth Matheny, THE MACROECONOMICS OF SELF-FULFILLING PROPHECIES

1078 Paul Alsemgeest, Charles Noussair and Mark Olson, EXPERIMENTAL COMPARISONS OF AUCTIONS UNDER SINGLE-AND MULTI-UNIT DEMAND

1079 Dan Kovenock, Casper D de Vries, FIAT EXCHANGE IN FINITE ECONOMIES

1080 Dan Kovenock, Suddhasatwa Roy, DYNAMIC CAPACITY CHOICE IN A BERTRAND-EDGEWORTH FRAMEWORK

1081 Burak Kazaz, Canan Sepil, PROJECT SCHEDULING WITH DISCOUNTED CASH FLOWS AND PROGRESS PAYMENTS

-1996-

1082 Murat Koksalan, Oya Rizi, A VISUAL INTRACTIVE APPROACH FOR MULTIPLE CRITERIA DECISION MAKING WITH MONOTONE UTILITY FUNCTIONS

1083 Janet S. Netz, John D. Haveman, ALL IN THE FAMILY: FAMILY, INCOME, AND LABOR FORCE ATTACHMENT

1098 Jeongwen Chiang and William T. Robinson, DO MARKET PIONEERS MAINTAIN THEIR INNOVATIVE SPARK OVER TIME?

1099 Glenn Hueckel, LABOR COMMAND IN *THE WEALTH OF NATIONS*: A SEARCH FOR "SYSTEM"

1100 Glenn Hueckel, SMITH'S UNIFORM "TOIL AND TROUBLE": A "VAIN SUBTLETY"?

1101 Thomas H. Brush and Philip Bromiley, WHAT DOES A SMALL CORPORATE EFFECT MEAN? A VARIANCE COMPONENTS SIMULATION OF CORPORATE AND BUSINESS EFFECTS

1102 Thomas Brush, Catherine Maritan and Aneel Karnani, MANAGING A NETWORK OF PLANTS WITHIN MULTINATIONAL FIRMS

1103 Sam Hariharan and Thomas H. Brush, RESOURCES AND THE SCALE OF ENTRY CHOICE: THE COMPETITIVE ADVANTAGE OF ESTABLISHED FIRMS?

1104 Thomas H. Brush, Philip Bromiley and Margaretha Hendrickx, THE RELATIVE INFLUENCE OF INDUSTRY AND CORPORATION ON BUSINESS SEGMENT PERFORMANCE: AN ALTERNATIVE ESTIMATE

1105 Thomas Brush, Catherine Maritan and Aneel Karnani, PLANT ROLES IN THE MANAGEMENT OF MULTINATIONAL MANUFACTURING FIRMS

1106 Thomas H. Brush, Catherine Maritan and Aneel Karnani, THE PLANT LOCATION DECISION IN MULTINATIONAL MANUFACTURING FIRMS: AN EMPIRICAL ANALYSIS OF INTERNATIONAL BUSINESS AND MANUFACTURING STRATEGY PERSPECTIVES

1107 Piyush Kumar, Manohar U. Kalwani and Maqbool Dada, THE IMPACT OF WAITING TIME GUARANTEES ON CUSTOMERS' WAITING EXPERIENCES

1108 Thomas H. Brush, Philip Bromiley and Margaretha Hendrickx, THE FREE CASH FLOW HYPOTHESIS FOR SALES GROWTH AND FIRM PERFORMANCE

1109 Keith V. Smith, PORTFOLIO ANALYSIS OF BROKERAGE FIRM RECOMMENDATIONS

- 1998 -

1110 Charles Noussair, Kenneth Matheny, and Mark Olson, AN EXPERIMENTAL STUDY OF DECISIONS IN DYNAMIC OPTIMIZATION PROBLEMS

1111 Jerry G. Thursby and Sukanya Kemp, AN ANALYSIS OF PRODUCTIVE EFFICIENCY OF UNIVERSITY COMMERCIALIZATION ACTIVITIES

1112 John J. McConnell and Sunil Wahal, DO INSTITUTIONAL INVESTORS EXACERBATE MANAGERIAL MYOPIA?

1113 John J. McConnell, Mehmet Ozbilgin and Sunil Wahal, SPINOFFS, EX ANTE

1114 Sugato Chakravarty and John J. McConnell, DOES INSIDER TRADING REALLY MOVE STOCK PRICES?

1115 William T. Robinson and Sungwook Min, IS THE FIRST TO MARKET THE FIRST TO FAIL?: EMPIRICAL EVIDENCE FOR MANUFACTURING BUSINESSES

1116 Margaretha Hendrickx, WHAT CAN MANAGEMENT RESEARCHERS LEARN FROM DONALD CAMPBELL, THE PHILOSOPHER? AN EXERCISE IN PHILOSOPHICAL HERMENEUTICS

1117 Thomas H. Brush, Philip Bromiley and Margaretha Hendrickx, THE FREE CASH FLOW HYPOTHESIS FOR SALES GROWTH AND FIRM PERFORMANCE

1118 Thomas H. Brush, Constance R. James and Philip Bromiley, COMPARING ALTERNATIVE METHODS TO ESTIMATE CORPORATE AND INDUSTRY EFFECTS

1119 Charles Noussair, Stéphane Robin and Bernard Ruffieux, BUBBLES AND ANTI-CRASHES IN LABORATORY ASSET MARKETS WITH CONSTANT FUNDAMENTAL VALUES

1120 Vivian Lei, Charles N. Noussair and Charles R. Plott, NON-SPECULATIVE BUBBLES IN EXPERIMENTAL ASSET MARKETS: LACK OF COMMON KNOWLEDGE OF RATIONALITY VS. ACTUAL IRRATIONALITY

-1999-

1121 Kent D. Miller and Timothy B. Folta, ENTRY TIMING AND OPTION VALUE

1122 Glenn Hueckel, THE LABOR "EMBODIED" IN SMITH'S LABOR-COMMANDED MEASURE: A "RATIONALLY RECONSTRUCTED" LEGEND

1123 Timothy B. Folta and David A. Foote, TEMPORARY EMPLOYEES AS REAL OPTIONS

1124 Gabriele Camera, DIRTY MONEY

1125 Wilfred Amaldoss, Robert J. Meyer, Jagmohan S. Raju, and Amnon Rapoport, COLLABORATING TO COMPETE: A GAME-THEORETIC MODEL AND EXPERIMENTAL INVESTIGATION OF THE EFFECT OF PROFIT-SHARING ARRANGEMENT AND TYPE OF ALLIANCE ON RESOURCE-COMMITMENT DECISIONS

1126 Wilfred Amaldoss, Robert J. Meyer, Jagmohan S. Raju, and Amnon Rapoport, APPENDICES FOR COLLABORATING TO COMPETE: A GAME-THEORETIC MODEL AND EXPERIMENTAL INVESTIGATION OF THE EFFECT OF PROFIT-SHARING ARRANGEMENT AND TYPE OF ALLIANCE ON RESOURCE-COMMITMENT DECISIONS

-2000-

1127 Sugato Chakravarty and Kai Li, AN ANALYSIS OF OWN ACCOUNT TRADING BY DUAL TRADERS IN FUTURES MARKETS: A BAYESIAN APPROACH

1128 Sugato Chakravarty, STEALTH TRADING: THE NEXT GENERATION

1129 S.G. Badrinath and Sugato Chakravarty, ARE ANALYST RECOMMENDATIONS INFORMATIVE?

1130 Sugato Chakravarty and Asani Sarkar, THE DETERMINANTS OF LIQUIDITY IN U.S. CORPORATE, MUNICIPAL AND TREASURY BOND MARKETS

1131 Vivian Lei and Charles Noussair, AN EXPERIMENTAL TEST OF AN OPTIMAL GROWTH MODEL

1132 Paul Healy and Charles Noussair, BIDDING BEHAVIOR IN THE PRICE IS RIGHT GAME: AN EXPERIMENTAL STUDY

1133 Kent D. Miller and Zur Shapira, BEHAVIORAL OPTION THEORY: FOUNDATIONS AND EVIDENCE

1134 Kent D. Miller, KNOWLEDGE INVENTORIES AND MANAGERIAL MYOPIA

1135 Gabriele Camera, Charles Noussair, and Steven Tucker, RATE-OF-RETURN DOMINANCE AND EFFICIENCY IN AN EXPERIMENTAL ECONOMY

1136 Timothy B. Folta, Jay J. Janney, SIGNALING FOR RESOURCE ACQUISITION: PRIVATE EQUITY PLACEMENTS BY TECHNOLOGY FIRMS

1137 Michael R. Baye, Dan Kovenock, Casper G. de Vries, COMPARATIVE ANALYSIS OF LITIGATION SYSTEMS: AN AUCTION-THEORETIC APPROACH

1138 Sugato Chakravarty, Asani Sarkar, DO DIFFERENCES IN TRANSPARENCY AFFECT TRADING COSTS? EVIDENCE FROM U.S. CORPORATE, MUNICIPAL AND TREASURY BOND MARKETS

-2001-

1139 Charles Noussair, Stephane Robin, Bernard Ruffieux, GENETICALLY MODIFIED ORGANISMS IN THE FOOD SUPPLY: PUBLIC OPINION VS CONSUMER BEHAVIOR

1140 Gabriele Camera, SEARCH, DEALERS, AND THE TERMS OF TRADE

1141 David Masclet, Charles Noussair, Steven Tucker, Marie-Claire Villeval, MONETARY AND NON-MONETARY PUNISHMENT IN THE VOLUNTARY CONTRIBUTIONS MECHANISM

1142 Charles Noussair, Stephane Robin, Bernard Ruffieux, DO CONSUMERS NOT CARE ABOUT BIOTECH FOODS OR DO THEY JUST NOT READ THE LABELS

1143 Timothy B. Folta, Douglas R. Johnson, Jonathan O'Brien, UNCERTAINTY AND THE LIKELIHOOD OF ENTRY: AN EMPIRICAL ASSESSMENT OF THE MODERATING ROLE OF IRREVERSIBILITY

1144 Alok Chaturvedi, Mukul Gupta, Sameer Gupta, ISSUES IN SERVER FARM DESIGN FOR REAL TIME E-COMMERCE TRANSACTIONS

1145 William Blankenau, Gabriele Camera, PRODUCTIVE EDUCATION OR A MARKETABLE DEGREE?

1146 Murat Köksalan, Selcen Pamuk, AN EVOLUTIONARY METAHEURISTIC FOR APPROXIMATING PREFERENCE-NONDOMINATED SOLUTIONS

1147 Gabriele Camera, Alain Delacroix, BARGAINING OR PRICE POSTING?

1148 Sugato Chakravarty, Asani Sarkar, A COMPARISON OF TRADING COSTS IN THE U.S. CORPORATE, MUNICIPAL AND TREASURY BOND MARKETS

1149 Sugato Chakravarty, Frederick H. deB. Harris, Robert A. Wood, DO BID-ASK SPREADS OR BID AND ASK DEPTHS CONVEY NEW INFORMATION FIRST?

1150 Sugato Chakravarty, Asani Sarkar, A MODEL OF BROKER'S TRADING, WITH APPLICATIONS TO ORDER FLOW INTERNALIZATION

1151 Sugato Chakravarty, Kai Li, AN EXAMINATION OF OWN ACCOUNT TRADING BY DUAL TRADERS IN FUTURES MARKETS

1152 Sugato Chakravarty, Venkatesh Panchapagesan, Robert A. Wood, INSTITUTIONAL TRADING PATTERNS AND PRICE IMPACT AROUND DECIMALIZATION

-2002-

1153 Sugato Chakravarty, RELATIONSHIPS AND RATIONING IN CONSUMER LOANS: EVIDENCE FROM THE NINETIES

1154 Sugato Chakravarty, Robert A. Wood, Stephen P. Harris, DECIMAL TRADING AND MARKET IMPACT

1155 Timothy B. Folta, Jonathan P. O'Brien, ENTRY IN THE PRESENCE OF DUELING OPTIONS