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Do traders strategically time their pledges during real-world Walrasian auctions?

James Eaves [a,1], Jeffrey Williams [b,2], Gabriel J. Power [c,*,3]

[a] Department of Management, Faculté des sciences de l'administration, Université Laval, Quebec City, Quebec G1V 0A6, Canada
[b] Department of Agricultural and Resource Economics, University of California-Davis, Davis, CA 95616, USA
[c] Department of Finance, Insurance, and Real Estate, Faculté des sciences de l'administration, Université Laval, Quebec City, Quebec G1V 0A6, Canada

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ABSTRACT

Experimental research suggests the Walrasian tâtonnement auction encourages traders to under-reveal preferences, even encouraging initial pledges contrary to true desires, because pledges are not binding. We analyze the timing and characteristics of individual pledges and trades during 9604 auctions for redbeans conducted by the Tokyo Grain Exchange. We find no evidence of contrarian pledging and little evidence of under-revelation – as many traders over-reveal as under-reveal. Most traders pledge seriously from the beginning. Despite the considerable heterogeneity in pledging behavior across individual traders, these differences appear to have no relationship with traders' profits, nor do they appear to affect the achievement of equilibrium.

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1. Introduction

Do traders act deceptively if their pledges are non-binding? Answering this question is an essential part of understanding how equilibrium is reached in financial markets. With the advance of high-speed algorithms, some traders "spoof" the market with a large buy offer just below the most recent price, a moment before reversing the offer to a sell at a slightly higher price. Such spoofing has emerged (or has been noted at least) in continuous double auction markets. The Walrasian tâtonnement auction (WTA), owing to its simplicity, has long been considered the abstraction of a market achieving equilibrium (Samuelson, 1941). Some researchers in finance and economics, however, suspect that traders can manipulate such a style of market because pledges in a WTA are not binding; a pledge, like talk, is cheap.

In their view, the WTA, rather than a straightforward mechanism for expressing desires to buy or to sell, represents a complex multi-player game in which each player plans to mislead others while anticipating what others intend through their pledges (Dubey et al., 1980; Amir et al., 1990). Traders seemingly have an incentive to under-reveal early, in an attempt to improve their ultimate terms of trade (Hurwicz, 1972; Otani and Sicilian, 1990; Stoll and Whaley, 1990). Especially if they are large, traders may enter pledges early in an auction contrary to their true intentions (Medrano and Vives, 2001). If either the under-revelation or the contrarian strategy is widespread, prices achieved using WTAs will be inefficient, if equilibrium can even be reached at all.[4]

* Corresponding author. Fax: +1 418 656 2624.
E-mail addresses: James.Eaves@fsa.ulaval.ca (J. Eaves), williams@primal.ucdavis.edu (J. Williams), Gabriel.Power@fsa.ulaval.ca (G.J. Power).
[1] Fax: +1 418 656 2624.
[2] Fax: +1 530 752 5614.
[3] Authorship is shared equally.

[4] A large financial literature exists on trading mechanisms. Among related work, Madhavan (1992) analyzes two important trading mechanisms, quote-driven and order-driven systems. Dhillon et al. (1997) contrast Walrasian discrete trading in futures in Japan (until April 1991) with continuous double-auction trading in US futures. Pagano and Roëll (1996) study different types of auction markets and conclude that uninformed traders generally benefit from lower trading costs when the market is more transparent. Martens (1998) examines the impact of the trading mechanism on price discovery and informational efficiency, examining financial securities that are simultaneously traded on more than one market, through different mechanisms. Kavajecz and Keim (2005) show how innovations in liquidity provision made possible by certain trading mechanisms lead to lower transaction costs.

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Table 1
Descriptive statistics for redbean auctions.

Position		Duration	Traders[a]	$ value	Buyers	Sellers	HHI
1	Mean	80.5	12.0	174,690	5.3	5.4	1749.0
	Median	69.0	11.0	98,909	5.0	5.0	1523.5
	s.d.	52.5	5.8	295,123	3.0	3.3	894.9
2	Mean	78.7	15.6	236,979	6.9	6.8	1359.6
	Median	71.0	15.0	188,262	7.0	6.0	1197.5
	s.d.	43.8	5.7	186,339	3.2	3.1	636.8
3	Mean	76.2	18.6	354,161	8.3	8.2	1144.3
	Median	69.0	19.0	291,360	8.0	8.0	1008.5
	s.d.	40.2	5.8	256,840	3.4	3.3	506.0
4	Mean	78.1	21.6	531,971	9.7	9.9	1001.0
	Median	70.0	22.0	457,694	9.0	10.0	889.7
	s.d.	40.7	5.7	359,232	3.6	3.7	422.4
5	Mean	82.6	24.7	808,013	11.4	11.1	924.7
	Median	75.0	25.0	659,985	11.0	11.0	823.9
	s.d.	43.1	5.6	557,825	3.8	3.8	395.3
6	Mean	87.2	27.1	1,046,678	12.7	12.2	805.1
	Median	79.0	28.0	883,636	13.0	12.0	721.1
	s.d.	45.3	4.7	683,610	3.6	3.7	314.0

[a] Note: This table reports descriptive statistics for FCMs 1–35, omitting small traders.

Walrasian tâtonnement auctions begin when the auctioneer indicates a provisional price to traders. The traders, who include multiple sellers as well as multiple buyers,[5] respond with non-binding pledges to sell or buy the commodity, usually in multiple units,[6] but no transactions occur until a market-clearing price is achieved. If pledges to buy do not balance pledges to sell at the initial provisional price, the auctioneer adjusts the provisional price in the direction of excess demand, possibly inducing traders to adjust their pledges. This iterative process continues as long as necessary – there is no deadline – until excess demand equals zero, at which moment the auction ends and all outstanding pledges are transformed into trades.[7] Because these trades all occur at the same price, the WTA is a uniform price auction.[8]

Even though there have been a few field studies of mechanisms similar to a WTA (Goldberg and Tenario, 1997; Biais et al., 1999),[9] the primary source of evidence supporting the hypothesis of strategic pledging has come from experiments (Joyce, 1984, 1998; Bronfman et al., 1996; Pouget, 2007b). These experiments have involved eight to twenty local students. These experiments have divided the subjects equally between buyers and sellers, not varying the concentration towards one side of the market. The variation is instead in the information available and in the rules governing revisions of pledges. Bronfman et al. (1996), for example, have fifteen replications.[10]

Rather than using experimental data, we inspect transcripts of 9604 WTAs during 1997–1998 for redbean futures contracts conducted on the Tokyo Grain Exchange (TGE), an exchange that used an actual WTA. It should be noted that the Tokyo Grain Exchange was acquired in 2013 by the Tokyo Commodity Exchange, which created on February 12, 2013, the Agricultural Product & Sugar Market (Tokyo Commodity Exchange, 2013).[11] As a result of this acquisition, this futures market no longer uses the auction method analyzed in this paper.[12]

Eaves and Williams (2007) studied auctions on the TGE, analyzing aggregate behavior, namely the "imbalance" between total supply and total demand. This study focuses on individual traders, and specifically whether they commonly behave deceptively. We examine the behavior of house traders of separate brokerage firms, who number at least forty and whose trades are reported separately. Although the sum of the individual behavior necessarily must accord with the aggregate behavior, it does not follow that most traders behave similarly to the aggregate.

We selected redbeans among the four commodities then actively traded on the TGE because the other three commodities were also traded elsewhere, by means of the more widely studied continuous double-sided auctions. [13] Each transcript of these redbean auctions narrates the sequence of provisional prices set by a

[5] Most types of auctions, in contrast, have a single seller or a single buyer of the specific good on offer, even if at other times, perhaps even on the same general session, others offer similar goods.

[6] Bidding strategies for multiple units are far more complex than for a single unit, whether from a theoretical perspective (Engelbrecht-Wiggans and Kahn, 1998; Lengwiler, 1999; Tenorio, 1999; Chakraborty, 2006) or an experimental perspective (Manelli et al., 2006).

[7] Auctions with a fixed ending time, such as many auctions conducted over the Internet, or even with an inevitable but stochastic ending time, such as when a candle's flame flickers out, presumably evolve differently than those without a deadline.

[8] This paper also relates to the literature on call auctions and how best to structure them. For example, Pagano and Schwartz (2003) study electronic call auctions at the Paris Bourse (Euronext Paris). They find that both less liquid and more liquid stocks benefit from the introduction of closing calls and that a positive spillover effect likely explains the lower transaction costs and improved price discovery. Related work by Chakraborty et al. (2012) shows that a theoretical "open" call auction, not unlike the WTA for redbean futures, dominates alternative auction structures. In particular, allowing for multiple orders that are displayed in an open book, this auction model allows for greater gains from trade as the order revelation of large participants is no longer inhibited. Ellul et al. (2005) also find, using a natural experiment at the London Stock Exchange, that price discovery is improved. Comerton-Forde and Rydge (2006) study call auctions at the Australian Stock Exchange and find improved price discovery resulting from the dissemination of indicative auction prices and surplus volumes.

[9] A number of stock exchanges employ a tâtonnement (groping) mechanism for determining an opening price each day. In the run-up to the opening, orders are tentative in the sense that they can be revised. These mechanisms, studied by Biais et al. (1999) among others, differ from a WTA, because indicative prices are determined by the orders, rather than the other way around, and because the iterative process ends at a specified time.

[10] Pouget (2007a) has one thousand trials in a comparison of types of market mechanism, one of which is a WTA, a size made possible by the players being computers programmed to learn from previous trades.

[11] Consolidation of futures exchanges within Japan has happened as in the USA. The Tokyo Grain Exchange itself had previously absorbed the Tokyo Sugar Exchange.

[12] The Tokyo Commodity Exchange had conducted trading in rubber by a live WTA, but switched the style of trading in rubber recently, to a continuous electronic market, in line with its metals markets. Given the time involved in a WTA, an exchange has a crowded schedule with more than a few commodities. For example, when the TGE introduced coffee trading in addition to redbeans, corn, soybeans and sugar, it had to conduct simultaneous WTAs, but brokers had difficulty in paying attention to two auctions at once.

[13] On the Tokyo Commodity Exchange, volume in redbeans has fallen almost to zero.

live auctioneer and each pledge entered.[14] A total of 562,274 pledges were entered by 76 distinct traders, the most active 30 of whom made 83% of the pledges. Of the 9604 auctions, 7729 had more than ten participants and 2370 had more than 30 participants. Across all auctions, buyers were precisely 50% of participants. However, in 555 auctions, buyers represented less than one-third of the participants, while in 957 auctions they were more than two-thirds of the participants. Table 1 presents descriptive statistics for several variables associated with the auctions, including duration, number of traders, and dollar value. In particular, mean dollar value ranges from $174,690 (position 1) to $1,046,678 (position 6).

These transcripts of real-world WTAs offer a rich opportunity to inspect for strategic behavior in traders' styles of pledging. What differs from one redbean auction to the next are market-level variables such as the number of participants, the balance between buyers and sellers, the degree of uncertainty about the sensible price, and the risk of the auction ending – all variables believed to affect each trader's inclination to behave deceptively. Even though these possible influences can be varied more systematically in an experiment, no experiment is likely to accomplish 9604 replications or involve groups of 30 subjects risking their own money.

The result of this inspection of TGE transcripts—traders rarely pledge deceptively during WTAs in the ways the literature has suspected—raises several methodological issues best made explicit at the outset. In any one auction, a given trader might act in a way that could be interpreted later as a clever strategy of deception but, if not repeated, would more appropriately be classified as a curiosity. The extent and success of deceptive pledging should be apparent in traders' patterns across many auctions. In particular, if many traders usually make one pledge early in the auction, it seems unlikely that they are trying to manipulate actions, or even that they perceive others as attempting to manipulate auctions.

Even with many auctions available, to demonstrate that no TGE trader ever pursued a deceptive strategy with his pledges is an impossible task, because one cannot imagine all deceptive strategies that traders could have pursued and all other traders' reactions to those strategies. For instance, it could be that a trader routinely pledges to buy 100 lots early in auctions, only to cancel that pledge seconds later, and then to put in the true pledge of 25 sells, but to attempt this precise deception only on Monday mornings, out of the belief that others are less alert then. It could also be that a trader follows well a deceptive strategy, but because the trader is so minor, no one else pays attention, and so the auctions are not affected. We can look for strategies and variants thereof which the literature has concluded should be present and should be pursued by many traders, especially the large ones. If few traders regularly follow the aggressive strategies researchers have imagined, it seems improbable that such strategic behavior dominates these auctions.

We can apply a profitability standard: A strategy followed by a trader while pledging should often make money or it is merely a curiosity. We have a record of every trade for an important subset of the traders. These "house traders" differ considerably in their pledging behavior, but these differences too are not correlated with profits. We know from interviews of house TGE traders that some are convinced they employ a clever deception while pledging. We also know from interviews that other house traders are aware of those traders and think that such strategies accomplish nothing but prolonging the auctions a few seconds.

[14] Eaves and Williams (2007) provide a transcript of a typical auction, in that case for corn.

2. The Tokyo grain exchange's method of auctions

The TGE conducts its auctions electronically.[15] Each auction begins when a live auctioneer, employed by the TGE, broadcasts an initial provisional price on the off-site computer terminals of TGE members, who respond electronically with their pledges to buy or sell. The pledges from each of the 85 authorized participants, the resulting aggregate imbalance, and the provisional price are visible to all participants instantly. The auctioneer, with the timing at his discretion, adjusts the provisional price in the direction of excess demand. Most redbean auctions conclude within two minutes, after five or six adjustments to the provisional price (Eaves and Williams, 2007), although the process takes as long as necessary to equilibrate. The auctions do equilibrate, consistent with the theory on existence (Jackson and Swinkels, 2005; Cripps and Swinkels, 2006; Fudenberg et al., 2007).

The same redbean futures contracts are repeatedly auctioned, at six "sessions" a day for the six months each contract can be traded. TGE auctions are not sequential, however, in the sense that the same item, such as cases of wine of the same vintage and vineyard, appears again within the same session. On any day, six redbean "delivery months" are auctioned one after the other at each of the sessions, which begin at 9:00, 10:00, 11:00, 13:00, 14:00, and 15:00.[16] Each futures contract specifies the delivery of a warehouse receipt, issued by an accredited facility in Tokyo, for 80 30-kilogram bags of redbeans (used as a sweet paste in confections).[17] All contracts are identical and interchangeable, except for the delivery month. Therefore, traders can chose among close substitutes, which flexibility presumably influences their pledges for any one particular delivery month.

Trades of any one delivery month at any one session have no bearing on the priority of pledges for subsequent auctions, unlike the auctions on the Seattle Fur Exchange (Lambson and Thurston, 2006). These futures contracts have both "private value" and "common value" in the terminology of the literature on auctions (e.g., Goeree and Offerman, 2003). Unlike in auctions for collectibles (Ganuza, 2004), the seller does not choose what information to reveal, because the contracts are standardized. Because the number of futures contracts open has no limit (which is to say, short-selling is common), the effect of the amount auctioned, as studied by Jackson and Kremer (2006), is not an issue.

Reflecting the long history of live auctions on Japanese exchanges, the electronic version on the TGE has several characteristics not anticipated by theorists or designers of experimental WTAs. Almost all the direct participants are futures commission merchants (FCMs), namely brokers. A FCM's pledge, seen by other participants, represents the net among orders placed by its many customers and speculative orders made by its own "house trader", who is often the individual entering pledges on the official computer terminal. Because of cross-trades within a FCM, the total volume usually exceeds its trading in the auction.[18] Each FCM reports to the exchange overnight, and hence to everyone else, the composition of its trading at each auction.

[15] Although the past tense is appropriate throughout this section, it is clearer to speak of the system as it existed.

[16] From February 2000, redbeans traded at only four of the six sessions. Each session has a specified order of commodities, and typically lasts 45 min. Auctions themselves are shorter. Redbeans' place in the sequence differs each session, usually being either second or third.

[17] As is typical with standardized futures contracts, most do not culminate in physical delivery, because traders treat the contracts as financial instruments, offsetting an obligation to deliver with an obligation to take delivery. At prevailing prices, a single contract represents about $10,000.

[18] Some FCMs who do not participate in an auction will report trades, as when customers collectively bought fifteen and sold ten while the house account sold five. A few FCMs routinely use their house accounts to cancel out their customers' net trading.

In part to allow directions from FCMs' customers to arrive during an auction, the direct participants can alter their pledges even if the auctioneer has not adjusted the provisional price. For similar reasons, the TGE does not impose a rule that traders must not buy more (or sell less) at a higher price, what is called the *improvement rule* in the literature on auction theory. As deceptive plays usually involve a violation of the improvement rule, such strategies can be attempted on the TGE.

The auctioneer begins with a provisional price based on the equilibrium price for that delivery month determined in the previous session with recognition of price movements in any intervening auctions for other delivery months or commodities (Eaves and Williams, 2010). The auctioneer can adjust the provisional price only in a small increment, similar to a "tick" on a U.S. futures exchange, but he can make adjustments quickly if he concludes the imbalance is large (Webb, 1991).[19] The game does not restart when the auctioneer adjusts the provisional price. Thus on the TGE, if a trader were to pledge, for example, +10 at the provisional price, that pledge to buy remains valid even if the auctioneer raises the provisional price. To reduce the proposed purchase, say to +7, the trader must take the action of entering −3. Actions by multiple traders often follow within less than a second of one another. While the human eye cannot discern actions so close in time, the imbalance is seen more easily on the computer screen.

When the auctioneer senses that the imbalance is not too large and that enough time has elapsed at any provisional price to accommodate revisions, he flashes an "OK" on the participants' computer terminals.[20] If any trader's pledge (or a combination of traders' pledges) drives excess demand to zero while the OK sign is on, the auction ends. In fact, the electronic trading system is designed to facilitate an abrupt ending. On their specially designed computer keyboards, traders can hit a button to "take all remaining". If no one takes up this opportunity, the auctioneer adjusts the provisional price by one tick while removing the "OK". Adjustments continue until a provisional price clears the market while the "OK" is posted.

3. Strategic ends to auctions

This section focuses on the patterns in the pledges that end auctions, for the last play of the game should offer much scope for strategies. Do a few traders disproportionately end auctions? Do those few traders who disproportionately "take all remaining" use that option strategically?[21] Do apparent strategies involving the take-all occur more often in auctions for first-position contracts than in auctions for later, say, sixth-position contracts? Besides being first in the sequence of auctions each session, a futures delivery month when it is the first position typically has fewer participants and fewer and smaller pledges per participant.

Nearly all auctions (9200 out of the 9604 redbean auctions considered) end with a single trader "taking all." Were all traders straightforwardly pledging in response to changes in the provisional price, any one trader would end auctions in proportion to his participation among auctions. Indeed, the probability of any one trader ending auctions could be compared to the number of auctions divided by the total participation in those auctions. In 1592 first-position redbean auctions, the average number of FCMs participating was 10.1, implying that any one FCM would have a 9.9% chance of ending an auction given it participated, were all FCMs similar. For sixth-position auctions, the comparable figure is only 2.8%, because more FCMs participate on average. The FCMs most likely to be using "take all remaining" strategically are those who use it more often than those two reported percentages.

Table 2 presents the take-all percentages for 35 FCMs, in descending order of their trading volume in all redbean futures contracts.[22] The percentage of auctions ended by a FCM given it participated is unusually large for seven of these 35, namely OC, YT, YZ, ST, HS, ML, and CL, marked in bold in Table 2. One of these seven, OC, is the most active FCM in the redbean market, while two others, ML and CL, are among the least active.[23]

For FCM CL, it is the house trader who makes the auction-ending pledge, which is very likely his one and only pledge. For CL, 36 of the 37 times it ended first-position auctions and 48 of the 94 times it ended sixth-position auctions, the "take-all" pledge equaled the trade by the house trader as reported to the exchange. In most of the auctions ended by CL, no customers of CL traded. FCMs ML, YT, and YZ similarly often end auctions in which only their house trader participated. OC follows the opposite pattern.

Table 3 investigates in more detail these seven FCMs who used "take all remaining" more than in proportion to their presence in auctions. Perhaps these FCMs are simply impatient. Should they be strategic, the possible strategies these FCMs used to end auctions can be recovered by comparison to their cumulative pledges outstanding at some earlier moment in the auction. Second 25 is a reasonable standard of comparison, as in most auctions the auctioneer has already adjusted the provisional price at least once or invoked the OK sign, which might have led to someone else ending the auction. If at second 25 a FCM had a cumulative pledge of +25 and later took-all-remaining with a pledge of −75, it could be concluded the FCM pursued a strategy of contrarian pledging to disguise a true desire to sell a large number, such as 50.

Table 3 offers little evidence of a strategy of contrarian pledging. Although some final trades do reverse the cumulative pledge as of second 25, few of the reversals involve large quantities or go against the direction of the change in the provisional price. These seven FCMs also cancel out their earlier pledge almost as frequently as they reverse it. It is very unlikely that early pledges ending in a trade of zero are strategic, though they could be associated with failed attempts to influence the price.

There is, however, some evidence in Table 3 of the strategy of under-revelation, because a number of the pledges ending auctions are the FCM's first and only pledge. Those seven FCMs also used the auction-ending pledge to increase their pledge as of second 25. But the substantial majority of those new pledges can be explained by the ensuing change in the provisional price, for relatively few violate the improvement rule. These FCMs also make their trade smaller than their pledge as of second 25. This could represent a strategy of over-revelation. More likely, the near-symmetry between increases and decreases to the pledge as of second 25 indicates that the pledge as of second 25 and the pledge ending the auction were not strategic pairs.[24]

[19] Discontinuities in price cause problems in other types of auctions, such as sealed-bid auctions, because ties can result (Jackson et al., 2002). The discreteness in price on the TGE is almost never a problem for achieving equilibrium. On the TGE, quantities, which must be integers, are discrete too, but a 1 lot is a small order. Multiples of 5 are common.

[20] The auctioneer cannot indicate "OK" if the excess demand is extreme – outside 100 lots for redbeans – but he would be unlikely to do so. In effect, the auctioneer uses the OK sign to ignore excess demands of zero reached inadvertently early in an auction.

[21] The Take-All-Remaining button is another potential tool for strategic behavior, since a trader can effectively end the auction after manipulating the provisional price. For example, suppose a trader pledges to sell 50 contracts in an attempt to depress the provisional price below the true value of the asset. Suppose also that the imbalance is −100 and the auctioneer has posted the 'OK' sign. Then the trader can click 'Take-All', reversing their position to buy 50 and locking-in a final-price that's below the contract's fair value.

[22] Trading volume for TGE contracts is increasing with maturity typically until the fifth or sixth contract month.

[23] OC abbreviates Okachi. Since the identities of the FCMs and the few independent traders do not matter for the analysis here, we use the abbreviations.

[24] Those auctions in which the auctioneer quickly changed price and which some FCM ended at the first opportunity may be the most likely strategic opportunities, in part because of the uncertainty about the appropriate price. We have reconstructed Table 3 for only those auctions moving at least three ticks and having the OK sign present only once. The patterns look similar.

Table 2
Futures commission merchants who end auctions.

FCM	First-position redbeans						Sixth-position redbeans					
	N	Pledge freq.	TA (%)	Pr1(H) (%)	N(H)	Pr2(H) (%)	*N*	Pledge freq.	TA (%)	Pr1(H) (%)	N(H)	Pr2(H) (%)
OC	1116	**3.3**	**21.6**	**6.1**	**33**	**9.4**	1544	**12.4**	**6.4**	**0.0**	**221**	**5.4**
MJ	648	2.0	4.7	22.6	40	2.5	1499	6.4	5.3	0.0	250	2.8
KN	698	1.9	2.9	47.6	63	1.6	1525	7.7	1.3	15.0	189	1.1
NS	661	1.8	4.4	13.3	29	3.4	1528	7.1	1.3	10.0	185	1.6
YT	721	**1.8**	**15.8**	**40.2**	**95**	**50.5**	1311	**3.4**	**15.8**	**6.5**	**118**	**41.5**
YZ	767	**2.2**	**24.5**	**39.3**	**155**	**50.3**	1359	**5.0**	**9.2**	**10.9**	**95**	**23.2**
TG	596	1.4	2.4	40.0	33	12.1	1326	3.1	6.7	9.9	132	15.9
YB	609	1.8	6.8	14.3	39	2.6	1446	5.9	1.3	5.3	40	0.0
KT	545	1.8	6.6	21.6	49	4.1	1309	3.6	1.3	0.0	39	0.0
AC	303	1.5	2.6	50.0	35	2.9	1468	2.9	1.0	0.0	64	3.1
DO	479	1.9	8.5	7.3	7	14.3	1284	4.1	1.5	0.0	8	0.0
UB	216	1.5	3.6	12.5	10	0.0	1354	3.2	0.6	0.0	57	1.8
MB	435	1.6	13.5	8.5	3	0.0	1317	3.0	1.5	0.0	12	0.0
OY	311	1.6	7.2	47.8	59	19.0	1407	4.1	1.0	7.1	189	0.0
NH	593	2.0	9.2	23.2	63	9.5	1054	3.0	0.3	0.0	46	0.0
ST	510	**2.6**	**13.8**	**11.1**	**24**	**17.4**	1079	**3.7**	**4.1**	**6.5**	**55**	**3.6**
KB	230	1.3	2.5	33.3	43	7.0	1365	3.2	4.9	7.2	196	15.8
YG	365	1.6	2.4	33.3	106	2.9	1231	2.6	1.6	0.0	71	4.2
YI	463	2.0	8.9	4.8	52	3.8	1067	3.0	2.7	13.3	35	17.1
OT	365	1.8	11.9	70.5	164	18.5	1196	2.8	3.5	4.7	280	4.6
FF	194	1.5	8.6	11.8	18	11.1	1074	3.4	0.8	0.0	118	1.7
MU	217	1.7	13.6	33.3	48	19.1	1020	3.2	1.8	15.8	76	3.9
CT	295	1.5	4.9	26.7	16	6.3	868	2.3	0.4	0.0	46	0.0
HS	189	**1.5**	**16.9**	**30.3**	**21**	**50.0**	964	**2.1**	**8.0**	**1.3**	**38**	**5.3**
DS	288	1.6	2.4	14.3	25	0.0	1105	2.2	0.1	0.0	140	0.0
AT	137	1.3	0.7	0.0	10	0.0	1125	2.5	0.2	0.0	11	0.0
CS	499	1.9	9.9	37.3	99	9.2	609	2.4	0.5	33.3	85	0.0
DF	82	1.3	2.4	50.0	24	4.2	1168	2.4	0.7	0.0	118	0.8
FC	295	1.5	4.3	46.2	122	4.9	879	1.9	0.2	0.0	235	0.0
KY	293	1.6	10.6	6.3	18	5.9	843	2.0	5.0	4.5	45	15.6
MM	228	1.6	11.7	14.3	10	20.0	797	2.1	1.6	0.0	1	100.0
ML	152	**2.1**	**10.8**	**88.2**	**37**	**33.3**	781	**2.7**	**6.4**	**59.6**	**248**	**14.5**
KU	73	1.3	1.3	0.0	5	0.0	884	2.0	0.0		37	0.0
SW	119	1.6	9.8	33.3	13	30.8	853	2.0	3.0	18.5	46	13.0
CL	182	**1.5**	**19.3**	**97.3**	**134**	**26.0**	774	**2.1**	**11.7**	**51.1**	**231**	**29.9**
Others	2198	1.6	5.3	49.5	441	10.3	14,206	1.7	0.5	32.4	1695	1.4

This table presents the "take-all" percentages for 35 FCMs, in descending order of their trading volume in all redbean futures auctions. *N* is number of auctions in which a FCM participated, out of 1578 first-position and 1422 sixth-position auctions ended by a single FCM. *Pledge freq.* is the average number of pledges in an auction, given the FCM participated. *TA* is the % among auctions in which the FCM "took all remaining", given participation. *Pr1(H)* is the % of the FCM's "take all remainings" where the take-all amount equaled the house trader's final trade. *N(H)* is the number of auctions in which only the house traded. *Pr2(H)* is the % of times the house took-all when only the house traded. In bold are statistics for the 5 largest FCMs.

4. Strategic violation of the no-improvement rule

Medrano and Vives (2001) predict that traders in WTAs, in an attempt to improve the terms of trade, will under-reveal or enter contrarian pledges when the risk of an auction ending is low, revealing their true intentions only when they perceive the auction will soon equilibrate. Since such strategic traders change their pledges out of deception between the start and the end of an auction, they will be more likely than non-strategic traders to violate the Weak Axiom of Revealed Preferences (WARP). In particular, strategic traders will be more likely to violate the condition that:

$$(p' - p) \cdot (x' - x) \leqslant 0 \qquad \text{(Condition1)}$$

where p' is an auction's final price, p is a provisional price during the same auction, x' is the trader's final trade and x is a pledge during the same auction. There are other explanations for violations of Condition 1. For instance, the arrival of new information may cause a trader's preference to change during an auction. However, because the TGE auctions are relatively short, on average less than 2 min, the arrival of new information during an auction should be relatively rare. A more likely explanation is the fact that most final trades represent an aggregation of individual trades since the auction's participants are brokers. However, if a broker's customers' demand satisfies Condition 1, then the aggregate pledge/final trade pairs should satisfy it as well (Shafer, 1977). There are likely other explanations, like factors that caused the delayed arrival of some of the initial pledges. In any case, there is no reason to expect that violations of Condition 1 would be systematically associated with certain traders, other than if those traders frequently engaged in deceptive pledging.

In experimental studies of Walrasian auction, Condition 1 is referred to as "the no-improvement rule", a rule that explicitly attempts to prevent participants from engaging in strategic pledging. Put differently, designers of experiments have anticipated that deceptive pledging will often violate Condition 1 (aka, the WARP).

In this section, we compare each FCM's cumulative pledge as of relatively early in the auction – second 25 – to its ultimate trade at the equilibrium price. The prevalence of deceptive pledging cannot be discovered by a simple count of altered cumulative pledges or pledge reversals, however, because some revisions should be made in response to the auctioneer's changes to the provisional price. We count how often the adjustment is in the opposite direction as the change to provisional price (indicating the adjustment can be explained by the price change). Instances where it is not are classified as violations of the improvement rule. Because strategic behavior is likely to appear as a violation of the improvement rule, should violations of the improvement rule be uncommon, strategic pledging itself is unlikely to be common.

The third column in Table 4 reports, for each of the six contract positions, the percentage of adjustments that violate the

Table 3
Pledging style of futures commission merchants who end auctions.

FCM	First-position redbeans					Sixth-position redbeans				
	First	More	Smaller	Cancel	Reverse	First	More	Smaller	Cancel	Reverse
Classification of take-all-remaining pledges										
OC	24	133	38	18	33	0	51	21	1	28
YT	41	45	16	8	7	37	131	20	5	21
YZ	63	66	39	8	15	12	55	23	3	36
ST	23	28	11	5	5	4	21	9	2	10
HS	19	11	1	1	1	24	43	3	2	7
ML	8	3	2	4	0	11	25	9	6	1
CL	22	9	3	3	0	30	42	7	0	15
% that violated the improvement rule										
OC	25.0	20.3	7.9	0.0	9.1	0.0	37.3	14.3	0.0	10.7
YT	26.8	42.2	25.0	0.0	14.3	16.2	29.8	20.0	0.0	4.8
YZ	9.5	31.8	7.7	0.0	20.0	0.0	36.4	17.4	0.0	11.1
ST	21.7	14.3	9.1	20.0	0.0	25.0	38.1	22.2	50.0	0.0
HS	26.3	45.5	0.0	0.0	100.0	20.8	25.6	33.3	0.0	57.1
ML	25.0	0.0	50.0	0.0	0.0	27.3	20.0	55.6	16.7	0.0
CL	27.3	0.0	0.0	0.0	0.0	20.0	14.3	14.3	0.0	6.7
% violating the improvement rule and > the median in size										
OC	16.7	17.3	5.3	0.0	9.1	0.0	35.3	9.5	0.0	7.1
YT	14.6	40.0	25.0	0.0	0.0	10.8	26.7	10.0	0.0	4.8
YZ	0.0	25.8	7.7	0.0	0.0	0.0	36.4	13.0	0.0	8.3
ST	8.7	10.7	0.0	0.0	0.0	25.0	38.1	22.2	0.0	0.0
HS	5.3	45.5	0.0	0.0	0.0	8.3	20.9	33.3	0.0	57.1
ML	0.0	0.0	0.0	0.0	0.0	9.1	8.0	33.3	0.0	0.0
CL	9.1	0.0	0.0	0.0	0.0	16.7	14.3	14.3	0.0	6.7

This table describes the seven FCMs who used "take all remaining" more than in proportion to their presence in auctions. For 1578 first-position auctions and 1422 sixth-position auctions, namely those ended by a single FCM, the ending pledge is characterized relative to the FCM's cumulative pledge as of the 25th second during the auction, which could have been zero. The column "first" refers to take-all-remaining pledges that were the FCM's first and hence only entry in the auction.

improvement rule (IR). All these percentages are low. For instance, only 11.4% of final trades entered during first-position auctions and 17.5% entered during sixth-position auctions violated the improvement rule as measured against the cumulative pledge as of second 25. If we restrict Table 4 to final trades in which the house trader alone traded, namely those auctions in which a single person was likely responsible for all pledges, the percentages of violations of the improvement rule are similarly low. If we restrict Table 4 to those auctions with relatively few FCMs participating, the percentages of violations of the improvement rule are lower still.[25]

The last column of Table 4 reports the percentage of adjustments to the cumulative pledge as of second 25 that are seemingly irrational and large enough to potentially affect price. An adjustment is classified as large if the absolute value of the adjustment – the difference between the final trade and the initial pledge – is greater than the median absolute imbalance of such an auction. With this restriction to large pledges, the percentage of suspect pledges drops to 0.6% for first-position auctions and 0.1% for sixth-position auctions. These are very small percentages of total pledges.[26]

The second column of Table 4 reports on another type of pledge entirely, those entered within the first 25 s of an auction and never adjusted thereafter. Such pledges, which are clearly not deceptive, represent nearly 33% of pledges entered during first-position auctions and 22.2% of pledges entered during sixth-position auctions.[27] Even the 22.2% during sixth-position auctions is sufficiently high to cast doubt on the prevalence of strategic pledging in WTAs. If some traders, even the small ones, found it advantageous to under-reveal pledges early in the auctions, presumably all would soon discover the advantage of that strategy. Yet many FCMs on the TGE routinely make but one pledge early.[28]

Table 5 reports the percentage of auctions that are characterized as having a high number of suspect pledge adjustments. For

Table 4
Pledges in violation of the improvement rule.

Position	Number of trades	Not deceptive (%)	IR violation (%)	IR violation and large (%)
First	14,096	33.0	11.4	0.6
Second	20,744	30.1	12.6	0.3
Third	27,190	28.3	14.5	0.3
Fourth	34,626	26.9	15.3	0.3
Fifth	42,648	24.2	16.3	0.2
Sixth	49,653	22.2	17.5	0.1

This table reports, for each of the six futures contract positions, the total number of trades and the percentage of adjustments that are either not strategic, in violation of the improvement rule (IR), or large and in violation of the IR. Each FCM's ultimate trade is compared to its cumulative pledge as of the 25th second in the auction. The second column reports the percentage of trades across all FCMs that where unambiguously not strategic, in the sense that the pledges were entered during the first 25 s and not adjusted later. The third column reports the violations of the improvement rule (IR). The fourth column considers whether those violations involved large quantities, defined as the median (absolute) imbalance observed just before the auctioneer's first adjustment to the provisional price.

[25] For purposes of robustness, we also conduct the empirical tests of Table 4 using (a) only FCMs 1–35, to exclude smaller traders, and (b) only for imbalanced auctions, i.e. those in which the difference between buyers and sellers equals the mean ±1.96 s.d., and in which strategic behavior might be more valuable. The results, presented in Tables A.1 and A.3, respectively, are similar to the broader findings. When we run the empirical tests using only FCMs 1–35, the findings are similar. The percentage of adjustments that violate the improvement rule is low across all positions and very similar to the percentages reported for all FCMs in the original table. Likewise, the percentage is very small for adjustments that are large (defined as when the difference between the final trade and the initial pledge is greater than the median absolute imbalance of such an auction).

[26] Such large but odd pledges usually occur when the trade seemingly combines orders by multiple customers, as can be inferred from the overall report of trading volume made to the exchange.

[27] As the average number of adjustments per FCM increases with the position of the futures contract, this percentage decreases monotonically.

[28] As a robustness check, we reanalyze the data (see Table A.3) using only imbalanced auctions (i.e., auctions where the difference between buyers and sellers is mean ±1.96 s.d). The number of imbalanced auctions is usually smaller than 1500. The original findings and interpretation are robust—they do not change meaningfully when only imbalanced auctions are considered. The percentage of IR violations remains small and the percentage of IR violations for large pledges remains very small across positions.

Table 5
Auctions in which futures commission merchants violated the improvement rule with a large pledge.

Position	Median # of traders	*X*			
		0%	(0%, 10%]	(10%, 20%]	(20%, 100%]
First	13	94.2	4.4	1.1	0.3
Second	18	96.1	3.3	0.4	0.0
Third	23	95.5	4.4	0.2	0.0
Fourth	27	94.4	5.5	0.0	0.0
Fifth	33	96.6	3.4	0.1	0.0
Sixth	38	97.6	2.4	0.0	0.0

This table reports the percentage of redbean auctions in which *X* percent of the participating FCMs entered a large pledge that violated the improvement rule.

each auction, we calculate the percentage of traders who entered large final pledges that violated the improvement rule. (As a standard, the table reports the median number of traders who participated in auctions.) In the vast majority of auctions, precisely zero traders enter large trades in violation of the improvement rule.[29]

In summary, most new pledges adjusting the cumulative pledge are rationalized by changes to the provisional price. Only a very small percentage of new pledges both cannot be rationalized by changes to the provisional price and are large enough to affect the equilibrium price. In only a small percentage of auctions, a large but odd pledge occurs. In one-third of all redbean auctions, including close to two-thirds of the first-position auctions, no pledge by any participant violates the improvement rule. Most of these auctions proceed without backtracking to an equilibrium price.

5. Relationship between pledges early in auctions and final trades

If a trader frequently enters contrarian pledges late in auctions, his final trade should often be on the opposite side of the market from his initial pledge. Consider a regression of the early pledge explaining the ultimate trade. If a trader frequently enters contrarian pledges, the coefficient on the first pledge will be less than 0. If a trader consistently under-reveals preferences early in auctions, this coefficient will be greater than 1. Indeed, it should be much greater than 1. If a trader's true preference is to buy 15 lots, it hardly seems worthwhile to fool everyone else with an initial pledge of 14. Perhaps the strategy would more likely work with an initial pledge of 10, in which case the regression coefficient is 1.5; cleverer yet, with 5 initially, in which case the regression coefficient is 3.0, provided this strategy is consistently followed.

Fig. 1 illustrates this regression relationship for FCM YT for the 721 first-position redbean auctions in which YT participated. The slope of the relationship shows that YT's final trade not only tends to be not only on the same side of the market as his initial pledge, but moves one for one with it. The intercept essentially goes through 0.0. YT, one of the seven FCMs inclined to end auctions, neither displays the pattern of contrarian pledging nor the pattern of under-revelation.

To see if either pattern resulting from strategic pledging holds for any of the other active redbean traders on the TGE, we ran a regression of a FCM's final trade against its cumulative pledge as of second 25 for each contract position.[30] Any single observation could have been the result of an FCM's clever deception, but this regression shows the FCM's overall pattern. The large number of auctions in which an FCM participates, as with YT, helps clarify what pattern is present. To help account for price effects, we include among the regressors the product of the initial pledge and the number of 10-yen ticks the price was adjusted after second 25. The estimated coefficient can be interpreted as the FCM's average price responsiveness for a futures contract of that maturity.[31]

In case the FCM responded differently if a prospective seller than if a prospective buyer, we include an indicator variable taking the value one if the cumulative pledge as of second 25 is a sell. As in Fig. 1 for FCM YT, the regression results for all FCMs suggest little, if any, asymmetry. The R-squared ranges from 0.02 to 0.97 across the 36 FCMs for each of six futures positions (totaling 216 regressions), but most often is between 0.40 and 0.60.

More important, Table 6 suggests no traders frequently enter contrarian pledges, as none of the estimated coefficients is negative. All but a few of the regressions have estimated coefficients close to 1.0, suggesting that few traders' behavior can be characterized as under-revealing preferences consistently. If anything, the few exceptions tend to have coefficients below 1.0, which would be consistent with a strategy of over-revealing.

As a robustness test, we estimate the same regressions after dropping outliers, i.e. those pledges greater in absolute value than the FCM's 90th-percentile trade. Panel B of Table 6 reports the results with these outliers removed. The outliers evidently explain the instances of over-revelation: in Panel B, most FCMs have a coefficient close to 1.0.[32]

Also included are variables representing the strategic situation as of second 25. A FCM might be more inclined to under-reveal its true desires if, as of second 25, it is one of the few sellers among many buyers, or one of few buyers among many sellers. Therefore, the FCM's pledge as of second 25 is interacted with two indicator variables, one when the proportion of sellers is under the 25th percentile over all auctions for that futures position and the other when the proportion of buyers is under the 25th percentile across all auctions. Across the 36 FCMs, few of these coefficients are statistically or substantively significant.[33]

Because a FCM might behave differently whenever a few of the pledges are outsized, we also construct a Herfindahl Index of pledges as of second 25 and interact that index with the FCM's own pledge as of second 25. The estimated coefficients in Table 6 are, however, not altered by the Herfindahl Index-own pledge interaction variable.[34] In short, even if a few FCMs can be categorized as tending to over-reveal or under-reveal, such pledging strategies are not common.

6. Effects of strategies on profits

If a trader's tendency to violate the improvement rule, to over- or under-reveal, or to end the auctions is a clever strategy, it should be correlated with profits. The data reported by each FCM to the TGE itself do not identify trades made by individual customers, but profits can be calculated for each FCM's house trader, who is

[29] For purposes of robustness, we also conduct the empirical tests of Table 5 using (a) only FCMs 1–35, to exclude smaller traders, and (b) only for imbalanced auctions. The results, presented in Tables A.2 and A.4, respectively, are similar to the broader findings.

[30] If the FCM has not entered a pledge by second 25 but later does, its cumulative pledge at second 25 is recorded as zero lots.

[31] This specification, in effect, is a linearization of the FCM's excess demand curve. If many FCMs had notably non-linear excess demand, we would need a different functional form, but almost all look like YT's: linear.

[32] In other robustness tests, we have included the absolute size (in lots) of the first pledge, both by itself and interacted with *Ticks* and *Sell*. We also have used different points in time to define the "first pledge," in particular, second 15 and second 40. In all cases, the results are qualitatively the same.

[33] The few statistically significant coefficients suggest that the FCM decides to sell less when it is an outnumbered seller (or to buy less if an outnumbered buyer), which is consistent with the FCM reacting to others' early pledges rather than using its own early pledge to mislead others.

[34] For example, for YT's pledges and trades as in Fig. 1, all additional variables, whether allowing asymmetry between buys and sells, response to price, or responses to the strategic situation, increase the R-squared merely from 0.77 to 0.81.

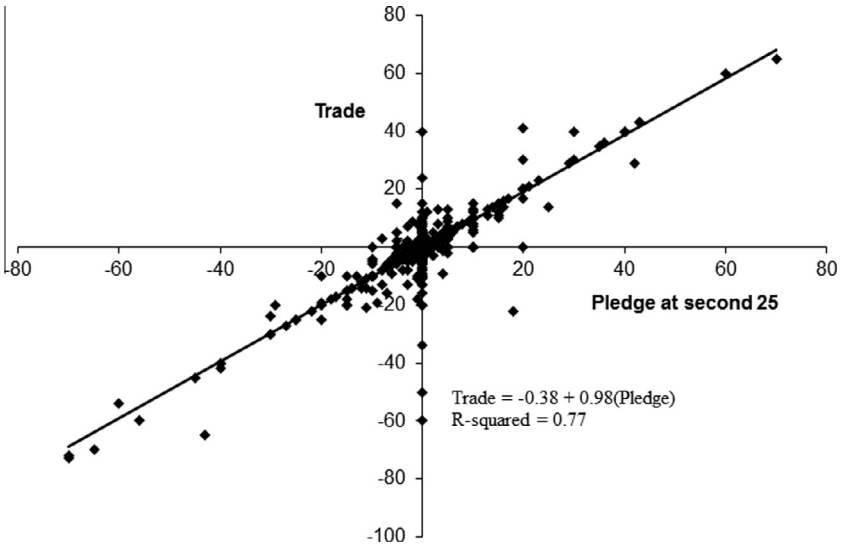

Fig. 1. Futures commission merchant YT's pledges and trades in first-position redbean auctions.

Table 6
Relationship between a futures commission merchant's early pledge and its ultimate trade.

	Futures contract position					
	First	Second	Third	Fourth	Fifth	Sixth
Panel A						
$0 < \beta_0 \leqslant 0.50$	2	4	4	6	5	6
$0.50 < \beta_0 \leqslant 0.80$	2	3	4	5	11	8
$0.80 < \beta_0 \leqslant 1.20$	30	26	28	24	20	21
$1.20 < \beta_0 \leqslant 1.50$	2	3	0	1	0	0
$\beta_0 > 1.50$	0	0	0	0	0	0
Mean *N*	396	576	730	888	1044	1155
Panel B						
$0 < \beta_0 \leqslant 0.50$	0	1	0	0	0	1
$0.50 < \beta_0 \leqslant 0.80$	10	7	4	3	6	4
$0.80 < \beta_0 \leqslant 1.20$	21	21	28	28	28	28
$1.20 < \beta_0 \leqslant 1.50$	3	4	4	3	1	3
$\beta_0 > 1.50$	1	3	0	2	1	0
Mean *N*	356	519	655	799	940	1038

This table reports coefficients from estimating, for each of 36 FCMs, the regression:

$$Trade_n = \alpha + \beta_0 Plg25_n + \beta_1 plg25_n \times Ticks_n + \beta_2 Plg25_n \times Sell_n + \beta_3 Ticks_n \times Plg25_n \times Sell_n + \varepsilon_n$$

where *Trade* is the FCM's ultimate trade for auction *n* out of the *N* auctions in which the FCM participated, *Plg25* is the FCM's cumulative pledge as of second 25 of the auction, *Ticks* is the number of ticks the provisional price was adjusted after second 25, and *Sell* is an indicator variable that equals one if *Plg25* was to sell. Panel A reports the number of FCMs for which the coefficient on the FCM's early pledge fell into particular intervals. Panel B reports the coefficients from regressions estimated excluding all auctions in which the pledge as of second 25 was larger than 90th percentile of such pledges (in absolute value) for that FCM. The 36th FCM is the composite "others" summing those ranking 36th through 76th among FCMs active in trading redbeans.

identified. Using an average-cost method,[35] we calculate house traders' profits per futures contract for the period from January 1997 through February 1998,[36] for each house trader of the 35 most active FCMs and for the house trader of the composite small FCM.[37] Then, we run a regression of these overall house profits on variables that characterize the FCM's style of pledging.[38]

The explanatory variables in this model of profits include the number of pledges entered by the FCM (*Pledges*), which necessarily encompass both the house trader and the FCM's customers, as well as variables indicating the FCM's level of potentially strategic behavior in its pledges. Because the relationships may not be linear, pairs of 0–1 indicator variables are used, with a third group subsumed in the constant term. The indicator variables include: *Few take-all*, which equals 1 if the percentage of auctions the FCM ends by taking all, given participation in the auction, is less than the 30th percentile for all FCMs, and equals zero otherwise; *Avg take-all*, which equals 1 if this percentage is between the 30th and 70th percentile; *Few IR vios*, which equals 1 if the percentage of the trader's final trades that violate the improvement rule is less than the 30th percentile for all traders, and equals zero otherwise; *Avg IR vios*, which equals 1 if this percentage is between the 30th and 70th percentile; *Low Beta*, which equals 1 if the FCM's final trades/pledge coefficient, as discussed in Table 6, is below the 90th percentile for all FCMs; and, finally, *Beta near 1.0* which equals 1 if this coefficient is between 0.80 and 1.20.[39]

To assess the relative importance of each type of possible strategic pledging, we estimate four models by regression. The first model includes only the number of trades while the remaining three add each pair successively. The results of these four regression models are reported in Table 7. None of the explanatory variables in any model is significant. The *R*-squared is near 0.00 for each regression. Indeed, if there was a strong relationship between profits and violations of the uncompensated law of demand, then we should see something—yet we see absolutely nothing.

In short, the different styles of pledging pursued by FCMs do not translate into profits for the FCM's house trader. The house traders'

[35] When a long position is unwound, the profit associated with the transaction is equal to the sale price minus the weighted average cost of the long position. When a short position is unwound, the profit is equal to the weighted average price received for the short contracts minus the cost of taking the opposing long position. For examples of this method, see Locke and Mann (2005).

[36] Positions that remained open as of the last trading session of the time-series were marked-to-market at that trading session's price.

[37] For robustness, we also considered alternative measures of profitability, including total profits and risk-adjusted profits. The results are not materially different.

[38] Our formulation presumes that a house trader's style of pledging within auctions is unrelated to the house trader's style measured on the scale of weeks or months: Someone aggressive during the auctions might be aggressive in market timing, for instance. If profits are related to trading style during the auction, there would be this ambiguity in the interpretation, but not if no relationship is present between profits and trading style.

[39] As a robustness test, we re-estimate the profit model after adjusting the threshold bands for the indicator variables. These modifications do not substantially alter the results. Of course, some other specification might reveal a connection between pledging style and overall profits, but that specification is not obvious.

Table 7
Trading profits and pledging behavior.

Pledges × 1000	0.06 (0.09)	0.01 (0.17)	0.02 (0.03)	−0.04 (0.42)
Few take-all		−0.42 (0.02)	4.58 (0.24)	−11.96 (0.57)
Avg. take-all		10.44 (0.66)	10.27 (0.63)	12.05 (0.76)
Few IR violations			−15.85 (0.82)	−5.68 (0.27)
Avg. IR violations			−9.24 (0.56)	2.81 (0.16)
Low beta				−55.64 (1.20)
Beta near 1.0				−24.82 (0.58)
Constant	−16.00 (2.21)*	−20.50 (1.67)	−13.14 (0.82)	16.87 (0.35)
Observations	36	36	36	36
R-squared	0.00	0.02	0.04	0.14
Adj *R*-squared	0.00	0.00	0.00	0.00

This table reports the results from estimating four models by regression using the following econometric specification:

$$\text{Profit} = \alpha + \gamma_0(Plgs) + \gamma_1(Few\_TA) + \gamma_2(Avg\_TA) + \gamma_3(Few\_vio) + \gamma_4(Avg\_vio) + \gamma_5(Low) + \gamma_6(One) + \varepsilon$$

where *Profit* is profit per contract traded and *Plgs* the number of pledges across all redbean positions for a particular futures commission merchant. The other variables for each FCM are indicator variables: (1) whether the percentage of auctions the FCM took-all was less than the 30th percentile for all traders (*few_TA*) or (2) between the 30th and 70th percentile (*Avg_TA*); (3) whether the percentage of FCM's pledge that violated the improvement rule was less than the 30th percentile (*Few_vio*) or (4) between the 30th and 70th percentile (*Avg_vio*); and (5) whether the estimated coefficient on the FCM's pledge as of second 25 in the regression explaining its final trade was below 0.80 (*Low*) or (6) between 0.80 and 1.20 (*One*). T-statistics are reported in brackets.

* Significant at the 5% level.

profits collectively also sum close to zero.[40] These results all accord with a competitive market in which no one has the ability to influence price. Evidently, the TGE's auctions have found the efficient prices.

7. Conclusion

The absence of deceptive pledging on the Tokyo Grain Exchange, especially of the sort expected to be attempted by large informed traders, accords with such studies as Camerer (1998), who deliberately placed and withdrew large bets at racetracks with no effect on the ultimate odds. The outcome of the careful tests presented here should not be surprising for a more fundamental reason. If the style of auctions on the TGE were easily manipulated, it is hard to imagine the exchange would have persisted for decades.

Even though pledges are non-binding and talk is cheap, the absence of strategic manipulation on the TGE refutes impressions of the strategies possible within WTAs gained from experimental economics or general equilibrium theory. Because the TGE is a much more complex market than are any of the experiments and much more repetitive than the single setting of prices considered by general equilibrium theory (Giraud, 2003), it is tempting to dismiss the comparison. When first witnessing a TGE auction some years ago, our first reaction was puzzlement that the exchange's rules allowed a trader to enter an auction without having made a pledge at the auctioneer's first provisional price. After all, would not more honest pledges necessarily improve auctions? The issue might rather be stated that traders on the TGE adjusted to strategic possibilities not considered by researchers, and it also might be stated that the TGE itself had an interest in devising rules such that its auctions are not easily gamed.

TGE rules allow any trader, once the auctioneer has concluded enough time has elapsed for everyone to pledge, to "take all remaining" with a touch of a button, ending the auction forthwith. A trader wanting to buy a substantial quantity might follow the strategy of making no pledge at initial provisional prices, hoping that the predominance of sellers causes the auctioneer to lower the price, at which moment he would end the auction. Of course, the trader does not have a monopoly on this strategy. He risks that others, practicing a similar strategy, are faster at recognition and button-pushing than he is. In those playing conditions, honest revelation earlier in the auction looks more advantageous.

[40] Why, given the lack of profits, the house traders pledge and trade at all, no matter their style, is another subject.

TGE traders are mostly brokers. On many financial markets – that for US Treasuries among the primary dealers, for example – brokers offer the service of making inquiries anonymously, revealing their principals only when a trade has been agreed. Brokers alter the strategic game. Even if a large commercial trader is known to use a particular futures commission merchant, rivals must consider the possibility that a pledge by the main broker is a feint for the pledge being placed by the commercial through another broker. If everyone can pursue this strategy of feigning among several brokers, the strategy may work regularly for no one, in which case the common strategy, as during TGE auctions, would be to reveal the true willingness to buy or sell.

Acknowledgement

The authors would like to thank the former Tokyo Grain Exchange for providing the data.

Appendix A

This appendix contains tables that present the results of several robustness checks (see Tables A.1–A.4).

Table A.1
Pledges in violation of the improvement rule: results for the imbalanced auction subset results for futures commission merchants 1–35 only.

Position	Number of trades	Not strategic (%)	IR violation (%)	IR violation and large (%)
1	12,857	27.6	15.1	0.8
2	19,337	25.2	14.8	0.5
3	24,671	22.7	15.5	0.4
4	30,586	20.6	17.4	0.5
5	36,250	17.5	17.0	0.3
6	40,574	14.8	18.4	0.2

Table A.2
Auctions in which FCMs violated the improvement rule with a large pledge: results for futures commission merchants 1–35 only.

Position	0%	(0,10%]	(10,20%]	(20,100%]
1	93.5%	3.3%	2.3%	0.8%
2	95.3%	3.4%	1.2%	0.1%
3	95.0%	4.6%	0.4%	0.0%
4	92.5%	6.9%	0.6%	0.0%
5	95.8%	4.1%	0.1%	0.0%
6	97.0%	2.9%	0.1%	0.0%

Table A.3
Pledges in violation of the improvement rule: results for the imbalanced auction subset.

Position	Number of trades	Not strategic (%)	IR violation (%)	IR violation and large (%)
1	913	26.1	12.4	1.2
2	1168	23.3	17.1	0.7
3	843	20.5	16.4	0.6
4	1245	19.4	19.5	1.0
5	1721	16.6	17.0	0.6
6	905	13.7	19.7	0.7

Note: imbalanced is defined as an auction where the difference between buyers and

Table A.4
Auctions in which futures commission merchants violated the improvement rule with a large pledge: imbalanced auctions only.

Position	0%	(0,10%]	(10,20%]	(20,100%]
1	94.6%	2.9%	2.1%	0.4%
2	92.6%	3.4%	4.0%	0.0%
3	96.1%	3.9%	0.0%	0.0%
4	92.2%	7.8%	0.0%	0.0%
5	93.1%	6.9%	0.0%	0.0%
6	96.9%	1.6%	1.6%	0.0%

Note: imbalanced is defined as an auction where the difference between buyers and sellers is mean ±1.96 s.d.

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