Chapter 33

A COMPARISON OF MARKET INSTITUTIONS

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This chapter summarizes a laboratory experiment comparing four different trading institutions, illustrated in Figure 1, in a random values environment with four single unit buyers and four single unit sellers. Figure 2 summarizes the main findings on efficiency: the continuous double auction (CDA) and high-frequency multiple-call market (MCM) are the most efficient institutions, followed by the low-frequency MCM and the single call market (SCM), with our implementation of uniform price double auction (UPDA) trailing the pack. Figures 3 and 4 summarize the main findings on transaction prices and volume. Price deviations from competitive equilibrium tend to be smallest in the SCM. Volume is highest in CDA, decreases with call frequency in MCM and SCM, and is lowest in UPDA. The body of this chapter describes the institutions, environment, performance measures, and results.

1. Market Institutions

The CDA is the richest trading institution in terms of within-period information feedback, trading opportunities and strategic complexity. The CDA sessions were conducted using multiple-unit double auction (MUDA) trading software (Plott, 1991), constrained to a single market and a single unit per trader. Every trader's screen displays the current market bid and ask. Buyers (sellers) are free to accept the market ask (bid) at any time, and the transaction is executed immediately. A transaction immediately removes both the market bid and ask. At any time during a trading period, buyers (sellers) who have not yet transacted are free to seize the market bid (ask) by posting a bid exceeding (ask below) the current market bid (ask). Traders perform their record-keeping by hand. Each period consists of 110 seconds of trading, which was sufficient for the typical 2- to 3-unit trading volume in our environment.

The SCM is the simplest trading institution in that it offers only one trading opportunity and minimal information within each trading period. The SCM sessions were conducted using a variant of the software employed in Friedman (1993) and several other studies. The SCM institution solicits a bid (or highest acceptable purchase price for a single unit) b_i from each buyer i and an ask (or lowest acceptable sale price) a_j

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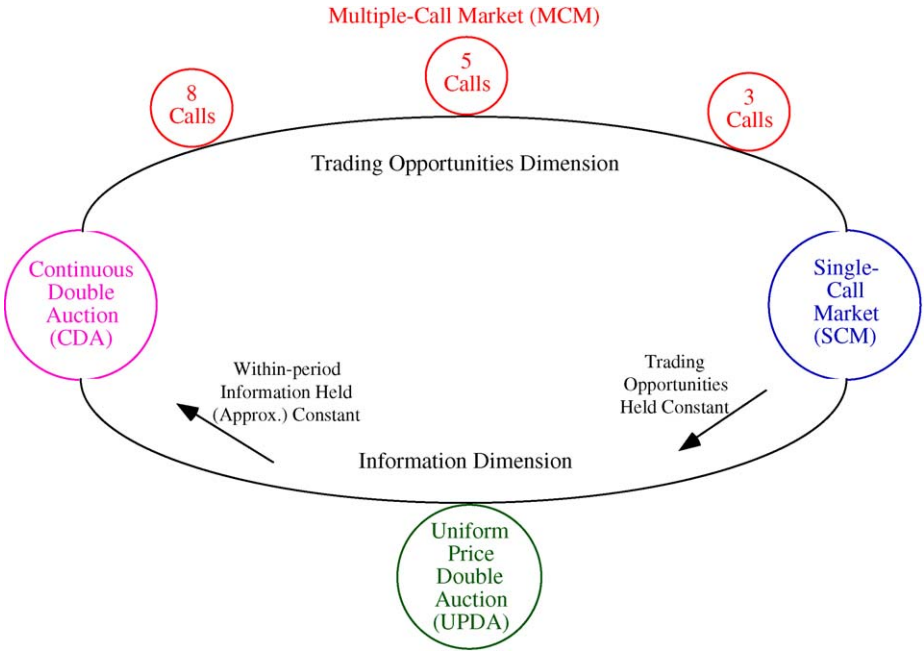


Figure 1. An overview of the trading institution comparison and experimental design.

from each seller j. The solicitations are simultaneous and private during the trading period. The demand revealed in $\{b_i\}$ and the supply revealed in $\{a_j\}$ then are cleared at a uniform equilibrium price p^*. With indivisible units, there often is an interval $[p_l, p_u]$ of market clearing prices, in which case the chosen price is $(1-k)p_l + kp_u$, where $k = 0$, $k = 0.5$ or $k = 1$. At the conclusion of the trading period traders observed p^* and the bids, asks, values, costs and profits of all other traders. Detailed analysis presented in Cason and Friedman (1997) indicates that trader behavior is generally insensitive to the pricing rule k, so for this institutional comparison we pool the data across the three k treatments.

As illustrated in Figure 1, the remaining two trading institutions link these polar institutions in two different ways. The MCM is just like the $k = 0.5$ SCM except that it has several calls (clearings) per period so traders have more trading opportunities. The number of calls is preannounced to be 3, 5, or 8 each period, with the length of the trading period is fixed at 120 seconds. Unaccepted bids and asks are automatically renewed for the next call, although traders can revise them at any time as in the CDA. After each call, all traders see whether their own offer was successful, and observe the transaction price (if any) as well as the best-rejected bid and best-rejected ask. At the end of the period subjects receive the same "full information" as in the SCM.

The UPDA market provides continuous information feedback as in the CDA, while limiting the number of trading opportunities to one per period as in the SCM. In the

UPDA, one call is held at the end of the trading period, but during the period traders submit and revise market bids and offers while observing changes in the possible terms of trade. A variety of information conditions are possible in the UPDA, many of which were explored in different environments from ours by McCabe, Rassenti, and Smith (1993) and by Friedman (1993). The choices made for this experiment reflect a desire to approximate the information conditions and environment of the CDA. Therefore, we provided subjects with the current "indicated market price" and the current best rejected bid and best rejected offer, which corresponds most closely to the CDA information concerning the current market bid and offer and available terms of trade. Moreover, the sessions allow traders to cancel bids and offers (which is allowed by many computerized CDA implementations including ours) and calls the market after 90 seconds. The UPDA sessions were conducted using the same market software (again appropriately modified) that was used in the SCM and MCM sessions. Once again, traders received complete information regarding the other traders values, costs, bids asks and profits at the conclusion of each period, and all sessions used the pricing rule $k = 0.5$.

2. Market Environment

To maintain comparability across institutions, we held constant several features of the environment. All sessions take place in a random values environment: in each trading period the buyers' redemption values and the sellers' costs are independently drawn from the uniform distribution with range [$0.00, $4.99]. This fact is publicly announced at the beginning of the session, and subjects have no other information regarding other subjects' drawn values during the trading period. The same sequences of drawn values were used in each session and across institutions to limit between-session variability. When the same subjects are brought back as experienced we employed a different set of random values, and these values were held constant across all experienced sessions.

All sessions used four buyers and four sellers, each with a trading capacity of only one unit. All inexperienced sessions ran 30 trading periods, and all experienced sessions ran 40 trading periods. In the 30-period inexperienced sessions, traders switched buyer and seller roles before period 9 and before period 25; in the 40-period experienced sessions, traders switched roles before period 11 and before period 31. This switch was preannounced, as was the number of buyers and sellers in each session. For each institution except SCM we conducted 3 sessions with inexperienced subjects and 2 sessions with experienced subjects. For the SCM we used three sessions (two employing inexperienced subjects) in each of the three k treatments.

3. Related Work

Several laboratory experiments have also compared these trading institutions in alternative environments. Smith et al. (1982) compares performance of the CDA to several

variants of the SCM in a repetitive stationary environment. Price formation was more rapid and reliable in the CDA but a multiple-unit recontracting version of the SCM had equivalent allocational efficiency. Friedman and Ostroy (1995) find that both the CDA and the SCM eventually produce highly efficient allocations even when the induced values and costs are chosen to encourage strategic misrepresentation. McCabe, Rassenti, and Smith (1993) study UPDA in an environment with additive random shifts superimposed each period on otherwise repetitively stationary demand and supply schedules. Friedman (1993) examines another variant of the UPDA institution as well as the MCM institution in an asset market environment. These studies find that the best variants of UPDA and MCM are almost as reliable as the CDA in producing prices and allocations near competitive equilibrium. The interested reader should consult our previous work (Cason and Friedman, 1996, 1997) for more details of additional experimental treatments in the CDA and SCM environments, respectively.

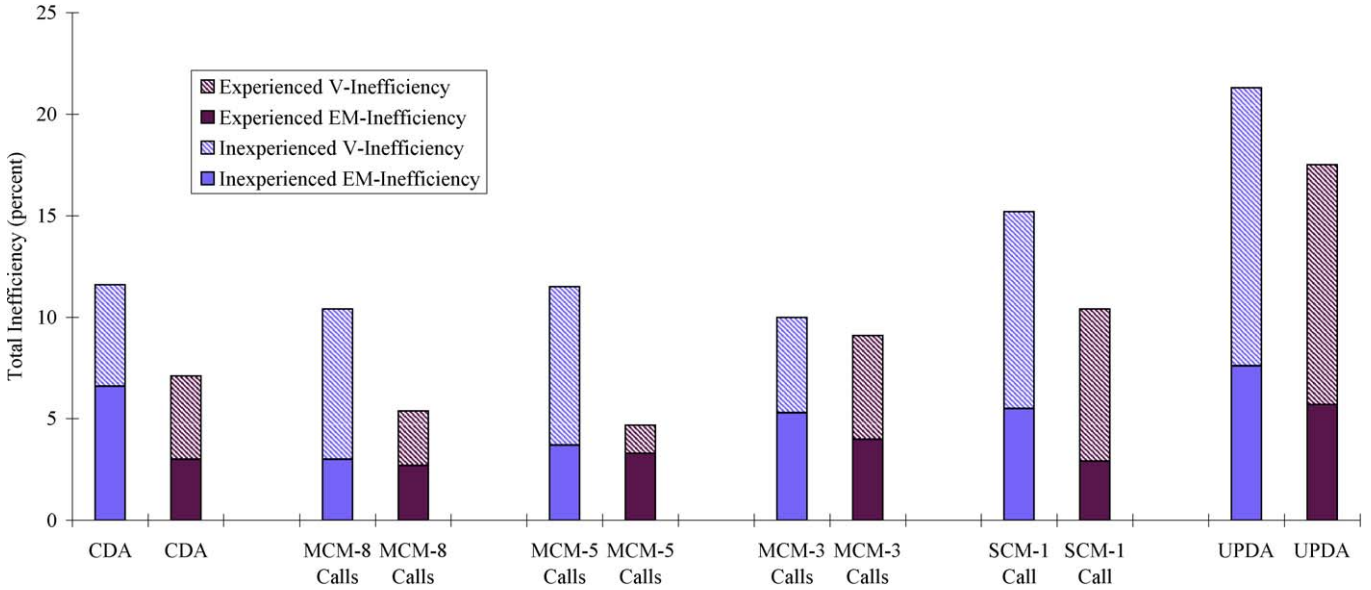
Two caveats are in order. First, we chose a thin, random-values environment because it provided the clearest view of the price formation process. It is not necessarily the most representative of important field environments, and the environmental robustness of our conclusions is not yet established. Second, several of the institutions have variants that may have different performance characteristics. In particular, McCabe, Rassenti, and Smith (1993) find that UPDA efficiency depends fairly sensitively on implementation details, and is not enhanced by two details we chose to maintain comparability to the CDA, viz., a fixed closing time and a two-side update rule.

4. Results

4.1. Market Efficiency

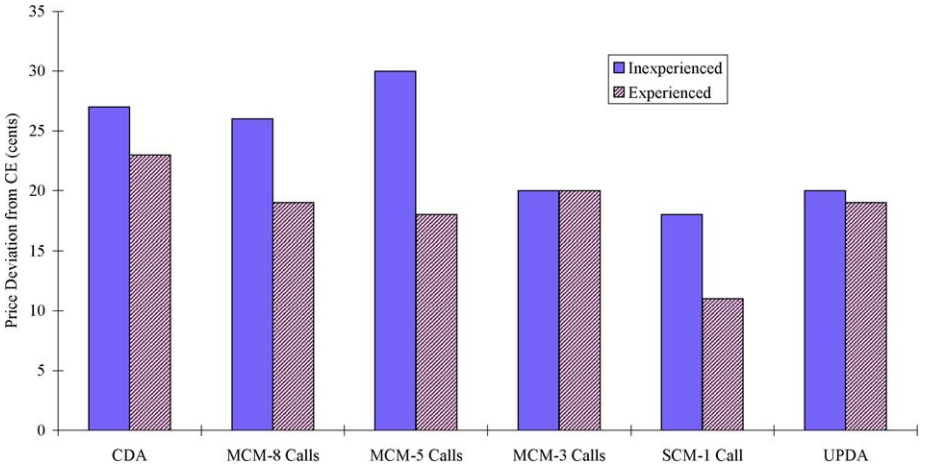
Define market *inefficiency* as the percentage of the maximum possible gains from exchange which traders fail to realize. Figure 2 summarizes the outcomes. Our most surprising finding is that UPDA is the most inefficient trading institution in this thin volume, random-values environment. In statistical tests based on a random effects model reported in Cason and Friedman (1999), we show that the UPDA inefficiency is significantly greater than the CDA inefficiency and is marginally significantly greater than the SCM inefficiency. UPDA inefficiency is also significantly greater than the inefficiency in all three MCM treatments.

Like UPDA, the SCM has only one transaction opportunity per period and has lower efficiency than the other institutions in both experience conditions. This provides some evidence that multiple trading opportunities are important to generate increases in efficiency. However, the differences between SCM efficiency and CDA and MCM efficiency are not statistically significant. Finally, note that the MCM institution generates efficient outcomes that compare favorably with (and are not statistically distinguishable from) the CDA outcomes, so it would appear that 3 to 5 calls per period are sufficient to generate market efficiency comparable to the CDA benchmark.



Note: CDA denotes continuous double auction; MCM denotes multiple call market; SCM denotes single call market; UPDA denotes uniform price double auction. Inefficiency falls with experience in all trading institutions. V-inefficiency arises when volume falls below the competitive equilibrium volume, and EM-inefficiency arises when extra-marginal units displace.

Figure 2. Trading inefficiency is greatest for the two institutions that permit only one transaction opportunity per period (UPDA and SCM), and inefficiency is lowest for the two institutions that permit multiple transaction opportunities per period (CDA and MCM).



Note: CDA denotes continuous double auction; MCM denotes multiple call market; SCM denotes single call market; UPDA denotes uniform price double auction.

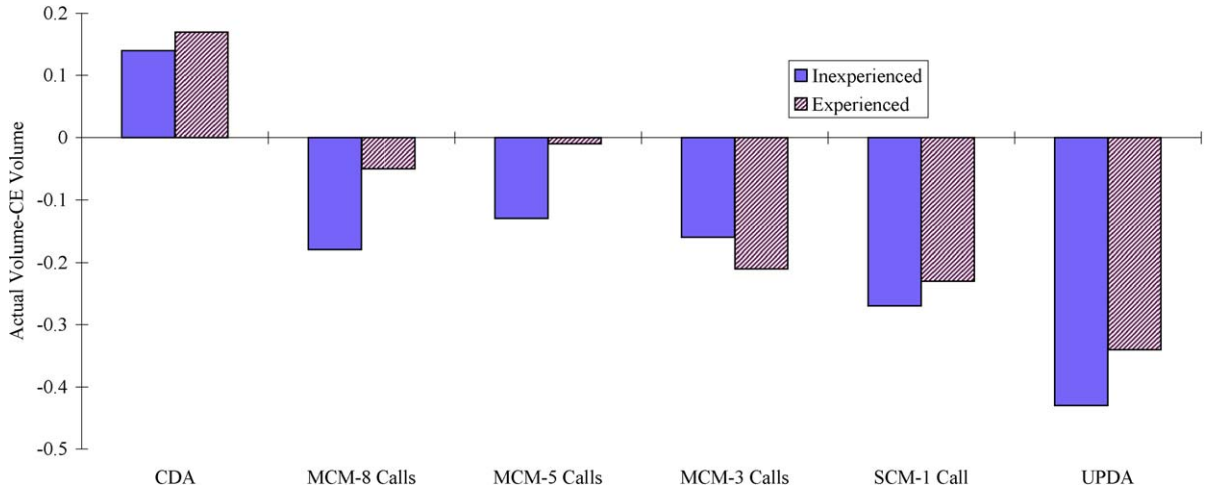
Figure 3. Mean absolute deviations from the competitive equilibrium are lowest in the SCM, in which all trades occur at one price; deviations tend to be greatest in the institutions that permit multiple transaction opportunities per period (CDA and MCM).

Efficiency can fall short of 100 percent if (a) traders with extra-marginal units transact (EM-inefficiency), or (b) profitable trades are not executed (low volume or V-inefficiency). The bars of Figure 2 distinguish the mix of V and EM inefficiency across institutions (see Cason and Friedman (1999) and Rust, Palmer, and Miller (1993) for details of this inefficiency decomposition). Both types of inefficiency are common, and in the inexperienced sessions the low volume efficiency losses exceed the extra-marginal efficiency losses in four of the six institutions. In all institutions the increase in efficiency due to experience generally occurs because of reductions in both types of inefficiency. In the 5-call and 8-call MCM, the reduction in V-inefficiency is quite pronounced. V-inefficiency is lowest for the CDA and MCM sessions, probably due to the multiple transaction opportunities permitted by these institutions.

4.2. Transaction Prices

The standard benchmark for price is the competitive equilibrium (CE), which equates true demand and true supply for the value and cost realization that period. In our thin, random values environment in nearly every period there exists a *range* of CE prices. Mean transaction prices in a period are within the CE range in less than one-half of the periods for all institutions. (The CDA and MCM final transaction prices, not shown here, are within the CE range no more often.)

Figure 3 presents the mean absolute deviation of average transaction prices (each period) from the nearest endpoint of the CE range. Of course, the price deviation is 0 if



Note: CDA denotes continuous double auction; MCM denotes multiple call market; SCM denotes single call market; UPDA denotes uniform price double auction.

Figure 4. Trading volume increases with experience, and exceeds the CE volume in the CDA; volume roughly declines with the number of transaction opportunities in the MCM, and is lowest in the UPDA.

average prices are within the CE range. Price deviations are smallest in the SCM, and are largest (at least for experienced traders) in the CDA. Statistically speaking (again, see Cason and Friedman (1999) for details), the CDA mean price deviation exceeds: (1) the UPDA mean price deviation; (2) the 3-call MCM mean price deviation; and (3) the SCM mean price deviation. The SCM mean price deviation is also lower than the 5-call MCM mean price deviation and the 8-call MCM mean price deviation. The other mean price deviations are not significantly different.

4.3. Transaction Volume

The competitive equilibrium (CE) also provides a benchmark for trading volume. CE volume ranges from 0 to 4 units but usually is 2 or 3. Figure 4 shows that actual transaction volume increases with experience in every institution, with the minor exception of the 3-call MCM. Volume is highest in the CDA, where it exceeds the CE benchmark. Volume falls below the CE benchmark in the other institutions and declines almost monotonically with the number of calls in MCM and SCM. It is lowest in UPDA. Cason and Friedman (1999) report that most of these differences are statistically significant.

5. Discussion

The comparison of four trading institutions in a thin market, random values environment supports the following general conclusions. First, trading efficiency in the uniform price double auction is lowest, and the single call market efficiency is second lowest. This suggests that multiple trading opportunities, as in the continuous double auction and the multiple call market, help generate high efficiency. Second, the primary source of efficiency losses in these (single opportunity) institutions is insufficient trading volume. Third, transaction prices are less accurate on average (in that they deviate more from competitive equilibrium levels) in the continuous double auction and multiple call market. Taken together, these results highlight a key tradeoff when the trading institution permits multiple transaction opportunities. Multiple transaction opportunities substantially reduce (low volume) inefficiency due to underrevelation of traders' true values and costs, but also reduce pricing accuracy because traders allow more noise when negotiating transactions.

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