2. Competitive Trading Institutions

- The double auction institution
  - Early results
  - Extreme earnings inequality
  - Response to shocks
  - Multiple interrelated markets
  - Duopoly and monopoly
  - The role of culture
  - Zero Intelligence Traders
  - Asset markets
  - Labor markets (lack of contract enforcement)
- Posted offer markets
  - Comparison with double auction
  - Extreme earnings inequality
  - Response to shocks
  - Posted offer monopoly

Assumptions of Perfect Competition

- Agents are rational and selfish utility or profit maximizers
- A homogeneous well defined good is traded
- There are numerous firms and consumers
- Agents are price takers

- All these assumptions can frequently be questioned
  - In many instances people are boundedly rational
  - People often have interdependent utility functions
  - There are many markets with only a few firms
  - In most markets there is no auctioneer but agents set prices.

Questions

- Do these deviations from the assumptions constitute negligible frictions or do they seriously challenge the predictive power of the model?
  - Answer is important because of the first and the second welfare theorems
- Are there “real” market institutions for which the competitive equilibrium is a good predictor of price and quantity outcomes?
- How do different market institutions affect efficiency and convergence to the competitive equilibrium?

Chamberlin‘s Experiment

- **Chamberlin (1948)** conducted a market experiment in which prices and quantitites failed to converge to the competitive equilibrium.
    - Subjects bargained bilaterally.
    - Trading prices were written on the blackboard.

- Chamerlin’s aim was to refute the competitive model.

V. Smith‘s Experiment

- Vernon Smith introduced two changes relative to Chamberlin’s trading institution:
  - (Oral) double auction instead of bilateral bargaining.
  - Stationary replication, i.e., there were several trading days with the same supply and demand structure.
  - There should be a chance that the market equilibrates over time.
- “These two changes seemed to me the appropriate modifications to **do a more credible job of rejecting competitive price theory**, which after all, was for teaching, not believing (everyone at Harvard knew that, and you just knew, deep down, that those Chicago guys also knew it).” (Smith 1991, p. 155)

The Double Auction

- Each buyer i is paid according to $[B_i(x_i) - \Sigma p_i]$ where x_i denotes the number of goods bought. This induces the inverse individual demand function $B_i'(x_i)$.
- Each seller i is paid according to $[\Sigma p_i - S_i(x_i)]$ which induces the individual supply schedule $S_i'(x_i)$.
- There is a limited time for trading per "market day". If trading ceases before the time limit is reached the "day" ends.
- Within a market period a buyer can make price bids to the group of sellers for a specified quantity and/or accept a seller's price offer for a specified quantity at any point in time.
- Within a market period a seller can make price offers to the group of buyers for a specified quantity and/or accept a buyer's price bid for a specified quantity at any point in time.
- Improvement rule: A new bid must be better (higher) than the highest standing bid. A new offer must be better (lower) than the lowest standing offer.
- If a bid (offer) is accepted a binding contract is concluded.
- Individuals only know their own $B_i(x_i)$- or $S_i(x_i)$- schedules.

What is the prediction?

"The mere fact that ... supply and demand schedules exist in the background of a market does not guarantee that any meaningful relationship exists between those schedules and what is observed in the market they are presumed to represent. **All the supply and demand schedules can do is set broad limits on the behaviour of the marke**t. ... In fact, these schedules are modified as trading takes place. Whenever a buyer and a seller make a contract and "drop out" of the market, the demand and supply schedules are shifted to the left in a manner depending on the buyer's and seller's position on the schedules. **Hence the supply and demand functions continually alter as the trading process occurs.** It is difficult to imagine a real market process which does not exhibit this characteristic." (Smith 1991, p. 12)

- Nothing ensures that trade will take place at the CE. Notice that the number of CE-trades is in general smaller than the number of economically feasible trades. In principle it might be possible that all feasible trades take place (see Chart 1, Smith 1962).
- There exists no *rigorous* theory about behaviour in the DA (though see Sadrieh 2000).

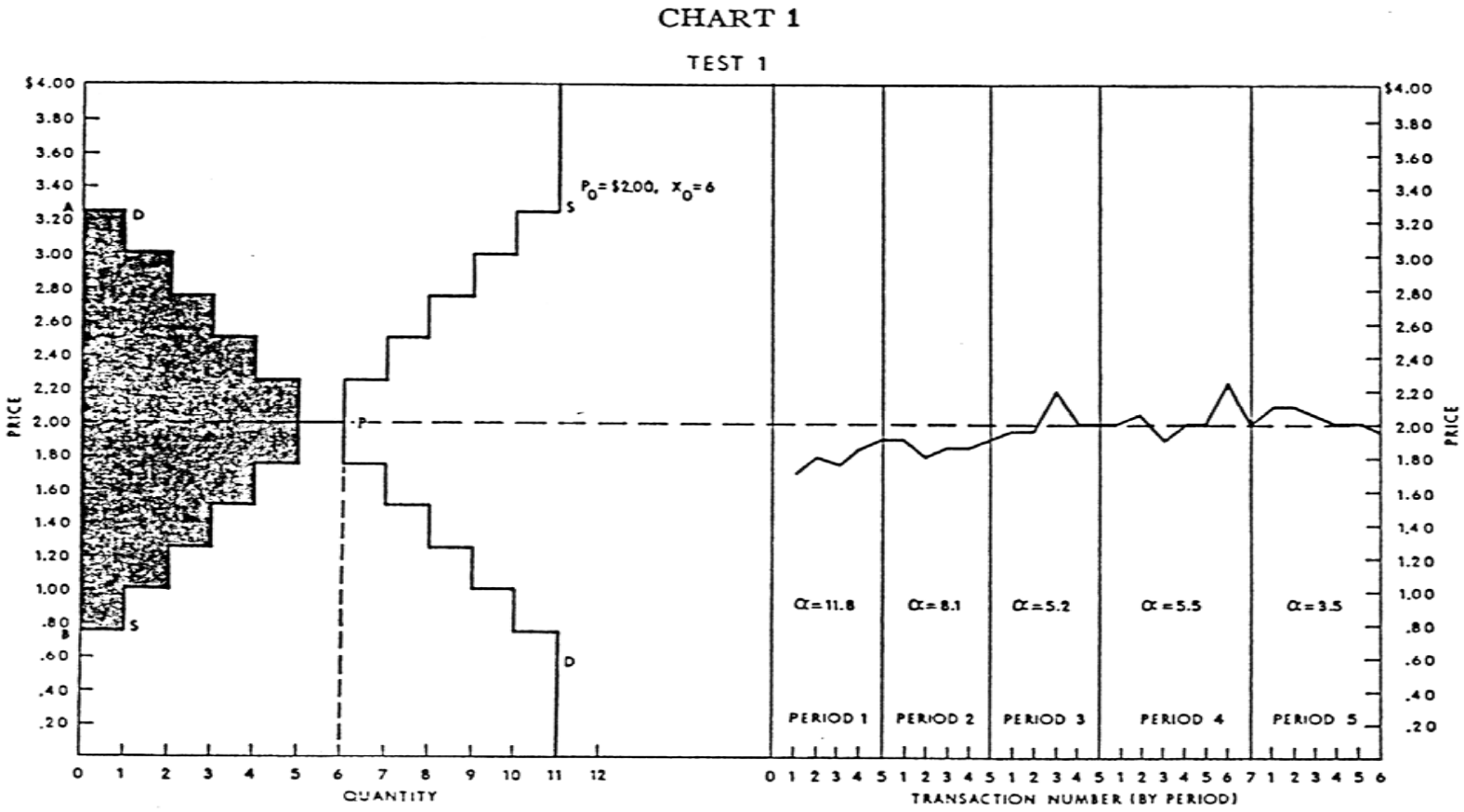
Hypothesis

- „Prices converge to the CE“
  - define: α = standard deviation of trading prices in a period relative to the CE-price.
  - α decreases over time.

- „Trading efficiency is high“
  - Efficiency = sum of realized incomes/maximal aggregate income

Symmetric Supply and Demand Functions prices converge (α declines)

Based on Smith (1962)

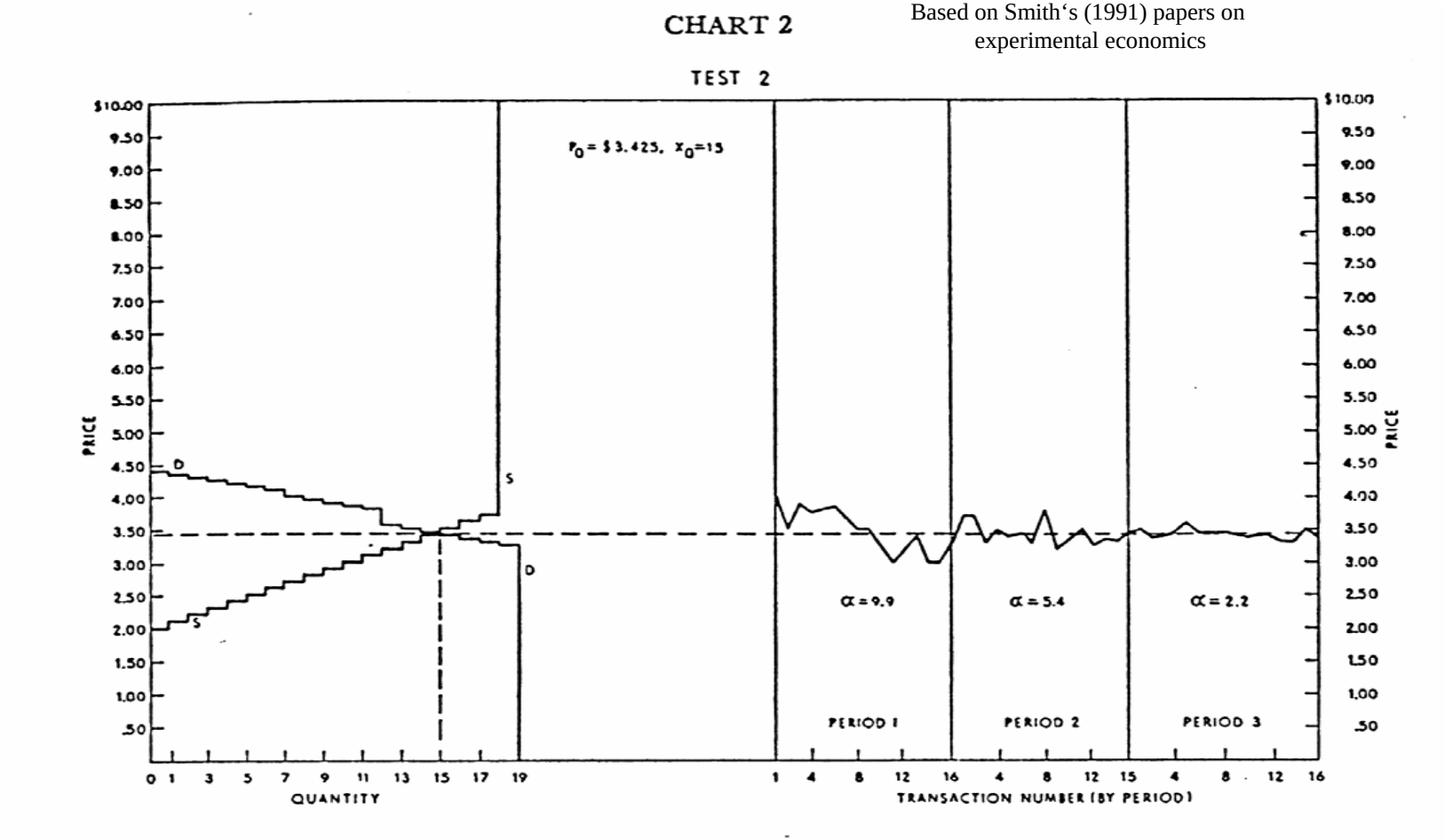


It can‘t be true!

“I am still recovering from the shock of the experimental results. The outcome was unbelievably consistent with competitive price theory. ... But the result **can’t** be believed, I thought. It must be an accident, so I will take another class and do a new experiment with different supply and demand schedules.” (Smith 1991, p. 156)

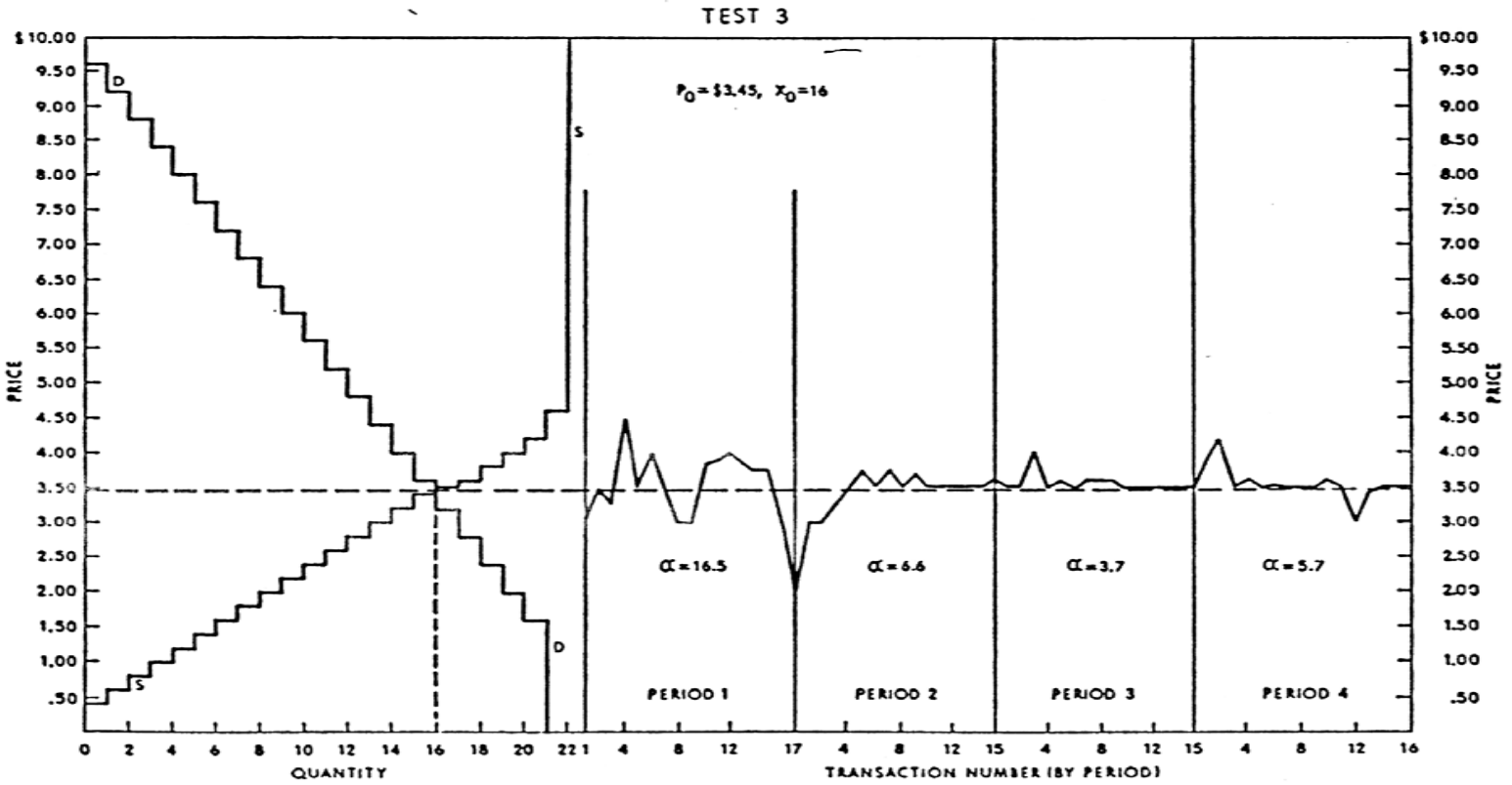
Very quick convergence with flat demand & supply schedules

Based on Smith's (1991) papers on experimental economics



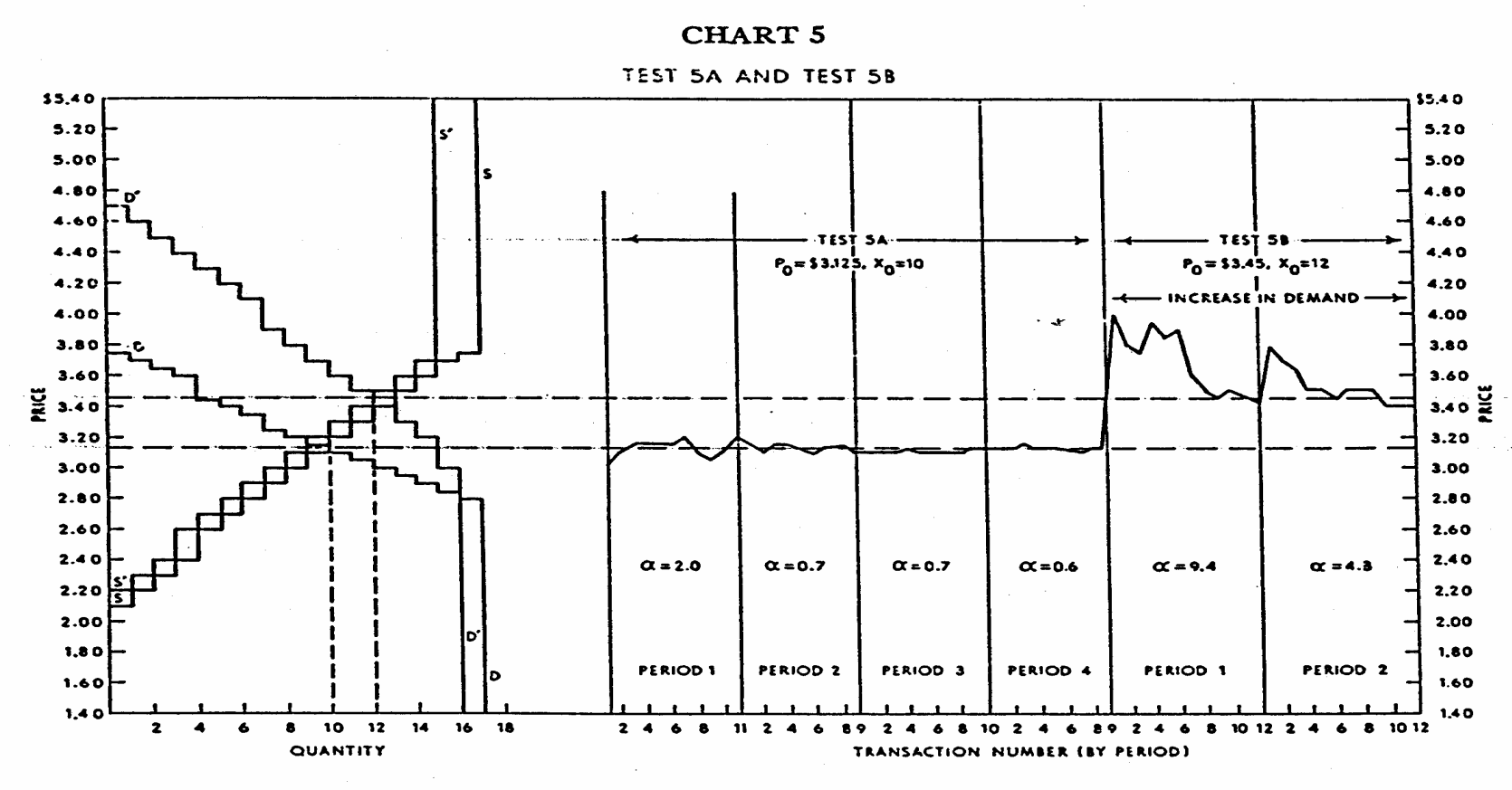
Somewhat less quick convergence with steep demand & supply schedules

Based on Smith's (1991) papers on experimental economics



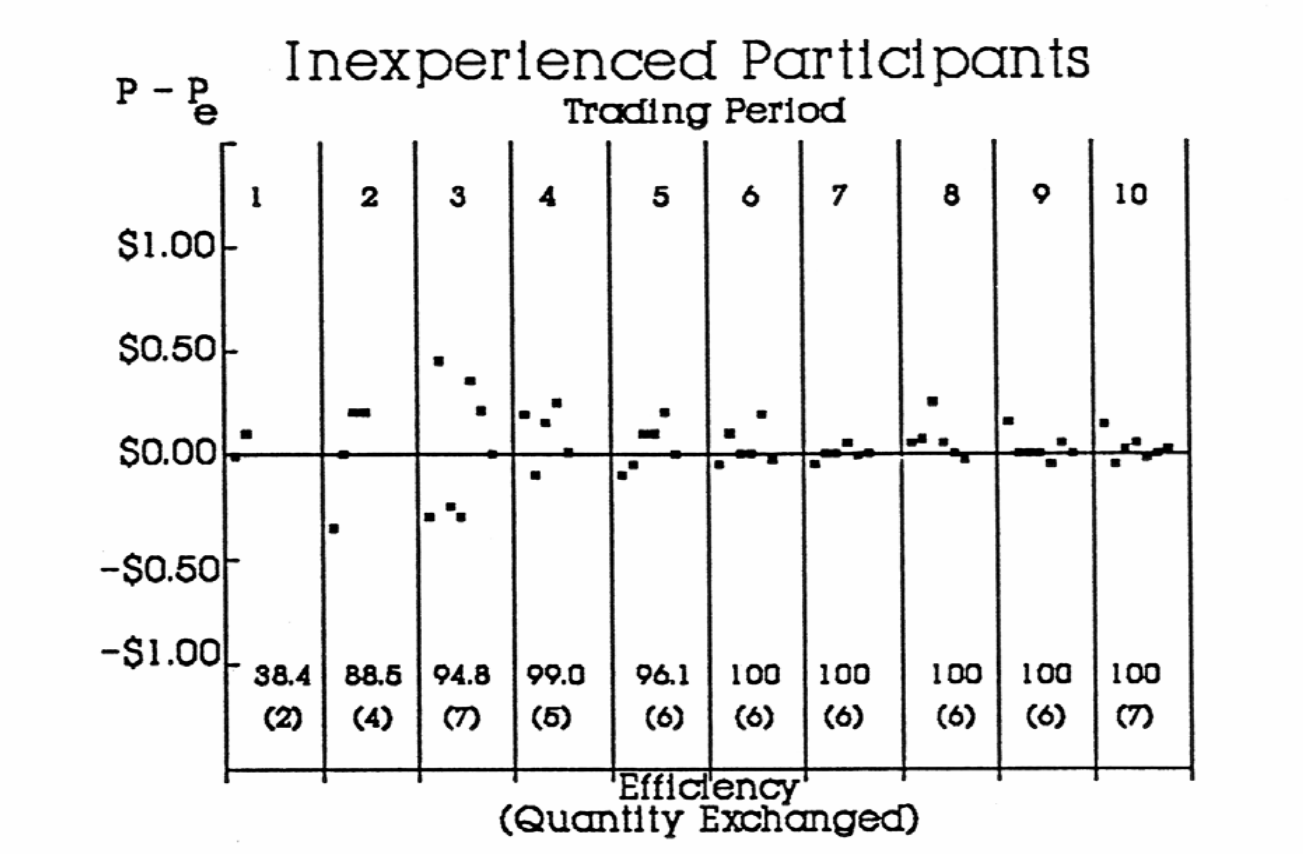
Market responds quickly to changes in equilibrium prices

Based on Smith's (1991) papers on experimental economics



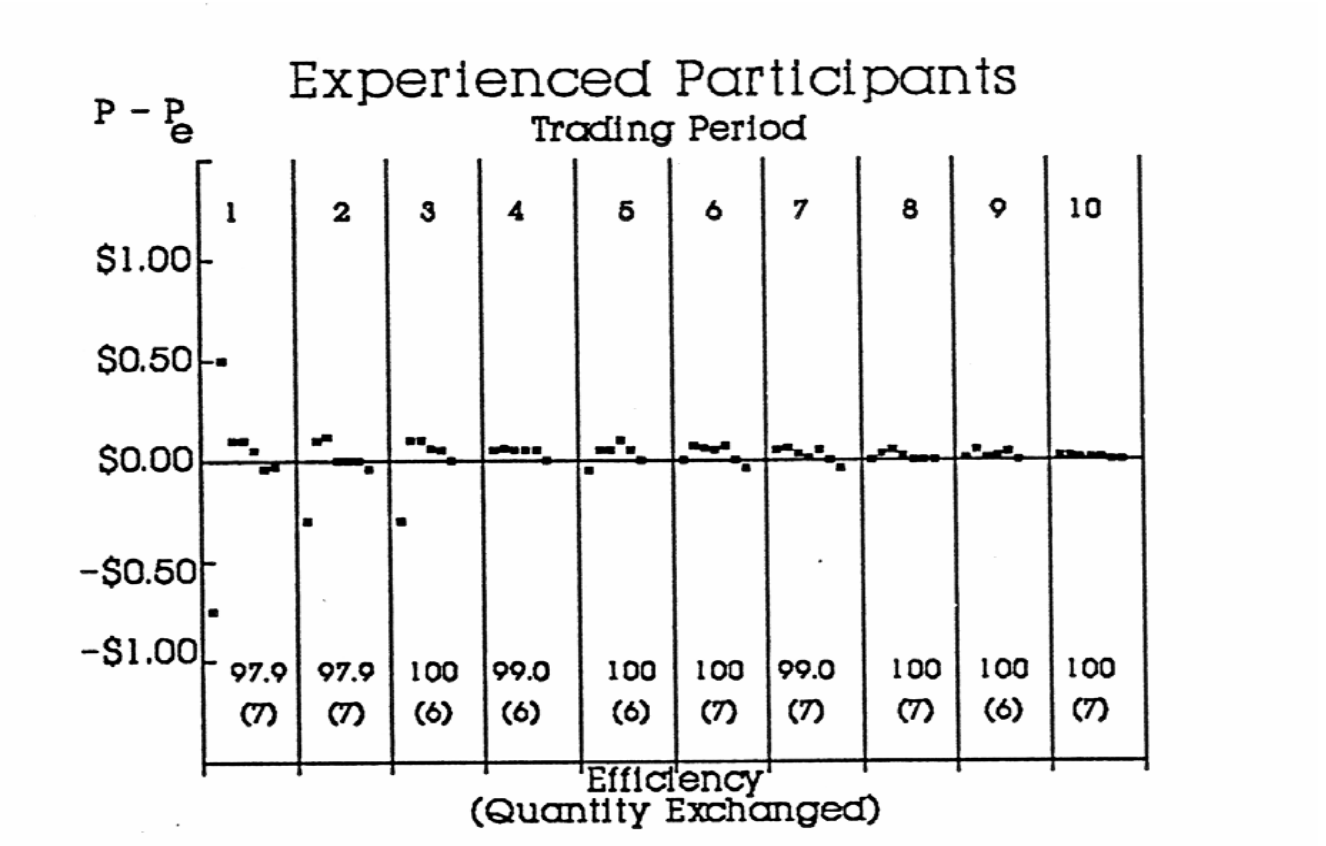
The Effects of Experience

Based on Davis & Holt (1993)



The Effects of Experience

Based on Davis & Holt (1993)



Summing Up

"In 1960 I wrote up my results and thought that the obvious place to send it was the Journal of Political Economy. It's surely a natural for those Chicago guys, I thought. What have I shown? I have shown that with

- remarkably little learning,
- strict privacy, and
- a modest number (of traders, E.F.),
- inexperienced traders

converge rapidly to a competitive equilibrium under the double auction institution mechanism. **The market works under much weaker conditions than had traditionally been thought to be necessary.**

- You didn't have to have large numbers.
- Economic agents do not have to have perfect knowledge of supply and demand.
- You do not need price-taking behaviour - everyone in the double auction is a price maker as much as a price taker.

A great discovery, right? Not quite, as it turned out. At Chicago they already knew that markets work. Who needs evidence?" (Smith, 1991, p. 157)

Robustness Check I – Extreme Earnings Inequality

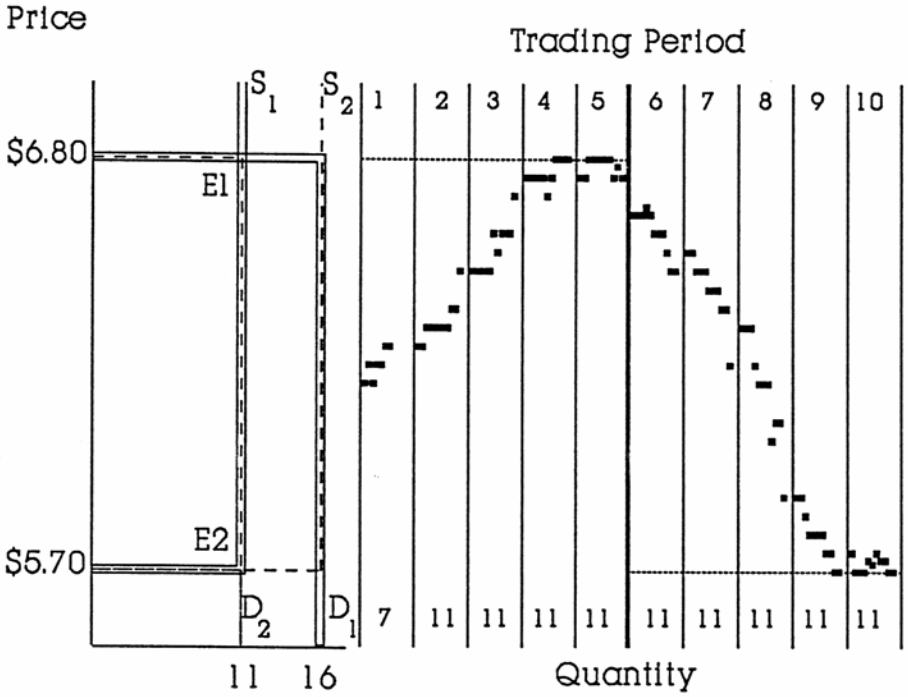


Figure 3.5 Contract Prices for a Box Design: First with Excess Demand, then with Excess Supply (Source: Holt, Langan, and Villamil, 1986)

The Role of Trading Commissions

- To facilitate adjustment towards equilibrium experimenters often paid a small commission fees per trade to the subjects. This induces subjects to trade even when their gains from trade are very small.
- Advantage
    - CE prediction is more likely to be met.
- **Decisive Disadvantage**
    - Prediction may change as a result of the fee.
    - Experimenter may overlook behavioral forces that create market frictions.

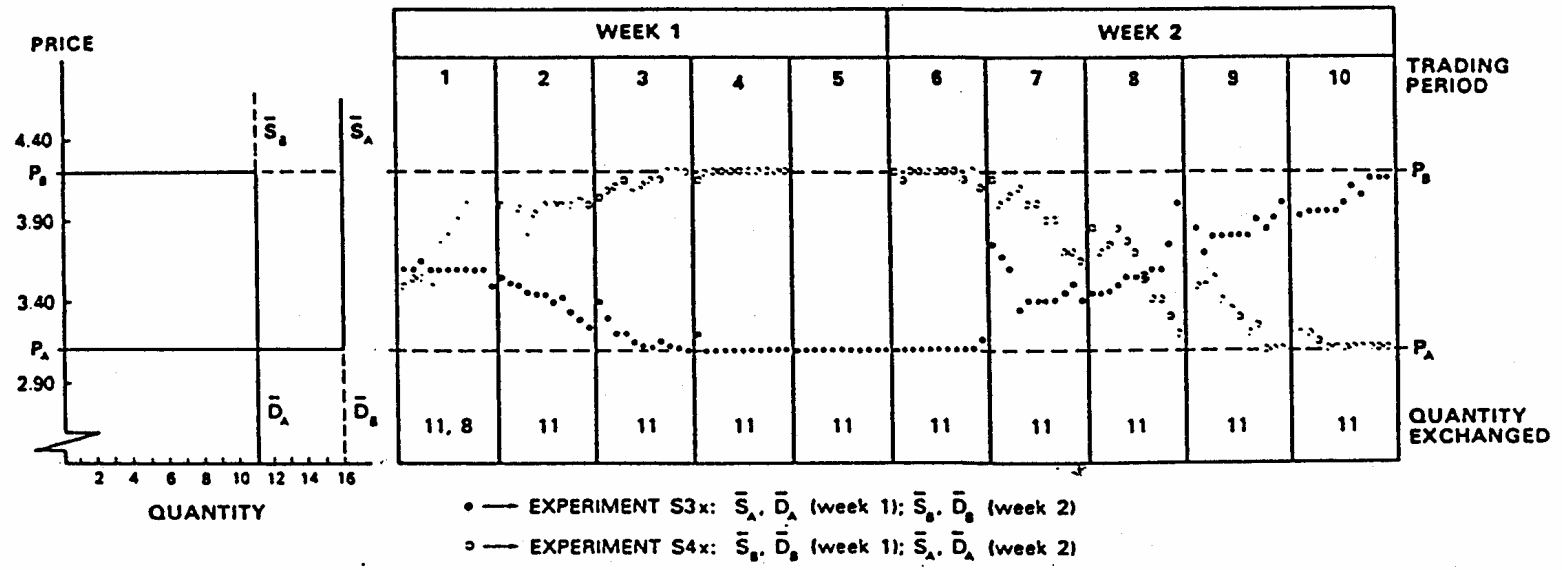


FIGURE 11. Swastika Experiments S3x and S4x: $.10 Commission

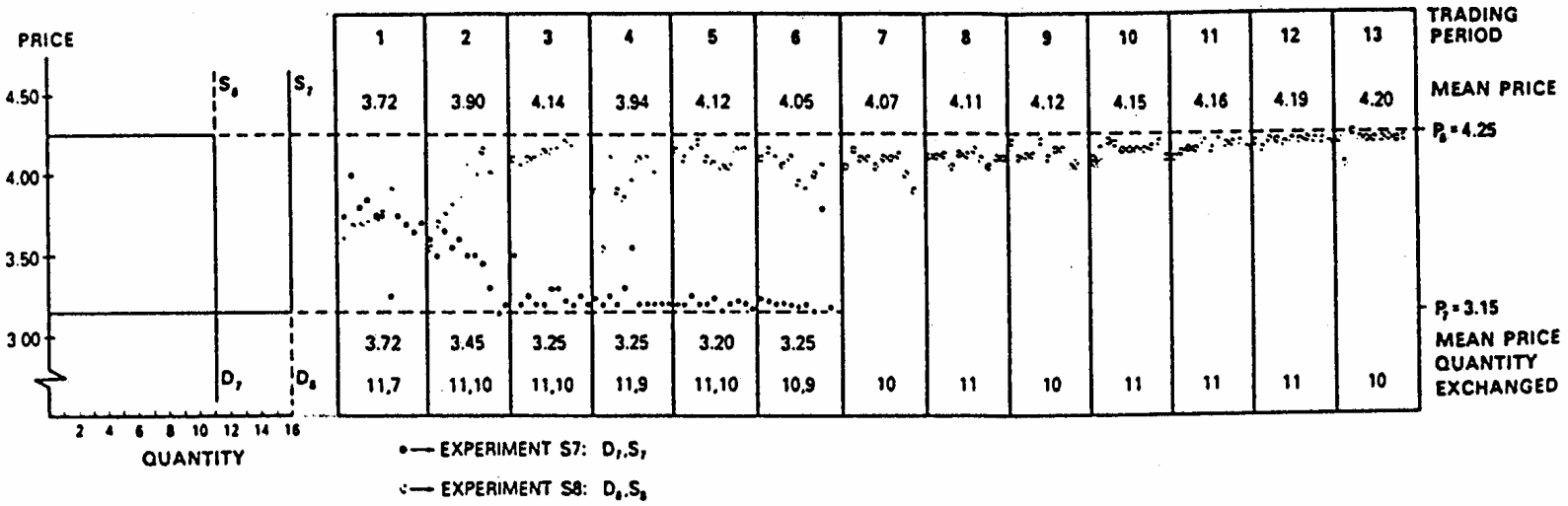


FIGURE 13. Swastika Experiments S7 and S8: Zero Commission

Robustness Check II – Cyclical Supply and Demand

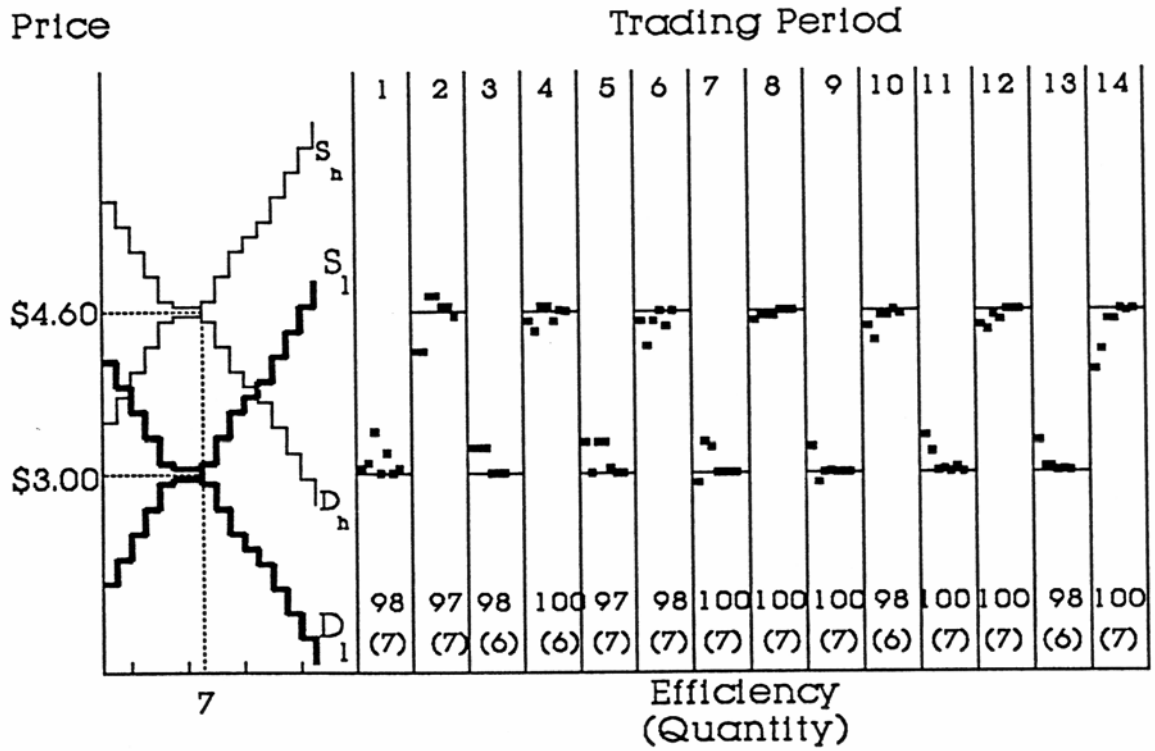


Figure 3.7 Contract Price Sequences with Cycling Supply and Demand
(Source: Williams and Smith, 1984)

Robustness Check III – Trading in Multiple Markets

Sellers have linear cost functions and can sell in two markets.
Buyers have non-linear induced utility functions V(x,y) and can buy in both markets.
Buyers have an exogenously given income.
Attainment of equilibrium is analogous to the solution of a set of non-linear simultaneous equations.
Subjects have role and environment experience.
In ten of 15 market sessions the same convergence standard as in the figure has been achieved.

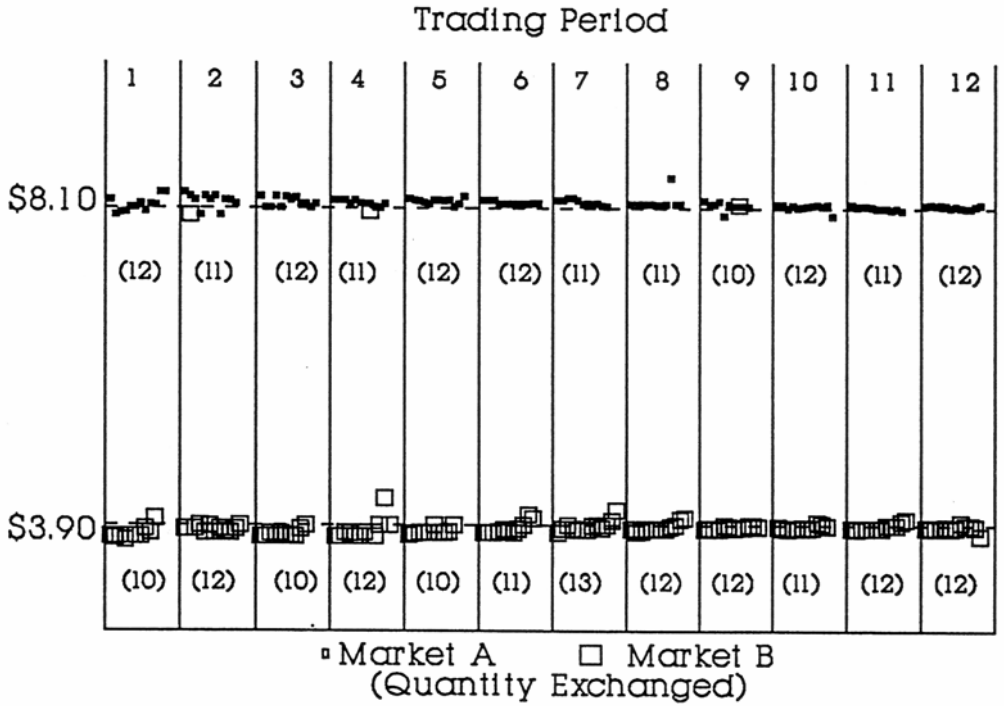


Figure 3.15 The Price Sequence for a Multiple-Commodity Double Auction (Source: Session 4pda009, Williams, Smith, and Ledyard, 1986)

Robustness Check IV - Duopoly and Monopoly (Smith Williams 1990)

- Duopoly
  - Prediction depends on whether sellers set prices or quantities. In the DA sellers and buyers set prices as well as quantitites.
  - Results for DA: In case of two sellers and 1 buyer there is convergence to the CE
- Monopoly
  - Seller commits to the monopoly price and sells whatever he can at this price.
  - Result: Fig 5,6,8: Attempts at price discrimination lead ultimately to the CE.

- Effectiveness of Monopoly = $\frac{\text{(Average price – CE price)}}{\text{(Monopoly price – CE price)}}$

TABLE 1. Design Parameters for Duopoly (D) and Monopoly (M) Experiments

Experiment	Number of buyers	Commission per trade	Buyers' Profit per period at CE	Sellers' Profit per period at CE	Sellers' Profit per period at P_M
D1	5	\$.05	\$2.80	\$1.00 (\$.50 per seller)	\$2.40 (\$1.20 per seller)
D2x	6	\$0	\$2.80	\$1.90 (\$.95 per seller)	\$3.30 (\$1.65 per seller)
D3x D4x	10	\$.10	\$5.60	\$2.20 (\$1.10 per seller)	\$4.90 (\$2.45 per seller)
M1x M2x M3x M4xs M5x	5	\$.10	\$2.80	\$1.10	\$2.45

"x" experiment suffix denotes all experienced subjects.
"xs" experiment suffix denotes experienced seller only.
Profits are calculated exclusive of any trading commissions.
CE profits for D2x are calculated at the midpoint of the CE range.

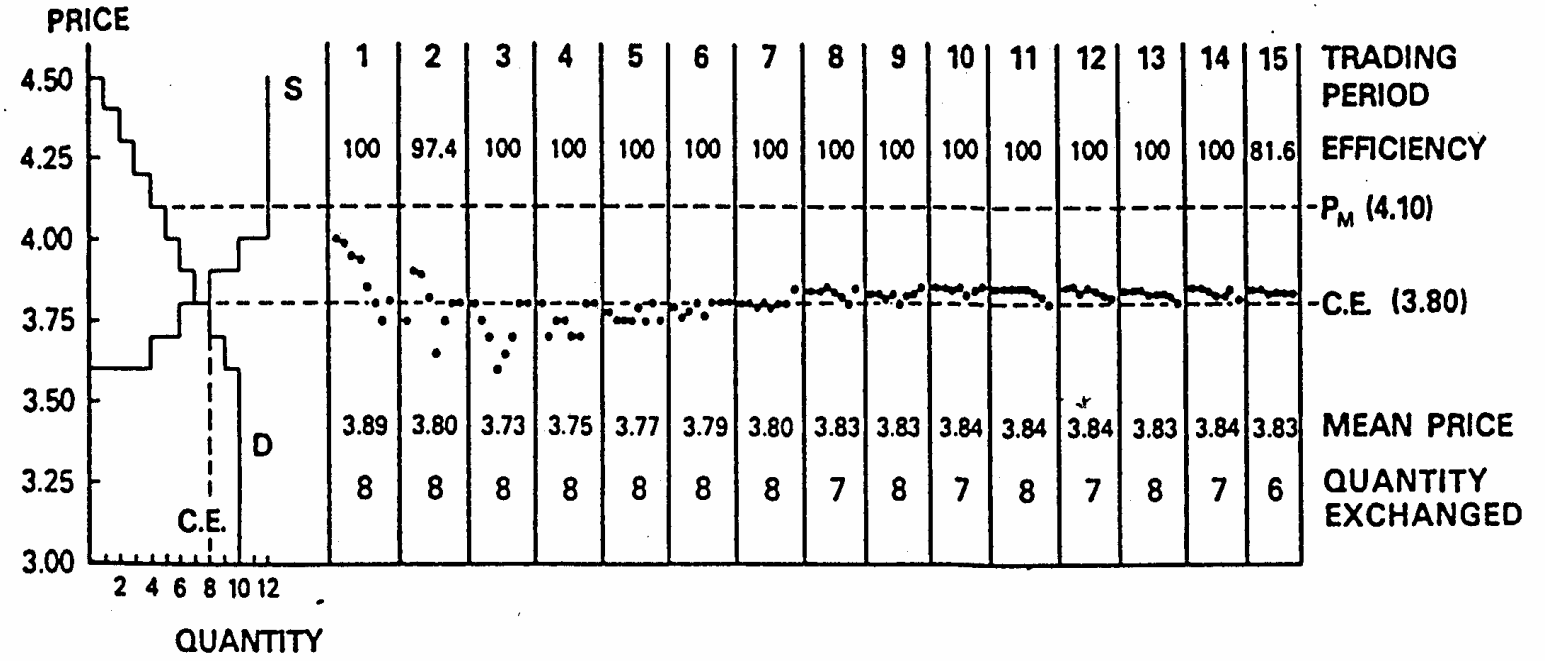


FIGURE 1. Duopoly Experiment D1

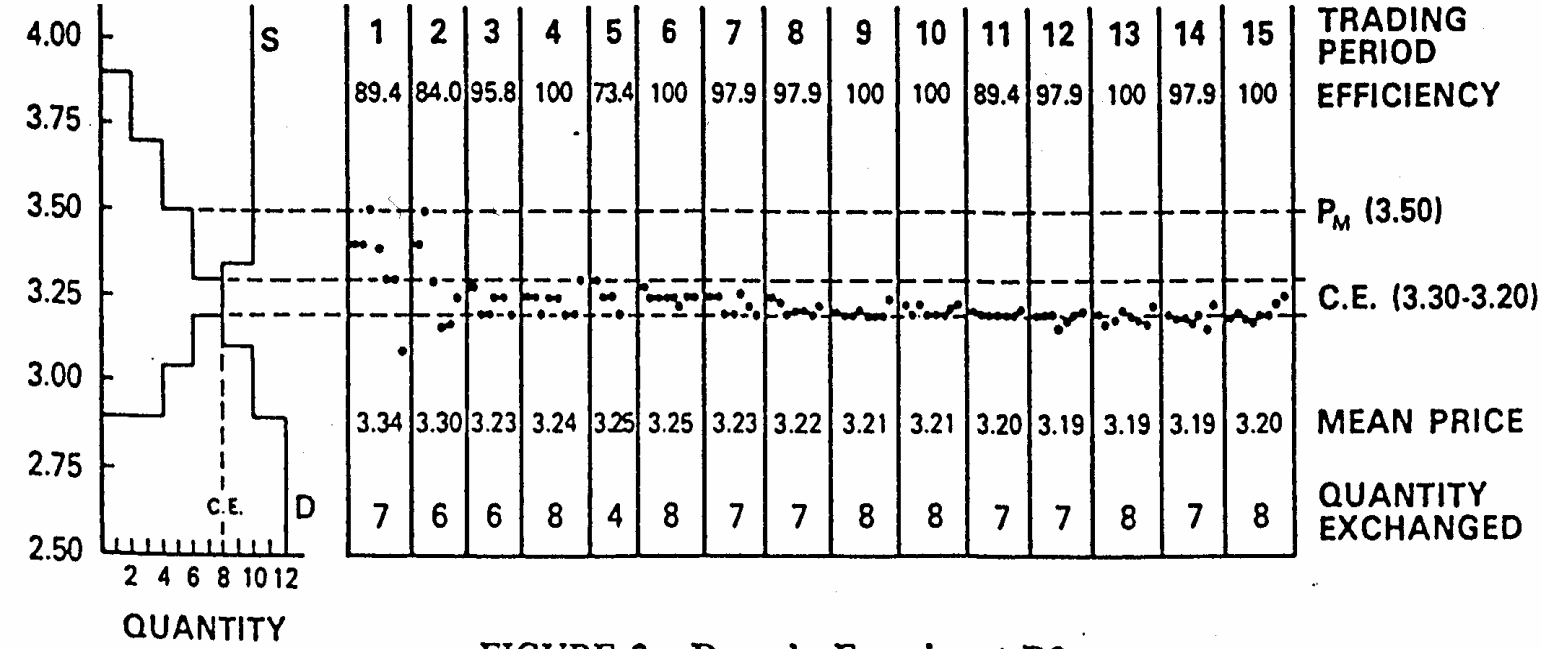


FIGURE 2. Duopoly Experiment D2x

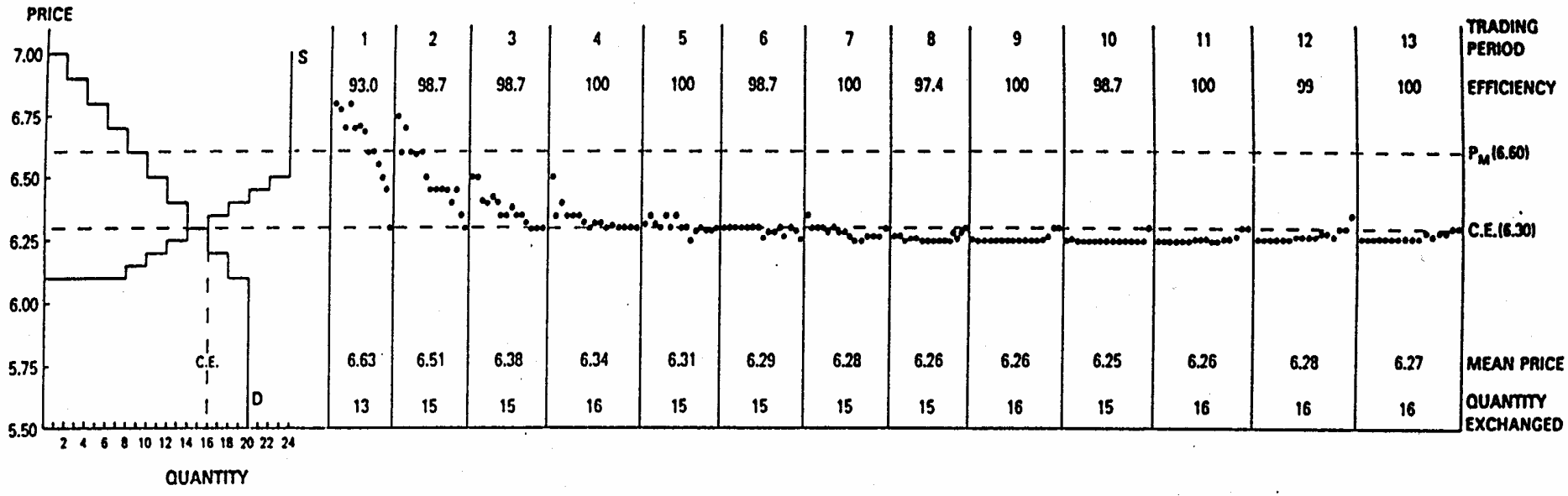


FIGURE 3. Duopoly Experiment D3x

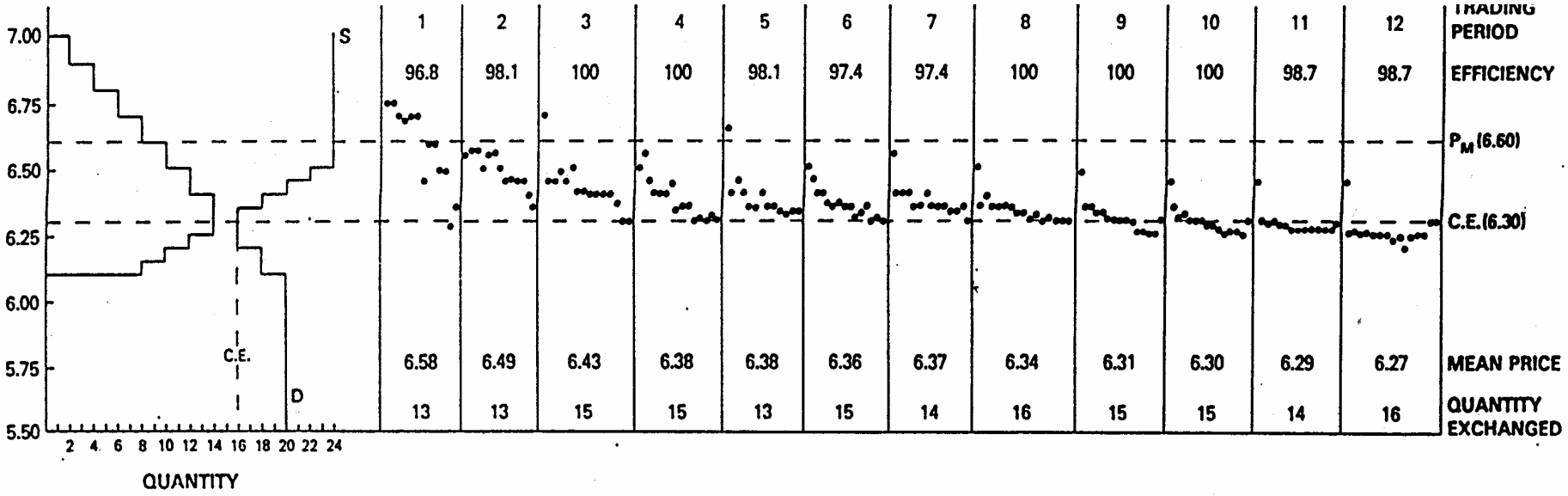


FIGURE 4. Duopoly Experiment D4x

Monopoly and Double Auction

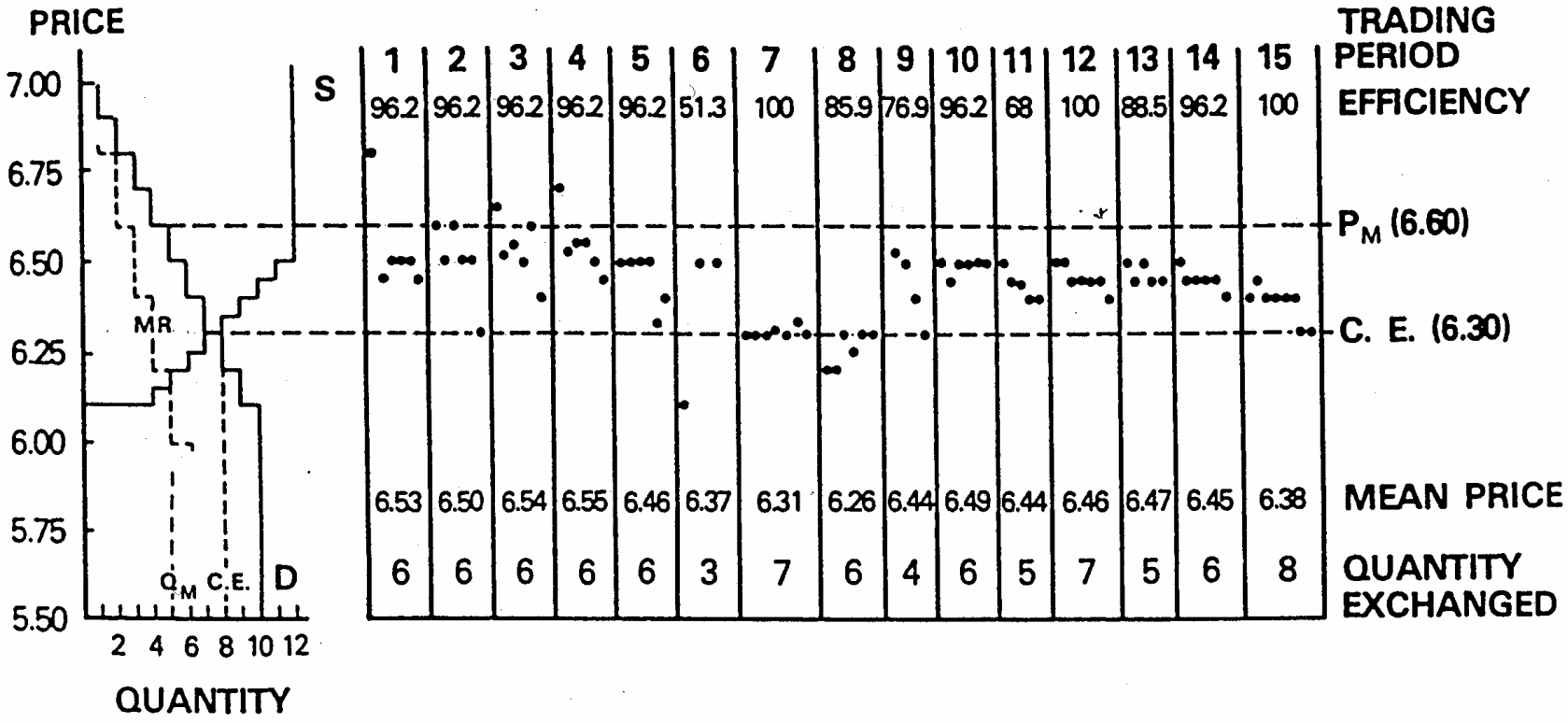


FIGURE 7. Monopoly Experiment M3x

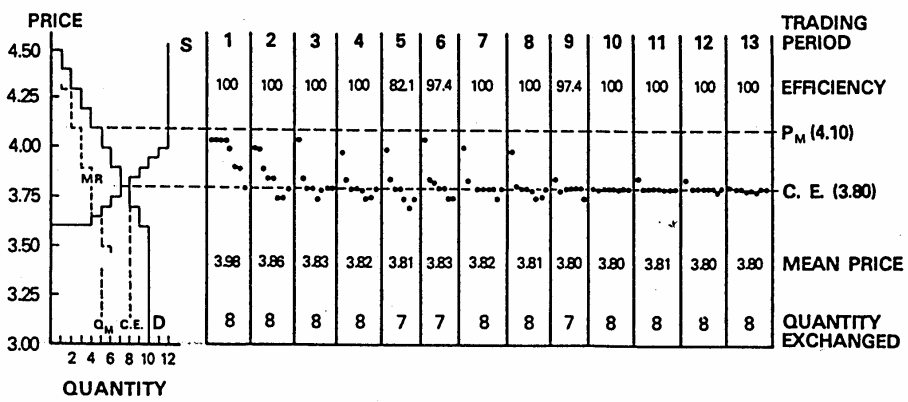


FIGURE 5. Monopoly Experiment M1x

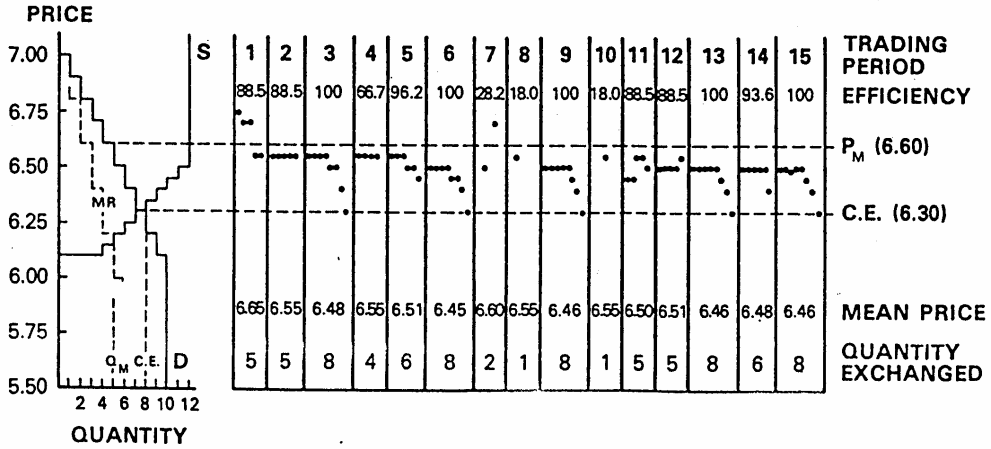


FIGURE 6. Monopoly Experiment M2x

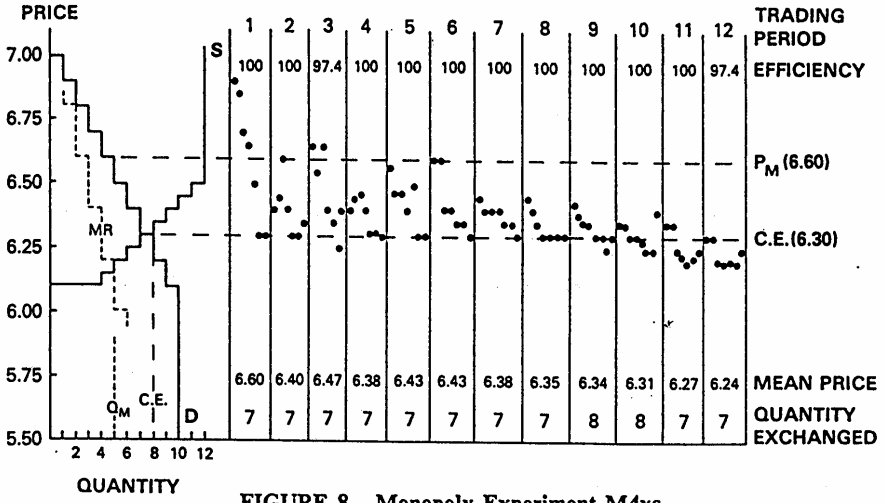


FIGURE 8. Monopoly Experiment M4xs

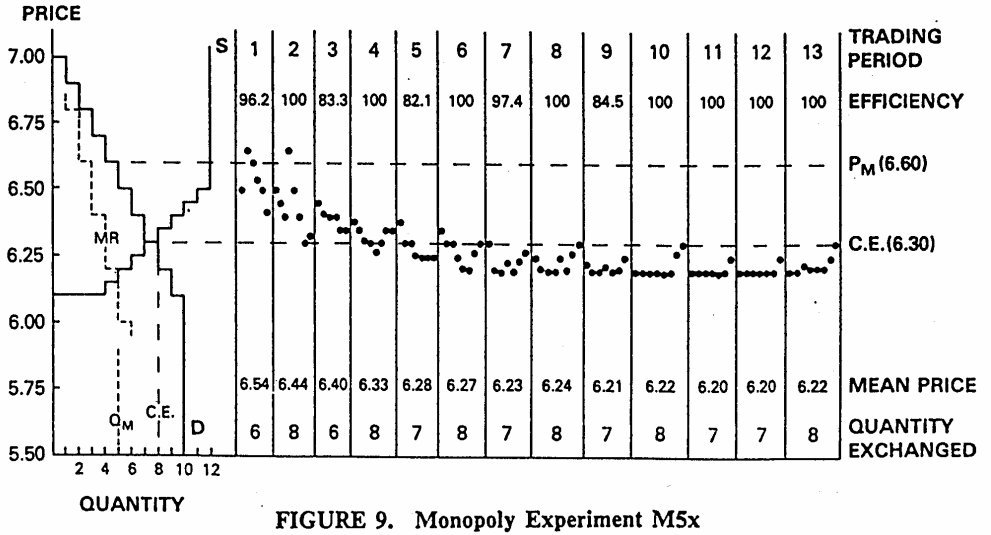


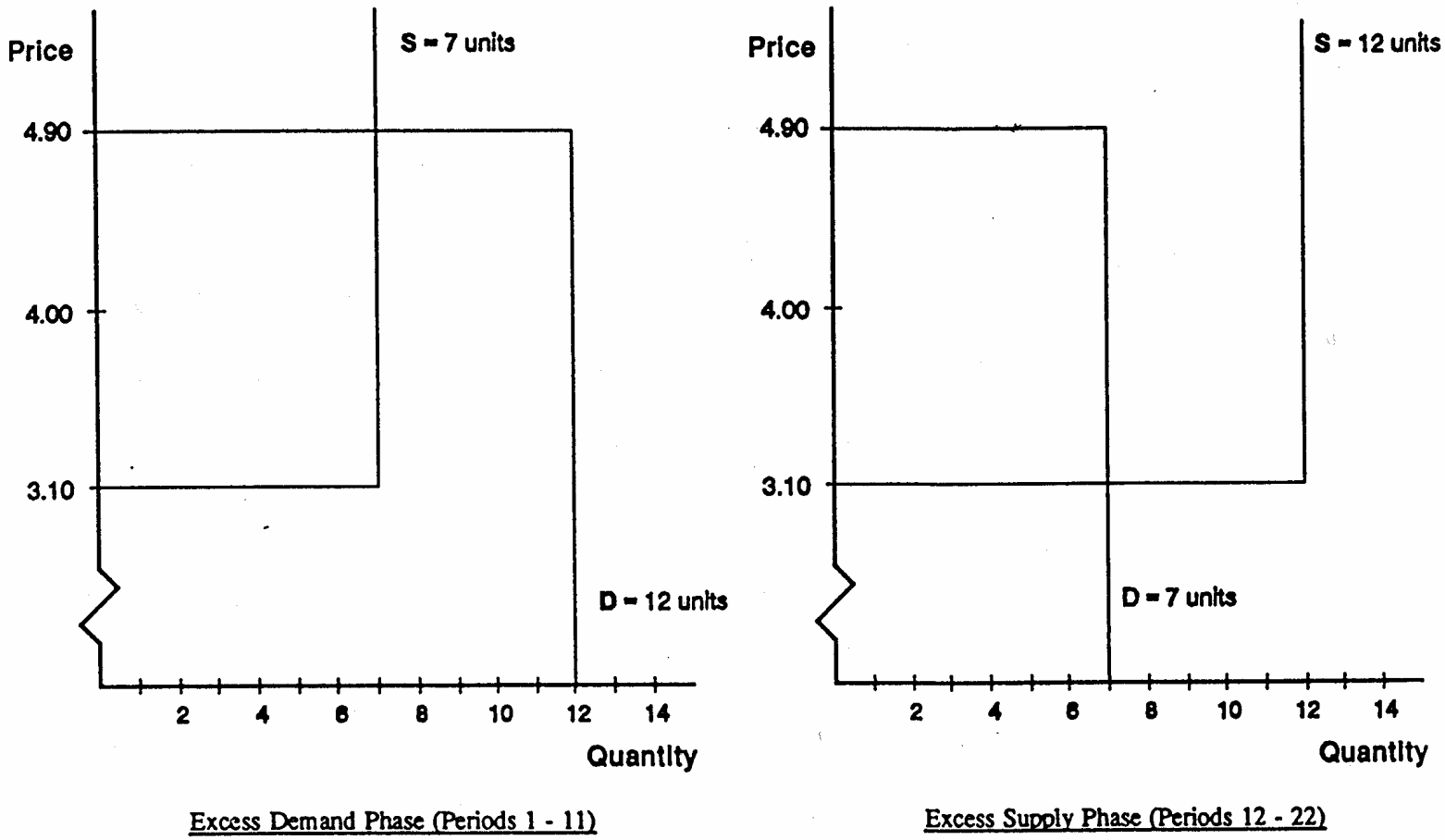
FIGURE 9. Monopoly Experiment M5x

TABLE 2. Index of Monopoly Effectiveness

Trading Period	Duopoly Experiments				Monopoly Experiments				
	D1	D2x	D3x	D4x	M1x	M2x	M3x	M4xs	M5x
1	.49	.41	1.46	1.32	1.04	1.19	1.00	1.56	1.01
2	−.03	.01	1.13	.90	.38	.81	.86	.52	.84
3	−.43	−.16	.42	.71	.19	1.11	1.01	.86	.39
4	−.29	−.07	.22	.45	.10	.52	1.06	.42	.16
5	−.17	−.46	.03	.39	.04	.93	.65	.69	−.08
6	−.08	0	−.06	.31	.17	.89	−.22	.67	−.16
7	.02	−.15	−.09	.38	.15	−.07	.03	.41	−.35
8	.17	−.19	−.21	.24	.07	−.48	−.22	.25	−.37
9	.15	−.24	−.24	.06	−.01	.93	.19	.21	−.44
10	.22	−.22	−.26	0	−.01	−.48	.81	.07	−.48
11	.23	−.27	−.23	−.04	.04	.63	.40	−.18	−.50
12	.20	−.32	−.16	−.20	.03	.70	.81	−.31	−.49
13	.16	−.31	−.18		−.01	.93	.52		−.44
14	.18	−.32				.78	.63		
15	.07	−.26				.92	.48		
MEAN	.06	−.17	.14	.38	.17	.62	.53	.43	−.07

Robustness Check V - The Role of Culture

- Double Auctions in China and USA/Canada with strong earnings inequality in equilibrium.
    - No cultural differences regardless of whether induced values are private or public information.
    - Introduction of private payoff information strongly strengthens resistance against equilibrium adjustment.



Excess Demand Phase (Periods 1 - 11)

Excess Supply Phase (Periods 12 - 22)

Fig. 1. Laboratory market design.

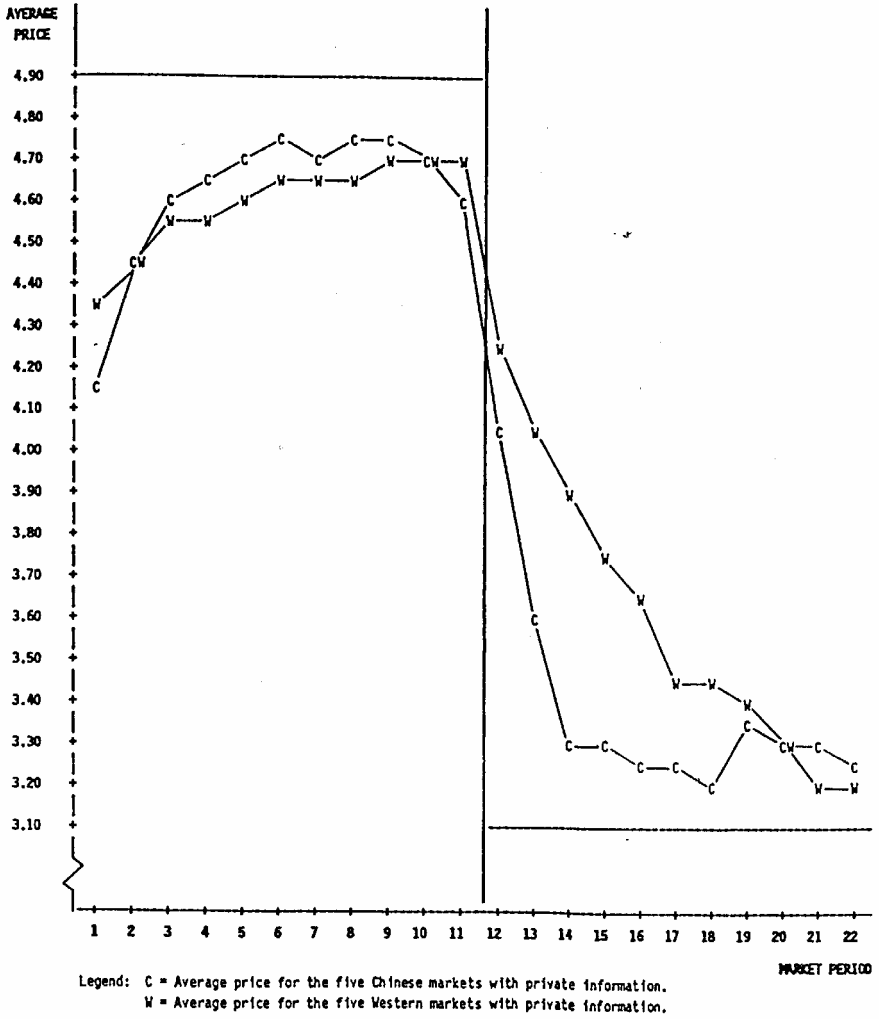


Fig. 2. Average negotiated prices in the private information markets.

S.J. Kachelmeier and M. Shehata, Culture and competition

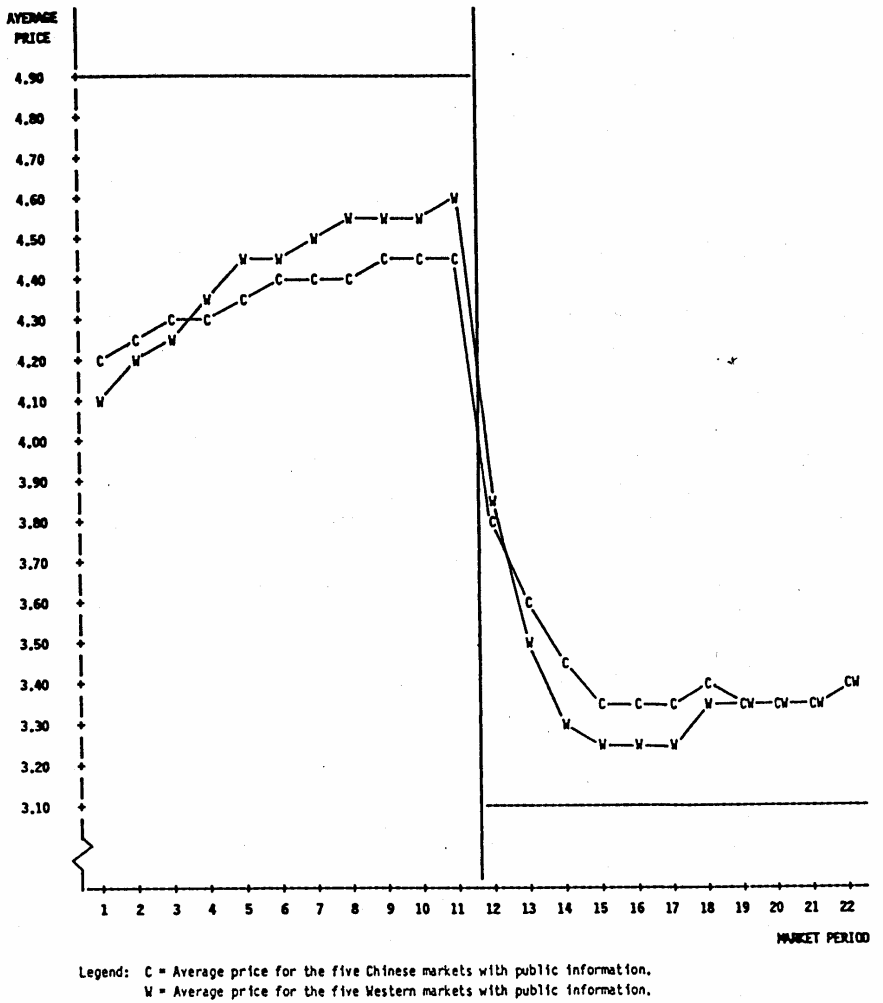
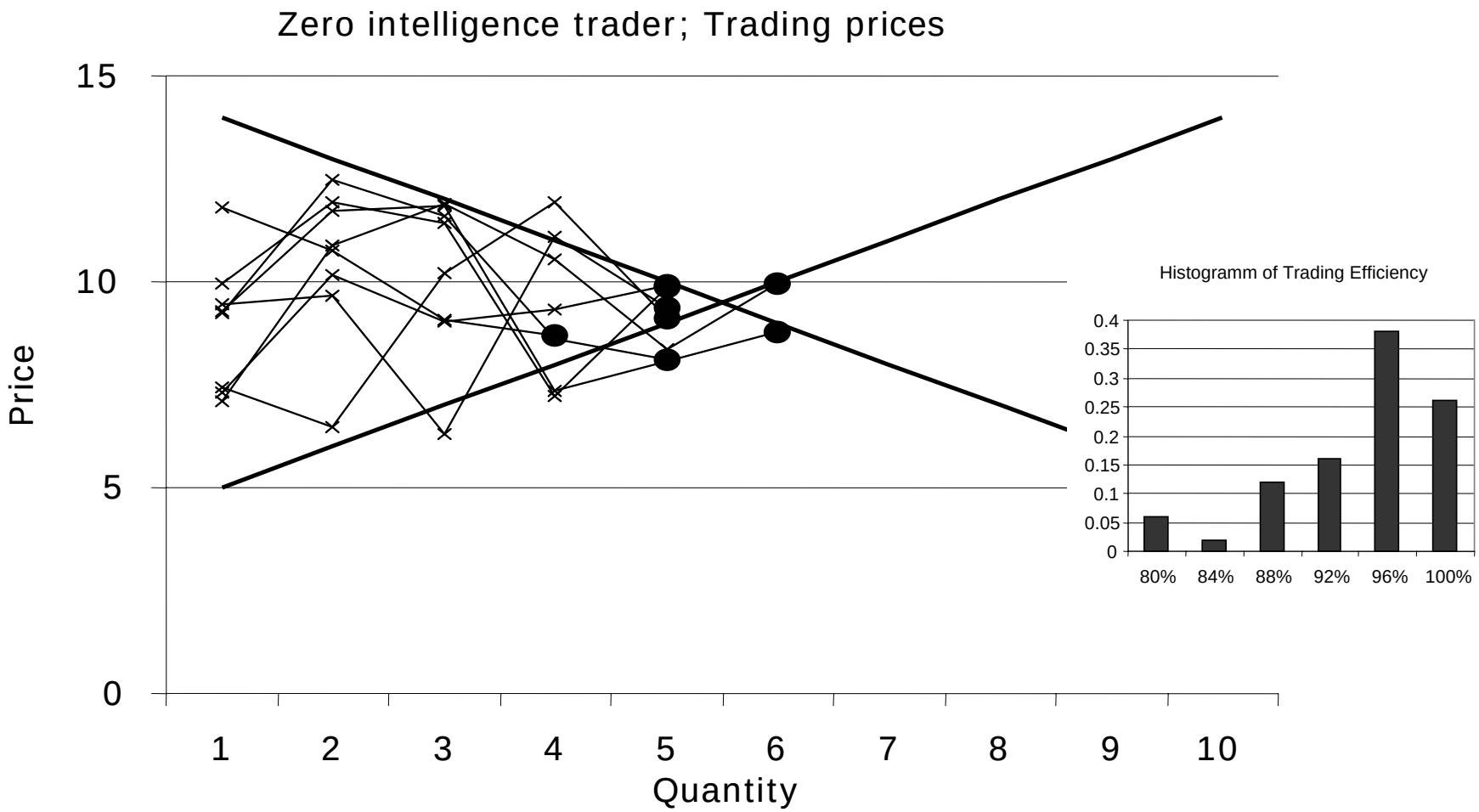


Fig. 3. Average negotiated prices in the public information markets.

Zero-Intelligence Traders
Gode&Sunder (1992, 1993)

- Simulated traders with a very simple algorithm. (random offers subject to a no-loss constraint)
- There is still convergence to CE.

- Quick convergence probably prevails because the buyers with the highest redemption value and the sellers with the lowest cost are likely to trade first. Then the next “best” participants have the highest probability to trade, etc. Thus, towards the end of a period the trades that occur are most likely by those traders with values that are close to intersection point between supply and demand.



Thin lines show the sequence of prices over time. Thick bubble shows the last trade in the period.

Random bids and asks subject to a no-loss constraint.

If a going offer is better than a random bid, the buyer accepts the offer.

If a going bid is better than a random offer, the seller accepts the going bid.

Double Auction Asset Markets (Smith, Suchanek and Williams 1988)

- Subjects are endowed with assets and cash which can be transferred to future periods.
- Total cash holdings at the end of the final period T are paid to the subjects.
- At the end of each period t assets yield a dividend of 0, 8, 28 or 60 cents with equal probability. Expected value of dividend payment is 24 cents.
- At the end of the final period, after the realization of the dividend return, assets are worthless.
- Assets can be traded in a double auction.

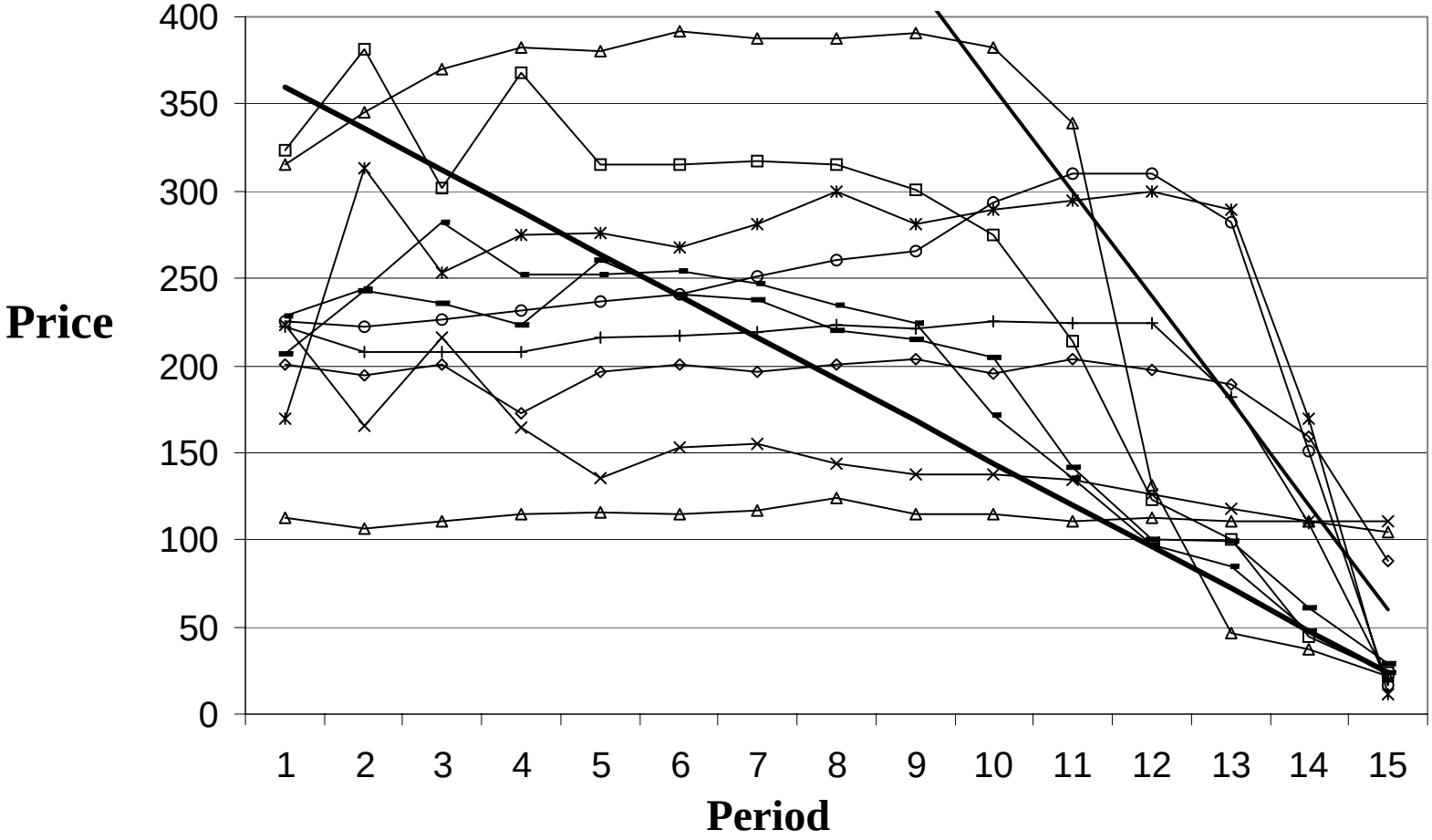
Predictions

- If the rationality and risk neutrality of all traders is common knowledge there should be no trade or, in case of a trade it should only occur at the expected (fundamental) value of the asset.
- Trade only takes place in case of heterogenous risk preferences.
- Suppose that for risk loving agents the certainty equivalent of the asset is $.24 + \varepsilon$ ($\varepsilon>0$ but small) per period while for risk averse agents it is $.24 - \varepsilon$. Then, under rational expectations, the price in period T must be within the ε-neighbourhood of .24. The maximum price of the asset in t is then $(T - t)(.24 + \varepsilon)$.
- Asset prices should never exceed (T-t)60 (i.e. be above the maximal dividend payment for the remaining life time of the asset).

Results

- Inexperienced and professional traders who participate for the first time in the asset market (not in other DA-markets) trade a lot at prices far above the fundamental value.
- Traders who participate for a second time trade less at lower prices but still above the fundamental value.
- Twice experienced traders trade, if at all, at the fundamental value.
- Interpretation: If rationality is not common knowledge even rational traders may have an incentive to speculate (analogy to the guessing game).

Price Bubbles in Asset Markets (Becker, Fischbacher and Hens 2002)



Price Bubbles and Experience

DOUBLE-AUCTION MARKETS

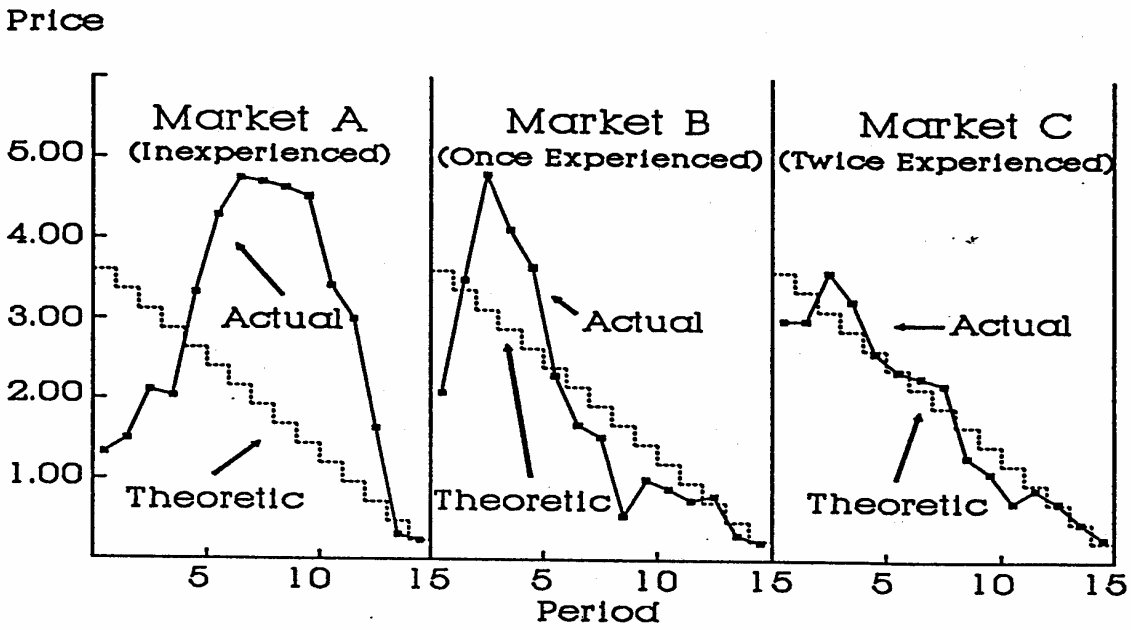


Figure 3.16 Intrinsic Value and Mean Prices in a Sequence of Three Double-Auction Asset Markets with the Same Participants (Source: Sessions 3pd295, 3pd296, and 3pd297, Peterson, 1991)

Volume of Trades

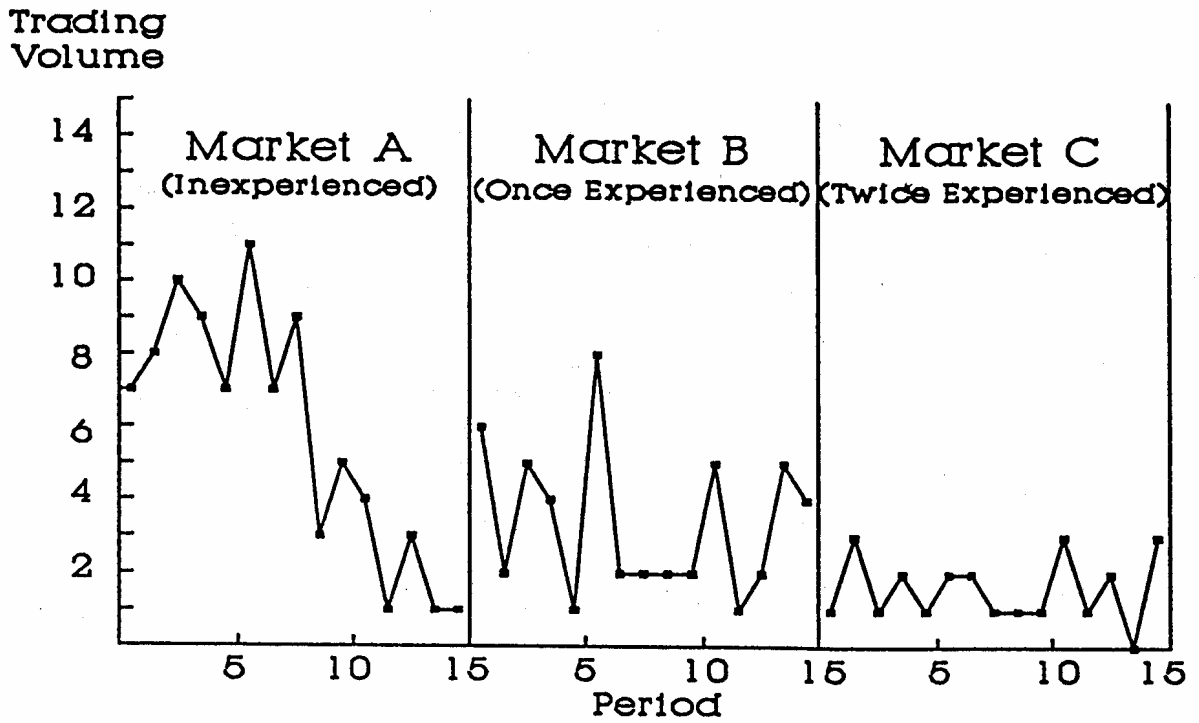


Figure 3.17 Transactions Quantities in a Repeated Series of Double-Auction Asset Markets (Source: Sessions 3pd295, 3pd296, and 3pd297, Peterson, 1991)

Extensions

- Short selling (selling unowned assets) and buying with credit exacerbate speculative bubble. Reason: Crazy types can have a bigger impact on the bubble because their financing constraints are softened.
- Derivatives do not remove the bubble (Porter/Smith 1995).
- Increase in liquidity blows up the bubble.
- Interest rate policy has only a limited impact. A high interest rate reduces the bubble only slightly (Becker et. al. 2002).

Double Auction Labor Markets

- In many labor markets effort is not contractible, i.e., it is not specified in the contract and even if it is, it is typically not third party verifiable.
- Generates an enforcement problem because wage is typically contractually fixed and enforceable whereas effort is not.
- Piece rate contracts do not solve the problem unless the quality of the pieces produced is third party verifiable.
- Similar problems occur in many markets for complex goods like, e.g., customer-tailored computer software.
- How do double auction markets function in this environment?

A Double Auction with Incomplete Contracts (Fehr & Falk JPE 1999)

- Oral double auction with 7 firms and 11 workers; each firm can at most employ one worker per period. 4 workers are unemployed
- Two stages in each period.
    - Stage 1: firms and workers make wage bids and offers in a double auction. Acceptance of a wage offer or bid implies that a contract is concluded.
    - Bids and offers written on a blackboard.
    - Stage 2: those workers who concluded a contract choose an effort level.
- Wage payment is third party enforceable, effort is not.
- Workers and firms are in separate rooms to preserve anonymity between workers and firms.
- Effort choice is only known to the parties involved in the trade. Rules out group pressure and reputation formation.
- Payoff functions, number of traders, bids, asks and accepted wages are common knowledge among the subjects.

Payoffs and Predictions

- Payoffs
  - (120 – w)e for the firms with e $\in \{.1, .2, ...1\}$
  - w – c(e) – 20 for the workers

effort	.1	.2	.3	.4	.5	.6	.7	.8	.9	1
cost	0	1	2	4	6	8	10	12	15	18

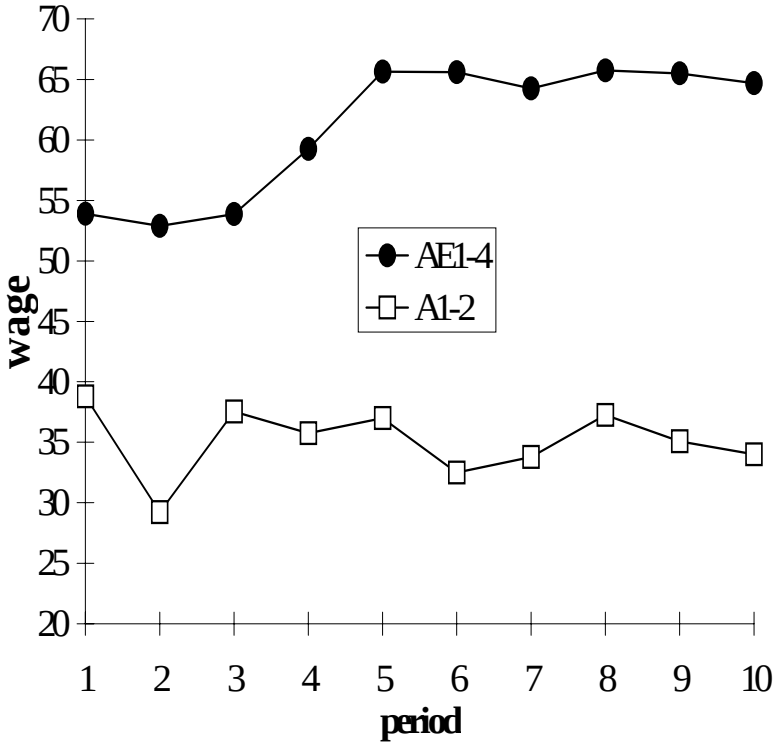
- Prediction if all players are selfish and firms know that workers are selfish:
  - Workers always choose the minimal effort
  - Firms pay wages close to 20
  - Takes some time to approach the CE of 20

Alternative Hypotheses

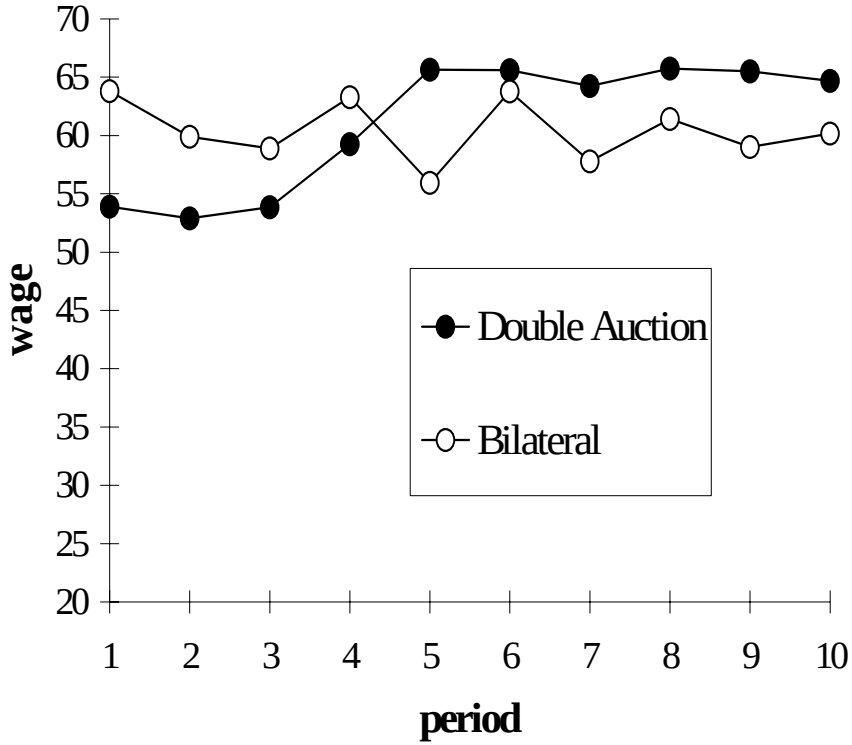
- There are workers who reciprocate to high wages with high effort levels.
- This generates a positive relation between wages and average effort.
- This relation is sufficiently steep to render the payment of high, noncompetitive, wages profitable.
- Therefore, no convergence to the competitive equilibrium with selfish preferences.
- All these hypotheses are borne out by the data.

Results
(Source: Fehr&Falk 1999)

Evolution of Average Wages in AE1-4 and A1-2 Sessions

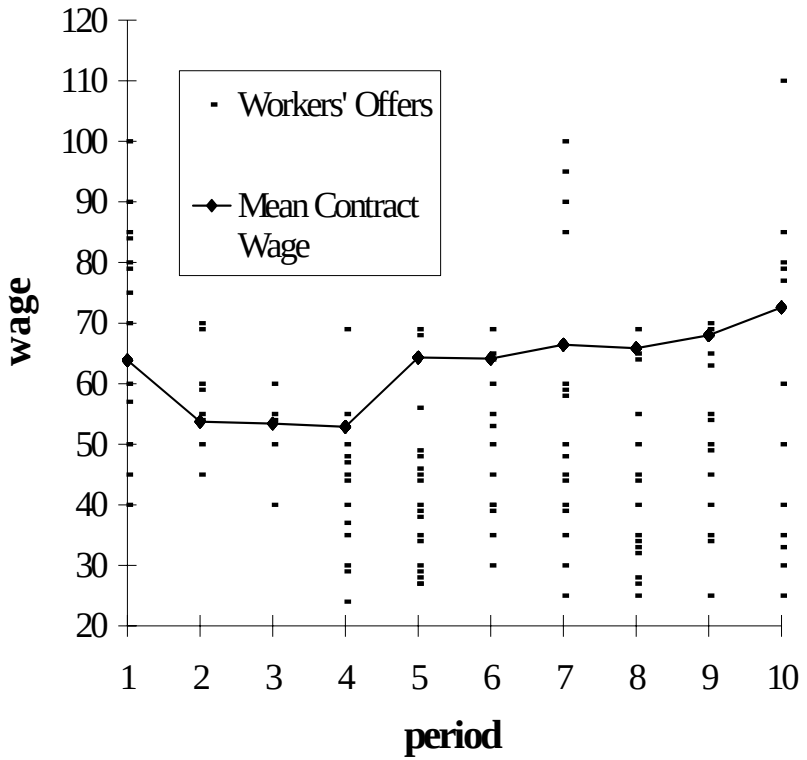


Evolution of Average Wages in the Double Auction- and the Bilateral-Treatment

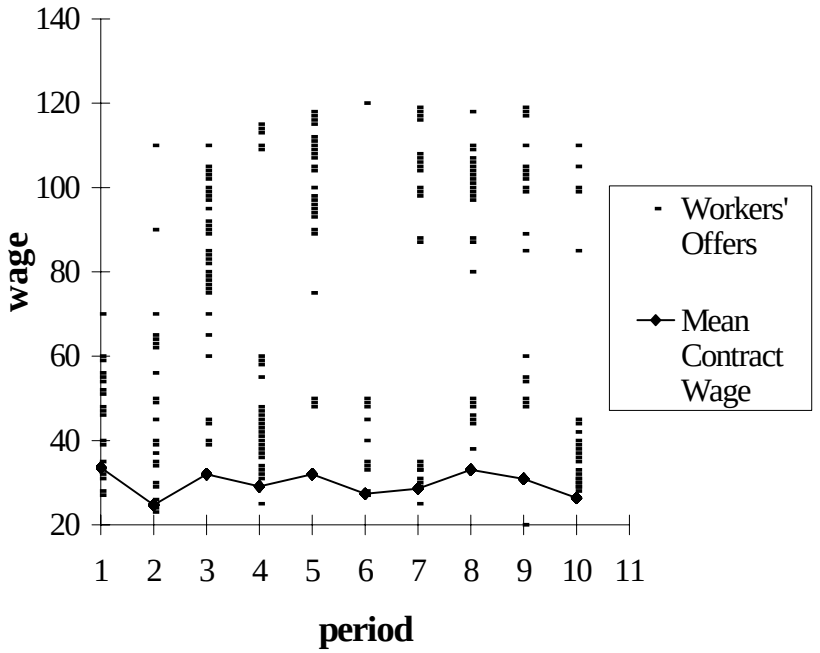


The Effects of Underbidding

Workers' Offers and Mean Contract Wages in Session AE4 (Source: Fehr&Falk 1999)

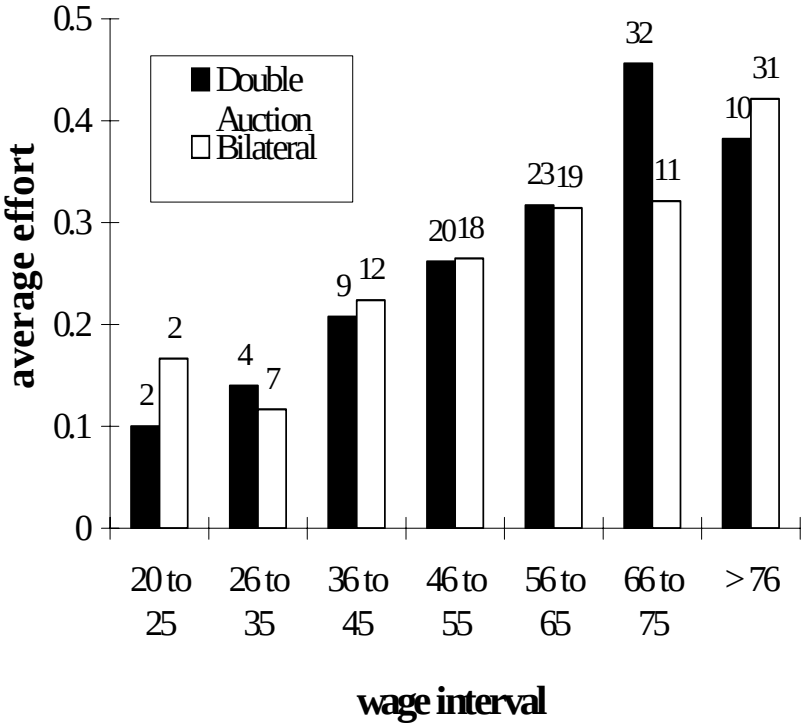


Workers' Offers and Mean Contract Wages in Control Session A1 (Source: Fehr&Falk 1999)

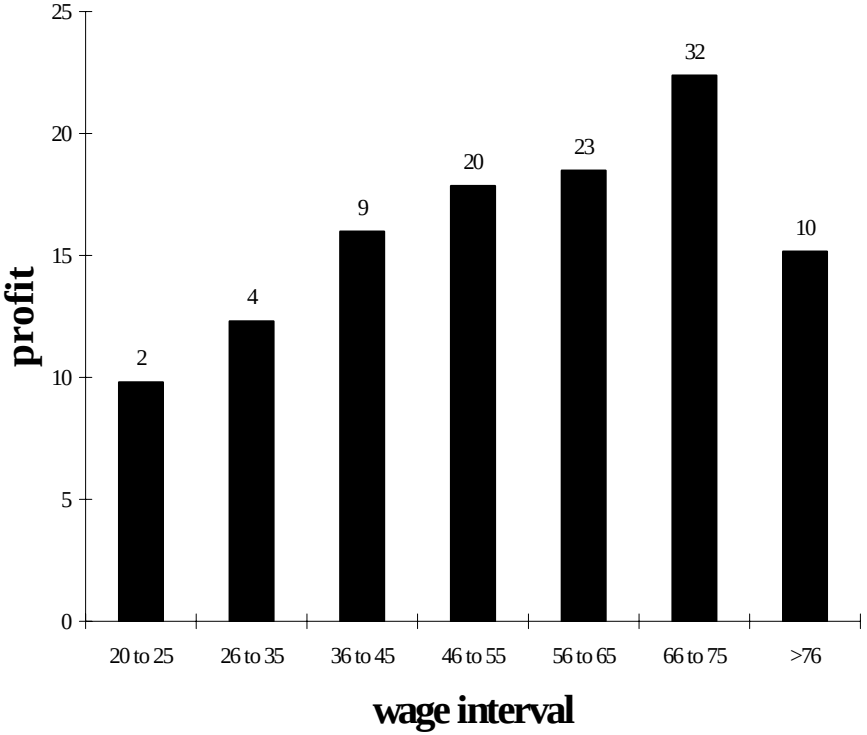


The Effects of Wages on Effort and Profits

Wage-Effort Relation in the Double Auction- and the Bilateral- Treatment (Relative Frequency of Observations above Bars; Source: Fehr&Falk 1999)



Wage-Profit Relation (Relative Frequency of Observations above Bars)



Posted offer markets

- At the beginning of a period sellers simultaneously commit to a price offer and fix the maximal quantity they are willing to sell at the offered price.
- The vector of prices chosen is revealed to all market participants but not the sellers' limit quantities.
- Then buyers are randomly and sequentially selected. They can choose among the (still) available price offers and can buy as many units as they want.
  - Buyers typically take the lowest available price. Therefore, they are often simulated by programmed players.
- Notice: sellers receive only very limited information about the buyers' willingness to pay (relative to a double auction).

Prices and Efficiency in a Posted Offer Market

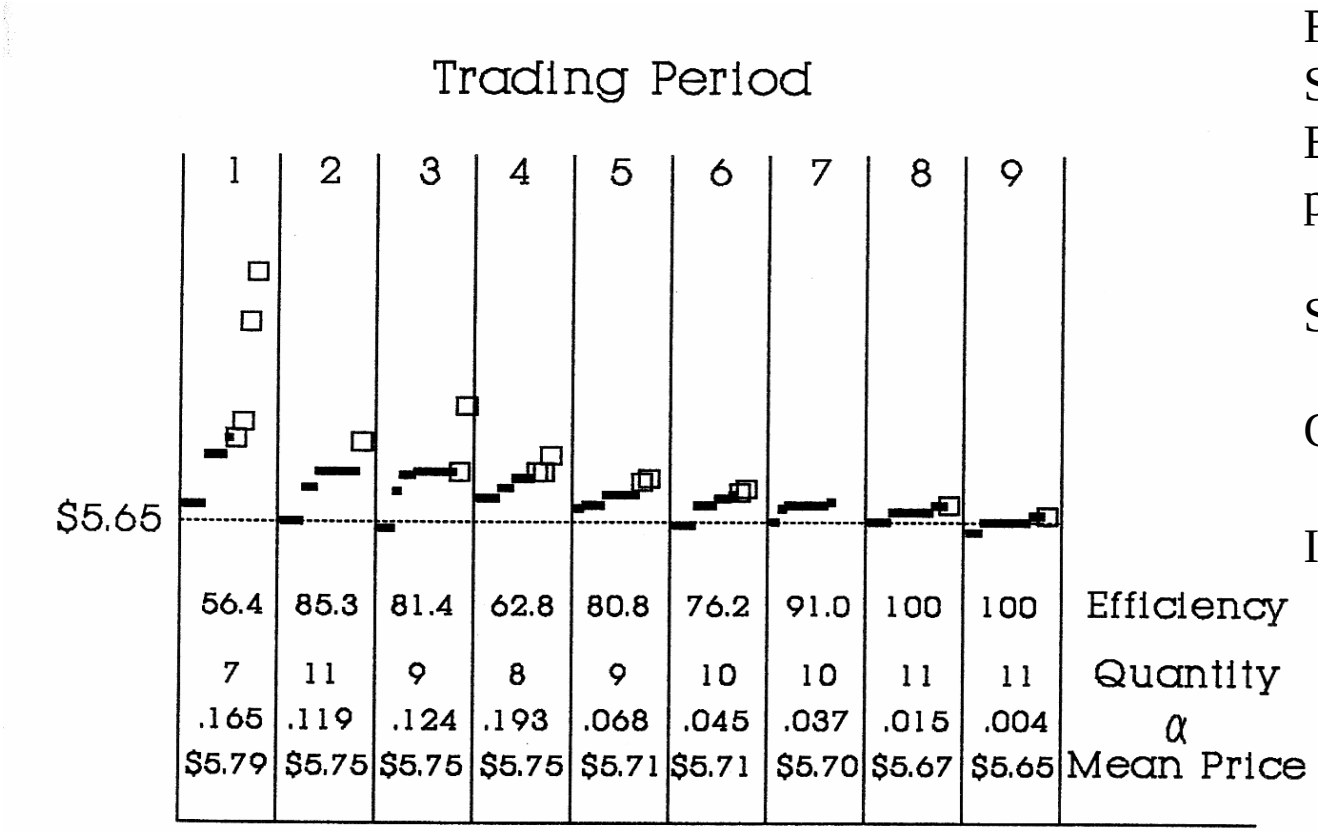


Figure 4.3 Price Sequence for a Posted-Offer Market

From Davis&Holt 1993
Solid dots: contract prices
Empty boxes: nonaccepted price offers

Slow convergence

Convergence from above

Initially efficiency very low

Adjustment Patterns in Double Auctions and Posted Offer Markets

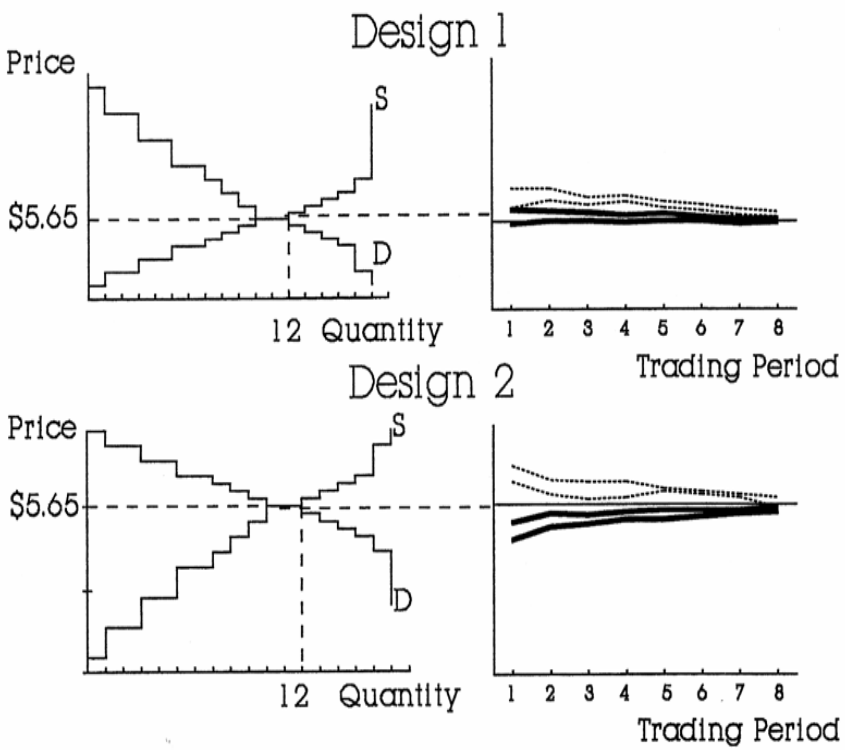


Figure 4.4 The Rent Asymmetries Designs, and 95 percent Price Bands for Double Auctions (bolded lines) and for Posted-Offer Auctions (dotted lines) (Sources: Smith and Williams, 1982, and Davis and Williams, 1986)

Design 1: 2/3 of the surplus in CE goes to buyers. Design 2: vice versa. 6 buyers & 6 sellers in each market session.

In the DA adjustment is from below when sellers get the higher rent share in CE.

In PO adjustment is always from above indicating that buyers have less market power.

Markets eventually converge to CE in the PO institution.

Comparison between Double Auction and Posted Offer Market

Mean Efficiency

	Design 1		Design 2	
Trading Period	PO	DA	PO	DA
1	76.5	89.9	65.4	92.4
2	76.7	96.8	84.2	95.6
3	74.1	97.8	82.3	97.8
4	72.0	99.6	77.4	98.6
5	80.8	98.4	84.4	97.4
6	82.3	99.4	84.2	98.3
7	87.2	98.4	87.2	99.5
8	97.0	99.7	96.2	99.3
Average	80.8	97.5	82.6	97.4

Source: Davis and Williams (1986).

In early periods efficiency is much higher in DA compared to PO-markets.

High prices in early periods cause low trading volume in PO-markets.

In the final period PO-efficiency also high.

Extreme Earnings Inequality

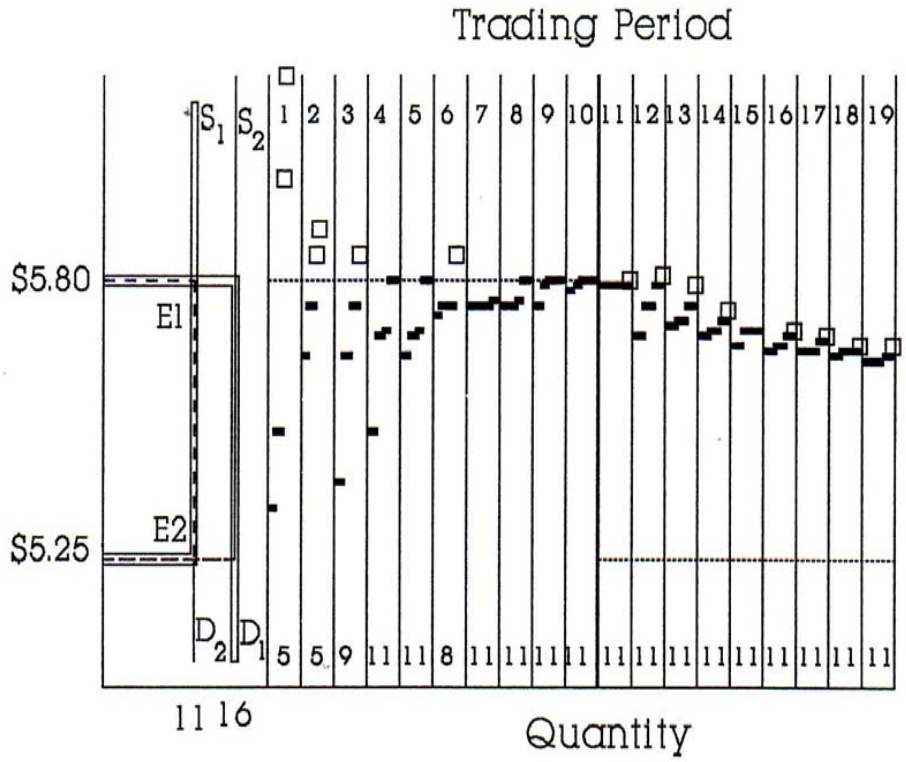


Figure 4.5 Supply-and-Demand Arrays, and Prices for a Posted-Offer Session with Severe Earnings Inequities (Source: Cason and Williams, 1990)

Responsiveness of Double Auction and Posted Offer Markets to Demand Shocks

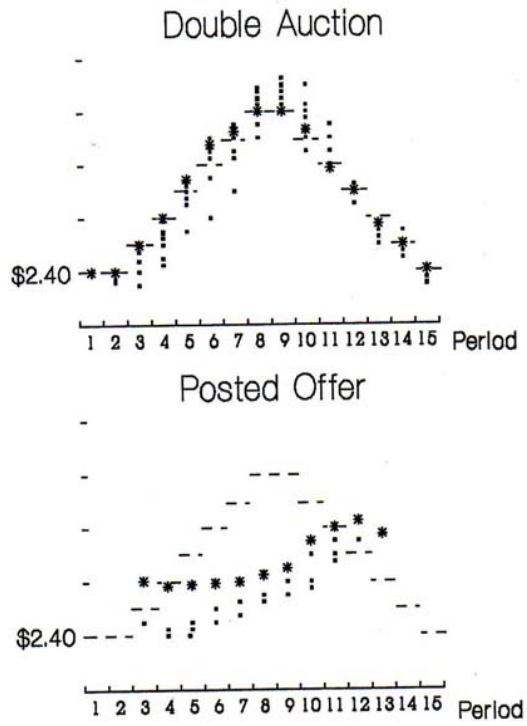


Figure 4.7 Double-Auction and Posted-Offer Contract Prices in a Design with Regular Demand Shifts (Source: Davis, Harrison and Williams, 1991) Key: contract prices: ·, Final contract prices: *, Equilibrium Price: --.

Demand increases till period 8 and falls from Period 9 onwards.

Initially, most prices in the DA are below CE. After the negative shock they are above CE. Closing prices in the DA track CE very well.

In the PO-market actual prices bear no resemblance to the CE-prices. They still rise when demand is already falling creating zero trades in period 13 and 14 (stagflation).

Posted Offer Monopoly

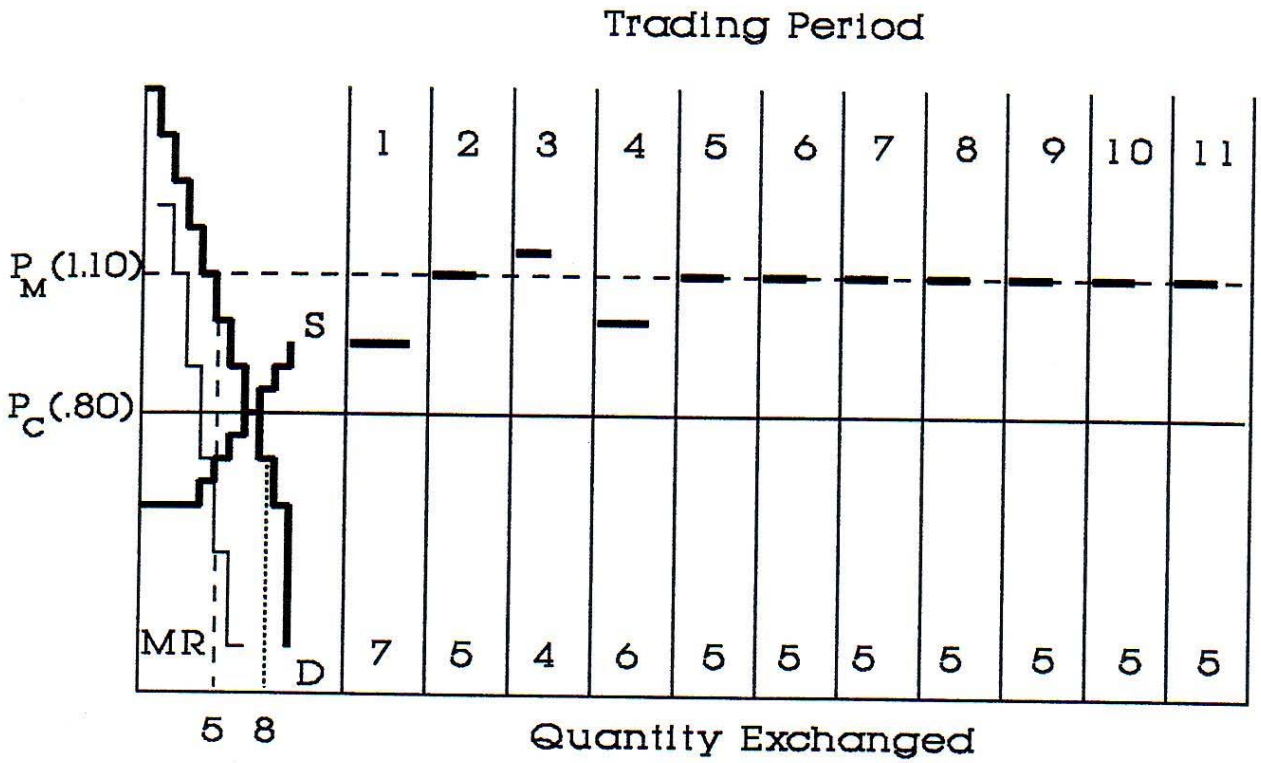


Figure 4.8 A Posted-Offer Monopoly (Source: Smith, 1981)