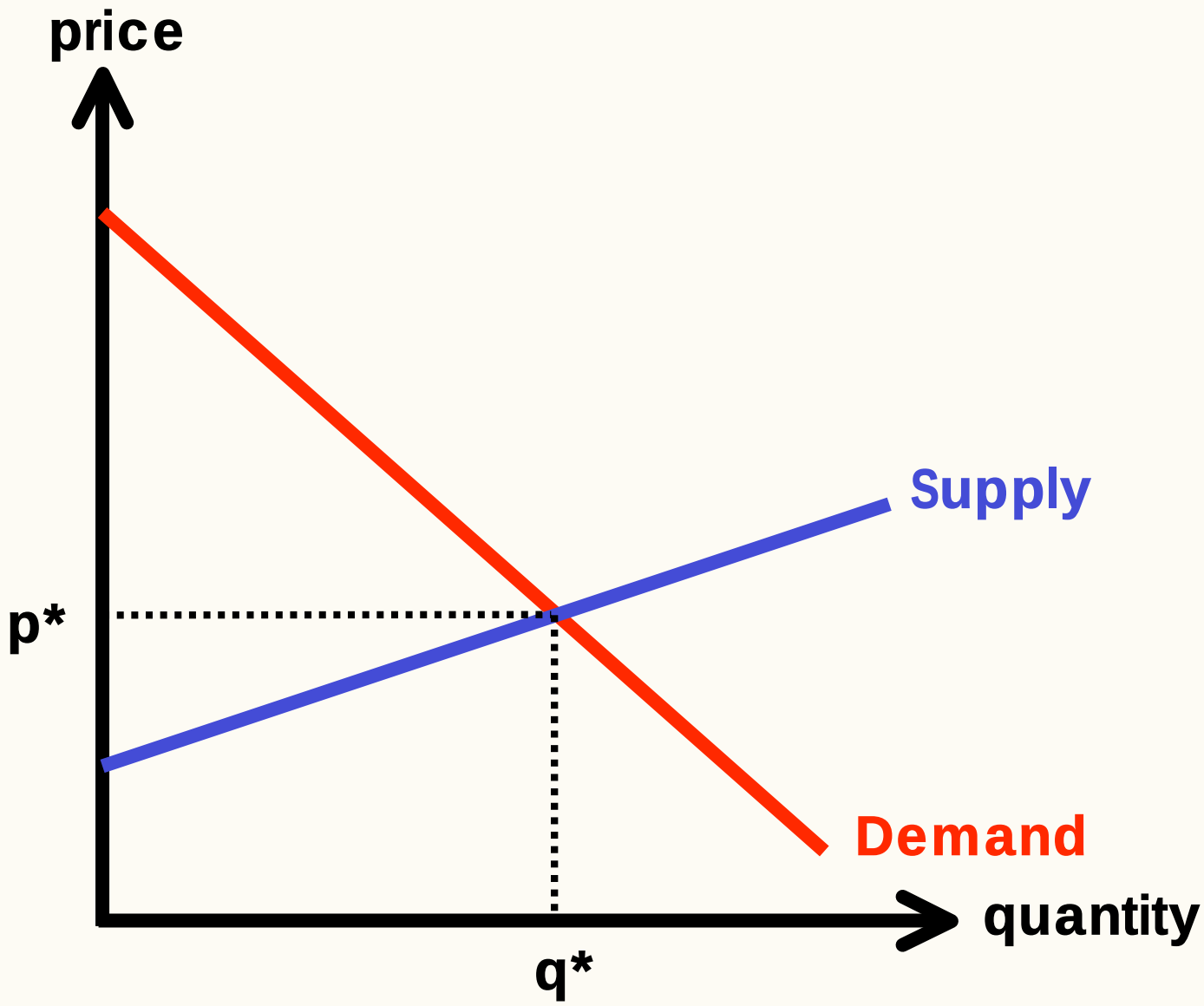
Lecture 9

Today's Agenda

- Double auction (DA)
  - Robustness of the outcomes of a DA
  - number of traders
    - Duopoly
    - Monopoly
- Cournot & Stackelberg
- Speculative Bubbles

Aims

- Be familiar with the functioning of different experimental market institutions.
- Be familiar with the key results and outcomes of experimental market institutions


price
Supply
p*
Demand
quantity
q*

Competitive markets

- Assumptions
  - Agents are rational and selfish utility/profit maximisers
  - A homogeneous well defined good is produced and traded
  - There are numerous firms and consumers
  - Agents are price takers (auctioneer)
- These assumptions can be seriously questioned
  - People are boundedly rational
  - People often have interdependent utility functions
  - There are many markets with only 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 competitive market model?
  - Answer is very important (e.g., for the first and the second welfare theorem).
- Are there “real” market institution for which the competitive equilibrium is a good predictor of price and quantity outcomes?
- How do different market institutions differ with respect to, e.g., efficiency, convergence etc.?

The first (market) experiment: Chamberlin

- **Chamberlin (JPE, 1948)** conducted bilateral trading experiments with his graduate students at Harvard to "prove" the failure of the competitive model.
- He concluded: "... economists may have been led unconsciously to share their unique knowledge of the equilibrium point with their theoretical creatures. The buyers and sellers, who, of course, in real life have no knowledge of it whatever." (p. 102)

Response by Vernon Smith

- Vernon Smith, a former Harvard student (and Nobel Prize laureate in 2002), changed Chamberlin's trading institution in the following way:
  - Instead of having subjects circulate and make bilateral deals he used the oral double auction procedure.
  - He also implemented the method of "stationary replication", which is a sequence of trading days with stationary demand and supply schedules.
- "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..." (Smith 1991, p. 155).

Details of the double auction (homogeneous goods)

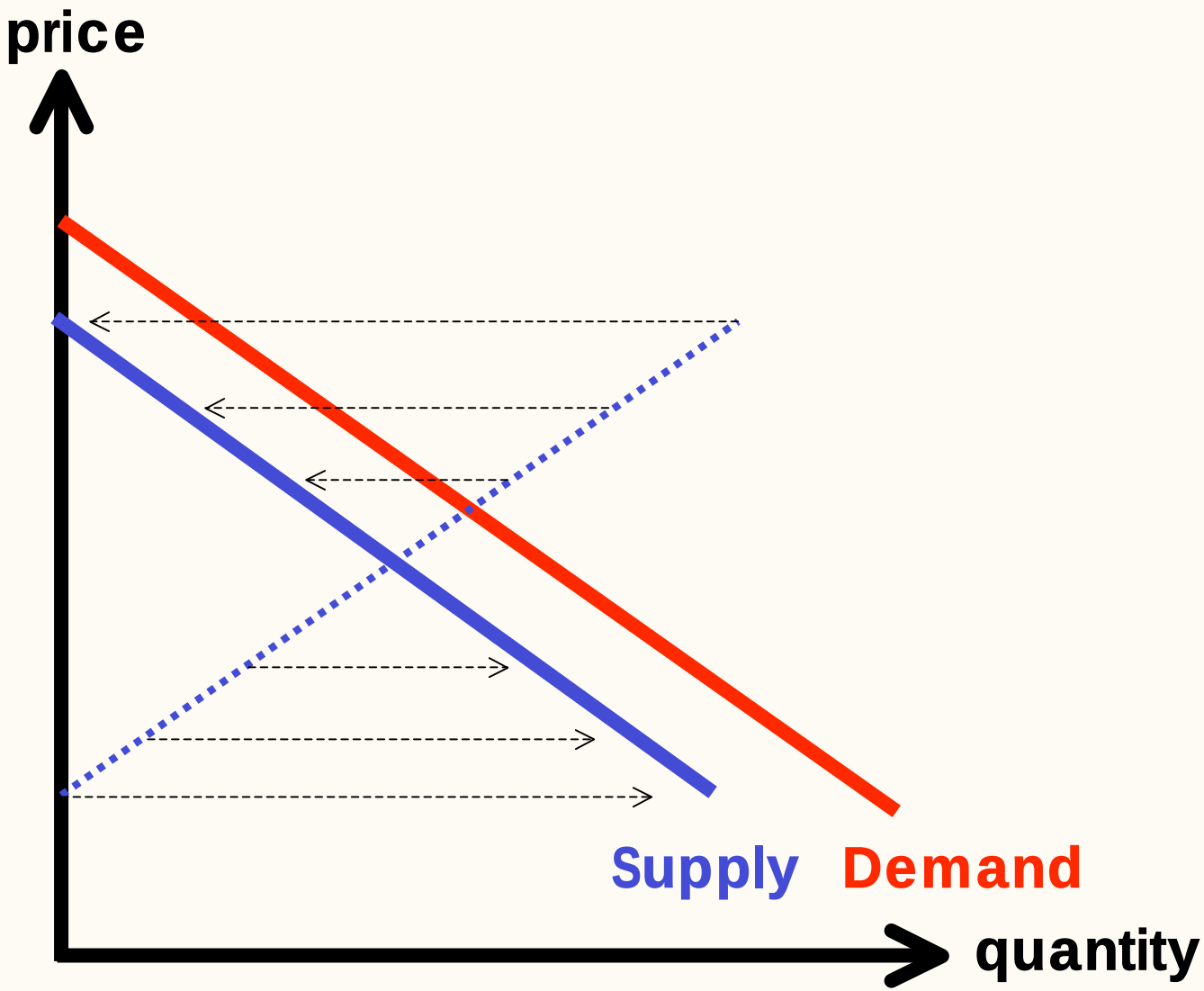
- Each buyer i is paid according to $B_i(x_i)-\sum p_i$ where xi denotes the number of goods bought and B_i denotes the buyers' utility from consuming x_i goods.
- Each seller is paid according to $\sum p_i-S_i(x_i)$.
- There is a limited time for trading per "market day". If trading ceases before the 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.

Details...

- 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.
- In general, individuals only know their own $B_i(x_i)$ or $S_i(x_i)$ values.

Is the outcome in the DA obvious?

- Demand and supply change during a trading period.
- 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.
- There is no rigorous game theoretic prediction.
  - No well defined game!


price
Supply
Demand
quantity

Obvious… ?

"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 market. … 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)

Hypotheses

- „Prices converge“
  - Def: α = standard deviation of the trading prices in a given period related to the predicted equilibrium price.
  - α declines over time
- „Efficiency is high“ = Sum of realised incomes divided by sum of possible income

Result: Symmetric supply and demand functions

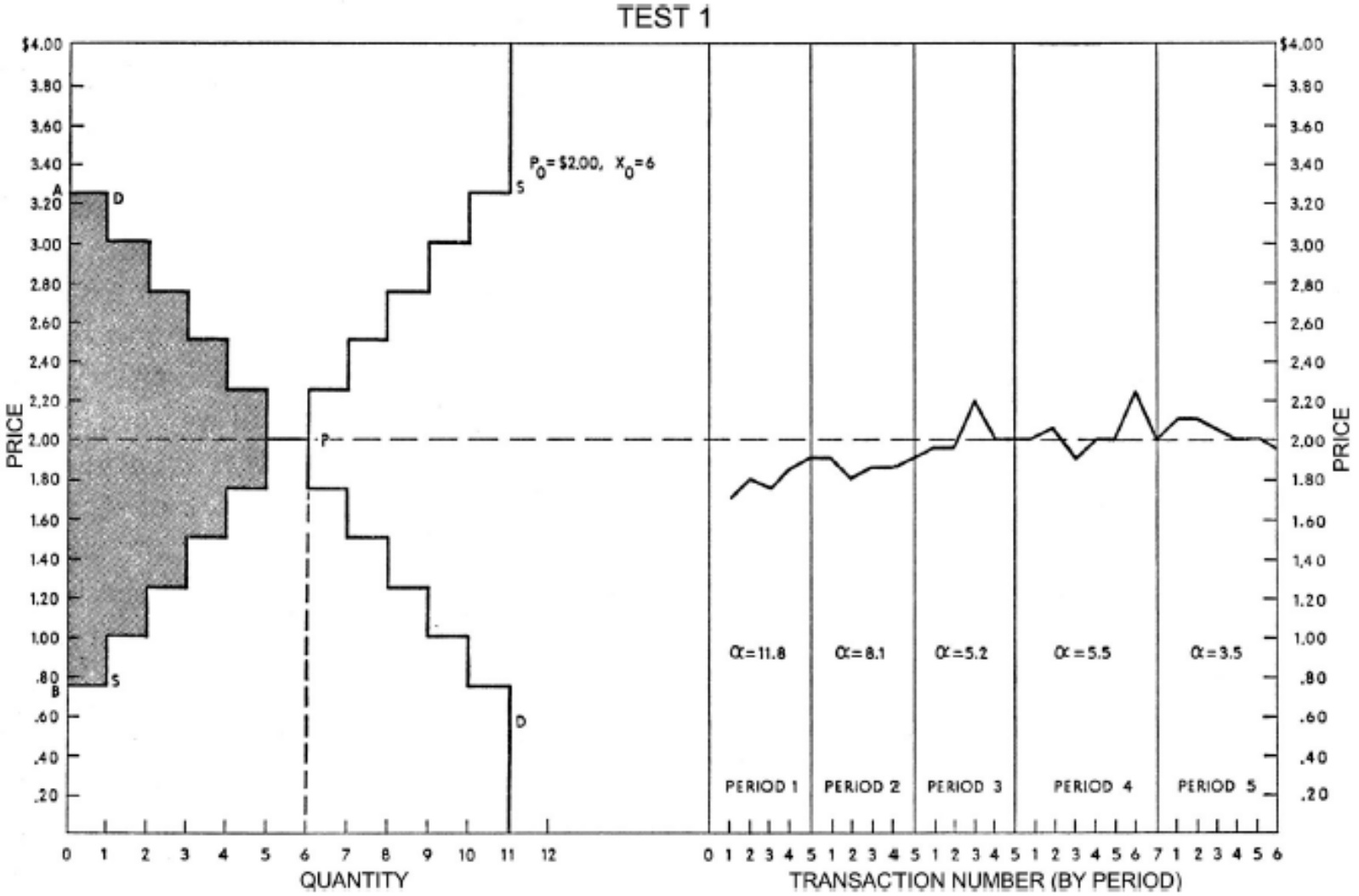
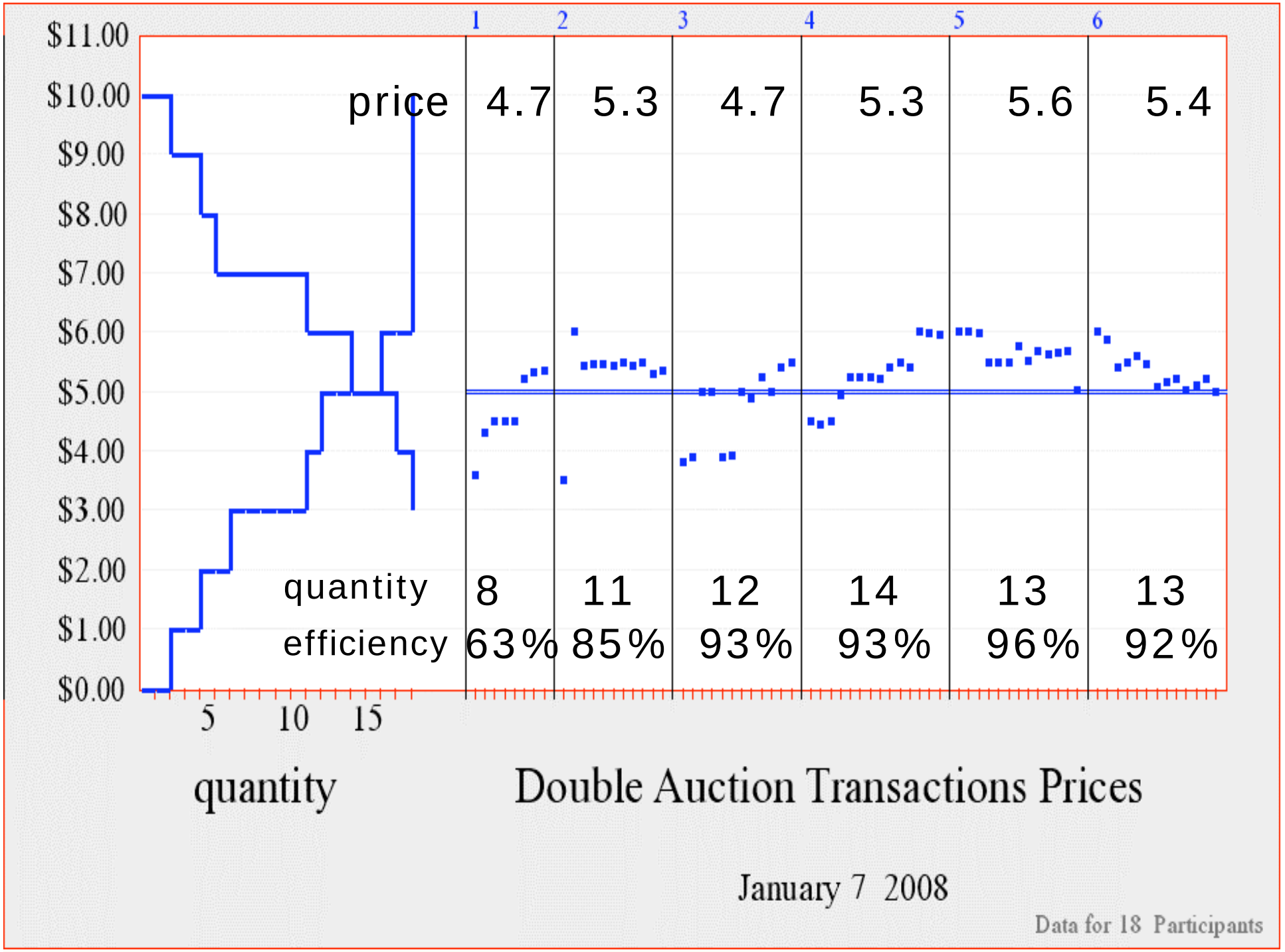


Chart 1: from Smith (1962)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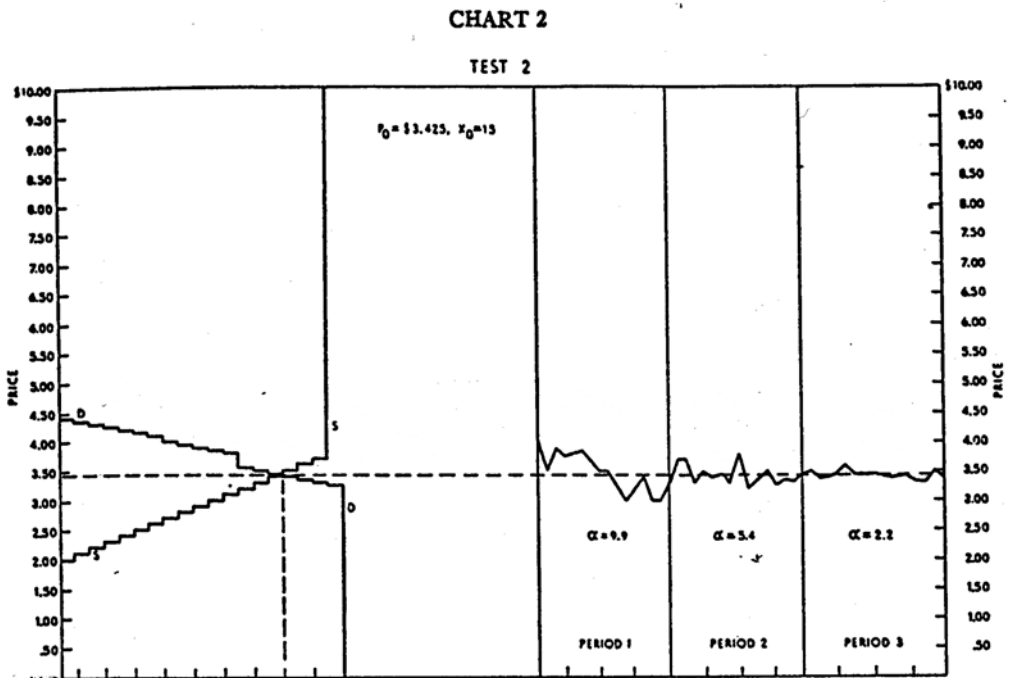
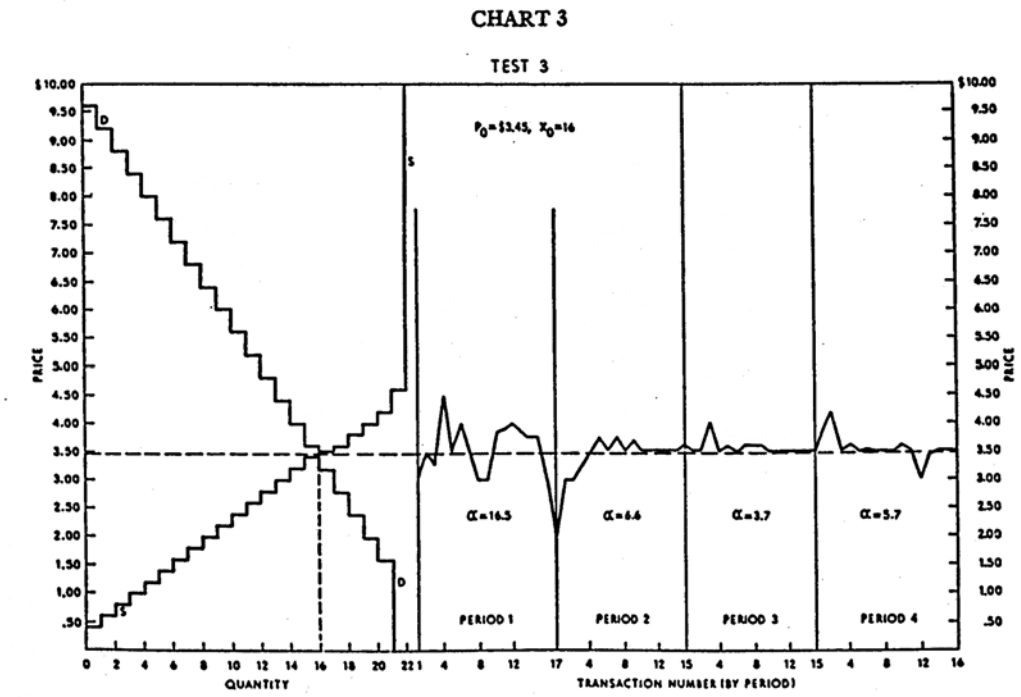
Double Auction Transactions Prices
January 7 2008
Data for 18 Participants

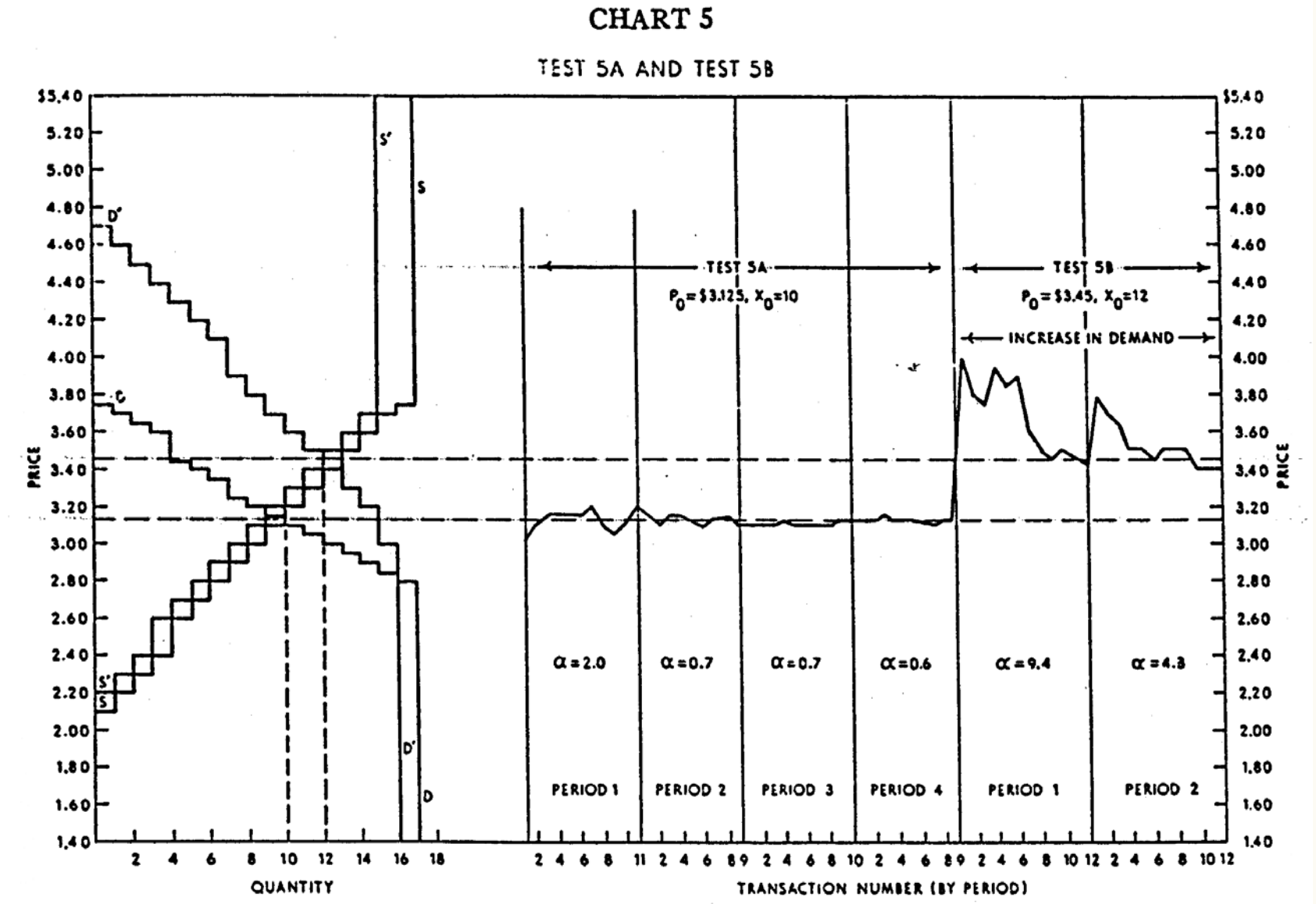




Result: flat supply- and demand functions

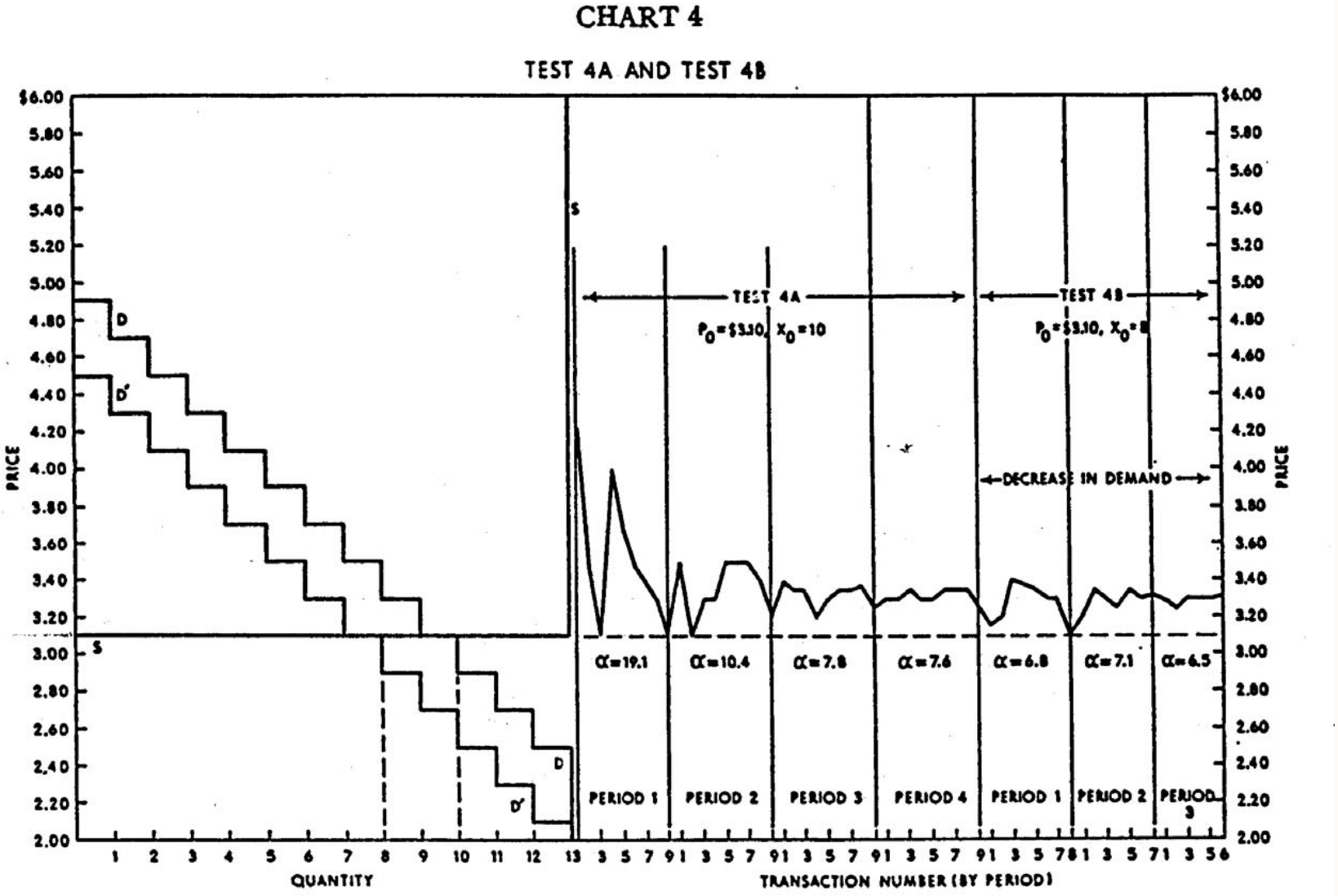
From: Smith (1962)

Result: changes in the supply- & demand functions



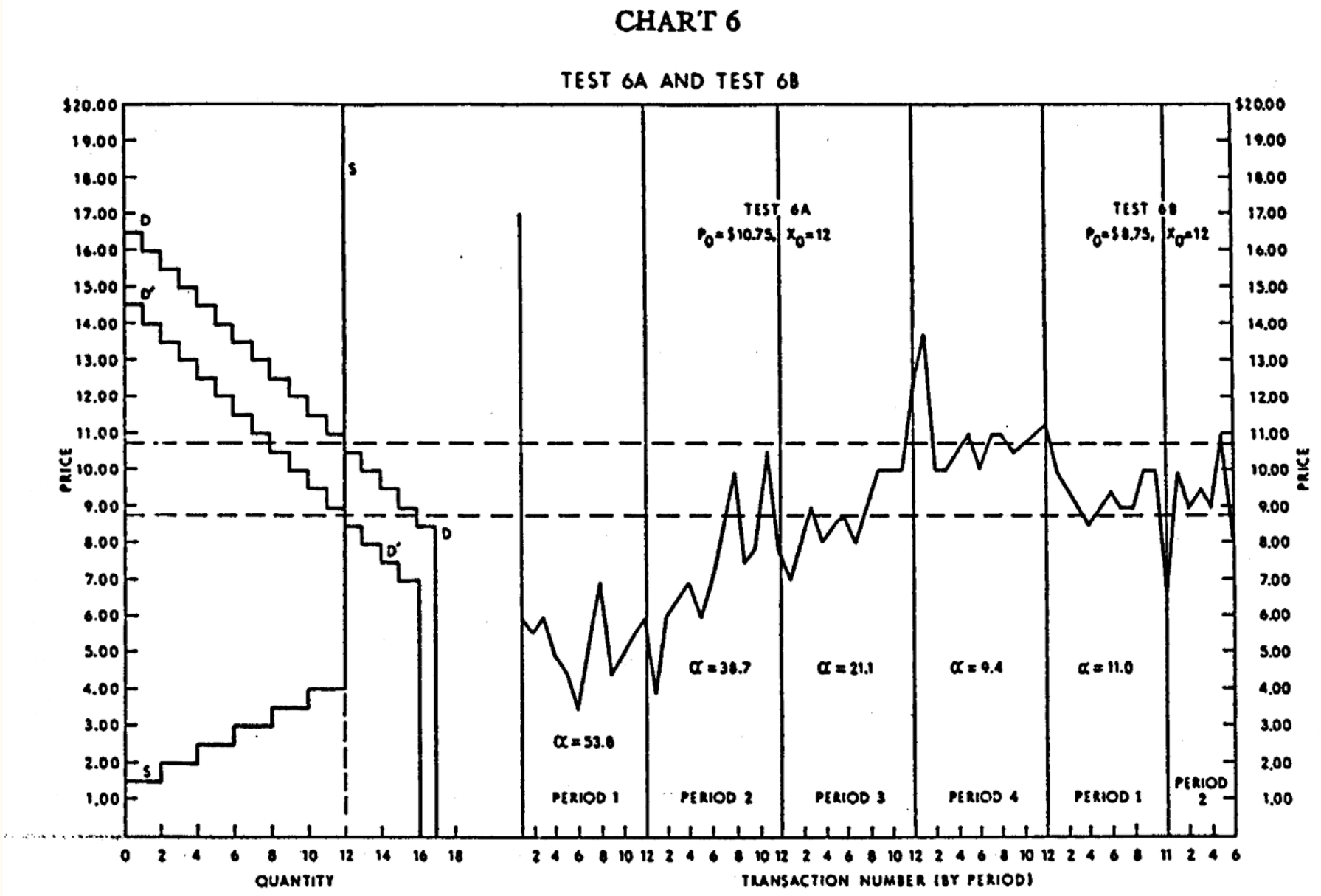
From: Smith (1962)

Result: buyers are on the short side of the market



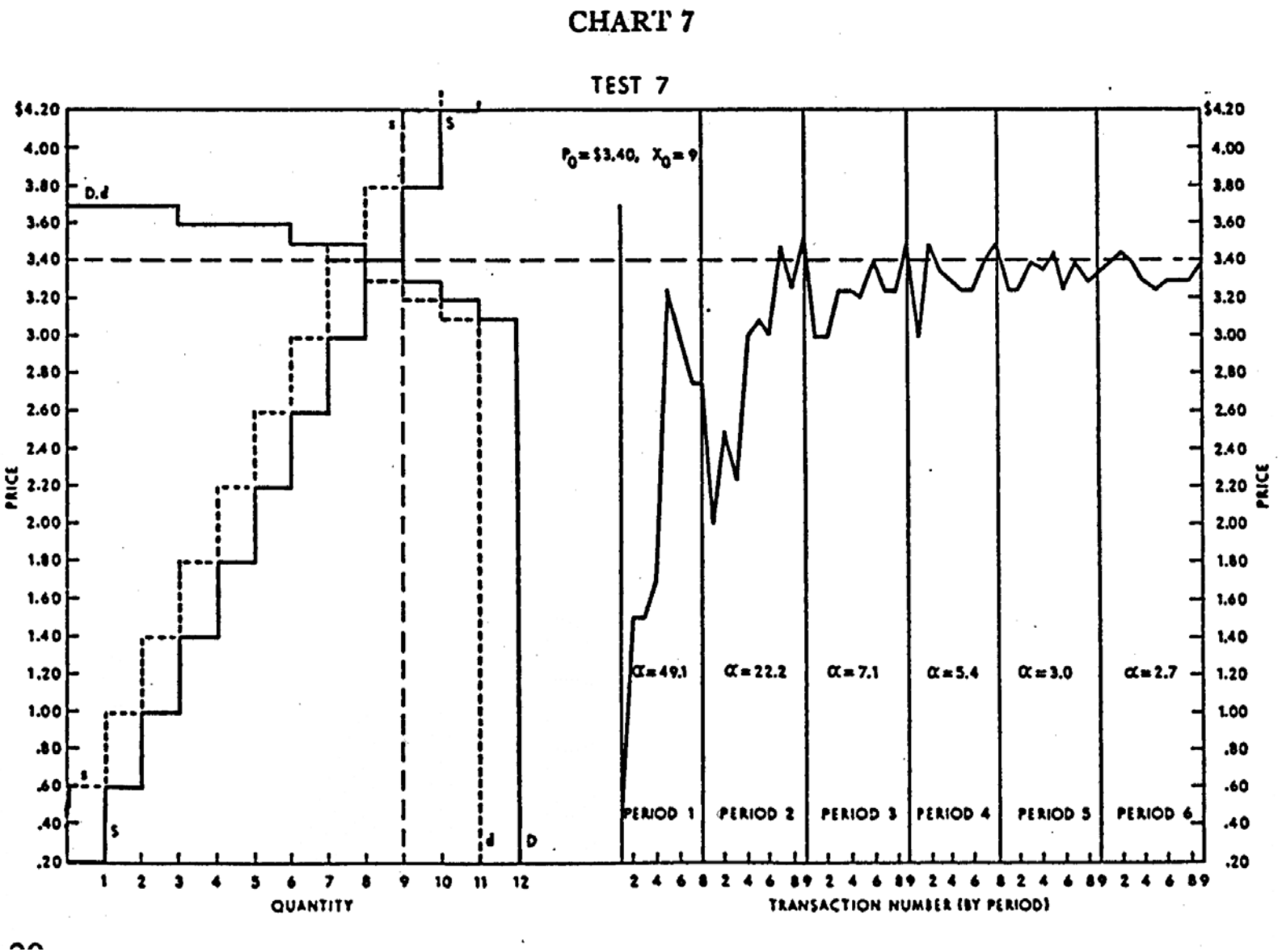
From: Smith (1962)

Result: sellers are on the short side of the market I



From: Smith (1962)

Result: sellers are on the short side of the market II



From: Smith (1962)

Results

- Main result:
  - Symmetric supply- and demand functions (Chart 1; Smith 1962)
  - Prices converge, i.e., α declines
- Further findings (less important and robust?)
  - Charts 2/3: better convergence for flat supply- and demand functions (range of offers!)
  - Chart 5: Quick reaction to changes in the supply- and demand functions
  - Charts 4/6/7: division of rents has an impact on the direction of convergence
    - Chart 4: Buyers are on short side, sellers earn almost nothing, prices come “slowly” from above
    - Chart 6/7: Sellers earn relatively high rents, buyers show resistance to pay high prices, convergence from below

Summary

- Relatively quick convergence of prices
  - Without knowledge of supply and demand functions
  - Few traders
  - Inexperienced traders, short time to learn
  - Trade without auctioneer, all traders are price makers and price takers

Reactions to these results

"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,
- a modest number (of traders), and
- 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 behavior - 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)

- After long discussions with the referees and the editor the paper was finally published in the JPE in 1962.

Robustness: Reducing the number of traders

(Smith Williams 1989)

- Duopoly (2 sellers)
  - Theoretical prediction: Bertrand competition, i.e., as in the CE
  - But both sellers could also coordinate on Monopoly solution and would earn more (see next slide)
- Monopoly (one seller)
  - Theoretical prediction : Monopoly leads to higher price and lower quantity
  - Monopoly effectiveness = $\frac{\text{mean price} - \text{CE price}}{\text{Monopoly price} - \text{CE price}}$
    - M>0 (M<0) if seller profit is above (below) CE-prediction
    - M=1 if monopoly profit is obtained

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.

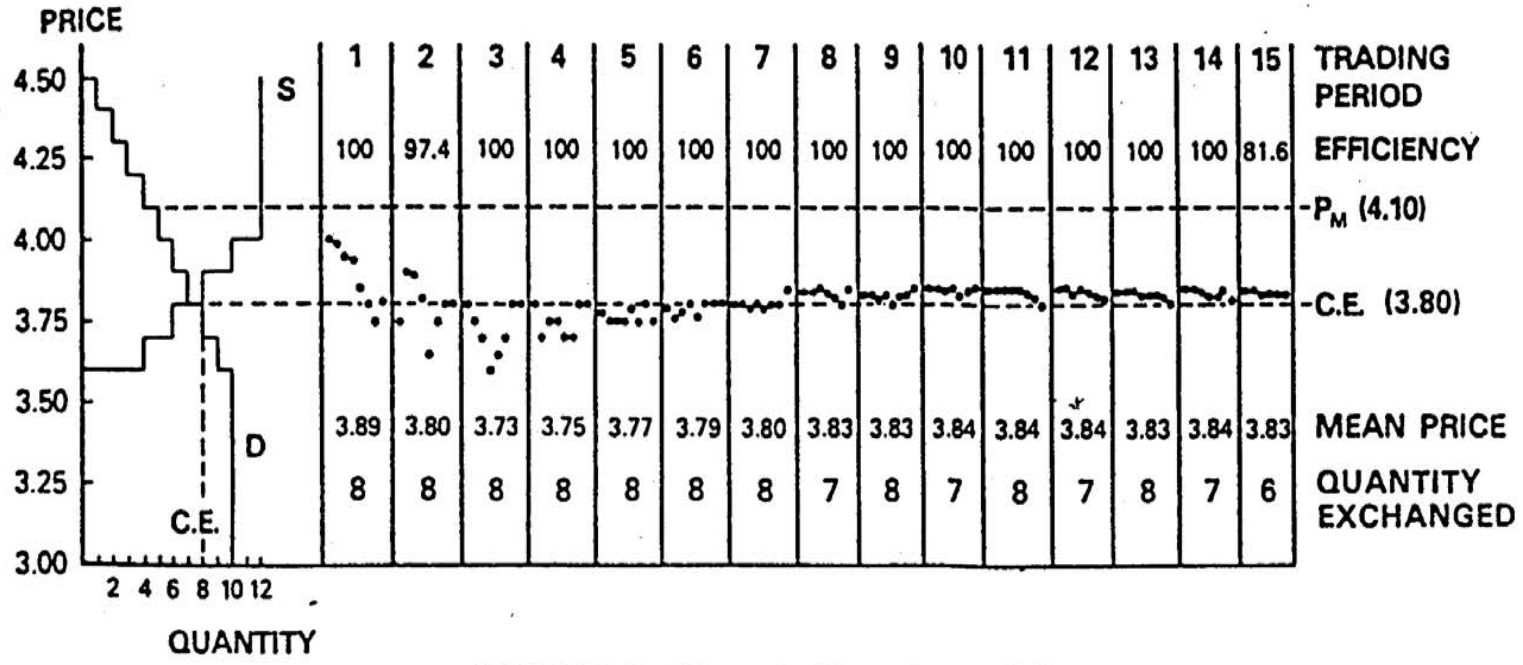


FIGURE 1. Duopoly Experiment D1

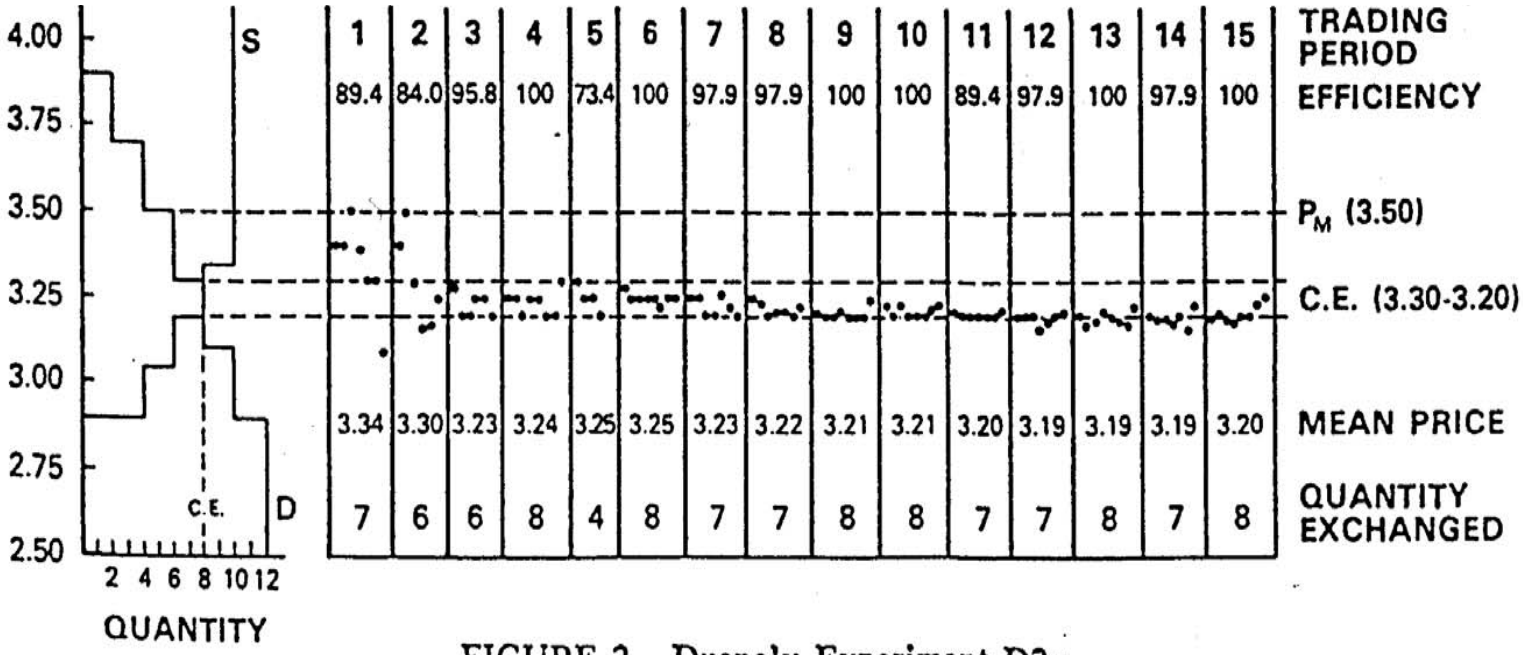


FIGURE 2. Duopoly Experiment D2x

Result: Duopoly with 5 and 6 buyers

Result: Duopoly with 10 buyers

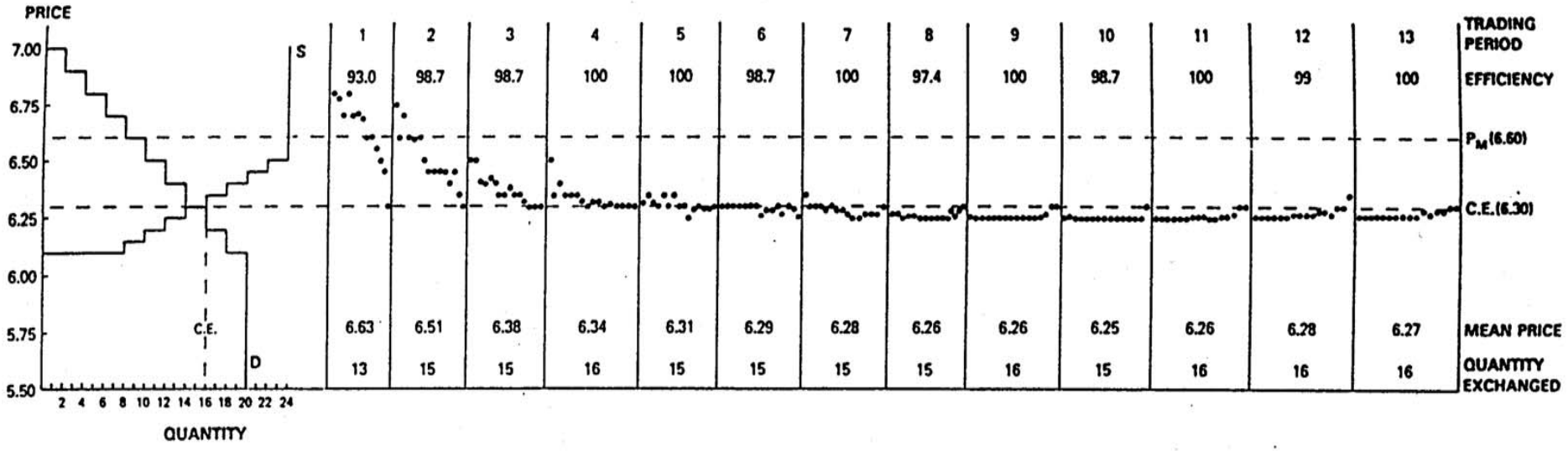


FIGURE 3. Duopoly Experiment D3x

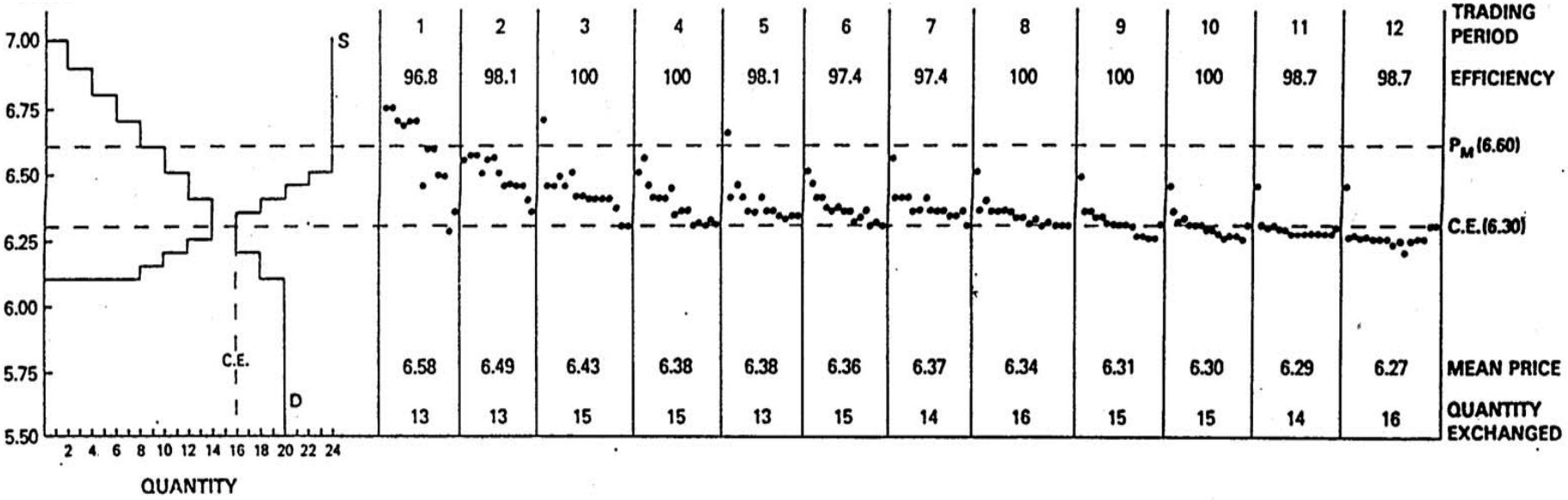


FIGURE 4. Duopoly Experiment D4x

Result: Monopoly I

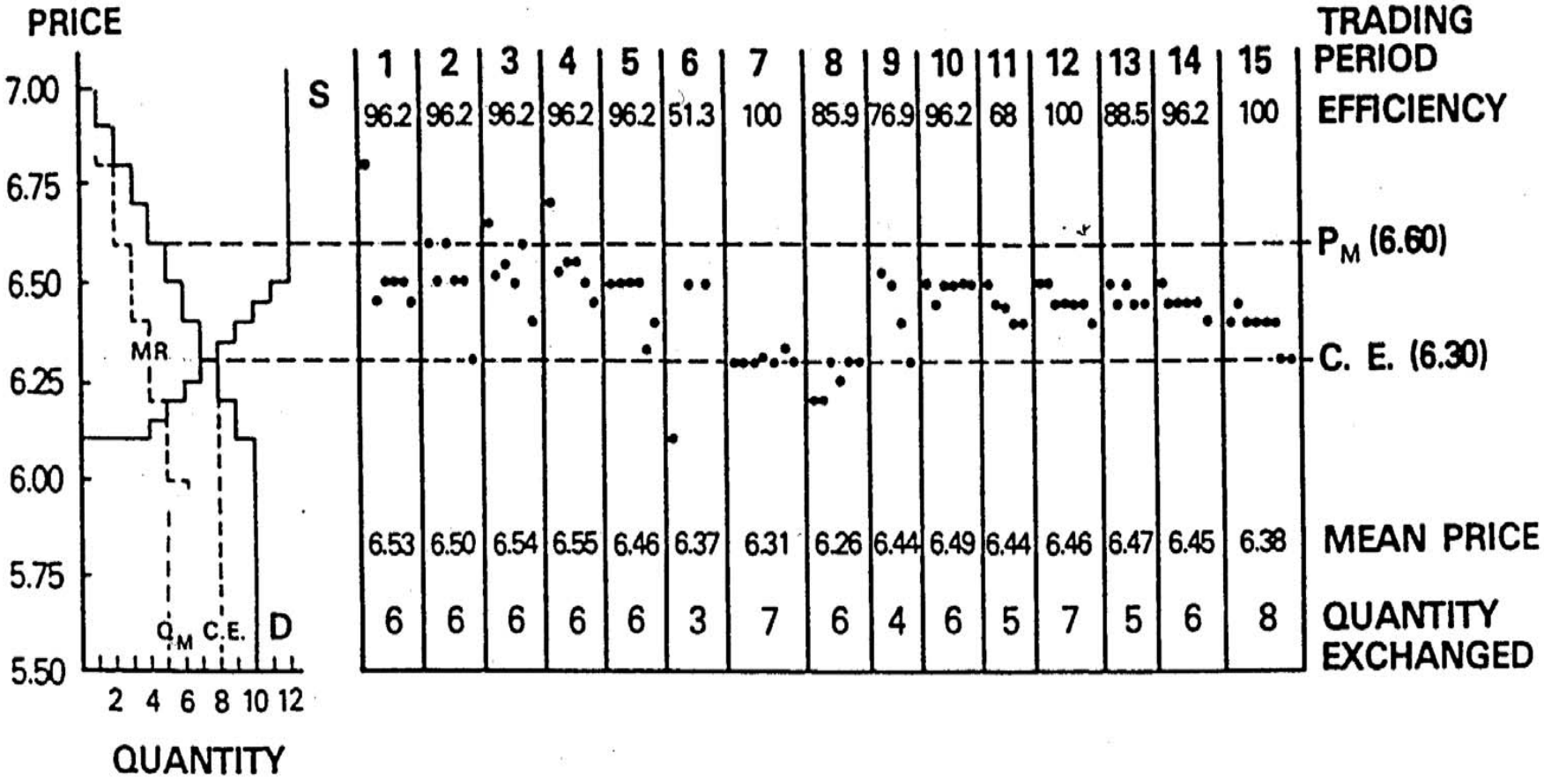


FIGURE 7. Monopoly Experiment M3x

Smith Williams 1990

Result: Monopoly II

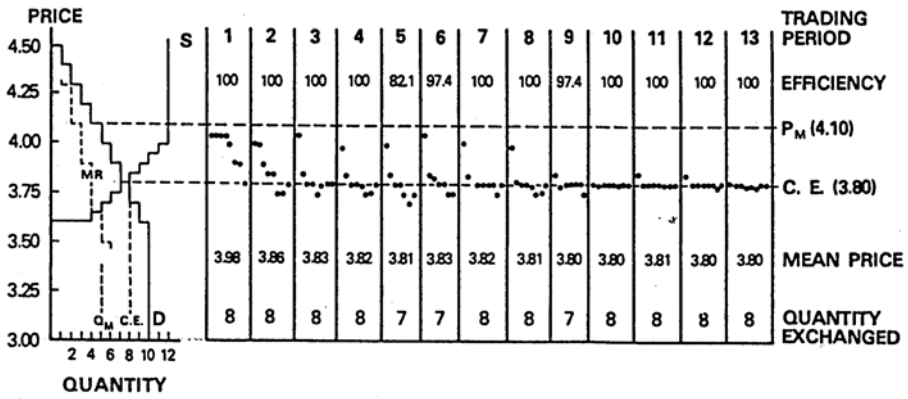


FIGURE 5. Monopoly Experiment M1x

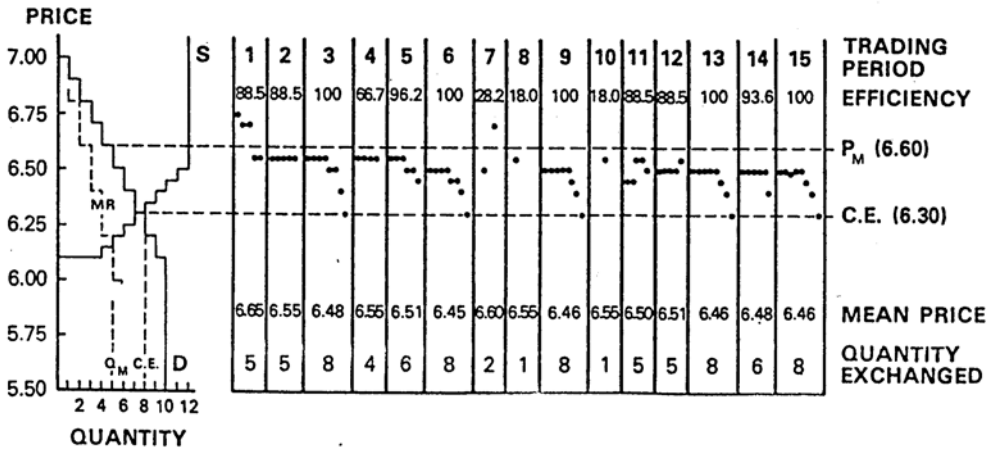


FIGURE 6. Monopoly Experiment M2x

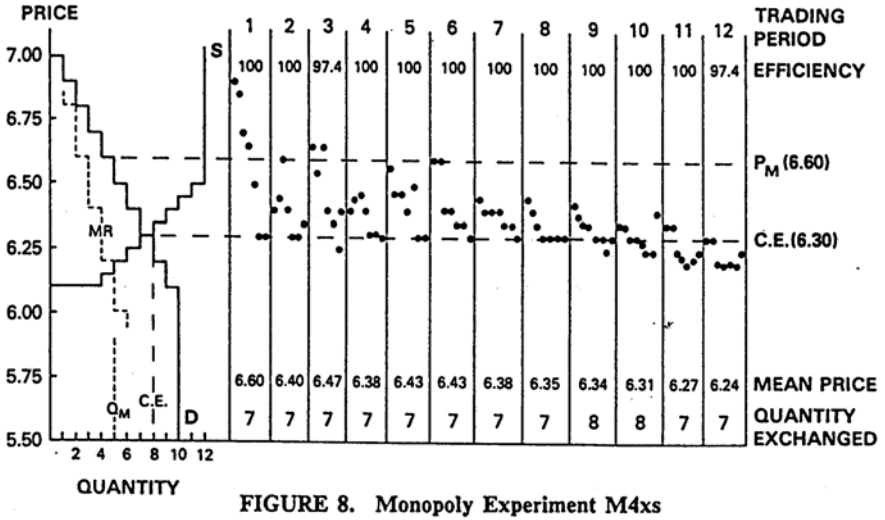


FIGURE 8. Monopoly Experiment M4xs

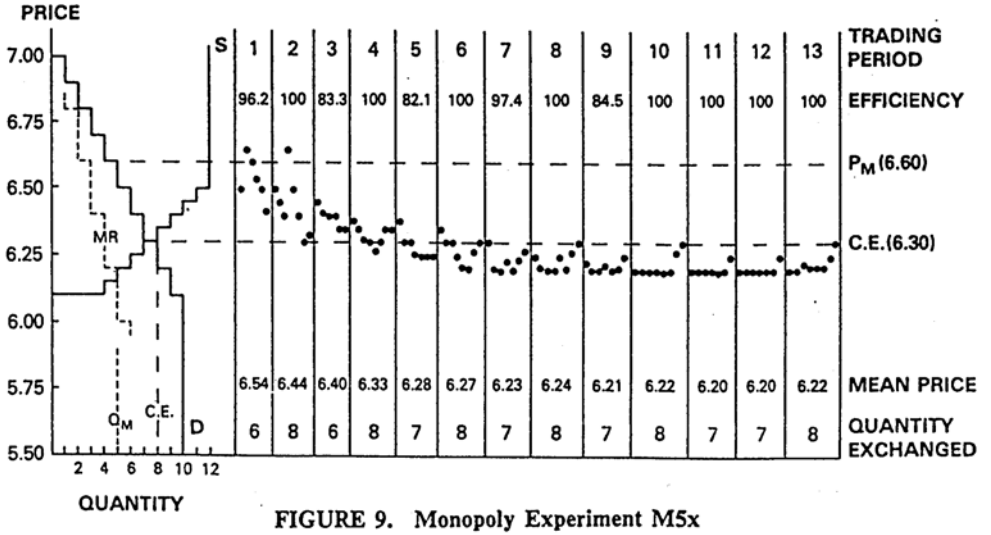


FIGURE 9. Monopoly Experiment M5x

Smith and Williams 1990

Result: Effectiveness of Duopoly and Monopoly

TABLE 2. Index of Monopoly Effectiveness

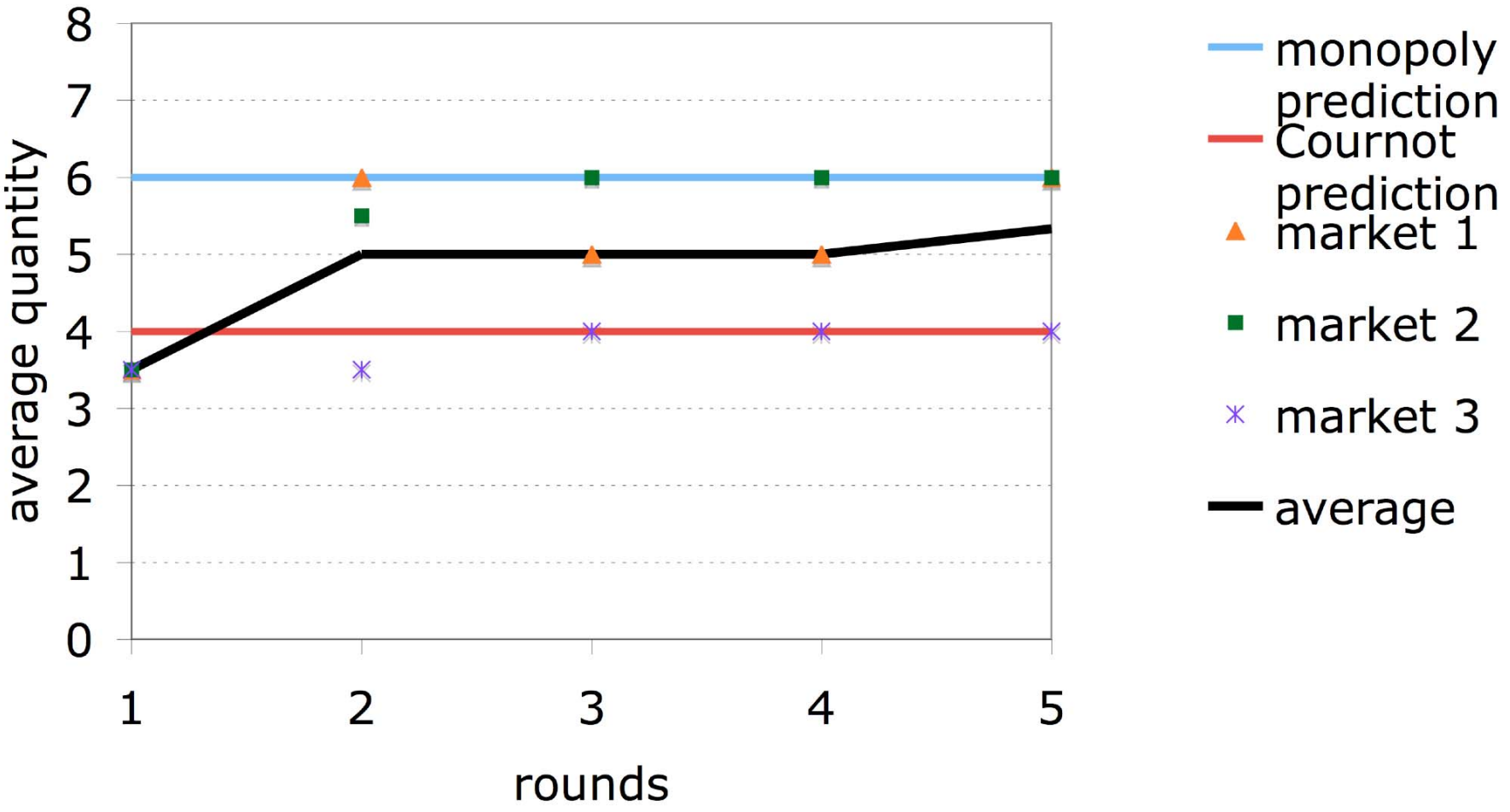
Trading Period	Duopoly Experiments				Monopoly Experiments				
	D1	D2x	D3x	D4x	M1x	M2x	M3x	M4xs	M5x
1	.49	.41	1.46	1.32	1.04	1.19	1.00	1.56	1.01
2	−.03	.01	1.13	.90	.38	.81	.86	.52	.84
3	−.43	−.16	.42	.71	.19	1.11	1.01	.86	.39
4	−.29	−.07	.22	.45	.10	.52	1.06	.42	.16
5	−.17	−.46	.03	.39	.04	.93	.65	.69	−.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

Smith Williams 1990

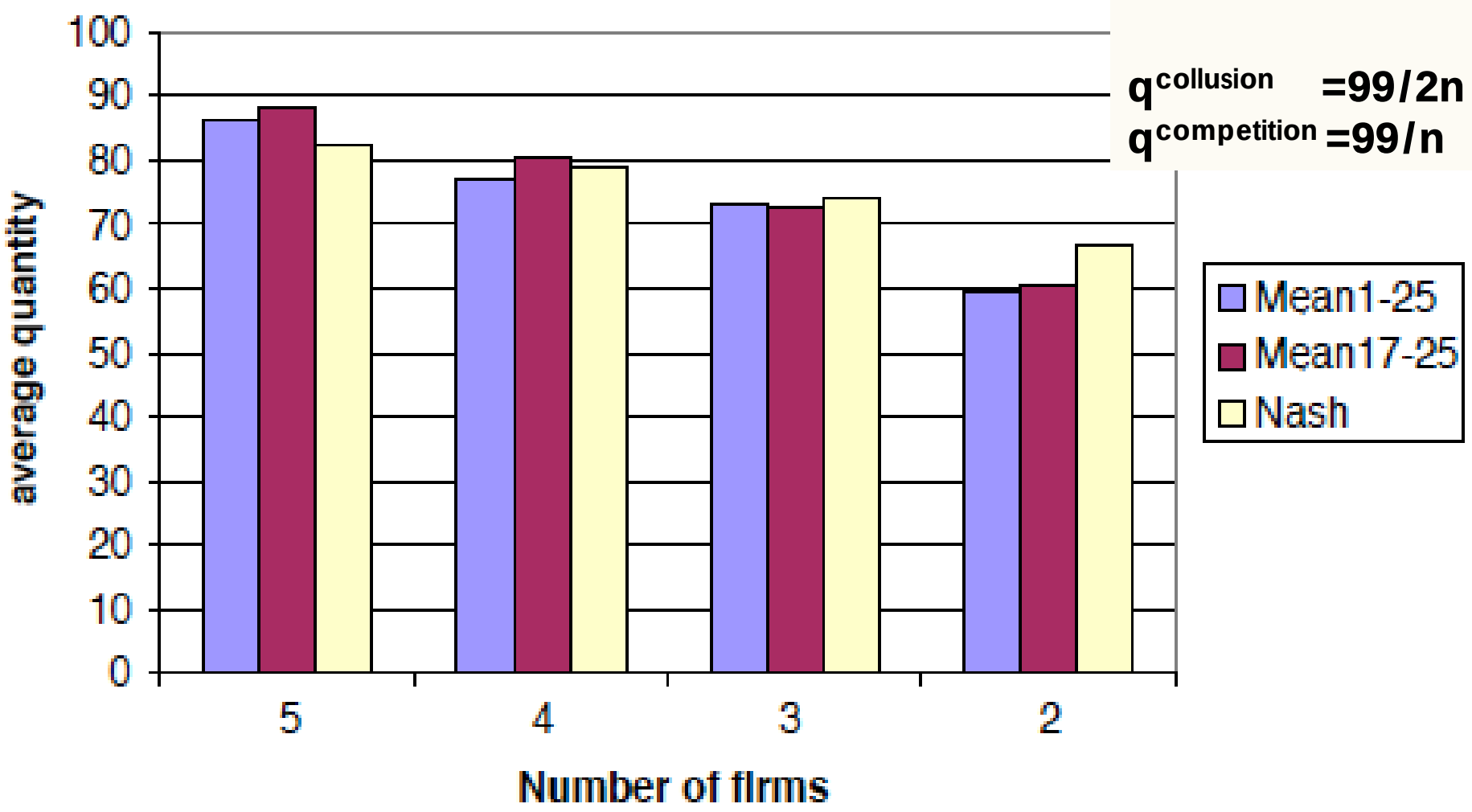
Results: Summary

- Duopoly
  - Even with only two sellers prices come close to the CE and aggregate welfare is most of the time well above 90 percent.
- Monopoly
  - Figures 5,6,8: Some units go close to the monopoly price, additional units are sold at successively lower prices, sometimes prices even below CE for many periods (fig. 8)
  - Attempts of price discrimination lead to CE price
    - Price discrimination is an advantage in a static context but informs buyers that monopolists can make profitable gains at low prices: Discriminative price cutting in early periods raises buyers' resistance against monopoly prices
  - Aggregate welfare in general rather high or Monopoly effectiveness is rather low (table 2).

Cournot: Experiment in Lecture 1



Cournot Market



Source: *S. Huck et al. / J. of Economic Behavior & Org. 53 (2004) 435–446*

Cournot & Stackelberg

Theoretical Predictions

	Cournot	Stackelberg
Individual quantities	$q_i^C = 8$	$q^L = 12;\ q^F = 6$
Total quantities	$Q^C = 16$	$Q^S = 18$
Profits	$\Pi_i^C = 64$	$\Pi^L = 72;\ \Pi^F = 36$
Consumers' surplus	$CS^C = 128$	$CS^S = 162$
Total welfare	$TW^C = 256$	$TW^S = 270$

Aggregate Data (Averages). Standard deviations in parentheses.

	STACKRAND	*STACKFIX*	*COURRAND*	*COURFIX*
Individual quantity	10.19/8.32	9.13/7.92	8.07	7.64
	(2.45/2.07)	(2.67/2.00)	(1.60)	(2.04)
Total quantity	18.51	17.05	16.14	15.27
	(2.86)	(3.67)	(3.21)	(4.08)
Total profits	93.48	105.01	116.60	116.73
	(45.59)	(45.99)	(36.02)	(42.87)
Consumers' surplus	175.37	152.14	135.38	124.91
	(56.70)	(66.12)	(55.04)	(68.74)
Total welfare	268.85	257.16	251.98	241.64
	(13.51)	(23.06)	(24.28)	(31.39)

(Note that for the Cournot markets under random matching average profit and surplus depend on the actual matching.)

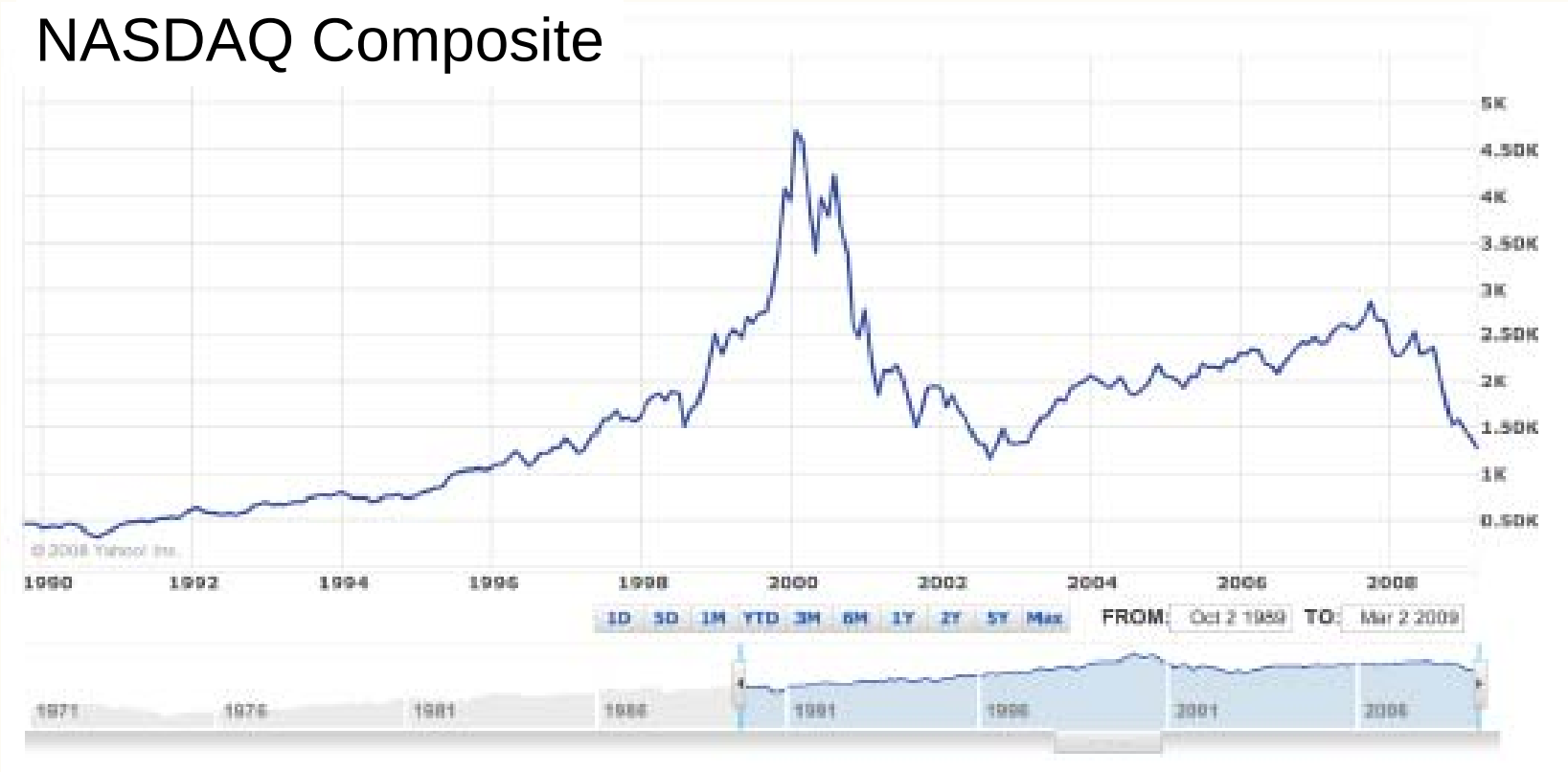
Source: *S. Huck et al. / Economic Journal 111 (2001) 1–17*

Summary

- Experimental tests of the functioning of different market structures confirm the theoretical predictions for
  - Competitive market
  - Bertrand
  - Cournot
  - Stackelberg
- The results for Monopolies yield different results than the theoretical predictions.

Speculative Bubbles: Stock market

NASDAQ Composite

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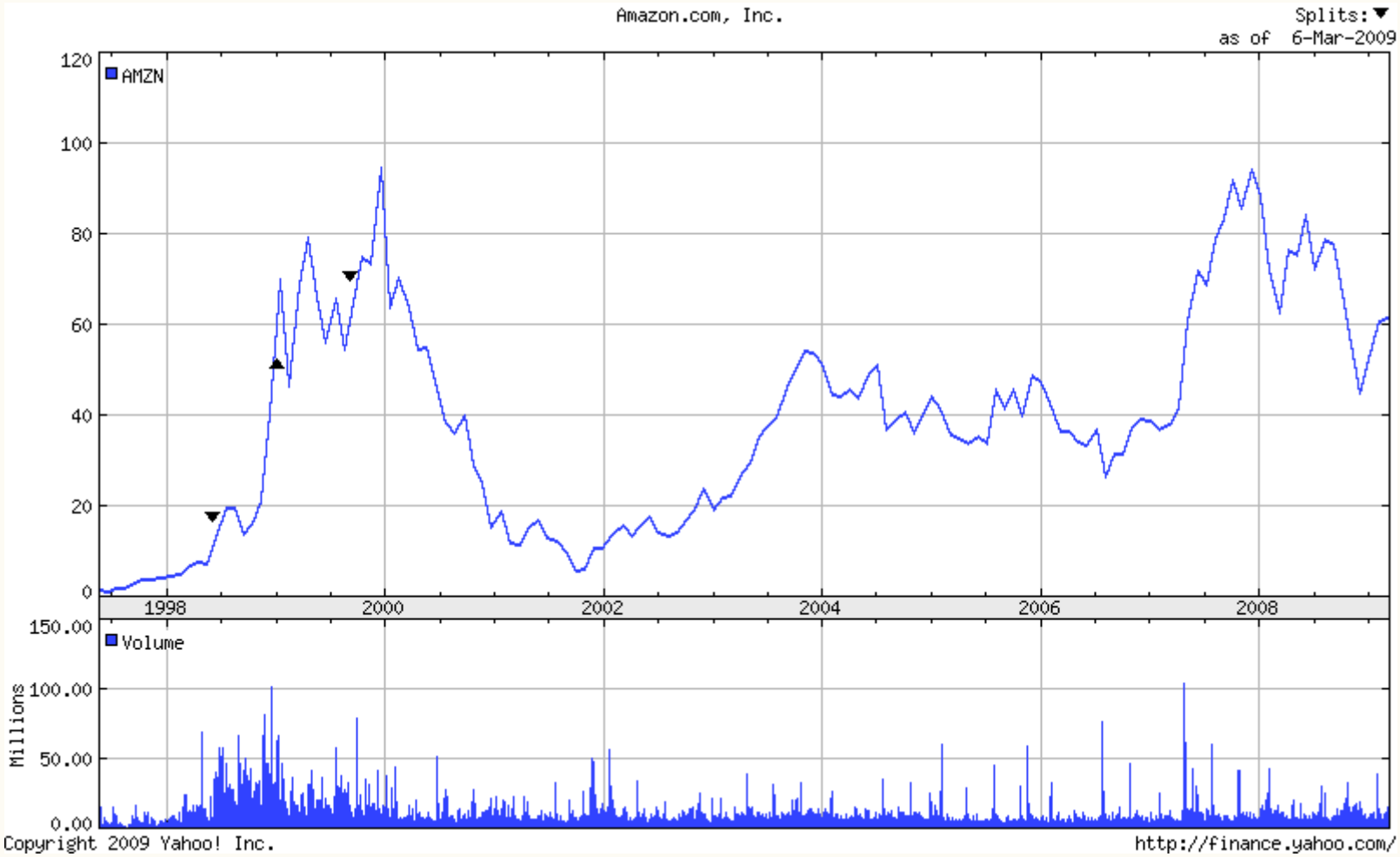
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Stock market with irrational price bubbles

(Smith et. al. 1988)

- Assets generate revenue for 15 periods, ${.6 , .28 , .08 , .00} each with probability 1/4.
  - Expected per period return is $ .24.
  - Expected value of asset in period 1 is $ 3.6, in period 15 $ .24.
- 9 traders are endowed with assets and experimental cash.
- 3 traders have 3 units, 3 have two units and 3 have one unit of the asset.
- Cash endowment is adjusted such that the expected value of everybody's endowment is the same.
- Assets are traded for cash under the DA-institution.

- At the end of each period one of the four states of the world occurs, which generates the corresponding dividend payment for the asset holders.
- Cash is transferred to future periods. Real money earnings are equal to amount of cash at the end.
- Only assets that are owned can be sold and assets have to be bought by currently owned cash.

- Trade only occurs if traders have different risk attitudes or different expectations regarding asset values.
  - No private values, No private information, why trade?
- Whatever the mix of risk attitudes, rational expectations of asset prices rule out price bubbles.

Predictions (if everybody is rational)

- In case of rational and risk neutral traders the asset value in any period is, by backwards induction, equal to the expected value of the asset.
- Therefore only trades at the expected value should occur, it they occur at all. Under near risk neutral agents we thus expect low trading volume at prices near the expected value.
- Suppose that for risk loving agents the certainty equivalent of the asset is .24 + ε (ε>0 but small) per period while for risk averse agents it is .24 - ε.
- Then, under rational expectations, the price in period 15 must be within the ε-neighbourhood of .24. The maximum price of the asset in t is then (T-t+1)(.24 + ε).

Results I

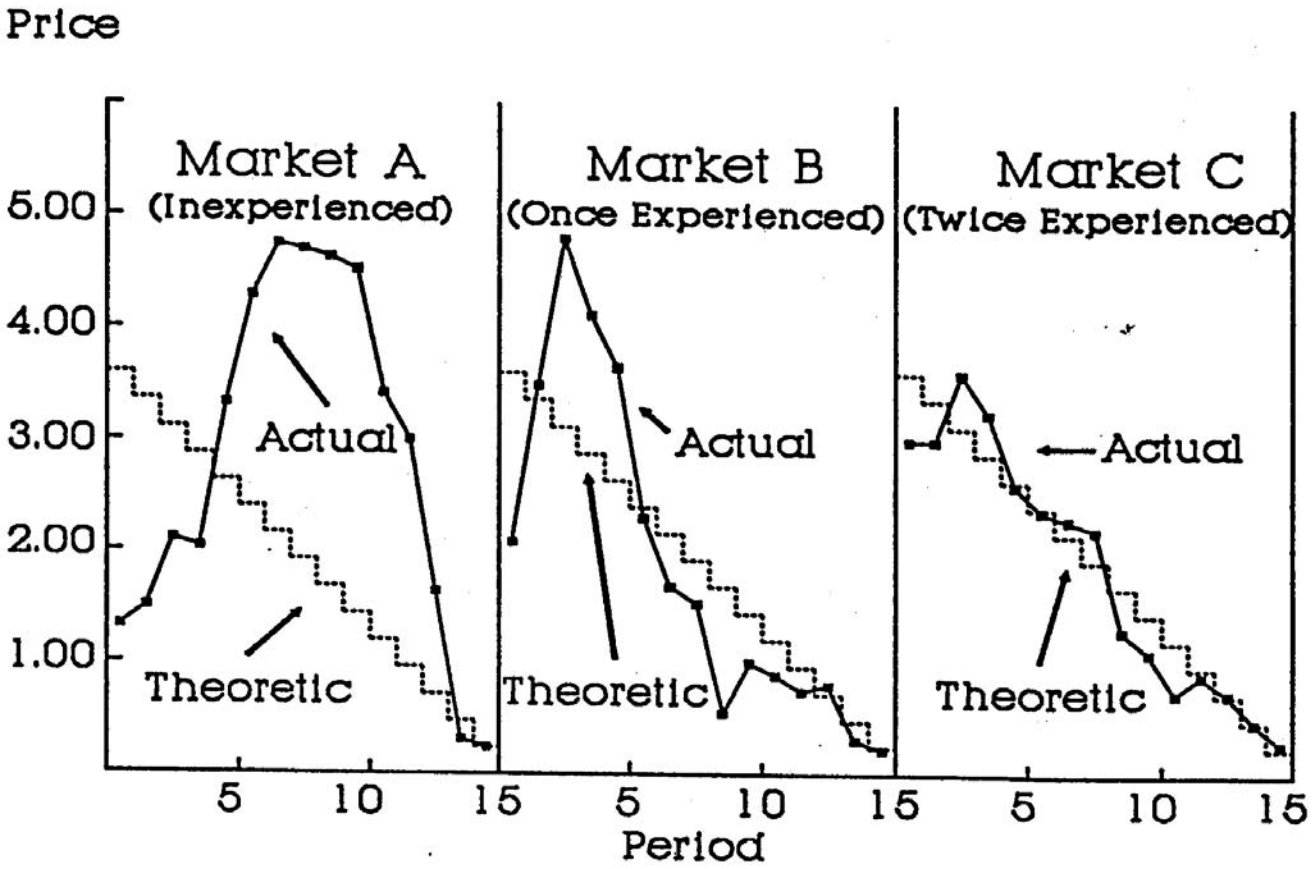

Figure 3.16 Intrinsic Value and Mean Prices in a Sequence of Three Double-Auction Asset Markets with the Same Participants (Source: Sessions 3pd295, 3pd296, and 3pd297, Peterson, 1991)

Source: Davis/Holt Experimental Economics

Results II

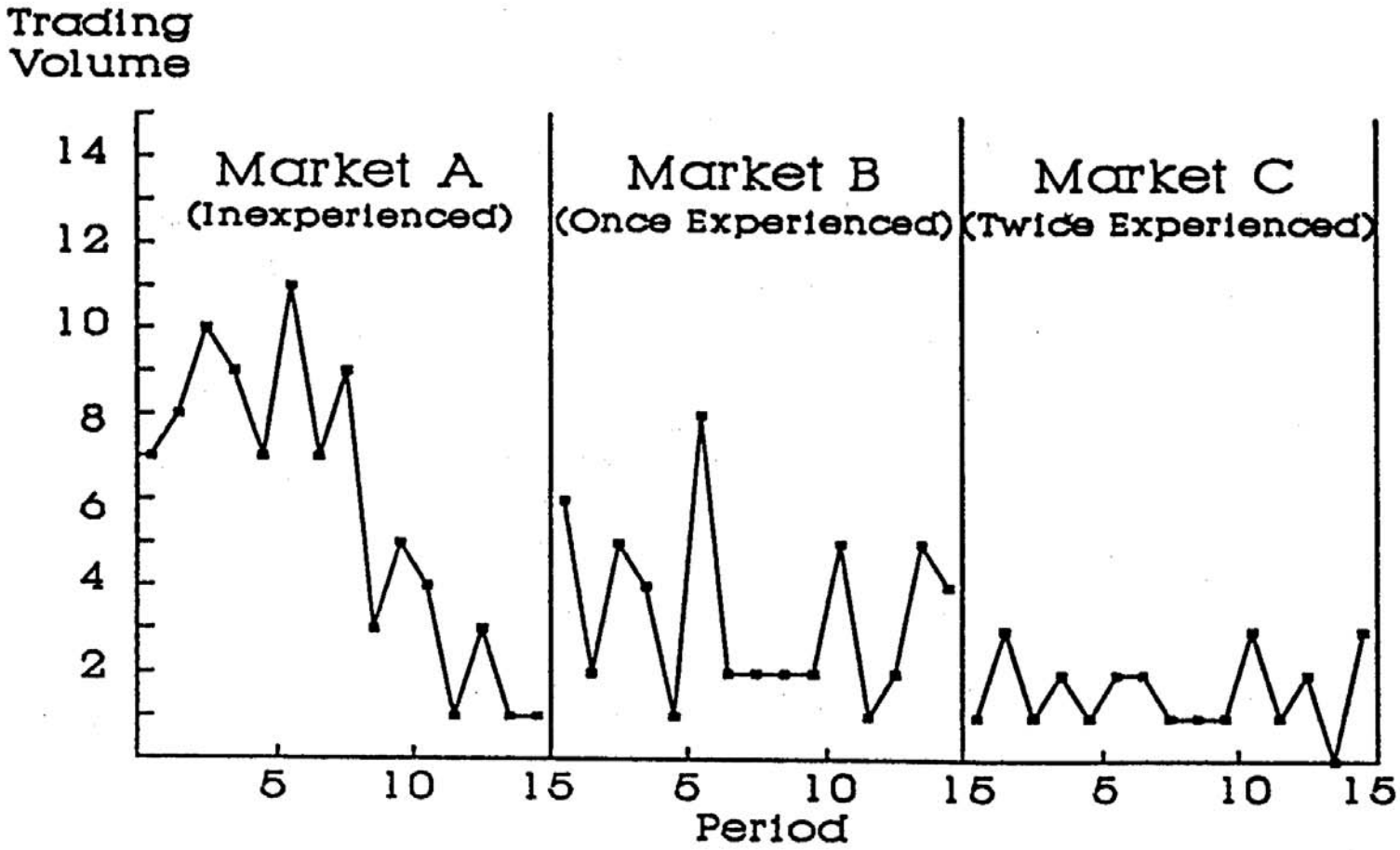

Figure 3.17 Transactions Quantities in a Repeated Series of Double-Auction Asset Markets (Source: Sessions 3pd295, 3pd296, and 3pd297, Peterson, 1991)

Source: Davis/Holt Experimental Economics

Results

- Traders who participate 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 the second time trade less at lower prices but still above the fundamental value.
- Twice experienced traders trade, if at all, at the fundamental value.

Remark

- Business professionals create the “same” speculative bubbles.
- This is an often cited result in “Behavioral Finance”.
- DA does not generate “rational” outcomes per se
- Possible interpretation: Absence of common knowledge of rationality renders speculation profitable even for rational traders. Even if everybody is rational but assumes the existence of some irrational traders the bubble can occur.
  - „I know it‘s a bublle but can‘t afford to stay out“
- Things can be quite different under asymmetric info…

Under asymmetric info people can induce bubbles

When I get a hold of the SOB who leaked this, I'm gonna tear his eyeballs out and I'm gonna suck his £%$&! skull.

Gordon Gekko , Wall Street, (1987)