Role of Extra-marginal Traders

Dan Gode and Shyam Sunder

Abstract

- The shape of extramarginal demand and supply does not matter in a Walrasian tatonnement.
- However, it matters in double auctions.
- Prior research has examined how extramarginal traders affect allocative efficiency.
- In this paper, we extend those insights to understanding how extramarginal traders affect price, quantity, distribution of surplus, and distribution of profits across individual traders.
- The key insight is that the extramarginal traders affect the pattern of convergence to equilibrium in a continuous double auction market.

Our prior efforts

- What Makes Markets Allocationally Efficient?
  - QJE 1997
  - Trade off between how “bad” an extra-marginal trader is and how likely it is to participate in a market
- Double Auction Dynamics: Structural Effects of Non-Binding Price Controls
  - Journal of Economic Dynamics and Control Volume 28, Issue 9, July 2004
  - Non-binding price controls should not affect the outcome of a Walrasian tatonnement. However, they can and do affect the outcome of double auctions. The paper used ZI traders to explore market dynamics.

Buyers and sellers

- Consider a market consisting of N buyers each endowed with the right to buy one unit each and N sellers with the right to sell one unit each.

- Buyer i has a redemption value of v_i and seller j has redemption value c_j.

- Shapes of market demand and supply functions can be changed by selecting different vectors v and c.

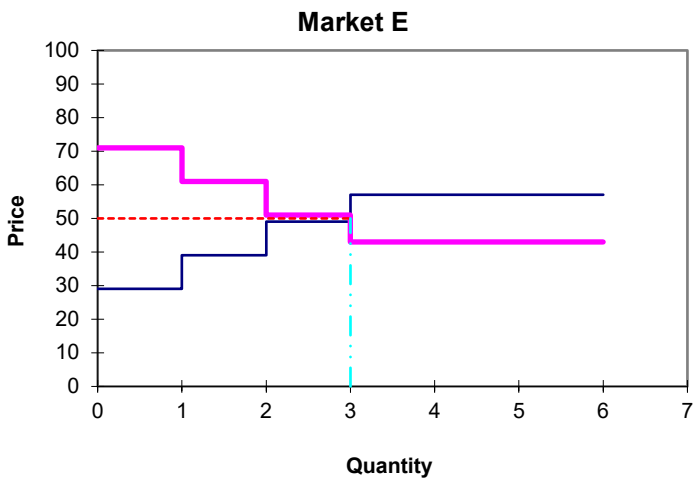
- The intramarginal segments of all sets of demand and supply functions are the same; therefore, the Walrasian tatonnement model predicts the same equilibrium for all four markets. All settings have equal number of intra- and extramarginal units, though the extra marginal units have no effect on the static predictions.

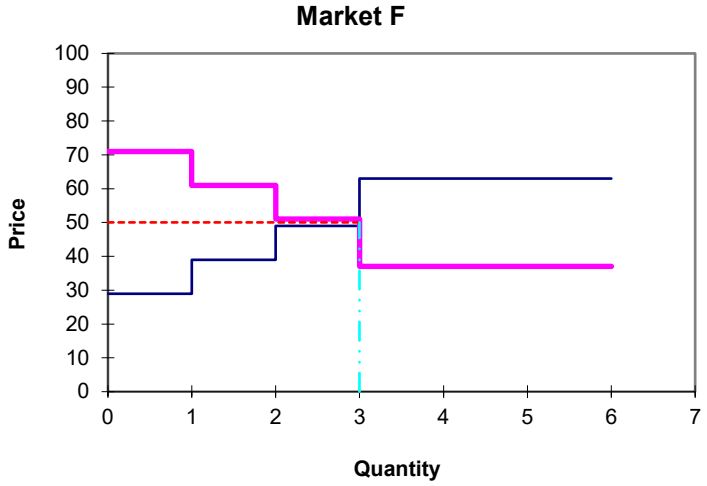
Double auction market rules and trader behavior

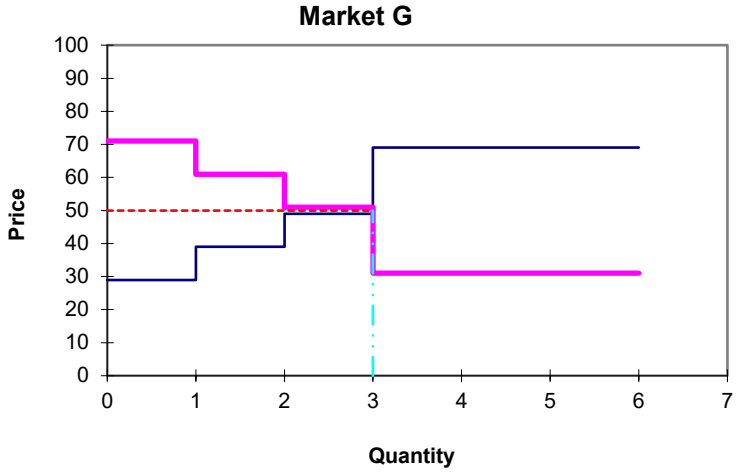
- A trader is randomly picked out of N buyers and N sellers.
- Buyers bid a uniformly distributed random number between 0 and their reserve value.
- Sellers generate a uniformly distributed ask between their cost and 100.
- A higher bid replaces a currently outstanding bid.
- A lower ask replaces a currently outstanding ask.
- Traders are picked randomly with replacement, which means that the same trader can be picked again to generate another bid (ask).
- Whenever the current bid is equal to or greater than the current ask, a transaction is executed between the relevant traders at the average of the bid and the ask.
- Since each trader is permitted only one transaction, these two traders exit the market, and the process of picking traders and their bids (asks) continues for a prespecified length of time or number of computer iterations.

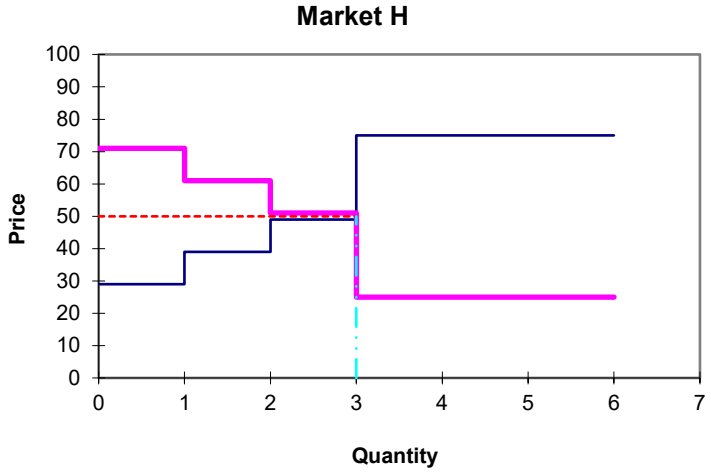
Allocative efficiency: Loss versus probability of loss

- QJE 1997 paper: The worse the extramarginal traders are, the less likely they are to trade in a market. The probabilities are affected by the market rules.





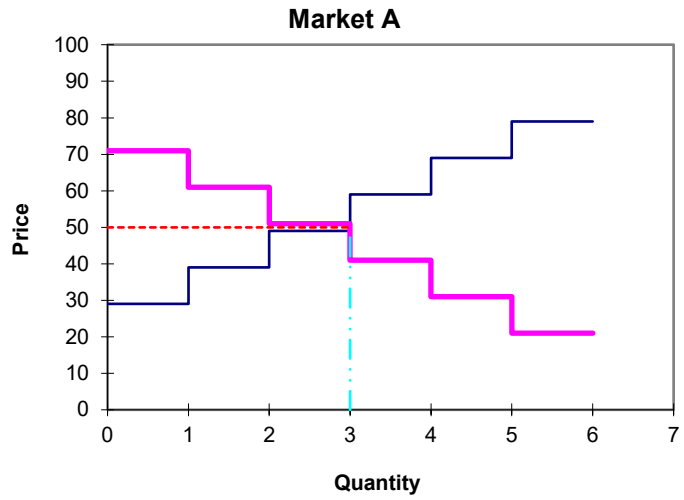


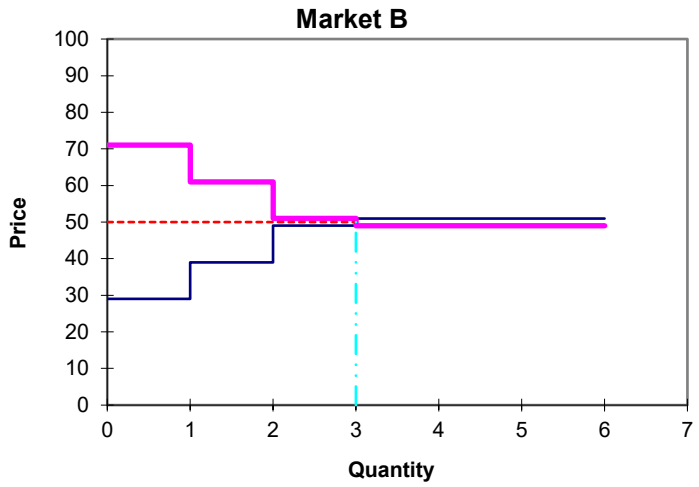


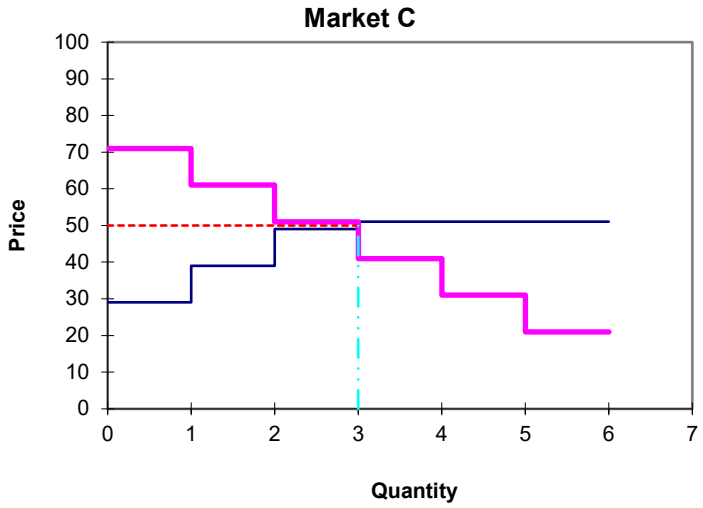
Four settings that we explore in this paper

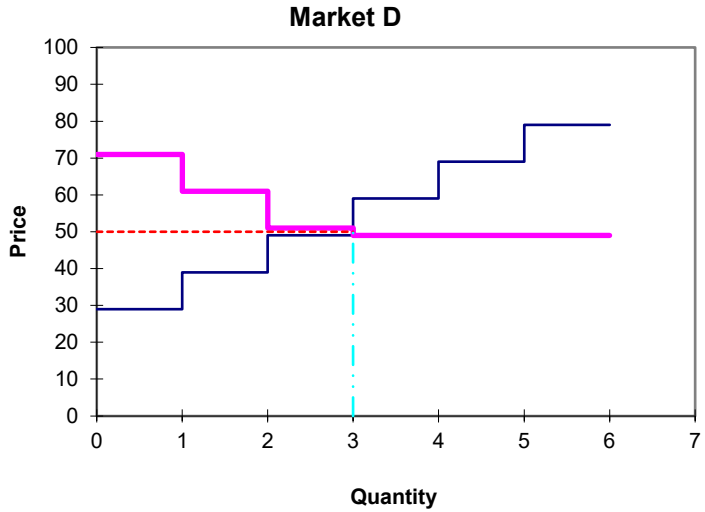
- The extramarginal segments of demand and supply differ across the four panels.
- Panel A has demand and supply functions with equal slopes throughout.
- In Panel B, the demand and supply functions are again symmetric, though these slopes drop to zero immediately after the marginal unit.
- In Panel C, the slope of demand function remains constant, but the slope of supply function drops to zero immediately to the right of the margin.
- In Panel D, the slope of the supply function remains constant, but the slope of the demand function drops to zero at the margin.

Asymmetric extramarginal demand and supply

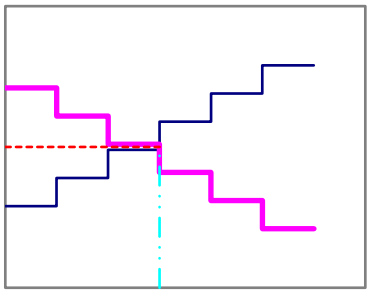
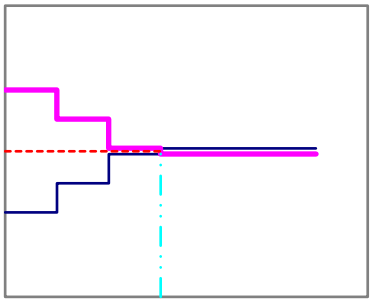
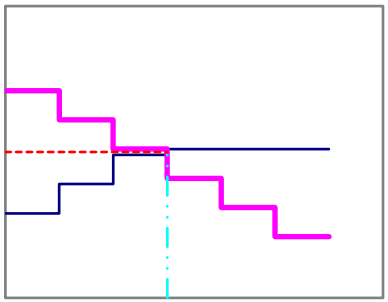
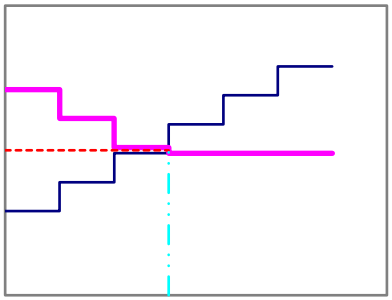








Preview

	A: Symmetric Wide Xtra-Marginal	B: Symmetric Narrow Xtra-Marginal	C: Flat Xtra Sellers	D: Flat Xtra Buyers
Mean Price	$P_A = P$	$P_B = P$	$P_C < P$	$P_D > P$
Price Variance	$V_A > 0$	$0 < V_B < V_A$	$V_B < V_C < V_A$? $V_C = V_D$	$V_B < V_D < V_A$? $V_C = V_D$
Slope of Price Path	0	0	Negative	Positive
Surplus split	$\pi_A^b = \pi_A^s$	$\pi_B^b = \pi_B^s$	$\pi_C^b > \pi_C^s$	$\pi_D^b < \pi_D^s$
Allocative Efficiency	$E_A < 100$	$E_A < E_B < 100$	$E_C < 100$	$E_D < 100$

Findings: 500 rounds of simulations

	A: Symmetric Wide Xtra-Marginal	B: Symmetric Narrow Xtra-Marginal	C: Flat Xtra Sellers	D: Flat Xtra Buyers
Mean Price $H_{0,}$ H_1: Accepted/Rejected Null Hypoth. Significance	$P_A = 50.24$ $P_A = P$ $P_A \neq P$ *Not Rejected* ($\alpha = 0.19$)	$P_B = 49.98$ $P_B = P$ $P_B \neq P$ Not Rejected ($\alpha = 0.93$)	$P_C = 49.20$ $P_C \geq P$ $P_C \leq P$ Rejected ($\alpha = 0$)	$P_D = 50.78$ $P_D \leq P$ $P_D \geq P$ Rejected ($\alpha = 0$)
Price Variance H_0: H_1: Accepted/Rejected Null Hypoth. Significance H_0: H_1: Accepted/Rejected Null Hypoth. Significance H_0: H_1: Accepted/Rejected Null Hypoth. Significance	$V_A = 50.30$ $V_A = 0$ $V_A > 0$ *Rejected* ($\alpha = 0$)	$V_B = 46.07$ $V_B = V_A$ $V_B < V_A$ *Rejected* ($\alpha = 0.04$)	$V_C = 52.01$	$V_D = 55.89$ $V_D = V_A$ $V_D \neq V_A$ *Not Rejected* ($\alpha = 0.07$) $V_B = V_D$ $V_B < V_D$ *Rejected* ($\alpha = 0$) $V_C = V_D$ $V_C \neq V_D$ *Not Rejected* ($\alpha = 0.43$)
Slope of Price Path	0	0	Negative	Positive
Surplus split	$\pi_A^b = \pi_A^s$ 97.19, 90.87	$\pi_B^b = \pi_B^s$ 94.19, 97.87	$\pi_C^b > \pi_C^s$ 102.87, 83.00	$\pi_D^b < \pi_D^s$ 86.07, 99.81
Allocative Efficiency	94.03	96.03	92.94	92.94

Price trends: Plausible but incorrect reasoning

- In Panel C, the lack of symmetry will push the expected value of transaction prices below P ($P_C < P$). The costs of the extramarginal sellers in this market are just above P, say ($P + \varepsilon$). Current ask is the minimum of all asks made since the last transaction. This is an order statistic. Until the current ask drops to ($P + \varepsilon$), the existence of the extramarginal sellers will exert a greater downward pressure on current ask than the extramarginal buyers' upward pressure on current bid.

- Two reasons for this difference in pressures on current asks and current bids.

  - For any value of x, the number of sellers whose costs are below P+x is equal to or more than the number of buyers whose redemption values are greater than P-x. Thus, the difference in the number of active sellers and buyers is one source of difference.

  - In addition, the expected magnitude by which the current asks drop (or current bids rise) is greater when the difference between the current ask and cost (or redemption value and current bid) is greater. Both these factors cause the current asks to drop faster than the rise of current bids.

- By using analogous argument, expected price P_D will be greater than P. Thus our price predictions, summarized in Table 1, are $P_C < P = P_A = P_B < P_D$.

Price trends: Correct reasoning

- In Panel C, in early trading, the asks of extramarginal sellers (whose costs are close to P) are more likely to be matched to the bids of intramarginal buyers than the bids of extramarginal buyers (whose values are farther away from P) are likely to be matched to the asks of intramarginal sellers. When an extramarginal seller gets matched to an intramarginal buyer, an intramarginal seller will have no option other than to trade with one of the extramarginal buyers. Since the values of the extramarginal buyers are much lower than P, they can only transact at a lower price. In such periods, lower price of such late transactions will not only impart a negative slope to the price path, it will also lower the average price of transactions.

- Whenever the extramarginal substitution described in the preceding paragraph does not take place, all transactions take place among the intramarginal buyers and sellers. Given the symmetry of demand and supply, the transaction prices in such periods are distributed around P.

- On average, across all periods of trading in Market C, price path will have a small downward slope, and the average prices will be lower than P. Analogously, in Market D, the price path will have a positive slope and prices will be higher than P on average. Thus, our price predictions, summarized in Table 1, are $P_C < P = P_A = P_B < P_D$.

Variance of prices

- Wrong thinking:
  - V_B will be smaller than V_A because the presence of extramarginal traders close to P in Market B will bring the bids and asks closer to P faster than in Market A.
  - This variance reduction effect of Market B is only partially present in Markets C and D. Therefore, their variance is likely to be an intermediate value.
  - Therefore, we summarize the variance relationships should be $0 = V < V_B < V_C = V_D < V_A$.
- Correct thinking
  - In synchronized markets V_B will be smaller than V_A because the presence of extramarginal traders close to P in Market B will tend to bring the current bids and asks closer to P than in Market A.
  - In continuous markets, the same effect will prevail, though for different reasons. In Market A, an extramarginal trade can take place only at prices farther away from P than in Market B, this raises the variance of prices in Market A relative to Market B.
  - It is more difficult to predict what the price variances will be for Markets C and D. We summarize the variance relationships in Table 1 as $0 < V_B < V_A$.

Buyer profits versus seller profits

- Given the symmetry of demand and supply functions, and $P = P_A = P_B$, buyers and sellers will have equal profits in static Walrasian model, and equal expected profits in Markets A and B.

- Given the lower prices in Market C, buyer profits will exceed seller profits.

- The reverse will be true in Market D which favors the sellers.

Conclusion

- The shape of extra-marginal demand and supply affect the following:
  - Efficiency
  - Average prices
  - Trends of prices
  - Variance of prices
  - Allocation of surplus between buyers and sellers