Competitive Exchange as a Microeconomic System

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Outline

How to Achieve Competitive Outcome?

- Environment, Institution, and Strategies ⇒ Competitive Outcomes
- Decentralized Institution and Centralized Institution

Attempts of Supply and Demand Revealing

- Clearinghouse Institution
- Sealed-bid/ask Institution

Incentive Comparable Institutions

- (Dynamic) Mechanism design

Exchange in Competitive Market

Adam Smith's narrative in the Wealth of Nations 1776

- The division of labor increases mutual dependency.
- Competition of buyers/sellers drives price down/up when price is not P^E.

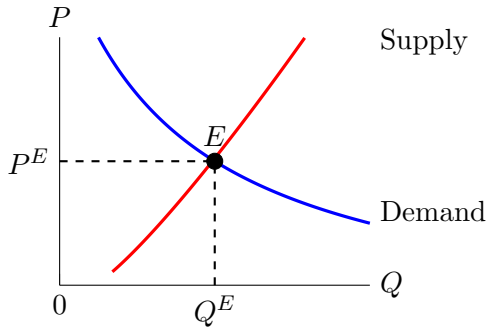


Figure 1: Equilibrium in Competitive Market

Microeconomic System (Smith 1982, AER)

> *In defining a microeconomic system two distinct component elements will be identified: an* ***environment*** *and an* ***institution****. ... A microeconomy is closed by the* ***choices of agents*** *in the intuition.*

Environment

- Resources, technologies, agents' preference

Institution

- Decides rules of interaction, collects message, delivers message, and governs

Agents' Strategy

- Receive message and make decision

Environment + Institution + Strategies $\Rightarrow$ Economic Outcome

Environment of Exchange System

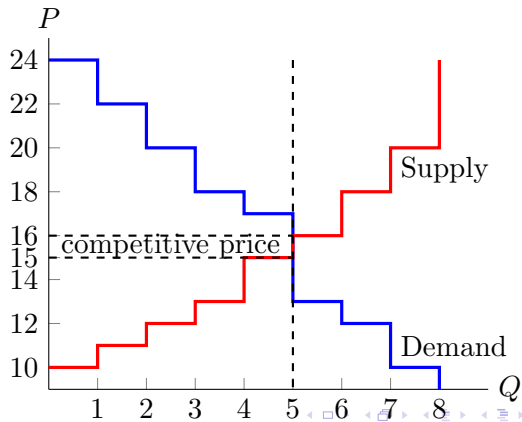
Consider the simplest setting

- Each buyer/seller can buy/sell at most one unit of a homogeneous good.

Preferences

Buyer	Value
1	24
2	22
3	20
4	18
5	17
6	14
7	12
8	10

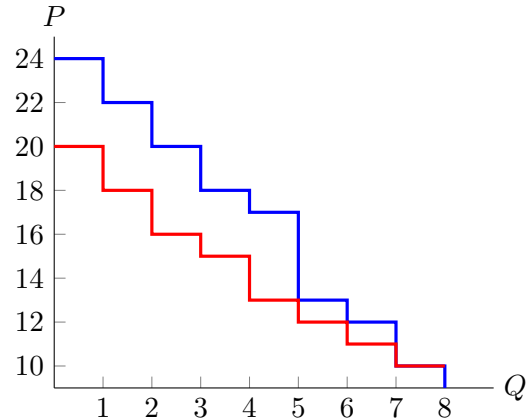
Seller	Cost
1	10
2	11
3	12
4	13
5	15
6	16
7	18
8	20



Desirable Outcome of Exchange System

The greatest number of transactions?

#	Buyer	Seller	Surplus
1	1 (24)	8 (20)	4
2	2 (22)	7 (18)	4
3	3 (20)	6 (16)	4
4	4 (18)	5 (15)	3
5	5 (17)	4 (13)	4
6	6 (14)	3 (12)	2
7	7 (12)	2 (11)	1
8	8 (10)	1 (10)	0
	Total surplus:		22
	Efficiency :		55%

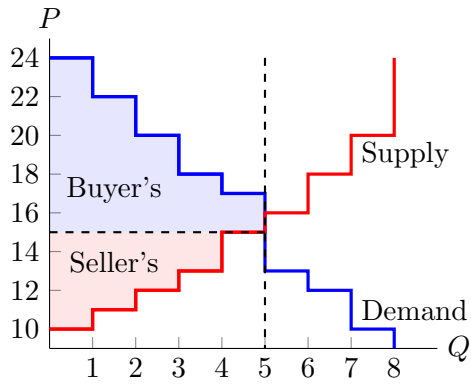


Multi-prices and deadweight loss.

Efficient Allocation as the Desirable Outcome

Competitive price leads to the greatest social surplus.

Buyer	Surplus	Seller	Surplus
1	$24 - p$	1	$10 + p$
2	$22 - p$	2	$11 + p$
3	$20 - p$	3	$12 + p$
4	$18 - p$	4	$13 + p$
5	$17 - p$	5	$15 + p$
6	0	6	0
7	0	7	0
8	0	8	0
	Total Surplus:		40
	Efficiency :		100%



Decentralized Institution and Random Strategy

Decentralized Institution

- Players are located in different grids.
- Players start bargaining when at least one buyer and one seller meet.

Zero-Intelligent-Affinity (ZIA)(Gode and Sunder, 1993; McKabe, 2021)

- Buyer bids randomly between a lower bound and their value.
- Seller asks randomly between their cost and an upper bound.
- Both like to stay in the current location than to move a step further.

Computational results (Gui and Mckabe, 2021)

- transaction prices with variance; efficiency $\approx 58\%$ (50 buyers and 50 sellers)

Decentralized Institution and Rational Strategy

Chamberlin's (1948) classroom experiment

- Students were given buyer or seller roles and corresponding cards with private dollar values or costs.
- Walk among desks in the classroom to make deals.
- Transactions quantities higher than Q^E, prices not converge to P^E.

Perhaps it is the perfect market which is "strange"; at any rate, the nature of the discrepancies between it and reality deserve study.

(Chamberlin, 1948, JPE, p.108)

Centralized Institution and Rational Strategy

Double Auction (DA) (Smith, 1962)

- Buyers and sellers submit bids and offers in any order to a centralized platform that display quotes and transaction prices.

Figure 2: Screenshots from VEconLab

The Miracle of the Market

Prices converge to P^E quickly, efficiency $> 85\%$

- Smith (1962): 6 buyers and 6 sellers, Efficiency $\approx 98.2\%$
- Martinelli et al (2023): 2 buyers and 2 sellers, Efficiency $\approx 89.1\%$

DA offers a price discovery process

- Price taker: The standing bid and ask keep update current prices.

Are traders player Nash (Friedman and Ostroy, 1995)?

- Nash equilibrium: given all other active traders bid/ask P^E, no better off from single deviation.
- But in order to play Nash, players need to know P^E to begin with.

Can a Institution Reveal Demand and Supply?

Demand and Supply is not revealed in DA

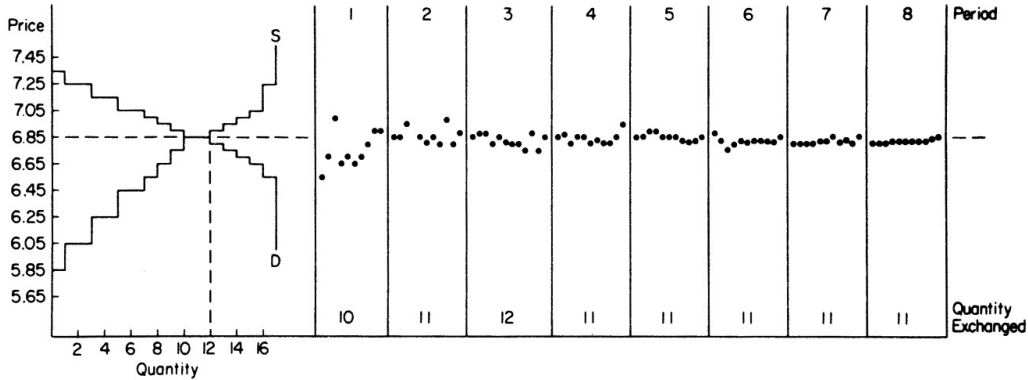


Figure 3: Efficency= 98.2% (Smith et al., 1982)

Revealing Demand and Supply as Desirable Outcome

. . . I will hand over to Mr. Counsel Böttiger a sealed note which contains my demand (2000 hexameters), and I wait for what Mr. Vieweg will suggest to offer for my work. If his offer is lower than my demand, then I take my note back, unopened, and the negotiation is broken. If, however, his offer is higher, then I will not ask for more than what is written in the note to be opened by Mr. Böttiger.

Goethe's letter to Vieweg, 1797

Auctions tend to be designed to collect more information.

Attempt 1: Clearinghouse Institution (Debuy, 1982)

Price and Allocation rule

- Clearinghouse orders bids from highest to smallest, orders asks from smallest to highest
- Transaction quantities: the number of pairs with $bid \geq ask$
- Transaction prices: buyers pay their bids, sellers receive their asks if there is a transaction
- Clearinghouse profit: sum of bids - sum of asks

Players are not incentives to report true values or costs

- Given all others bid/ask true values, one buyer is better off by bidding lower.
- The only Nash equilibrium is to bid and ask the same competitive price for those who can trade.

Experiment Results of Clearing House

The two-buyer-two-seller case in Martinelli et al (2023)

- Price lower than P^E, Efficiency $\approx 70\%$

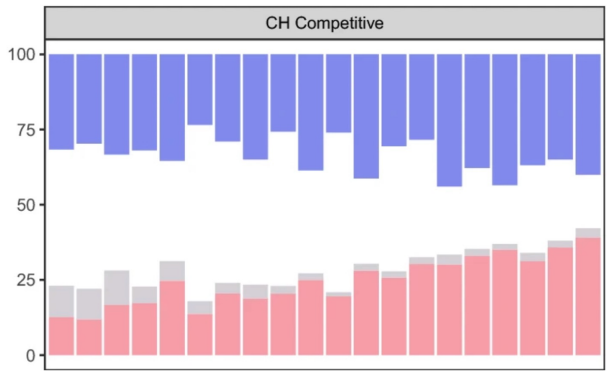


Figure 4: Buyer Surplus (blue), Seller Surplus (red), and Clearinghouse Profit (grey)

Attempt 2: Sealed Bid/Ask Institution (Shubik, 1977)

Price and Allocation rule

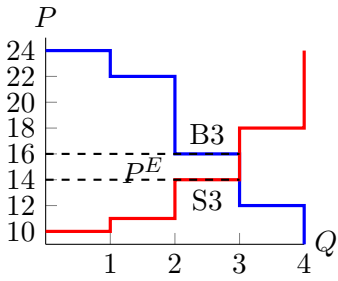
- Orders bids from highest to smallest, orders asks from smallest to highest
- Transaction quantities: the number of pairs with $bid \geq ask$
- Transaction price: intersection of last $bid \geq ask$ pair and first $bid \leq ask$ pair

Bid/ask competitive price is a Nash Equilibrium

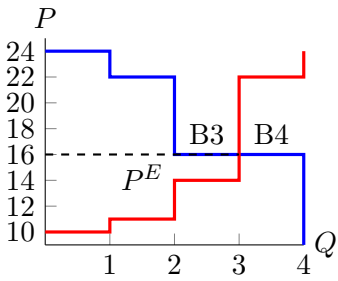
- Given that all (active) traders bid/ask the competitive price, a single deviation is not better off.
- Experimental results: bids and asks vary, efficiency = 90.6% (Smith et al., 1982)

Reporting truth in a Sealed Bid/Ask Institution?

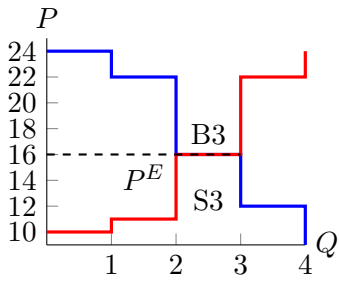
It is possible, but only in a strict condition (Case (c)).



(a) P^E in a range



(b) Margin Competition



(c) Reporting Truth is a NE

- Impossibility Theorem for multi-units demand: For any rule selecting a competitive equilibrium after players announce their valuations, there is a player who has incentives to manipulate the rule. (Perez-Castrillo and Sotomayor, 2017)

Incentive Comparable Static Mechanism Design

System Setting

- Environment: the buyer's value is private information, $i.i.d$, drawn from a common distribution F.
- Desired outcome: the single seller is to maximize the profit
- Strategies: to play Bayesian Nash
- Institution: incentivizes buyers to bid true value (IC), and ensures all buyers keep non-negative payoff (IR).

Optimal Static Mechanism (Myerson, 1981)

- The optimal direct mechanism is a second-price auction with a reserve price that solves $r = \frac{1-F(r)}{f(r)}$

Dynamic Mechanism Design

- To maximize the revenue, the seller sets rules of allocations and prices over multi-period as the buyer receives private information over time.
  - **Repeated selling of perishable goods**
  - Long-term principal-agent relationship
- Dynamic mechanism improves revenues and the efficiency (Baron & Besanko, 1984).

Thinking: A "Simple" Example (Mirrokni et al., 2020)

Scenario U

- two-period, single-buyer
- the seller sells one item in each period; zero production cost
- Distribution of the buyer's value: $F_1 = U[0, 1] = F_2$, independent draws

What are the best rules of allocation and price?

- Dynamic IC: the buyer reports the true value
- Ex-post IR: the buyer gains a non-negative payoff after realization of values

Summary

Exchange System as a Microeconomics System

- Competitive price leads to efficient allocation.
- Double Auction institution duplicates the miracle of the market.
- How and why the real market works: more work to be done.

Attempts of Supply and Demand Revealing

- A competitive market: always deviation from truthful quoting.
- A static monopoly: truthful bidding is incentivized.
- A dynamic monopoly: more work to be done.


Thank You!

A complicated Answer

Buyer knows the clairvoyant bundle:

$$p_2 = 1 - \sqrt{2p_1 - 0.5}$$

- Buyer makes a bid in Period 1, pays p_1 if $b_1 \geq p_1$
- p_1 is a function of b_1