

# Competitive Exchange as a Microeconomic System

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# Outline

## How to Achieve Competitive Outcome?

- ▶ Environment, Institution, and Strategies  $\Rightarrow$  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  $P^E$ .

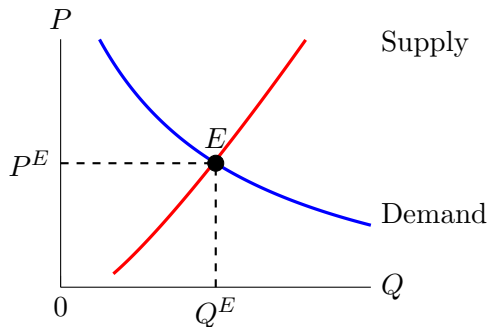


Figure 1: Equilibrium in Competitive Market

# Macroeconomic 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

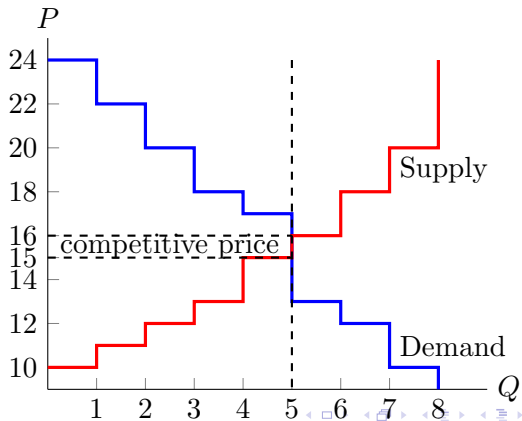
# Environment of Exchange System

Consider the simplest setting

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

Preferences

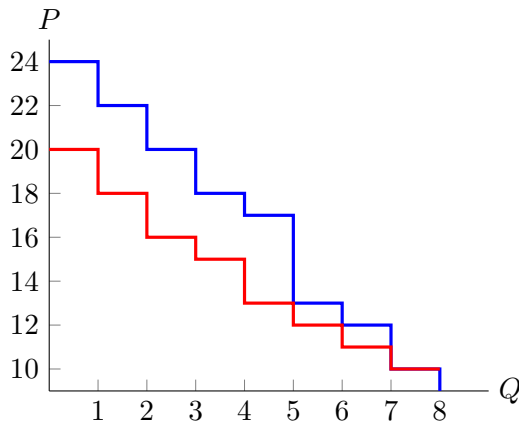
Buyer	Value	Seller	Cost
1	24	1	10
2	22	2	11
3	20	3	12
4	18	4	13
5	17	5	15
6	14	6	16
7	12	7	18
8	10	8	20



# 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%

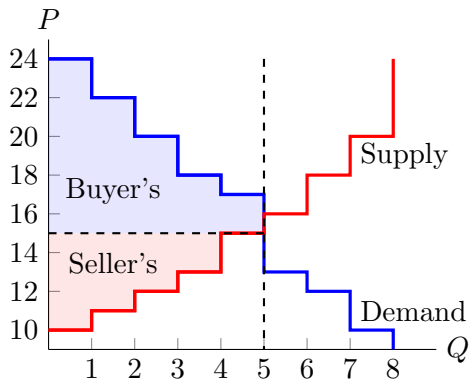


Multi-prices and deadweight loss.

# 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.

Bid/Ask Sequence		Highest Bid = <b>\$5.00</b> , Lowest Ask = <b>\$7.00</b>					Highest Bid = <b>\$5.00</b> , Lowest Ask = <b>\$7.00</b> Please enter or revise ask prices.				
Bid	Ask	unit	value	bid	price	earnings	unit	cost	ask	price	earnings
5.00		1	\$7.00			\$0.00	1	\$2.00	<b>\$7.00</b>		\$0.00
4.00		Total Earnings:				<b>\$0.00</b>	Total Earnings:				<b>\$0.00</b>
	<b>7.00</b>	Round 1 Price Sequence					Round 1 Price Sequence:				
		<b>\$6.00</b>					<b>\$6.00</b>				
		Buyer					Seller				

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

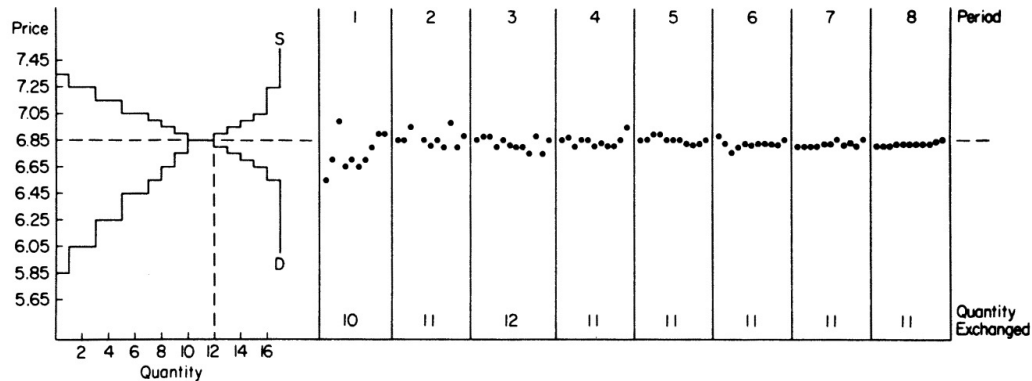


Figure 3: Efficiency= 98.2% (Smith et al., 1982)

# 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  $\approx 70\%$

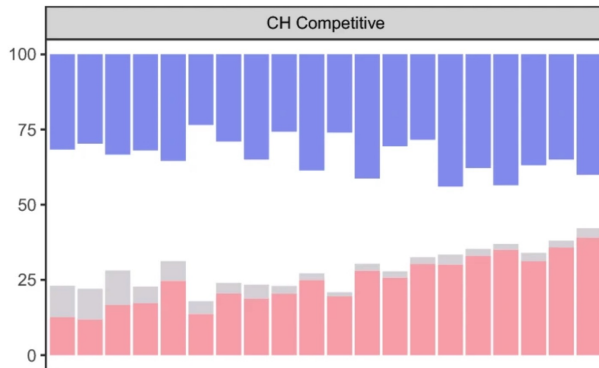


Figure 4: Buyer Surplus (blue), Seller Surplus (red), and Clearinghouse Profit (grey)

## 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

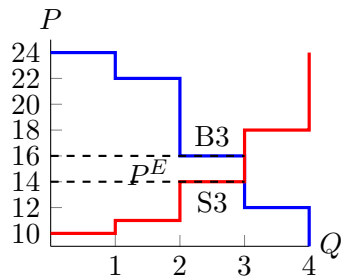
### Bid/ask competitive price is a Nash Equilibrium

- ▶ 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)

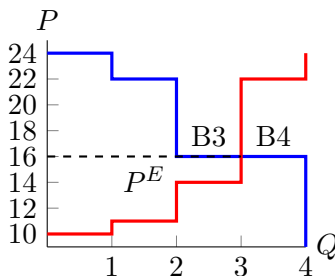


# Reporting truth in a Sealed Bid/Ask Institution?

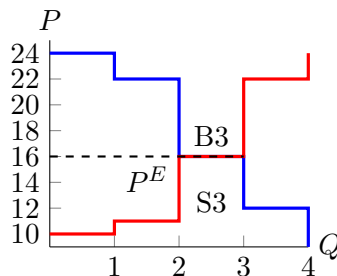
It is possible, but only in a strict condition (Case (c)).



(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  $b_1$

