Introduction to market design

"Only recently have we economists started to understand enough about how markets work so that we can help in that process."

Alvin E. Roth

2012 Nobel Prize laureate (with Lloyd Shapley)
"for the theory of stable allocations and the practice of market design."

What is market design

Application of economic principles and game theory to the design (or re-design) of market institutions.

$$\text{Theory} \longrightarrow \text{Pratice} \longrightarrow \text{Evaluation}$$

Market Design investigates (scarces) ressources allocations both via:

- a price mechanism, e.g., market for mobile radio frequencies,
- a non-price allocation procedures, e.g., allocation of students to universities.

Bibliography

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Road map

- Market and equilibrium price: definition and examples.
- How a market operates.
- Example: food banks.

What is a market?

In economics:

- a demand for *something*
- a supply for *that* something

There is a market for *that* something.

The traditional approach consists of finding an equilibrium price, i.e., a price p such that:

$$\sharp \text{ units buyers are willing to buy at } p \text{ or more}$$
$$=$$
$$\sharp \text{ units sellers are willing to sell for } p \text{ or less}$$

Questions

- How do we get the equilibrium price?
- Is the “price recipe” the same for all markets?
- What if the price is not the only parameter driving individuals’ decisions?

The exact details about how to organize a market do matter: they affect:

- Who gets what
- At what price

Example 1: Easy case

A market for a very common good (e.g., milk):

- Milk is the same everywhere
- Large number of buyers and sellers
- Quantities for demand/supply can be adjusted
- sellers adjust their prices, depending on the sales. Consumers react to prices. After some time, prices stabilize and we get an "equilibrium" price.
- This is the usual approach supply/demand (Léon Walras, 1834-1910), there is no need to be specific on the price mechanism.

Example 2: More difficult

What is the price for a Monet painting? Seller wants at least 1 M€.

- Price discovery: How do we get to know the price buyers are willing to accept?
- Each buyer has a maximum price at which he/she is willing to buy the painting:
  - Alice has the highest such maximum price: 5 M€.
  - Bob has the 2nd highest maximum price: 2 M€.
- There's only one such painting, so the seller needs to find out the price beyond which there's at most one buyer.

- Any price between higher than 2 M€ and at most 5 M€ thus an equilibrium price. What is the “right” or “correct” equilibrium price?
- We made a non trivial assumption: Bob’s valuation of the painting may depend on how much Alice desires it. . .
- Few buyers, few sellers: the environment is not competitive, we need to be more precise about how prices are made comes out.

Example 3: More challenging

- College or BS admission: large demand (students) and large supply (colleges).
- price = tuition
- Looks like the market for milk. So, why don't we have a "*market for BS admission*"?

  Obviously we are not in equilibrium: top schools accept less than 7% of the applicants.

  For instance, Harvard (or HEC, ESSEC in France) could raise tuition until

$$\sharp \text{ applicants} = \sharp \text{ seats}$$

- What matters here: Buyers/sellers do not only care about the good they are buying/selling (education), but also with whom they make transaction:

  BS and students have preferences over each other. Price (tuition) is not the only variable of decision.

- Conclusion: price may affect decisions for each other, but may not be sufficient to determine the “equilibrium” (or the final allocation).

Example 4: Even worse

What if there's no monetary transaction at all?

- In almost all countries, selling/buying human organs for transplants is illegal
- Yet, there is a market: a demand (patients) and a supply (live/cadaveric donors).
- Is there a way to organize such markets?

Prices could have adverse effects.

- It is legal in some countries to compensate blood/sperm/eggs donors.
- Such compensation may prevent donation.

What a market needs to work

Several conditions must or should be met.

- We need “enough” actors from both sides. This is called market thickness.

  Sellers need to meet buyers, and buyers need to meet sellers. Roads, internet or trade treaties bring/lead to thickness.

  If a seller can face many different buyers she can have a good knowledge of how the demand looks like.

- Avoid congestion: Too much thickness can create problems, like too much traffic can create traffic jams.
- Make the market safe: Actors must be able to make the “right” decision:
  - They need to understand the rules, how the market works
  - Avoid feeling ripped off.

Commodities

We often think that market design is about the rules, how the market operates.

But defining what are the goods or services being traded can have some effect, too.

How goods and services are defined can influence the design of the trading institution.

Take wheat, to make flour (to make bread).

- Two bags of wheat from two different farmers are no exactly identical
- In the past, a baker would then negotiate with each farmer/mill.
- This can make the market thin, or create congestion.

- But wheat/flour can be categorized, as a function of the type of grain, the quality (the “grade”), etc.

  $\rightarrow$ Wheat/flour become a commodity: what matters is the type of wheat/flour, not its origin.

- 1775: Trieste commodity exchange was created.

  1848: The Chicago commodity market was created.

  2008: Ethiopian commodity exchange (ECX) for sesame, coffee, etc.

Market Design: a first example

- Food banks provide food to the poor.
- Distribution is typically done at the local level (food pantries, soup kitchens, churches, community centers, etc.) .
- Food in a food pantry can originate from nearby and far away (via regional food bank).

Feeding America

- 3rd largest not-for-profit in the US after the Red Cross and United Way Worldwide).
- Sources food donations from
  - Large food manufacturers
  - Large distributors
  - small/local entities

  and allocated it to ≈ 210 regional entities.
- 2 ways for distribution:
  - facilitate donations from donor to a particular food bank
  - donations directly to Feeding America, who allocates it to food banks.

How to allocate food?

Feeding America receives donations (truckloads of some particular products).

Objectives

- Fairness: allocate to the neediest foodbanks
- Don't waste:
  - Avoid spoiling food.
  - If some food donation is not distributed the donors may refrain to make future donation.

Give to the neediest

- Feeding America calculates for each food bank
  - The quantities of food that **should** receive (using comparisons across food banks and population size in service area)
  - The quantities of food that is received.
- Food offered to banks, starting with the bank with the highest ratio

$$\frac{\text{quantities should receive}}{\text{quantities received}}$$

This mechanism is known as the serial dictatorship.

Incentives

A food bank would be proposed some food. Then choices between

- Yes.
  - Food bank is liable for transportation costs.
  - The "received quantities" add up to the tally, thus changing the ranking of the food bank in the queue.
- No
  - The "received quantities" add up to the tally, thus changing the ranking of the food bank in the queue (as if the food bank said "yes").

$\rightarrow$ Nothing to lose to say "yes" (up to the transportation cost).

Incentives (cont'd)

But incentives may be too harsh:

- If the food cannot be stored for long, forcing the food bank to accept may be counterproductive.
- transportation cost can be prohibitive for long distance,

  $\rightarrow$ Feeding America skips food banks that are too far away.

Problems

- Some food banks would receive food they didn't need.

  E.g., Idaho food bank receiving potatoes.

- Some food banks would never receive food they need.

  E.g., Alaska food bank never receives offer for produce.

Problems from a market perspective

Lack of information:

- Food banks typically receive only 20% from Feeding America (and FA knows little about the other 80%).

- For FA, 1 kg of potato chips = 1 kg milk = 1 kg frozen meat = 1 kg of whatever.

  $\rightarrow$ needs depending of regional differences, nutritional value, transportation costs not taken into account.

Finding an allocation system: Issues

- One key issue is to reveal information, i.e., food banks reveal how much they need each particular item.
- Need to introduce choice. So we need a budget.
- Without a budget, a consumer raises her hand for all items, and thus choice become uninformative:

In 2004 Feeding America created a task force to fix the problem.

- 9 directors of regional food banks
- 3 senior staff at Feeding America
- 4 economists from the University of Chicago

For the economists, a solution quickly came out: use a market mechanism. But…

- Markets have a bad reputation, they don't always work well.
- Food banks precisely targets those who are left out by the system.
- One food bank director initially said:

  > *"I am a socialist. That's why I run a food bank. I don't believe in markets. I'm not saying I won't listen, but I am against this."*

Introducing prices?

- Prices are useful: solve the local lack of information, showing how much people value different things.
- Real money not the right solution: neediest food banks may be the poorest.
- What about fake money? Just give fake money to the food banks.
- How do we ensure that the neediest get the most food?

The auction

- FA distributed “shares” to food banks, with neediest banks receiving more shares.
- Everyday, food banks log onto a website where food offering are posted.
  On average, 30-40 offerings/day
- Two auctions/day, first-price, sealed bid auction:
  - clearer for participants
  - avoid sniping (by large food banks)
- All shares spent on a given day redistributed at midnight, using the same formula as for the initial allocation.

Additional features

- **Joint bidding** allowed. Helps small food banks: truck for transportation creates an indivisibility.
- **Delegated bidding**: food banks can delegate bidding to FA (explaining their needs).
- **Credit**: Food banks can access credit, paid off with their future allocations. One credit at a time.

- **Maroon pounds**
  - Some food banks may be in excess of some type of food.
  - Allow them to “sell” this food on the market.
  - 10% tax imposed on these sales.
- **Negative prices**
  - To maintain donor relations (don’t want to refuse food).
  - make some “undesirable” products more attractive.

Results

- Observing prices FA obtained information about which types of food are
  - highly demanded (meat, poultry, fish)
  - least demanded (produce, sugary drinks, potato chips).
- Price are stable (it facilitates bidding with a new currency). Some quantitative money theory introduced to manage monetary mass.
- Supply of food increased (from 125 to 200 million kilo/year).

Reference

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