Prices as Optimal Competitive Sales Mechanisms

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Broad Motivation

Matching

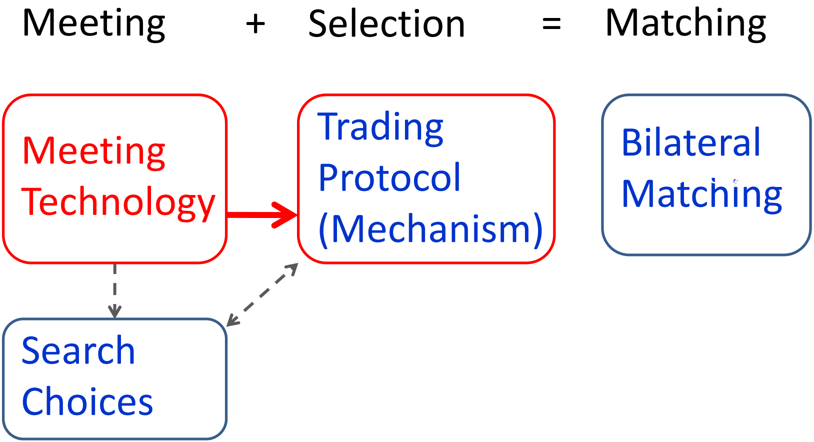
Bilateral Matching

Broad Motivation

Meeting + Selection = Matching

Meeting	Selection	Matching
Meeting Technology	Trading Protocol (Mechanism)	Bilateral Matching
Search Choices		

Broad Motivation



How are goods/labor sold ***depending on the frictions*****? (fixed prices/auctions/bargaining)**
How is competing mechanism design ***affected by the meeting process*****?**

Broad Motivation

Meeting Function Example

Example Meeting Technology:

- urnball application process
- N applications can be opened

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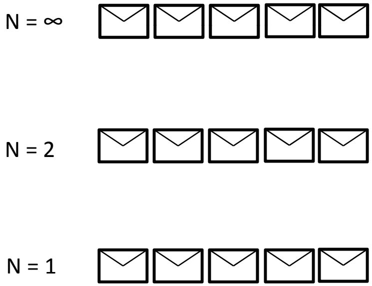

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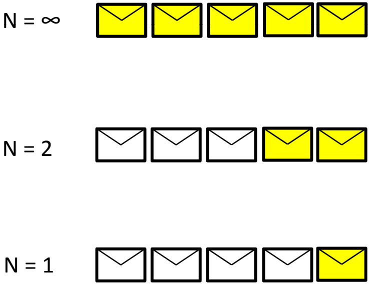

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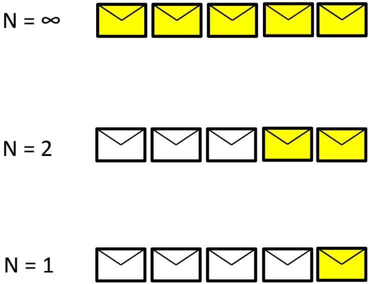

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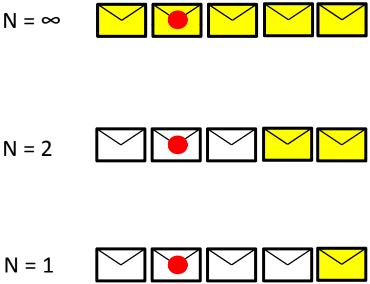

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(no externality in meeting – ***no crowding out***)

N = 2

(negative externality in meeting –***crowding out***)

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Peters (1984, 1991, 1997a,b, …);
McAffee (1993),
Burdett, Shi, Wright (2001);
Shi (2002); Shimer (2005),…

((Moscarini 2001,…))

"**Competitive Search**":
Shi (2001; Guerrieri (2008),
Menzio (2009);
Guerrieri, Shimer, Wright (2009)
(Moen '97; Mortensen, Wright '01..)

((Albrecht, Vroman 2002,…))

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How does this affect the type of trading protocol (mechanism)?

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This paper's approach

The approach in this paper:

- Lay out multilateral meeting function
- Specify mechanism space
- Analyze which mechanisms sellers use to attract buyers
  - homogeneous buyers
  - heterogeneous buyers with private values

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Focus on price posting (relative to auctions, bargaining...):

- When is price posting an equilibrium? When is it efficient?
- What is the relationship to random search?
- What is the relationship to the meeting technology?
  [Difference: "competitive" vs "directed" search]

Competition in Mechanisms

The game:

1. each buyer draw private value (if heterogeneous).
2. each seller posts mechanisms m.
3. each seller decides which mechanisms m to seek.
4. this gives buyer-seller ratios $\lambda_i(m)$ at each mechanism.
5. meeting function: how many buyers of each type arrive at seller.
6. mechanisms are being played.

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Open questions even for standard urnball ($N = \infty$):

- McAffee '93: auctions are always best reply, and strictly help under uncertainty about buyer types.
- Under price posting each seller only faces one buyer types (no uncertainty), and prices satisfy some planners problem.
- Are auctions only a weak best reply; are prices equally good?

Results

Homogeneous Sellers:

- equivalence of many selling mechanisms
  (generalizes Camera and Selcuk 2009, justifies Kultti 1999)
- random search is socially efficient and equilibrium outcome

Heterogeneous Sellers: Price Posting

- is constrained constrained efficient if planner *can only use mechanisms that give the good away at random*
- is is constrained efficient and equilibrium outcome under bilateral matching (and under multilateral matching with strong crowding out, auctions still also weak best reply)
- is is not socially efficient and no equilibrium outcome under (but auctions are)

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More search then mechanism design. Trade-offs:

- random search leads to most matches
- but crowding might make separation of types preferable

COMPETITIVE PRICE POSTING

Competitive Search / Directed Search

(Peters ('84,'91,'00,'05); Montgomery ('91); Moen ('97); Acemoglu & Shimer ('99a); Burdett, Shi & Wright ('01);

Julien, Kennes & King ('00); Albrecht, Gautier & Vroman ('06); Galenianos & Kircher ('06); Shi ('07)...)

- competitive price setting with frictions
- alternative to random search
- good efficiency properties
  (Moen ('97); Acemoglu & Shimer ('99b); Shi ('01,'02); Mortensen & Wright ('03); Shimer ('05); Kircher ('06), Moen & Rozen ('06)...)

Question: When can we restrict attention to price posting?

- When is price posting an equilibrium? When is it efficient?
- What is the relationship to random search?
- What is the relationship to the meeting technology?
  [Difference: "competitive" vs "directed" search]

Competitive Price Posting

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Large measure of (homogeneous) risk-neutral sellers
Large measure of (possibly heterogeneous) risk-neutral buyers

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- Buyer who trades gets $v - p$

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The market interaction:

- Sellers post prices
  - Seller's max. problem when buyers can get utility U elsewhere

$$\max_{p,\lambda} \quad [1 - P_0(\lambda)]p$$

$$\text{s.t.} \quad \sum_{n \geq 1} Q_n(\lambda) \frac{[v - p]}{n} = U \texttt{ if } \lambda > 0$$

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Price Posting

$\Leftrightarrow$

Random Search under urnball meetings and
Second price auctions w/o reserve

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b) random in equilibrium

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general questions:

1. **Is price posting as efficient as other mechanisms?**
2. **Is price posting an equilibrium?**
3. **Is efficiency achievable by random search?**

Importance: Can we restrict attention to "simple" mechanisms?
What is the role of the meeting technology?

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heterogeneous buyers (high and low valuations):

Price Posting **(screens perfectly between buyers)** **(efficient in class of non-discriminatory mech.)**

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a) efficient, equivalent to other mech.
Not b) random search not efficient

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***Multilateral* Meetings** **(no crowding out)**

Not a) rather: auctions are efficient
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"Competitive"	**"Directed"**
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What we know from competing mechanism design under "urn-ball" matching: (McAffee ('93), Peters ('97, '99), Peters & Severinov ('97))

- second price auctions are always a best reply
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Deeper Question:

- Are auctions only a weak best reply?
- Are prices also a best reply, as they "screen" ex ante?

Outline

- The price model
- The meeting function
- The general mechanism model

1. Price posting
    1. homogeneous buyers
    2. heterogeneous buyers
2. General Mechanisms
    1. "Directed Search" (multilateral matching, no crowding out)
    2. "Competitive Search" (bilateral matching, crowding out)
       Comment: multilateral matching with crowding out

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- Sellers post prices according to measure μ_s
  - Seller's maximization problem

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$$\texttt{s.t.} \quad \sum_{n \geq 1} Q_n(\underline{\lambda} \quad) \frac{[\underline{v} - p]}{n} = \underline{U}^* \quad \texttt{if } \underline{\lambda} > 0$$

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Equilibrium

Definition (Equilibrium)

An equilibrium consists of distributions of trading strategies, buyer-seller ratios and buyer utilities such that

1. Seller Optimality: sellers solve their maximization problem.
2. Buyer Optimality: buyer choose sellers optimally.
3. Market Clearing: buyer-seller ratio arises from trading.

   For any measurable subset $\mathcal{P}$ of prices:

   $s \int_{\mathcal{P}} \underline{\lambda}(p) d\mu_s = \underline{b} \int_{\mathcal{P}} d\underline{\mu}_b$ and $s \int_{\mathcal{P}} \overline{\lambda}(p) d\mu_s = \overline{b} \int_{\mathcal{P}} d\overline{\mu}_b$.

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For definition with arbitrary anonymous mechanisms:

- A mechanism describes expected payoff for low buyer
- Similar for high buyer type and for seller.
- Has to obey resource constraint and incentive compatibility

THE MEETING FUNCTION

- λ: expected number of buyers
- $P_n(\lambda)$: Prob. that seller has n buyers
- $Q_n(\lambda)$: Prob. that buyer faces $n-1$ other buyers
- $nP_n(\lambda) = \lambda Q_n(\lambda)$, $n \geq 1$

The meeting function

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$$P_0'(\lambda) < 0 \quad \text{and} \quad \sum_{n=0}^{N} P_n'(\lambda) \leq 0 \quad \text{for all } N.$$

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- Examples:
  1. urnball matching: $P_n(\lambda) = \lambda^n e^{-\lambda}/n!$
  2. Kiyotaki-Wright matching: $P_1(\lambda) = \alpha\lambda/(1+\lambda) = 1 - P_0(\lambda)$

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- All types have equal meeting chances in a market.

Price Posting and Mechanisms

1.1) Homogeneous Buyers

Proposition (Price Posting w/ homog. buyers)

Under price posting, in equilibrium one price is offered, buyers select at random, and randomness is efficient

Def.: A class of mechanisms is *payoff complete* if it has some dimension (like the reserve price in an auction) to shift payoffs between buyers and sellers.

Proposition (Equivalence)

In any class of pay-off complete (full-trade) mechanisms

- *an equilibrium mechanism exists*
- *remains equilibrium mech. when other mech. are added*
- *equilibrium payoffs are identical as under price posting*
- *search is (essentially) random.*

Second price auctions: $r^* = 1 + \lambda^* P_0'(\lambda^*)/P_1(\lambda^*)$

Price Posting

1.2) Heterogeneous Buyers

Proposition (Price Posting w/ heterog. buyers)

Price Posting leads in equilibrium to

- *two prices, one for each type*
- *buyers separate by "voting with their feet"*
- *constrained efficient given frictions and within the class of non-discriminatory mechanisms (Hosios' Condition).*

Sketch of separation argument:

- low types want low price more than good matching probability
- single crossing property
- pricing effectively separates the types.

MECHANISM POSTING

2.1) "DIRECTED" (MULTILATERAL MATCHING - NO CROWDING OUT)

DEFINITION (NO CROWDING OUT)

The meeting technology exhibits "no crowding out" if the meeting probability for one buyer type is independent of choices by the other.

PROPOSITION (MECHANISM POSTING)

- *Identical auctions are more efficient than price posting*
- *Price posting is not an equ. when auction are available.*

Sketch of Proof:

- Random search yields most matches [$1 - P_0$ concave]
- More matches with identical auctions than w/ price posting
- High types choose randomly and get the object fist
- $\Rightarrow$ most matches for high types.
- Most matches & most matches for high types $\Rightarrow$ efficiency.
- Individual deviation to auction mechanisms is profitable.

Mechanism Posting

2.2.) "Competitive" (Bilateral Matching - Crowding Out)

Bilateral matching has "crowding out": $Q_0(\underline{\lambda} + \overline{\lambda})$ increases in $\underline{\lambda}$.

$[1 - Q_0(\lambda) = Q_1(\lambda) = P_1(\lambda)/\lambda = (1 - P_0(\lambda))/\lambda, P_1' < 0.]$

Proposition (Mechanism Posting)

Under bilateral matching

- *Price posting is constrained efficient.*
- *Price posting is an equilibrium.*
- *Random search is never constrained efficient.*

Sketch of Proof:

- The presence of low types "crowds out" high types.
- Sellers never see high types when a low type is present.
- All "selection" before the seller can intervene.
- Best not to mix types.
- Under separation: prices do a good job.

Mechanism Posting

2.2) Comment: Multilateral Matching - Crowding Out

Multilateral Matching w/o Crowding Out and Bilateral Matching are extremes.

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Example: Consider an urnball arrival but

- a seller can only show up to N buyers the good (his house/car...)
- a firm can only screen up to N applicants

N$=1$: Bilateral Meetings
N$=\infty$: Multilateral Meetings without Crowding Out
N$\in(1,\infty)$: Multilateral Meetings with Crowding Out

MECHANISM POSTING

2.2) COMMENT: MULTILATERAL MATCHING - CROWDING OUT

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- a firm can only screen up to N applicants

N$=$ 1: Bilateral Meetings
N$= \infty$: Multilateral Meetings without Crowding Out
N$\in (1, \infty)$: Multilateral Meetings with Crowding Out

Surplus under separate markets: $S^{sep}(\underline{b}, \overline{b})$
Surplus under separate markets: $S^{joint}(\underline{b}, \overline{b})$.

Conjecture:

- $S^{sep}(\underline{b}, \overline{b}) > S^{joint}(\underline{b}, \overline{b}) \forall (\underline{b}, \overline{b})$: Price Posting optimal and equilibrium
- $S^{sep}(\underline{b}, \overline{b}) < S^{joint}(\underline{b}, \overline{b}) \forall (\underline{b}, \overline{b})$: Auctions optimal and equilibrium
- Otherwise: Possibly "partial pooling"

Conclusion

- "Competitive" (Homog. agents or bilatateral matching):
  - Prices are constrained efficient
    (other mechanisms only replicate the pricing outcome)
  - Random search is not efficient under buyer heterogeneity.

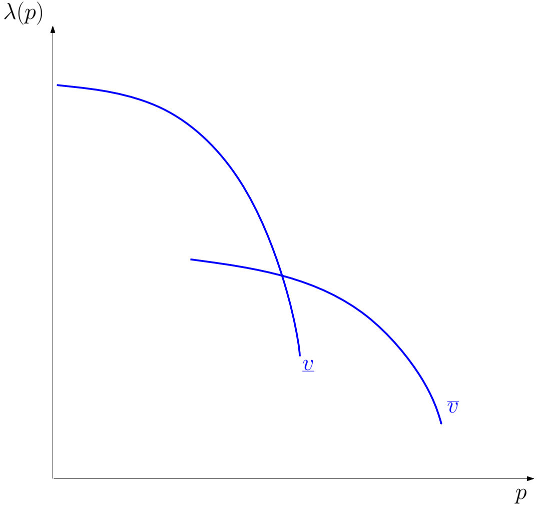
- "Directed" (multilateral matching w/o crowding out):
  - Prices are not constrained efficient
    (when discriminatory mechanisms are available).
  - Random search is efficient
    (when discriminatory mechanisms are available – Caveat: only when sellers are homogeneous).

- Larger relevance:
  - Clarifies when prices do a "good job".
  - Shows relevance of the specific meeting technology.
  - Highlights when we can focus on one buyer type (even under additional problems such as moral hazard ect.)

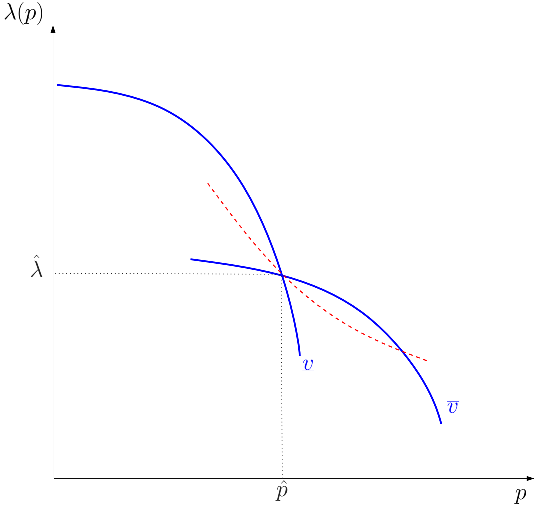
PRICE POSTING

1.2) SINGLE CROSSING - SEPARATION "BY FEET"

Buyer's indifference curves



Iso-profit curve at a single market price



Equilibrium with two prices