Screening and Adverse Selection in Frictional Markets

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Introduction

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- Examples: insurance, loans, some financial securities

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- Theory: restricted contracts or extremes (perfect/zero competition)

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- how does market structure affect contracts terms? estimates of AS?
- will recent attempts to $\uparrow$ competition & transparency $\uparrow$ trade? welfare?

This Paper

A tractable model of adverse selection, screening and imperfect competition

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- Adverse Selection: sellers have private info about asset quality.
- Screening: Uninformed buyers offer general menus of contracts.
- Imperfect Comp: sellers either receive 1 or 2 offers (Burdett-Judd).

Preview of Results

- New **techniques** $\rightarrow$ complete characterization of unique eqm
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  - Separation when adverse selection (AS) severe, competition high
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  - Identifying AS requires knowledge of market structure
- Effects of more competition & better info on **trade volume, welfare**
  - AS severe: welfare $\bigcap$-shaped with $\uparrow$ competition. Otherwise: decreasing.
  - Low comp: welfare $\bigcap$-shaped as $\uparrow$ transparency. Otherwise: decreasing.
  - Competition interacts with IC constraints in non-monotonic fashion.
  - $\uparrow$ competition/transparency desirable only when AS severe, competition low

Related Literature

Empirical

- Chiappori-Salanie ('00), Ivashina ('09), Einav et al. ('10,'12), ...

Adverse Selection and Screening

- Rothschild-Stiglitz ('76), Dasgupta-Maskin ('86), Rosenthal-Weiss ('84), Bisin-Gottardi ('06), ...
- Mirrlees ('71), Stiglitz ('77), ...
- Guerrieri-Shimer-Wright ('10), Guerrieri-Shimer ('14), Chang ('14)...

Imperfect Competition and Selection

- Burdett-Judd: Garrett, Gomes, and Maestri ('14)
- Hotelling: V-B & S-M ('99), Benabou-Tirole ('14), Townsend-Zhorin ('15), Weyl & co-authors...

Environment

Environment

2 buyers, large number of sellers

- Each seller has 1 unit of divisible good
    - Good is of quality $i \in \{l, h\}$ with probability μ_i
    - Seller: receives utility c_i per unit of consumption.
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- Assumptions
  - Gains from trade for both types: $v_h > c_h$ and $v_l > c_l$
  - 'Lemons' assumption: $v_l < c_h$
  - Adverse Selection: Only sellers know asset quality

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  - General mechanisms + communication → identical outcomes ▸ Proof

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Imperfect competition

- Each seller receives 1 offer w/ prob $1 - p$ & 2 offers w/ prob p
- From buyer's perspective, conditional on a match,
  - Pr(seller has another offer): $\pi = \frac{2p}{1-p+2p}$
  - Can vary degree of competition with a single parameter, nesting extremes:
    - $p = \pi = 0$: monopsony.
    - $p = \pi = 1$: Bertrand/perfect competition.

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    - $p = \pi = 0$: monopsony.
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  - Note that market is always fully "covered" under this formulation
    - isolate effect of competition. (later: general setting where coverage also varies)

Applications

Market for financial securities

- Buyers make offers to sellers (or issuers): price and quantity
- Sellers have private information about value

Loan markets

- Lenders make offers to borrowers: loan size and interest rate
- Borrowers have private information about default risk

Insurance markets

- Insurers make offers to potential customers: coverage and premium
- (Risk-averse) customers have private info about health/accident/death risk

Strategies

buyer: offers menu of contracts

- sufficient to consider two contracts $\mathbf{z} \equiv \{(x_l, t_l), (x_h, t_h)\}$

$$(IC_i): \qquad t_i + c_i(1 - x_i) \geq t_{-i} + c_i(1 - x_{-i}) \qquad i \in \{l, h\}$$

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seller: chooses a contract from available menus

- 1 offer (captive seller): chooses (x_i, t_i) by incentive compatibility
- 2 offers (non-captive seller): chooses (x_i, t_i) or (x_i', t_i') by

$$\chi_i(\mathbf{z}, \mathbf{z}') = \left\{ \begin{array}{c} 0 \\ \frac{1}{2} \\ 1 \end{array} \right\} \quad \text{if} \quad t_i + c_i(1 - x_i) \left\{ \begin{array}{c} < \\ = \\ > \end{array} \right\} t_i' + c_i(1 - x_i').$$

Equilibrium definition

A symmetric equilibrium is a distribution $\Phi(\mathbf{z})$ such that almost all $\mathbf{z}$ satisfy,

1. *Incentive compatibility*:

$$t_i + c_i(1 - x_i) \geq t_{-i} + c_i(1 - x_{-i}) \qquad i \in \{h, l\}$$

2. *Seller optimality*:

$$\chi_i(\mathbf{z}, \mathbf{z}') \text{ maximizes her utility}$$

3. *Buyers optimality*:

$$\mathbf{z} \in \arg\max_{\mathbf{z}} \sum_{i \in \{l,h\}} \mu_i \left[1 - \pi + \pi \int_{\mathbf{z}'} \chi_i(\mathbf{z}, \mathbf{z}') \Phi(d\mathbf{z}') \right] (v_i x_i - t_i) \quad (1)$$

Only Mixed Strategy Equilibrium for $\pi \in (0, 1)$

Why ? Suppose a pure strategy equilibrium exists.

1. Buyers make strictly positive profits from some type
2. Buyers compete for this type with probability $\pi > 0$

Therefore,

$\Rightarrow$ Incentives to undercut

$\Rightarrow$ Equilibrium necessarily features dispersion in menus

Characterization Strategy

Equilibrium described by non-degenerate distribution in 4 dimensions

Proceed in 4 steps

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   - Menus rank-ordered (Strict Rank Preserving)
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3. Construct SRP equilibrium
4. Show that constructed equilibrium is unique

A utility representation

Result

In all menus offered in equilibrium,

- *the low types trades everything:* $x_l = 1$
- IC_l *binds:* $t_l = t_h + c_l(1 - x_h)$

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$$t_l = u_l \qquad x_h = 1 - \frac{u_h - u_l}{c_h - c_l} \qquad t_h = \frac{u_l c_h - u_h c_l}{c_h - c_l}$$

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Since we must have $0 \leq x_h \leq 1$,

$$c_h - c_l \geq u_h - u_l \geq 0$$

A utility representation

We define the marginal distributions:

$$F_i\left(u_i\right) = \int_{\mathbf{z}'} \mathbf{1}\left[t_i' + c_i\left(1 - x_i'\right) \leq u_i\right] d\Phi\left(\mathbf{z}'\right) \qquad i \in \{h, l\}$$

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Then, each buyer solves

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Need to characterize the two interlinked distributions F_l and F_h.

Properties of Equilibrium

Result

F_l and F_h have connected support and are continuous.

- Except for a knife-edge case (see paper)
- Proof more involved than standard case because of interdependencies

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The profit function $\Pi(u_h, u_l)$ is strictly supermodular.

- Intuition: $u_l \uparrow \Rightarrow \Pi_h \uparrow \Rightarrow$ stronger incentives to attract high types
- $\Rightarrow$ $U_h(u_l) \equiv argmax_{u_h} \Pi(u_h, u_l)$ is weakly increasing

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Theorem (Strict Rank Preserving)

$U_h(u_l)$ is a strictly increasing function.

- Weakly increasing because of super-modularity
- Strictly increasing, not a correspondence because F_l, F_h well-behaved

intuition

Strict Rank Preserving Equilibria

- Useful for characterization:
  - Ranking of equilibrium menus identical across types
  - Menus attract same fraction of both types $F_l(u_l) = F_h(U_h(u_l))$
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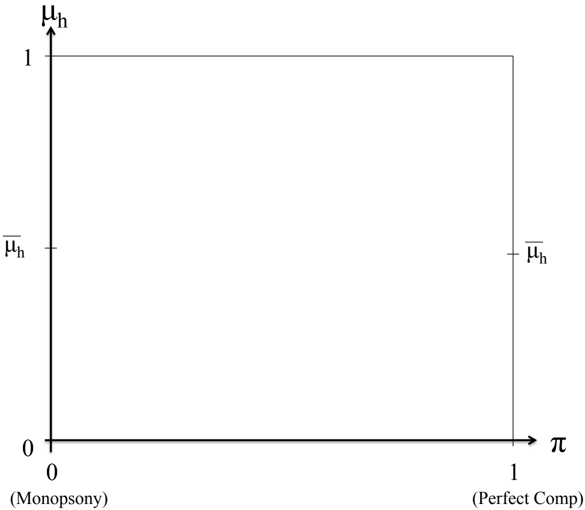
- Implications for outcomes:
  - Terms of trade positively correlated across types
  - Buyers don't specialize, trade with equal frequency across types

Constructing Equilibria

What We Already Know



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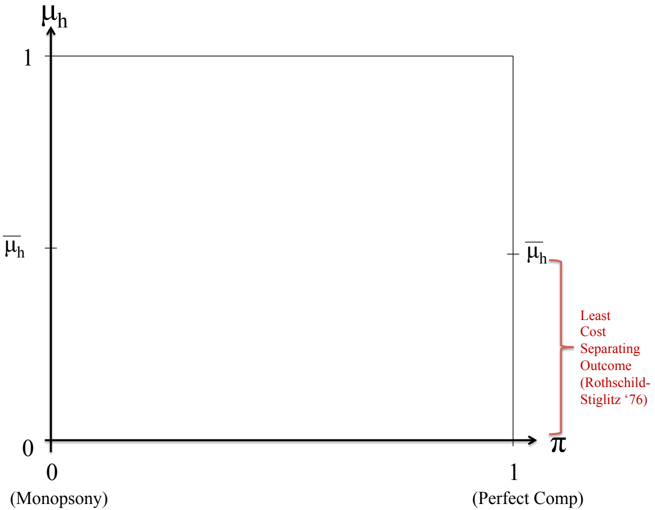

Perfect comp and "severe adverse selection" $\Rightarrow$ Pure strategy separating eq.

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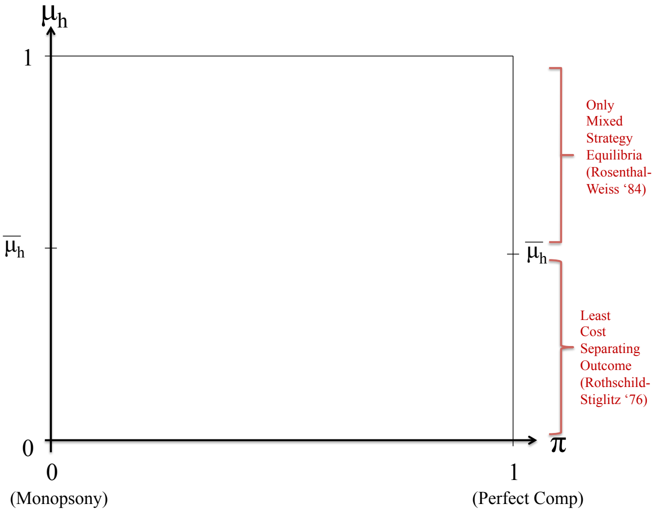

Perfect comp and "mild adverse selection" $\Rightarrow$ Mixed Strategy Eq.

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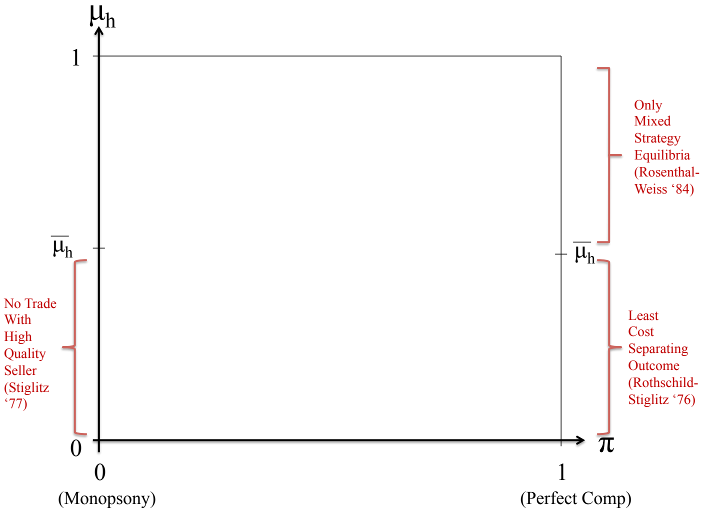
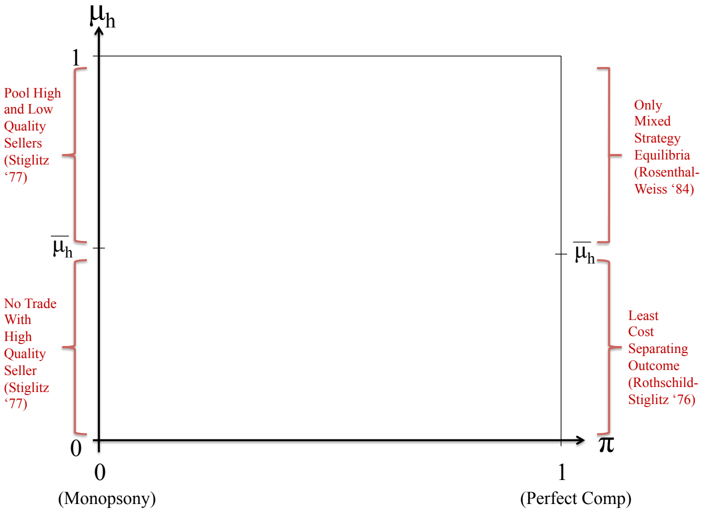


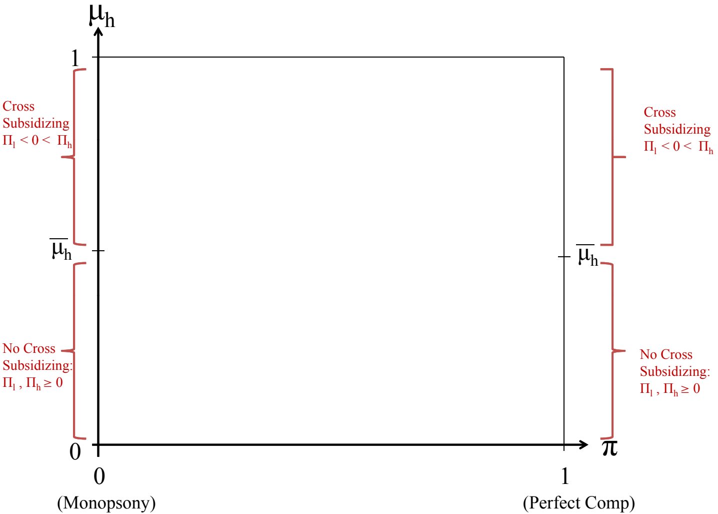
Monopsony and "severe adverse selection" ⇒ No Trade with High Type

What We Already Know



Monopsony and "mild adverse selection" $\Rightarrow$ Full Trade

What We Already Know



Cross Subsidizing or Not?

Equilibrium Characterization

Today:

- Construct equilibrium with $\mu_h < \bar{\mu}$ explicitly
- Briefly describe equilibrium with $\mu_h \geq \bar{\mu}$

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Terminology:

- "Separating eqm:" all contracts have $u_h > u_l$ (i.e., $x_h < x_l = 1$)
- "Pooling eqm:" all contracts have $u_h = u_l$ (i.e., $x_h <= x_l = 1$)
- "Mixed eqm:" some separating offers, some pooling.

Conjecture & Confirm: Equilibrium with $\mu_h < \bar{\mu}_h$ is Separating

Remember the buyer's problem:

$$
\begin{aligned}
\Pi(u_h, u_l) \quad &= \quad \max_{u_l \geq c_l,\ u_h \geq c_h} \sum_{i \in \{l,h\}} \mu_i \left[1 - \pi + \pi F_i\left(u_i\right)\right] \Pi_i\left(u_h, u_l\right) \\
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Marginal benefits vs costs of increasing u_l

$$\underbrace{\mu_l \pi f_l(u_l) \Pi_l}_{\text{MB: more low types trade}} + (1 - \pi + \pi F_l(u_l)) \left[\underbrace{-\mu_l}_{MC} + \underbrace{\mu_h \frac{v_h - c_h}{c_h - c_l}}_{\text{MB: relaxed } IC_l} \right] = 0$$

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Boundary condition

$$F_l(c_l) = 0 \qquad F_l(\bar{u}_l) = 1 \qquad \to \quad F_l(u_l)$$

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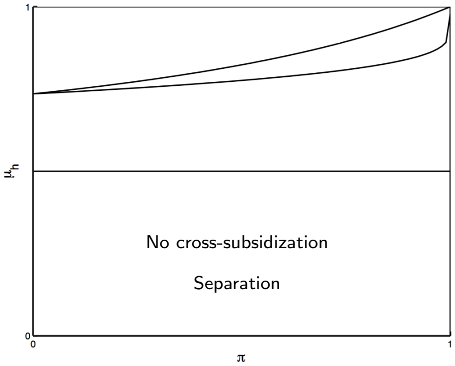
These conditions are necessary (see paper for sufficiency).

Equilibrium



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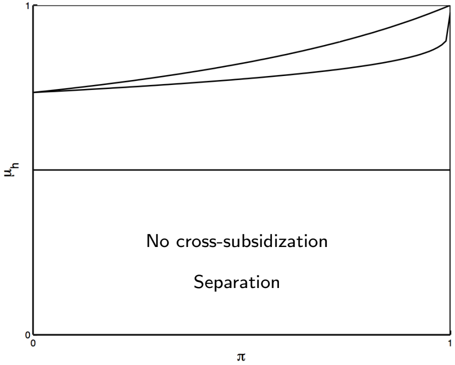
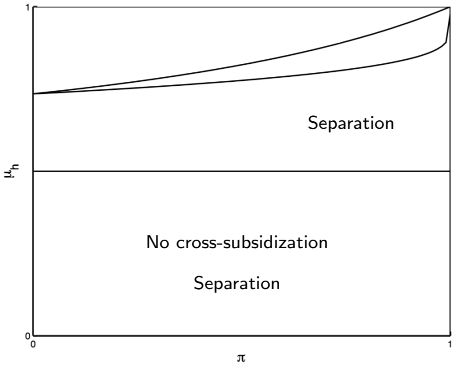


Cross-subsidization equilibrium may feature:

Equilibrium



Cross-subsidization equilibrium may feature:

- Full Separation: $0 < x_h < 1$ a.e.

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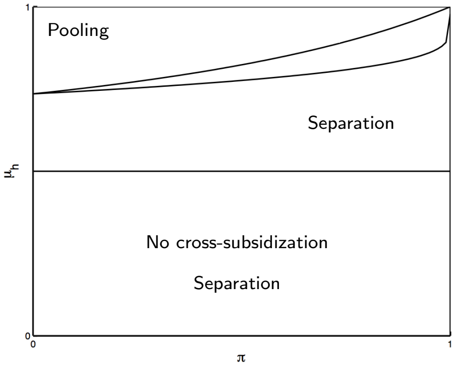

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- Full Pooling: $x_h = 1$ a.e.

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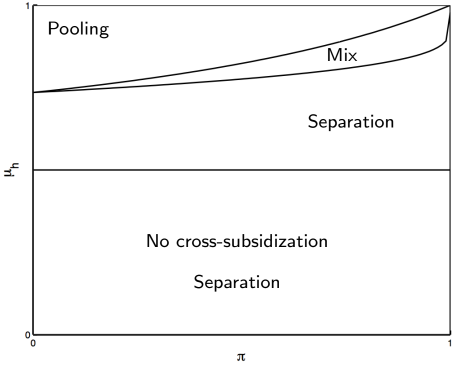

Cross-subsidization equilibrium may feature:

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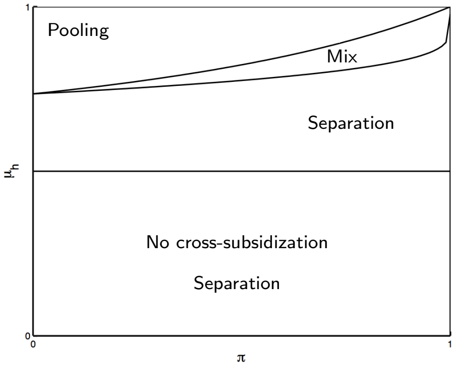
- Full Pooling: $x_h = 1$ a.e.
- Mix: pool below $\bar{u}_l$, separate above

Equilibrium



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- Mix: pool below $\bar{u}_l$, separate above

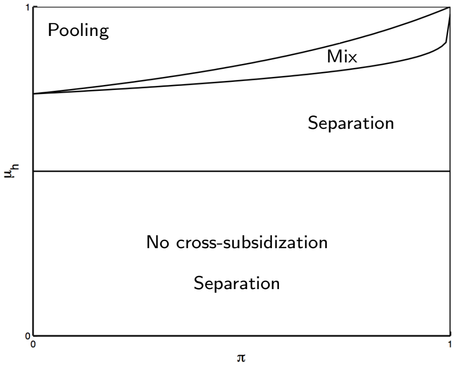
More competition (higher π) $\rightarrow$ *less* pooling

- gains to cream-skimming increase in π

Milder adv sel (higher μ_h) $\rightarrow$ *more* pooling

- increased incentives to trade with h

Equilibrium



Cross-subsidization equilibrium may feature:

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Theorem

For every (π, μ_h) there is a unique equilibrium.

Context: Literature on Adverse Selection with Screening

- Most papers: competitive models with Bertrand-type structure
  - Rothschild-Stiglitz, Riley, ...
  - Well-known problems with existence of equilibria

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  - But what happens when a contract attracts more than 1 type?
  - Requires a sampling rule $\Rightarrow$ Beliefs about rules for off-path offers?
- This paper:
  1. Varying degrees of competition
  2. No capacity constraints
  3. No need to separately specify off-path beliefs
     - Meeting tech + equilibrium offer distribution pins down off-path payoffs

Implications

Positive Implications

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- Structure of eqm depends on distribution of asset quality (μ_h)
  - determines structure of eqm: separating, mixed, or pooling (Burdett-Judd)
- Effect of adverse selection on outcomes depends on trading frictions (π)

  $\rightarrow$ need to know trading frictions to identify info frictions.

Normative Implications

Are these policies desirable?

- Increase in competition
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- Changes in information
  - E.g. credit scores, allowing principals to condition on more variables
  - Implications for restrictions/mandates

Welfare Criterion

Utilitarian welfare:

$$\begin{aligned} W &= \mu_l v_l + \mu_h [v_h X_h + c_h (1 - X_h)] \\ \text{with } X_h &\equiv \int_{\underline{u}_l}^{\bar{u}_l} x_h(u_l) \; d\hat{F}(u_l) \end{aligned}$$

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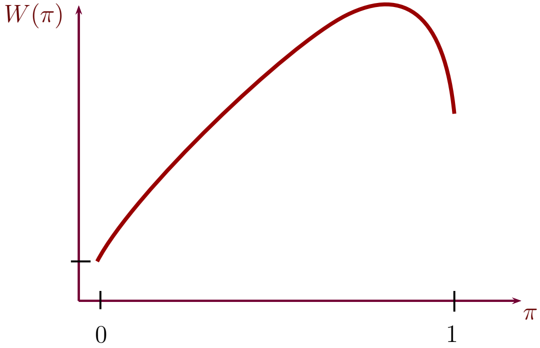
Low type always trades fully so key is what happens to X_h?

Focus on severe adverse selection ($\mu_h < \bar{\mu}_h$), show all these policies

- Desirable or irrelevant at the extremes, i.e. $\pi = 0$ or $\pi = 1$
- But, can be undesirable in the interior, esp. for π high

Welfare and Competition



Result

If $\mu_h < \overline{\mu}_h$, W maximized at $\pi \in (0, 1)$.

Implications

- Taxing entry (or otherwise limiting buyer competition) may be desirable

(Quick) Intuition

Key: interaction between competition and incentives.

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Which effect dominates depends on relative profits (Π_h/Π_l).

- First effect dominates when π is small (Π_h/Π_l small).
- Second effect dominates when π is large (Π_h/Π_l large). ▸ Details

Asset Purchases

Asset purchases proposed to help markets suffering from adverse selection

- Similar: government option (insurance markets), FAFSA (student loans)

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2. But if government willing to do so, $\uparrow W$ for sure

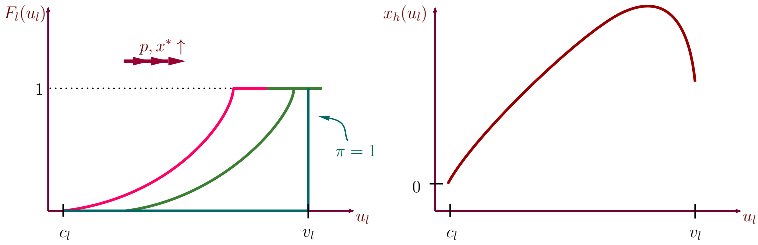
Our model: neither result true when $\pi < 1$.

- Government losing money neither necessary nor sufficient for $\uparrow W$

Asset Purchases

Policy: Government will purchase any quantity at $\mathcal{P} \in [c_l, v_l]$.

Can be mapped into an *exogenous* lower bound for u_l



Government option never exercised, so cost to the government $= 0$.

1. Helpful for low $\pi, \mathcal{P}$.
2. Harmful if $\pi, \mathcal{P}$ high enough.

What About More/Better Information?

Examples

- Permitting insurance providers to discriminate based on observables
- Introducing credit scores in loan markets
- Requiring OTC market participants to disclose trades

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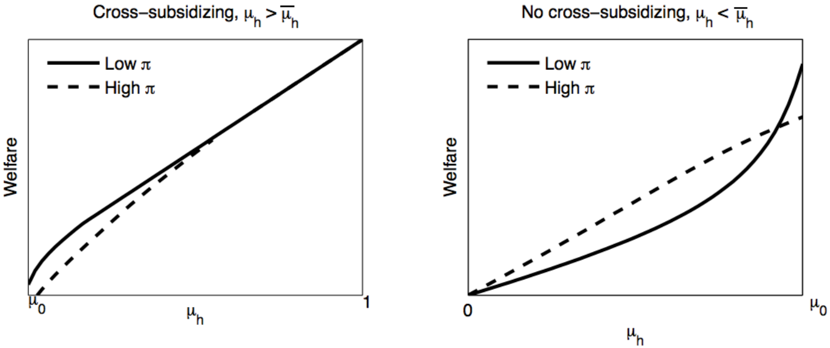
- Need to compare $\mathbb{E}[W(\mu_h)]$ to $W(\mathbb{E}[\mu_h])$
- Desirability is about the sign of $W''(\mu_h)$

Answer: desirability depends on (π, μ_h)

- Note: W is linear when $\pi = 0$ and $\pi = 1 \;\Rightarrow\;$ no effect on welfare

Desirability of information



- $\mu_h < \bar{\mu}_h$:, W convex (concave) for low (high) π

  $\Rightarrow$ more info desirable in concentrated markets, undesirable otherwise

- $\mu_h > \bar{\mu}_h$:, W is (weakly) concave for all π

  $\Rightarrow$ more info always undesirable

Robustness, Extensions, and Conclusion

Robustness

1. Endogenous π ▸ Details
   - buyers choose "advertising intensity" at cost $\rightarrow \quad \pi$
   - Taxing this margin desirable when equilibrium π is high
2. Constrained efficiency ▸ Details
   - A mechanism design approach
   - $\mu_h < \bar{\mu}_h \quad \Rightarrow \quad$ equilibrium is efficient
3. General meeting technologies ▸ Details
   - Methodology extends to many buyers, arbitrary distribution over meetings
   - Welfare effects of competition depend on strength of 'coverage' effect

Other extensions (see paper)

1. Concave preferences: canonical insurance problem
2. Different levels of competition across types: $\pi_l \neq \pi_h$
3. More than two types
4. Vertical/horizontal differentiation across buyers
5. Multi-dimensional heterogeneity across sellers

Conclusion

Lots of interest in markets where asymmetric info is a significant concern

- Insurance, loans, CDS, ...

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Conclusion

Lots of interest in markets where asymmetric info is a significant concern

- Insurance, loans, CDS, ...
- Empirical: identifying adverse selection from terms/outcomes
- Theory: optimal intervention/regulation.

Existing literature either restricts contracts or assumes perfect comp

This paper:

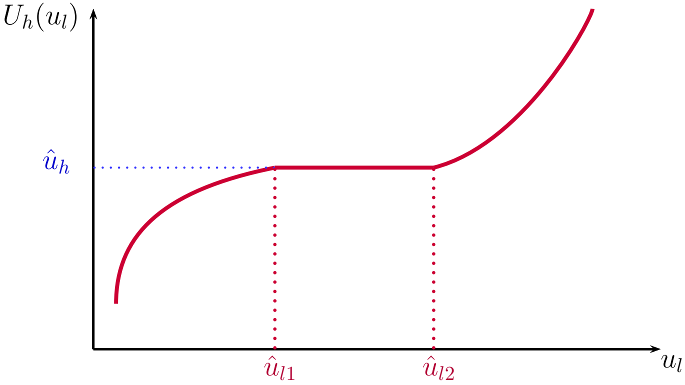
1. Tractable model w/ AS, imperfect comp, sophisticated contracts
2. Many testable implications
3. Novel normative implications: different from $\pi = 1$ case

Extra Stuff

Intuition

Theorem

$U_h(u_l)$ *is a strictly increasing function.*



Back to ▸ Properties of Equilibrium

Intuition

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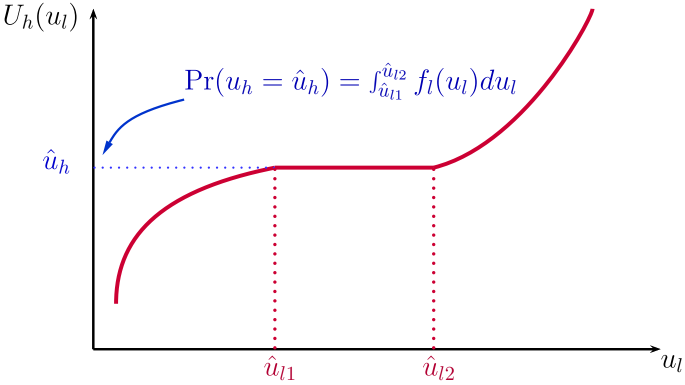

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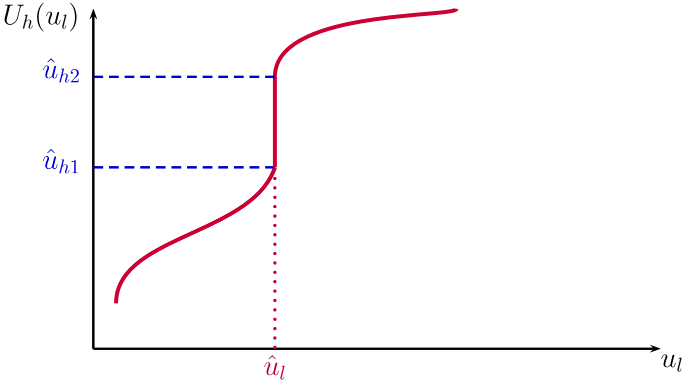

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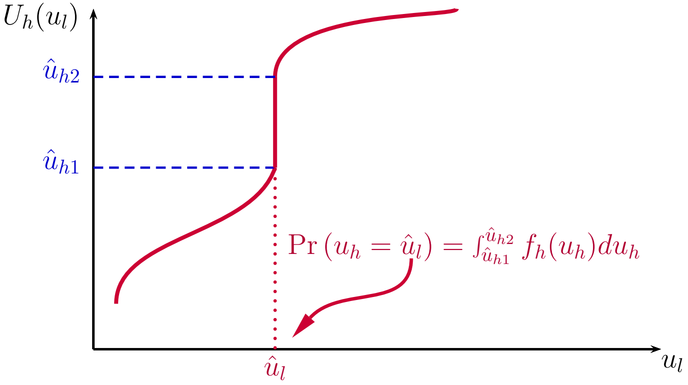


Back to ▸ Properties of Equilibrium

Imperfect Competition

Insurance markets

- Brown and Goolsbee (2002), Dafny (2010), Cabral et. al. (2014), Einav and Levin (2015)...

Credit markets

- Ausubel (1991), Petersen and Rajan (1994), Calem and Mester (1995), Scharfstein and Sundaram (2013)...

Financial markets

- Barclay et. al. (1999), Weston (2000),...

Back to ▸ Introduction

Quotes

Einav, Finkelstein, and Levin

> *"There has been much less progress on [...] models of insurance contracting that incorporate realistic market frictions. One challenge is to develop an appropriate conceptual framework. Even in stylized models of insurance markets with asymmetric information, characterizing competitive equilibrium can be challenging, and the challenge is compounded if one wants to allow for [...] market imperfections."*

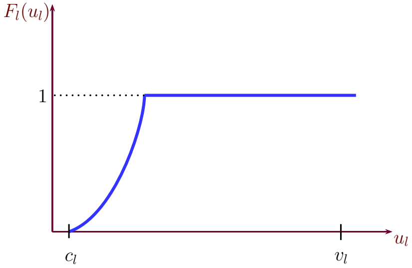
Or, as Chiappori et al (2006) put it:

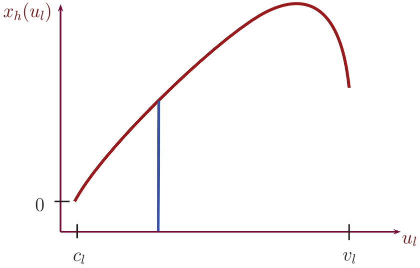
> *"there is a crying need for...models...devoted to the interaction between imperfect competition and adverse selection"*

Back to ▸ Introduction

Why is Welfare Hump-Shaped in π?

Because x_h is hump-shaped in π and F_l is shifting right.





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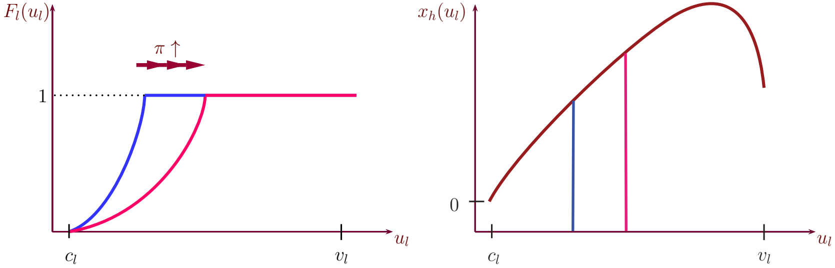

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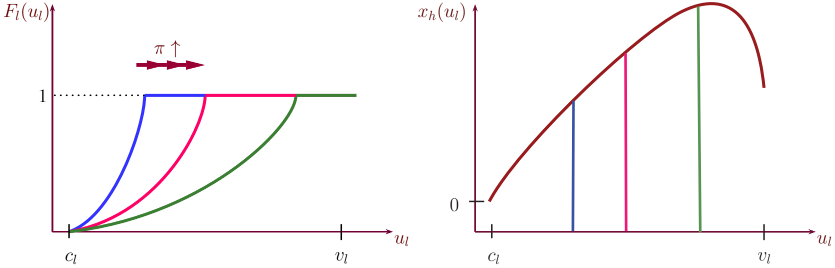

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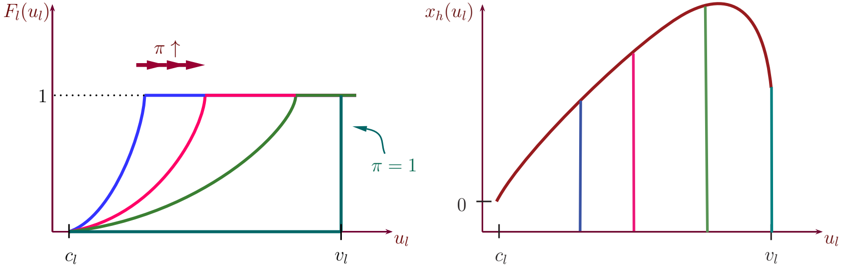

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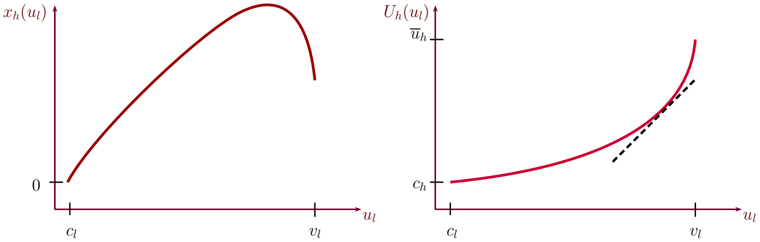

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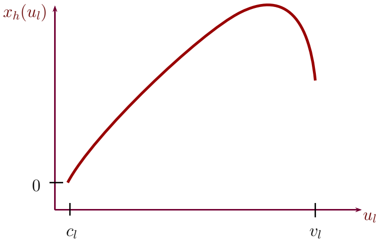

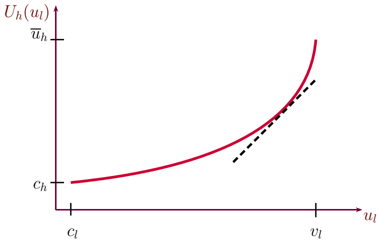

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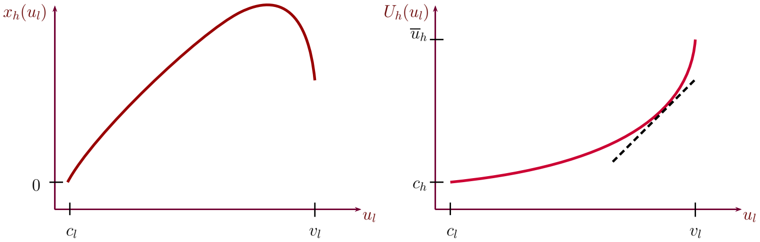

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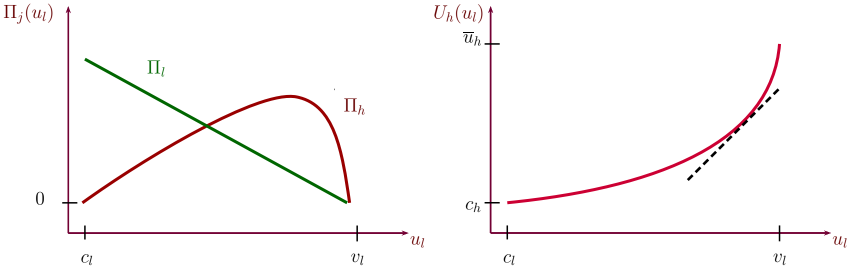
Which dominates? Depends on whether $U_h'(u_l) \lesseqqgtr 1$.

- i.e., whether buyers trying to attract more l or h.
- this depends on relative profits $\frac{\Pi_h}{\Pi_l}$...

Severe Adverse Selection: Allocations



- Slope of U_h determined by ratio of profits, Π_h/Π_l

Back to Welfare

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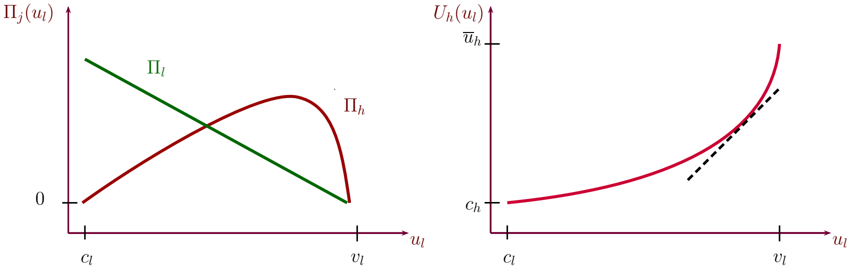

- Slope of U_h determined by ratio of profits, Π_h/Π_l
  - At low u_l, Π_h/Π_l small, competition stronger for type-l, $U_h'(u_l) < 1$
  - At high u_l, Π_h/Π_l large, competition stronger for type-h, $U_h'(u_l) > 1$

Back to Welfare

General Mechanisms

A communication game between a seller and the buyer(s) she meets

- Buyers offer mechanisms that map seller's 'messages' into an offer (x, t)
  - Deterministic and exclusive but otherwise unrestricted
- Seller sends a message to each buyer
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Proposition

Any equilibrium of the communication game can be achieved by a menu game.

Proof: See Martimort and Stole (2002).

Proposition

In any menu, at most 2 contracts are chosen by some seller type in equilibrium.

Proof: If type-j seller chooses 2 (or more) contracts in eq., they must yield same utility to seller *AND* same profit to buyer.

Back

Constrained Efficiency: A mechanism design approach

Types

- Seller: Quality, buyers matched with
- Buyer(s): Set of sellers matched with

A direct mechanism: a map from reports to allocations, subject to

- Feasibility: Only matched agents can trade
- Incentive compatibility: Types reported truthfully
- Participation: Outside option is equilibrium described earlier
- Exclusivity: Each seller can trade with at most 1 buyer

Proposition

If $\mu < \bar{\mu}_h$, the equilibrium allocation is constrained efficient.

- Utilities are the same as in equilibrium (allocations might differ)
- Trade volume (or eq., utilitarian welfare) still maximized at interior π

Back

General Meeting Technologies

Large number of buyers and sellers (measure b and s resp.)

Meeting technology: described by

- $\lambda(\alpha)$: Average number of offers sent by buyers
- $P(n,\alpha)$: Pr(a seller receives n offers)
- $Q(n,\alpha)$: Pr(offer received by seller with $n-1$ other offers) $= \frac{nP(n,\alpha)}{\lambda(\alpha)}$
- α: Summarizes 'frictions' in matching

Examples

- Poisson: $\lambda(\alpha) = \alpha$ $\qquad P(n,\alpha) = \frac{e^{-\alpha}\alpha^n}{n!}$
- Geometric: $\lambda(\alpha) = \frac{\alpha}{1-\alpha}$ $\qquad P(n,\alpha) = \alpha^n(1-\alpha)$
- For both, coverage (sellers with at least 1 offer) increases with α

▸ Back

General Meeting Technologies: Solution

$$\arg\max_{u_l, u_h} \quad \sum_{i \in \{l,h\}} \mu_i \left[\sum_{n=1}^{\infty} Q(n) F_i^{n-1}(u_i) \right] \Pi_i(u_l, u_h)$$

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- Characterization from baseline $\rightarrow G_i(u_i)$ (and therefore, F_i)
- Shape of $W(\alpha)$ depends on strength of coverage effect
    - Hump-shaped for Poisson, always increasing for Geometric

Back

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Back

Endogenizing π

Buyer k also chooses $\hat{\pi}^k$: Pr(her offer reaches a seller) subject to cost $C(\hat{\pi}^k)$

$$\max_{\hat{\pi}^k, u_l^k, u_h^k} \sum_{i \in \{l,h\}} \mu_i \left[\hat{\pi}^k \left(1 - \hat{\pi}^{-k}\right) + \hat{\pi}^k \hat{\pi}^{-k} F_i^{-k}\left(u_i^k\right)\right] \Pi_i \left(u_l^k, u_h^k\right) - C(\hat{\pi}^k),$$

Optimality in a symmetric equilibrium

$$C'\left(\hat{\pi}^*\right) = \sum_{i \in \{l,h\}} \mu_i \left[1 - \hat{\pi}^* + \hat{\pi}^* F_i^{-k}\left(u_i^k\right)\right] \Pi_i \left(u_l^k, u_h^k\right). \tag{2}$$

Implications

- Unique symmetric equilibrium (under regularity conditions on C)
- $\hat{\pi}^*$ increasing (decreasing) in μ_h when μ_h is less (greater) than $\bar{\mu}_h$
- Welfare: 'taxing' effort (advertising?) can be optimal if $\hat{\pi}^*$ sufficiently high

Back