Screening and Adverse Selection in Frictional Markets

Benjamin Lester
Philadelphia Fed

Ali Shourideh
Carnegie Mellon University

Venky Venkateswaran
NYU Stern

Ariel Zetlin-Jones
Carnegie Mellon University

Spring 2017

Introduction

Many important markets feature adverse selection (AS) and screening

- Examples: insurance, loans, some financial securities

Introduction

Many important markets feature adverse selection (AS) and screening

- Examples: insurance, loans, some financial securities

These markets are often also imperfectly competitive

References

Introduction

Many important markets feature adverse selection (AS) and screening

- Examples: insurance, loans, some financial securities

These markets are often also imperfectly competitive ▸ References

A model of AS, screening contracts & imperfect competition is lacking ▸ Quotes

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

Introduction

Many important markets feature adverse selection (AS) and screening

- Examples: insurance, loans, some financial securities

These markets are often also imperfectly competitive ▸ References

A model of AS, screening contracts & imperfect competition is lacking ▸ Quotes

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

Essential to answer some important questions, including...

- how does market structure affect contracts terms? estimates of AS?

Introduction

Many important markets feature adverse selection (AS) and screening

- Examples: insurance, loans, some financial securities

These markets are often also imperfectly competitive ▸ References

A model of AS, screening contracts & imperfect competition is lacking ▸ Quotes

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

Essential to answer some important questions, including...

- 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

Key Ingredients

A model of trade in assets with

Key Ingredients

A model of trade in assets with

- Adverse Selection: sellers have private info about asset quality.

Key Ingredients

A model of trade in assets with

- Adverse Selection: sellers have private info about asset quality.
- Screening: Uninformed buyers offer general menus of contracts.

Key Ingredients

A model of trade in assets with

- 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
  - No issues with existence, off-path beliefs.

Preview of Results

- New **techniques** $\rightarrow$ complete characterization of unique eqm
  - No issues with existence, off-path beliefs.
- **Predictions** for distribution of contracts offered/traded
  - Equilibrium can be pooling, separating, or a mixture of both
  - Separation when adverse selection (AS) severe, competition high
  - Pooling when AS mild, competition low
  - Identifying AS requires knowledge of market structure

Preview of Results

- New **techniques** $\rightarrow$ complete characterization of unique eqm
  - No issues with existence, off-path beliefs.
- **Predictions** for distribution of contracts offered/traded
  - Equilibrium can be pooling, separating, or a mixture of both
  - Separation when adverse selection (AS) severe, competition high
  - Pooling when AS mild, competition low
  - 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.
  - Buyer: receives utility v_i per unit of consumption.

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.
    - Buyer: receives utility v_i per unit of consumption.

- If seller gives up x units in exchange for a transfer t, payoffs are
    - Seller: $t + (1 - x)c_i$
    - Buyer: $xv_i - t$

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.
  - Buyer: receives utility v_i per unit of consumption.
- If seller gives up x units in exchange for a transfer t, payoffs are
  - Seller: $t + (1 - x)c_i$
  - Buyer: $xv_i - t$
- 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

Environment

Screening

- Buyers post arbitrary menus of **exclusive** contracts
  - General mechanisms + communication → identical outcomes ▸ Proof

Environment

Screening

- Buyers post arbitrary menus of **exclusive** contracts
  - General mechanisms + communication → identical outcomes ▸ Proof

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.

Environment

Screening

- Buyers post arbitrary menus of **exclusive** contracts
  - General mechanisms + communication → identical outcomes ▸ Proof

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.
  - 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 $\mathbf{z} \equiv \{(x_l, t_l), (x_h, t_h)\}$

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

Strategies

buyer: offers menu of contracts

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

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

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

Characterization Strategy

Equilibrium described by non-degenerate distribution in 4 dimensions

Proceed in 4 steps

1. Show that menus can be summarized by a pair of utilities (u_h, u_l)
   - Reduces problem to distributions over 2 dimensions

Characterization Strategy

Equilibrium described by non-degenerate distribution in 4 dimensions

Proceed in 4 steps

1. Show that menus can be summarized by a pair of utilities (u_h, u_l)
   - Reduces problem to distributions over 2 dimensions

2. Show there is a strictly increasing map between u_l and u_h
   - Menus rank-ordered (Strict Rank Preserving)
   - Reduces problem to distribution in 1 dimension + a monotonic function

Characterization Strategy

Equilibrium described by non-degenerate distribution in 4 dimensions

Proceed in 4 steps

1. Show that menus can be summarized by a pair of utilities (u_h, u_l)
   - Reduces problem to distributions over 2 dimensions
2. Show there is a strictly increasing map between u_l and u_h
   - Menus rank-ordered (Strict Rank Preserving)
   - Reduces problem to distribution in 1 dimension + a monotonic function
3. Construct SRP equilibrium

Characterization Strategy

Equilibrium described by non-degenerate distribution in 4 dimensions

Proceed in 4 steps

1. Show that menus can be summarized by a pair of utilities (u_h, u_l)
   - Reduces problem to distributions over 2 dimensions
2. Show there is a strictly increasing map between u_l and u_h
   - Menus rank-ordered (Strict Rank Preserving)
   - Reduces problem to distribution in 1 dimension + a monotonic function
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:* $t_l = t_h + c_l(1 - x_h)$

- Reduces dimensionality of problem to distribution in 2 dimensions

A utility representation

Result

In all menus offered in equilibrium,

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

- Reduces dimensionality of problem to distribution in 2 dimensions

Result

Equilibrium menus can be represented by (u_h, u_l) *with corresponding allocations*

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

A utility representation

Result

In all menus offered in equilibrium,

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

- Reduces dimensionality of problem to distribution in 2 dimensions

Result

Equilibrium menus can be represented by (u_h, u_l) *with corresponding allocations*

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

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:

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

A utility representation

We define the marginal distributions:

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

Then, each buyer solves

$$\begin{aligned}
\max_{u_l \geq c_l,\ u_h \geq c_h} \Pi(u_h, u_l) &= \max_{u_l \geq c_l,\ u_h \geq c_h} \sum_{i \in \{l,h\}} \mu_i \left[1 - \pi + \pi F_i(u_i)\right] \Pi_i(u_h, u_l) \\
\text{s. t.} &\quad c_h - c_l \geq u_h - u_l \geq 0 \\
\text{with } \Pi_l(u_h, u_l) &\equiv v_l x_l - t_l = v_l - u_l \\
\Pi_h(u_h, u_l) &\equiv v_h x_h - t_h = v_h - u_h \frac{v_h - c_l}{c_h - c_l} + u_l \frac{v_h - c_h}{c_h - c_l}
\end{aligned}$$

A utility representation

We define the marginal distributions:

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

Then, each buyer solves

$$\begin{aligned}
\max_{u_l \geq c_l,\ u_h \geq c_h} \Pi(u_h, u_l) \quad &= \quad \max_{u_l \geq c_l,\ u_h \geq c_h} \sum_{i \in \{l,h\}} \mu_i \left[1 - \pi + \pi F_i\left(u_i\right)\right] \Pi_i\left(u_h, u_l\right) \\
\text{s. t.} \quad & \quad c_h - c_l \geq u_h - u_l \geq 0 \\
\text{with} \ \ \Pi_l\left(u_h, u_l\right) \quad &\equiv \quad v_l x_l - t_l = v_l - u_l \\
\Pi_h\left(u_h, u_l\right) \quad &\equiv \quad v_h x_h - t_h = v_h - u_h \frac{v_h - c_l}{c_h - c_l} + u_l \frac{v_h - c_h}{c_h - c_l}
\end{aligned}$$

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

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

Result

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

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

Result

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

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

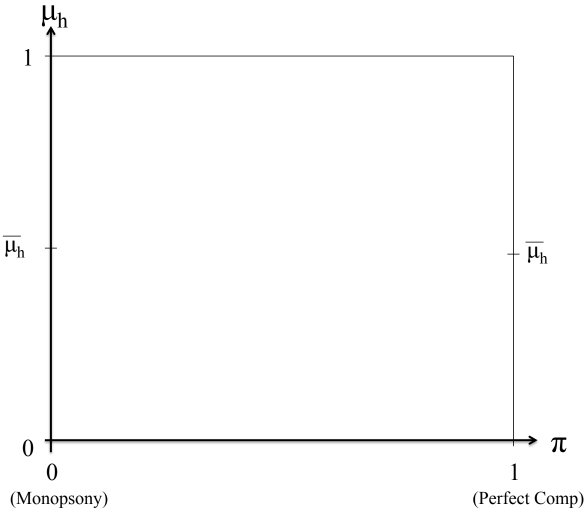
- Useful for characterization:
  - Ranking of equilibrium menus identical across types
  - Menus attract same fraction of both types $F_l(u_l) = F_h(U_h(u_l))$
  - Greatly simplifies our task: only have to find $F_l(u_l)$ and $U_h(u_l)$

Strict Rank Preserving Equilibria

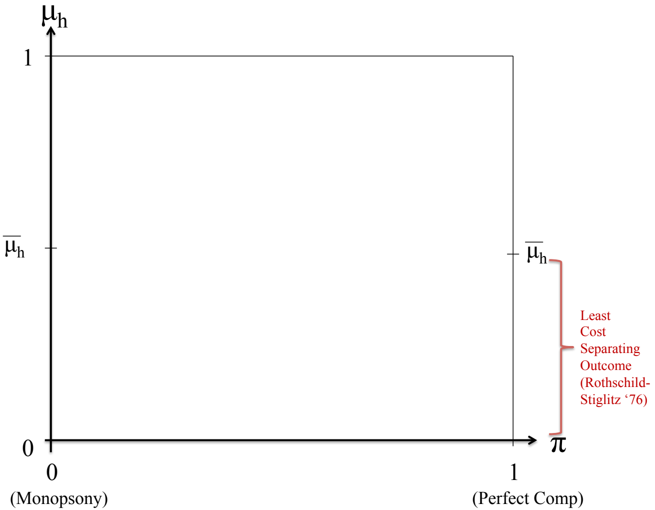
- Useful for characterization:
  - Ranking of equilibrium menus identical across types
  - Menus attract same fraction of both types $F_l(u_l) = F_h(U_h(u_l))$
  - Greatly simplifies our task: only have to find $F_l(u_l)$ and $U_h(u_l)$
- Implications for outcomes:
  - Terms of trade positively correlated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

Constructing Equilibria

What We Already Know

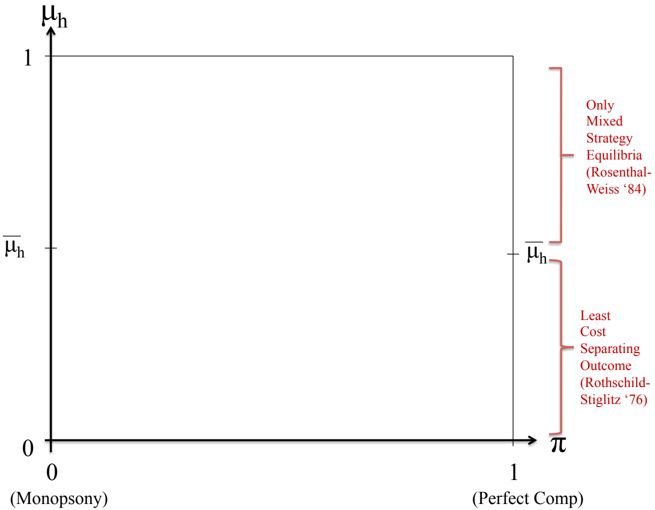


What We Already Know



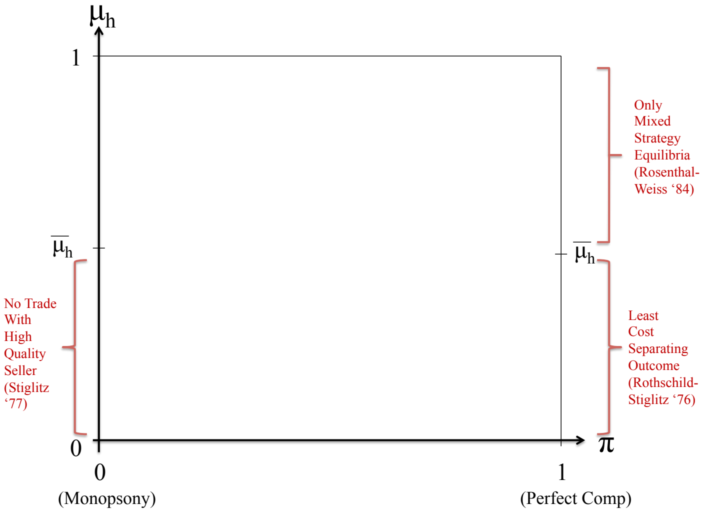
Perfect comp and "severe adverse selection" $\Rightarrow$ Pure strategy separating eq.

What We Already Know



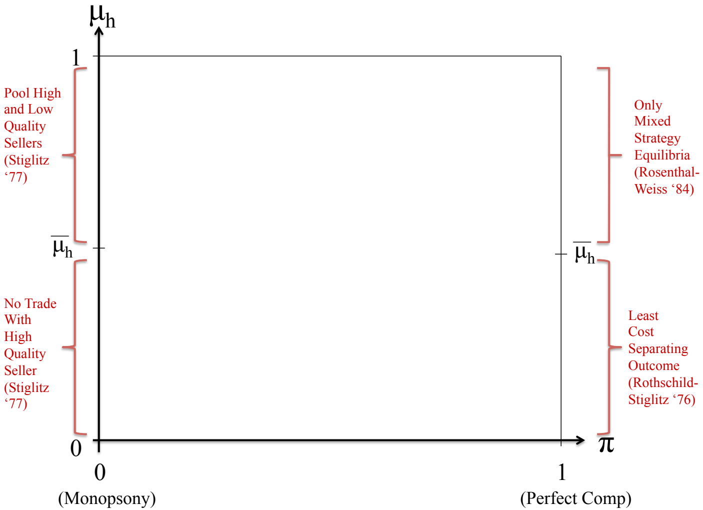
Perfect comp and "mild adverse selection" $\Rightarrow$ Mixed Strategy Eq.

What We Already Know



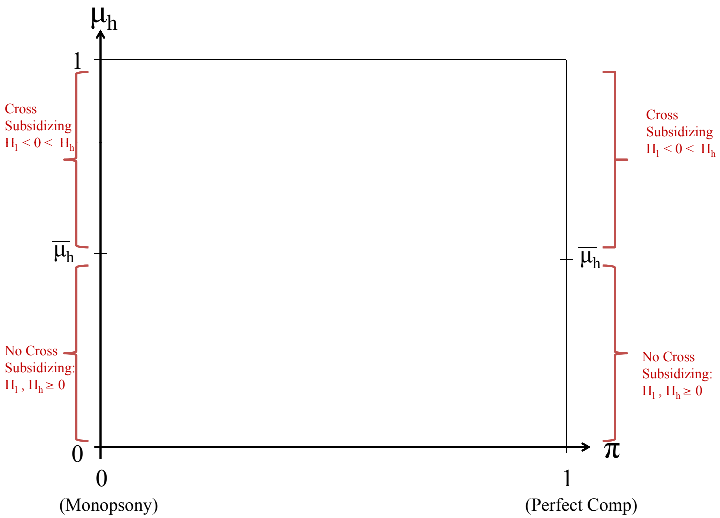
Monopsony and "severe adverse selection" $\Rightarrow$ No Trade with High Type

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 $\mu_h \geq \bar{\mu}$

Equilibrium Characterization

Today:

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

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:

$$
\begin{aligned}
\Pi(u_h, u_l) \quad &= \quad \max_{u_l \geq c_l,\ u_h \geq c_h} \sum_{i \in \{l,h\}} \mu_i \left[1 - \pi + \pi F_i\left(u_i\right)\right] \Pi_i\left(u_h, u_l\right) \\
\text{s. t.} \quad & \quad c_h - c_l \geq u_h - u_l \geq 0 \\
\text{with } \Pi_l\left(u_h, u_l\right) \quad &\equiv \quad v_l x_l - t_l = v_l - u_l \\
\Pi_h\left(u_h, u_l\right) \quad &\equiv \quad v_h x_h - t_h = v_h - u_h \frac{v_h - c_l}{c_h - c_l} + u_l \frac{v_h - c_h}{c_h - c_l}
\end{aligned}
$$

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

Marginal benefits vs costs of increasing u_l

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

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

Marginal benefits vs costs of increasing u_l

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

Boundary condition

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

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

Marginal benefits vs costs of increasing u_l

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

Boundary condition

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

Equal profit condition

$$[1 - \pi + \pi F_l(u_l)] \; \Pi(U_h, u_l) = \overline{\Pi} = \mu_l(1 - \pi)(v_l - c_l) \quad \rightarrow \quad U_h(u_l)$$

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

Marginal benefits vs costs of increasing u_l

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

Boundary condition

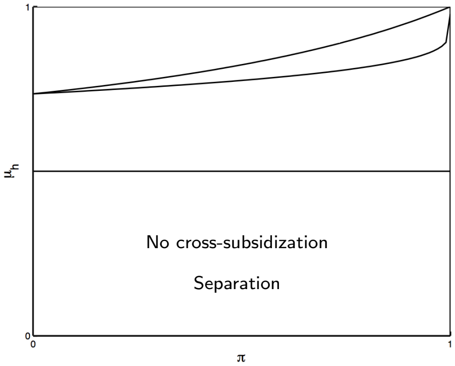
$$F_l(c_l) = 0 \qquad F_l(\bar{u}_l) = 1 \qquad \rightarrow \quad F_l(u_l)$$

Equal profit condition

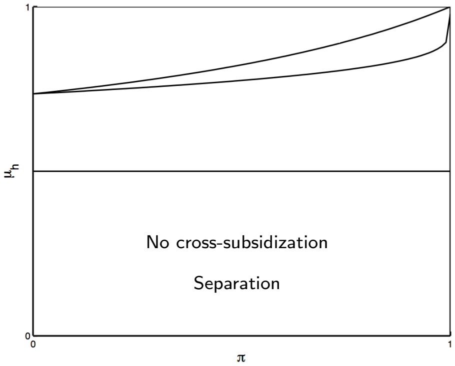
$$[1 - \pi + \pi F_l(u_l)] \; \Pi(U_h, u_l) = \overline{\Pi} = \mu_l(1-\pi)(v_l - c_l) \quad \rightarrow \quad U_h(u_l)$$

These conditions are necessary (see paper for sufficiency).

Equilibrium

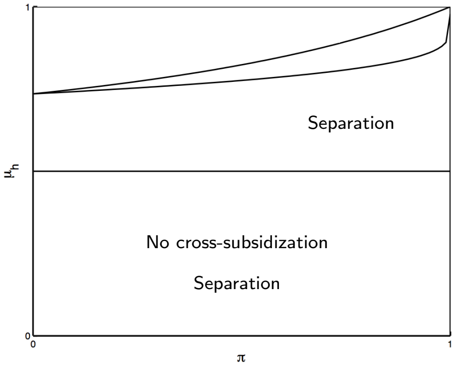


Equilibrium



Cross-subsidization equilibrium may feature:

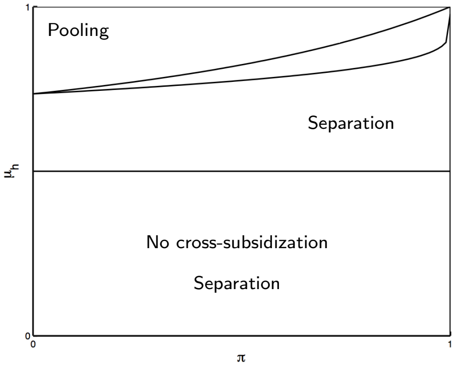
Equilibrium



Cross-subsidization equilibrium may feature:

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

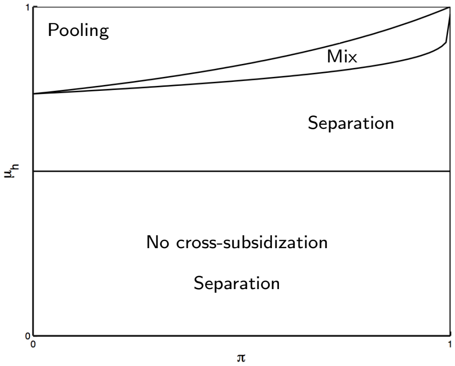
Equilibrium



Cross-subsidization equilibrium may feature:

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

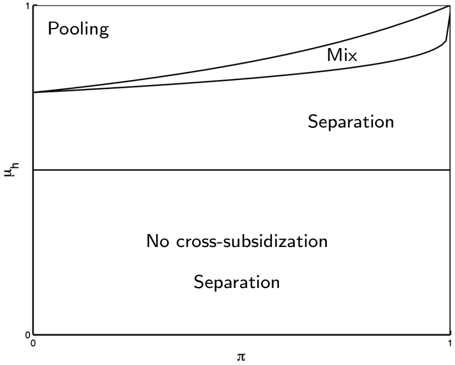
Equilibrium



Cross-subsidization equilibrium may feature:

- Full Separation: $0 < x_h < 1$ a.e.
- Full Pooling: $x_h = 1$ a.e.
- Mix: pool below $\bar{u}_l$, separate above

Equilibrium



Cross-subsidization equilibrium may feature:

- Full Separation: $0 < x_h < 1$ a.e.
- Full Pooling: $x_h = 1$ a.e.
- Mix: pool below $\bar{u}_l$, separate above

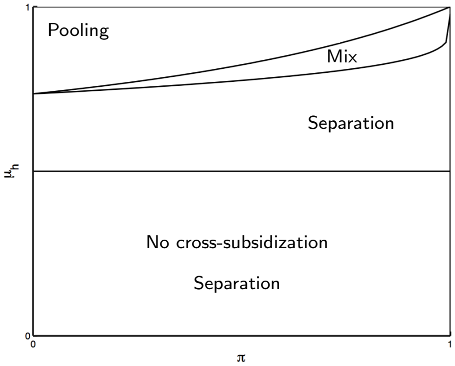
More competition (higher π) $\rightarrow$ *less* pooling

- 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:

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

Theorem

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

Literature on Adverse Selection with Screening

- For the most part, competitive models with Bertrand-type structure
  - Rothschild-Stiglitz, Riley, ...Guerrieri-Shimer-Wright ,...
  - **This paper:** varying degree of competition
- What about off-path beliefs?
  - A common assumption: buyers have capacity constraints (e.g. GSW)
  - What happens when a contract attracts more than 1 type?
  - Requires a sampling rule $\Rightarrow$ Beliefs about rules for off-path offers?
  - GSW: off-path, the type who gains the most is chosen
  - **This paper:** No capacity constraints

    $\Rightarrow$ Meeting tech + equilibrium offer distribution pins down off-path payoffs

    $\Rightarrow$ No need to separately specify off-path beliefs.

Implications

Positive Implications

- Dispersion in prices and quantities, across and within types

Positive Implications

- Dispersion in prices and quantities, across and within types
- SRP $\Rightarrow$ buyers don't target a specific type
  - terms of each contract correlated across offers

Positive Implications

- Dispersion in prices and quantities, across and within types
- SRP $\Rightarrow$ buyers don't target a specific type
  - terms of each contract correlated across offers
- Structure of eqm depends on distribution of asset quality (μ_h)
  - determines structure of eqm: separating, mixed, or pooling (Burdett-Judd)

Positive Implications

- Dispersion in prices and quantities, across and within types
- SRP $\Rightarrow$ buyers don't target a specific type
  - terms of each contract correlated across offers
- 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
  - E.g. encouraging entry, price discovery
- Changes in information
  - E.g. credit scores, allowing principals to condition on more variables

Normative Implications

Are these policies desirable?

- Increase in competition
  - E.g. encouraging entry, price discovery
- Changes in information
  - E.g. credit scores, allowing principals to condition on more variables
- Direct interventions
  - E.g. asset purchase programs, a public option in insurance

Normative Implications

Are these policies desirable?

- Increase in competition
    - E.g. encouraging entry, price discovery
- Changes in information
    - E.g. credit scores, allowing principals to condition on more variables
- Direct interventions
    - E.g. asset purchase programs, a public option in insurance
- Quantity restrictions/mandates
    - E.g. the health insurance mandate

Welfare Criterion

Utilitarian welfare:

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

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

Welfare Criterion

Utilitarian welfare:

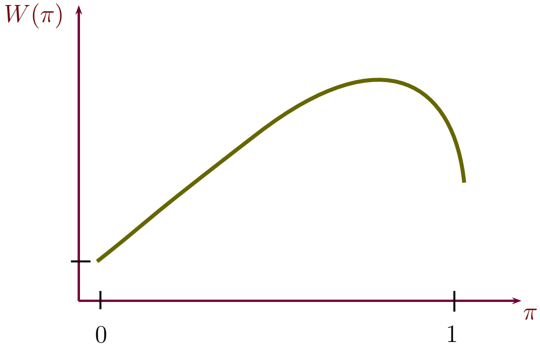
$$\begin{aligned} W &= \mu_l v_l + \mu_h[v_h X_h + c_h(1 - X_h)] \\ \text{with } X_h &\equiv \int_{\underline{u}_l}^{\bar{u}_l} x_h(u_l)\ d\hat{F}(u_l) \end{aligned}$$

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.

(Quick) Intuition

Key: interaction between competition and incentives.

1. All else equal, increasing competition for low types causes:
   - $\Rightarrow$ buyers offer more utility to low types, which relaxes their IC constraint
   - $\Rightarrow$ allows for more trade with high types, which increases W.

(Quick) Intuition

Key: interaction between competition and incentives.

1. All else equal, increasing competition for low types causes:
   - $\Rightarrow$ buyers offer more utility to low types, which relaxes their IC constraint
   - $\Rightarrow$ allows for more trade with high types, which increases W.
2. All else equal, increasing competition for high types causes:
   - $\Rightarrow$ buyers offer more utility to high types, which tightens IC constraint
   - $\Rightarrow$ less trade with high types, which decreases W.

(Quick) Intuition

Key: interaction between competition and incentives.

1. All else equal, increasing competition for low types causes:
   - $\Rightarrow$ buyers offer more utility to low types, which relaxes their IC constraint
   - $\Rightarrow$ allows for more trade with high types, which increases W.
2. All else equal, increasing competition for high types causes:
   - $\Rightarrow$ buyers offer more utility to high types, which tightens IC constraint
   - $\Rightarrow$ less trade with high types, which decreases W.

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

(Quick) Intuition

Key: interaction between competition and incentives.

1. All else equal, increasing competition for low types causes:
   - $\Rightarrow$ buyers offer more utility to low types, which relaxes their IC constraint
   - $\Rightarrow$ allows for more trade with high types, which increases W.
2. All else equal, increasing competition for high types causes:
   - $\Rightarrow$ buyers offer more utility to high types, which tightens IC constraint
   - $\Rightarrow$ less trade with high types, which decreases W.

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)

Asset Purchases

Asset purchases proposed to help markets suffering from adverse selection

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

Lessons from lit with competitive markets (Tirole, Guerrieri-Shimer):

1. Can only $\uparrow W$ if government overpays for bad assets, loses money
2. But if government willing to do so, $\uparrow W$ for sure

Asset Purchases

Asset purchases proposed to help markets suffering from adverse selection

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

Lessons from lit with competitive markets (Tirole, Guerrieri-Shimer):

1. Can only $\uparrow W$ if government overpays for bad assets, loses money
2. But if government willing to do so, $\uparrow W$ for sure

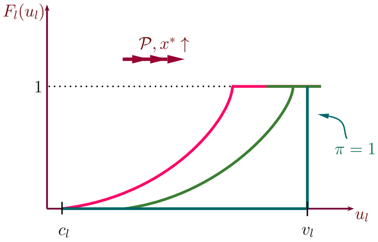
Our model: neither result true when $\pi < 1$.

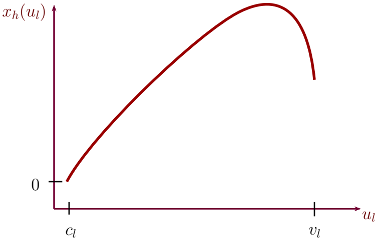
- Government losing money neither necessary nor sufficient for $\uparrow W$

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

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

Allow principals to condition on more information

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

Allow principals to condition on more information

- Can be mapped into a mean-preserving spread of μ_h
- Need to compare $\mathbb{E}[W(\mu_h)]$ to $W(\mathbb{E}[\mu_h])$
- Desirability is about the sign of $W''(\mu_h)$

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

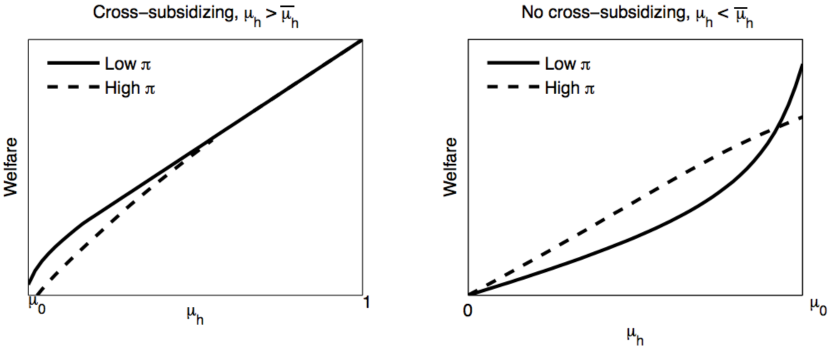
Allow principals to condition on more information

- Can be mapped into a mean-preserving spread of μ_h
- 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 $\to \pi$
   - Taxing this margin desirable when equilibrium π is high
2. Constrained efficiency ▸ Details
   - A mechanism design approach
   - $\mu_h < \bar{\mu}_h \Rightarrow$ 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, ...

Conclusion

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

- Insurance, loans, CDS, ...
- Empirical: identifying adverse selection from terms/outcomes

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.

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

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:

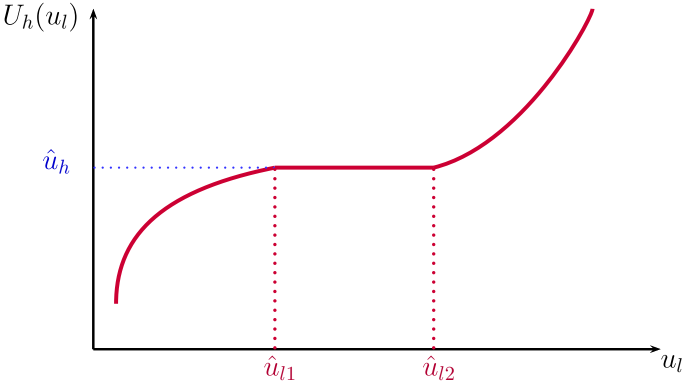
1. Tractable model w/ AS, imperfect comp, sophisticated contracts
2. Many testable implications
3. Novel normative implications: different from $\pi = 1$ case

Extra Stuff

Intuition

Theorem

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

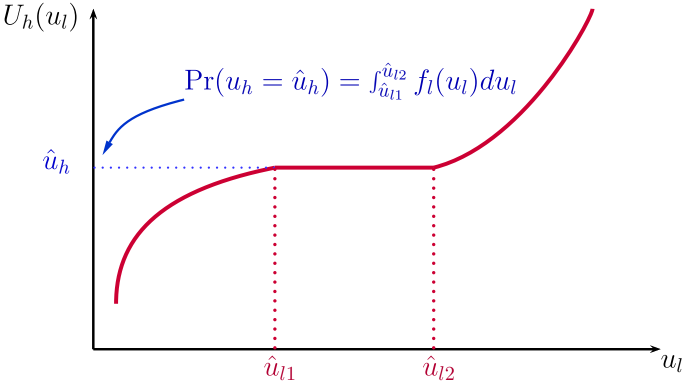


Back to ▸ Properties of Equilibrium

Intuition

Theorem

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

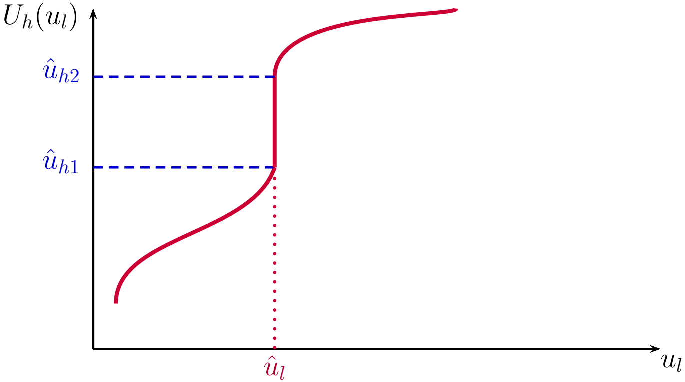


Back to ▸ Properties of Equilibrium

Intuition

Theorem

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

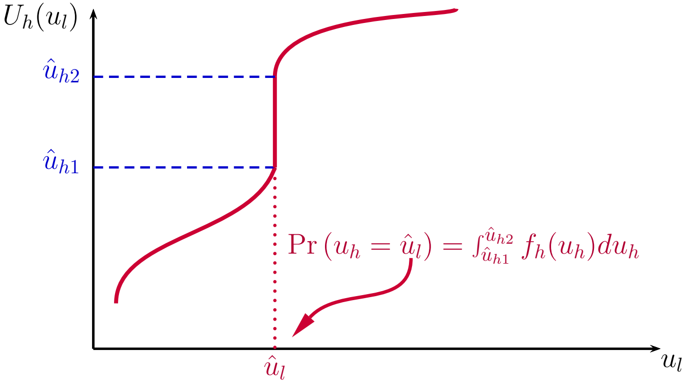


Back to ▸ Properties of Equilibrium

Intuition

Theorem

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



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."*

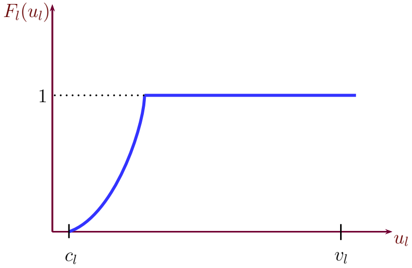
Or, as Chiappori et al (2006) put it:

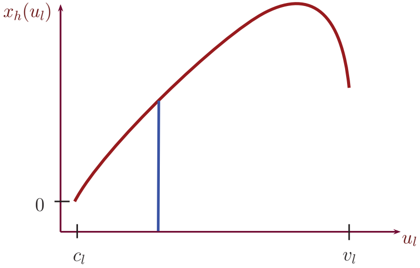
> *"there is a crying need for...models...devoted to the interaction between imperfect competition and adverse selection"*

Back to ▸ Introduction

Why is Welfare Hump-Shaped in π?

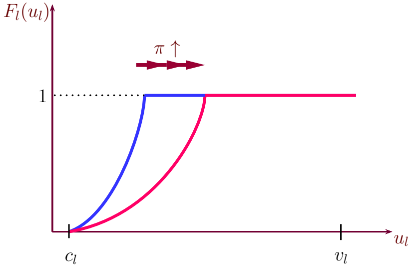
Because x_h is hump-shaped in π and F_l is shifting right.

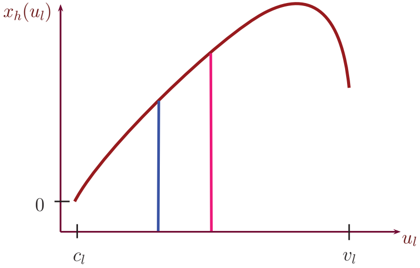




Why is Welfare Hump-Shaped in π?

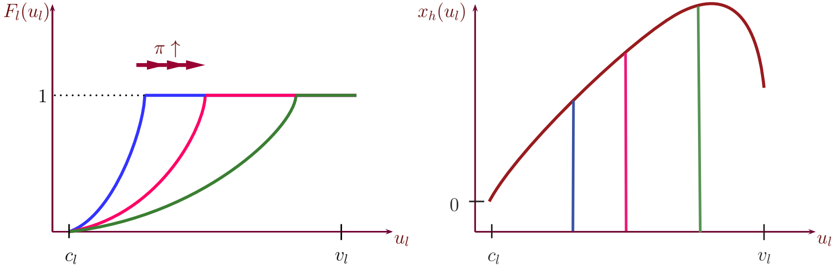
Because x_h is hump-shaped in π and F_l is shifting right.





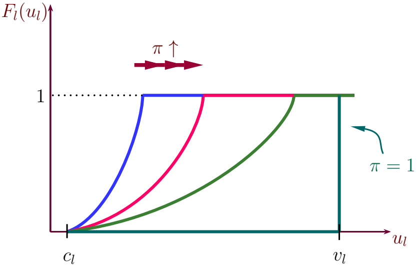
Why is Welfare Hump-Shaped in π?

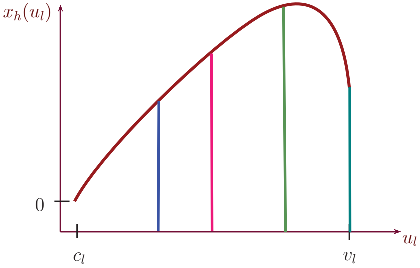
Because x_h is hump-shaped in π and F_l is shifting right.



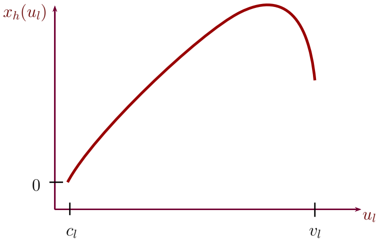
Why is Welfare Hump-Shaped in π?

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





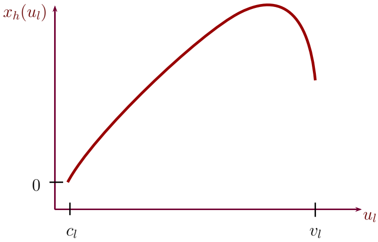
Why is $x_h(u_l)$ Hump-Shaped?

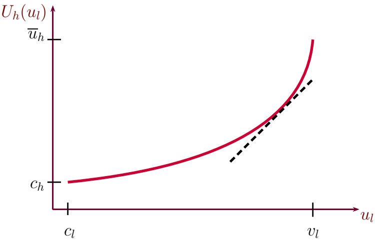


Two effects from competition:

1. buyers give more surplus to l type sellers.
   - relaxes IC constraint $\rightarrow$ $x_h \uparrow$

Why is $x_h(u_l)$ Hump-Shaped?

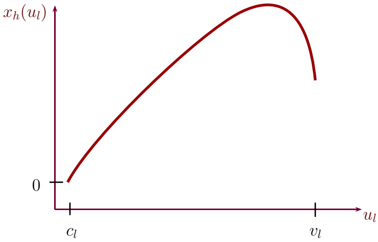


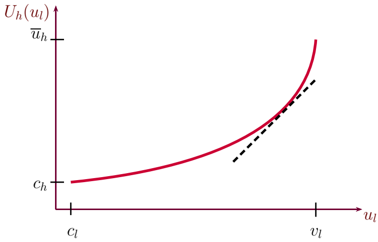


Two effects from competition:

1. buyers give more surplus to *l* type sellers.
   - relaxes IC constraint $\rightarrow$ $x_h \uparrow$
2. buyers give more surplus to *h* type sellers.
   - tightens IC constraint $\rightarrow$ $x_h \downarrow$

Why is $x_h(u_l)$ Hump-Shaped?





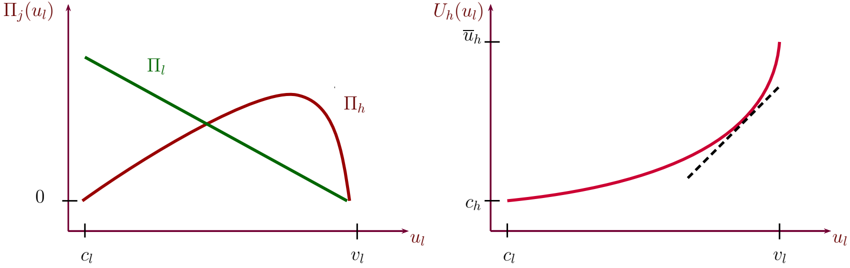
Two effects from competition:

1. buyers give more surplus to l type sellers.
   - relaxes IC constraint $\rightarrow x_h \uparrow$
2. buyers give more surplus to h type sellers.
   - tightens IC constraint $\rightarrow x_h \downarrow$

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 $\frac{\Pi_h}{\Pi_l}$...

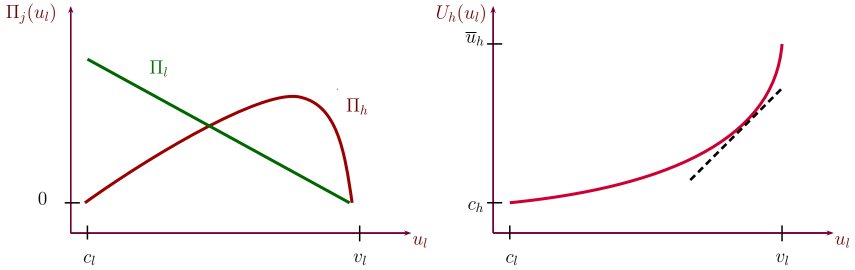
Severe Adverse Selection: Allocations



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

Back to Welfare

Severe Adverse Selection: Allocations



- 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
  - Arbitrary message space (quality, contact with other buyer etc.)

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
  - Arbitrary message space (quality, contact with other buyer etc.)

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

Back

General Meeting Technologies: Solution

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

$$
\begin{aligned}
&\arg\max_{u_l, u_h} \quad \sum_{i \in \{l,h\}} \mu_i \left[\sum_{n=1}^{\infty} Q(n) F_i^{n-1}(u_i) \right] \Pi_i(u_l, u_h) \\
= &\arg\max_{u_l, u_h} \quad \sum_{i \in \{l,h\}} \mu_i \left[\frac{Q(1)}{\sum_{n'=1}^{\infty} Q(n')} + \sum_{n''=2}^{\infty} \frac{Q(n'')}{\sum_{n'=1}^{\infty} Q(n')} F_i^{n''-1}(u_i) \right] \Pi_i(u_l, u_h)
\end{aligned}
$$

General Meeting Technologies: Solution

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

$$= \arg\max_{u_l,u_h} \sum_{i\in\{l,h\}} \mu_i \left[\frac{Q(1)}{\sum_{n'=1}^{\infty} Q(n')} + \sum_{n''=2}^{\infty} \frac{Q(n'')}{\sum_{n'=1}^{\infty} Q(n')} F_i^{n''-1}(u_i)\right] \Pi_i(u_l,u_h)$$

$$= \arg\max_{u_l,u_h} \sum_{i\in\{l,h\}} \mu_i \left[1-\tilde{\pi}+\tilde{\pi} G_i(u_i)\right] \Pi_i(u_l,u_h) \quad \text{where} \quad \tilde{\pi} = 1 - \frac{Q(1)}{\sum_{n=1}^{\infty} Q(n)}$$

- 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

General Meeting Technologies: Solution

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

$$= \arg\max_{u_l, u_h} \quad \sum_{i \in \{l,h\}} \mu_i \left[1 - \tilde{\pi} + \tilde{\pi} G_i(u_i) \right] \Pi_i(u_l, u_h) \quad \text{where} \quad \tilde{\pi} = 1 - \frac{Q(1)}{\sum_{n=1}^{\infty} Q(n)}$$

- 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

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

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

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