Multidimensional Screening and Menu Design in Health Insurance Markets

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April 2022
Health insurance menu design is a complicated, multidimensional screening problem

→ Agents differ along (at least) three important dimensions
→ And asymmetric info (or regulation) often leads to adverse selection

• Recent empirical work has made progress in centrally planned markets
• But little is known about the interaction with market power
• And we have few general, theoretical results

Research question:

What can theory and empirics together tell us about this problem?
This paper:

- Considers a general model of a health insurance market with
  - multidimensional consumer heterogeneity
    - (all private information + some cost-relevant = selection)
  - ex-post moral hazard (agents act on hidden realization of uncertainty)
  - an insurer that can
    - offer **vertically differentiated** products
    - set prices
  - unified framework where menu designer has flexible objective
    (e.g., social planner, monopolist)
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  - multidimensional consumer heterogeneity
    \[ \leftrightarrow (\text{all private information} + \text{some cost-relevant} = \text{selection}) \]
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  - an insurer that can
    - offer \textit{vertically differentiated} products
    - set prices
  - unified framework where menu designer has flexible objective
    \[ (\text{e.g., social planner, monopolist}) \]

1. Provides necessary conditions that any optimal menu must satisfy
2. Proves optimal menus are well-approximated by finite set of contracts
3. Presents and validates a first order approach
Main theoretical challenge

- Consumers are intrinsically multidimensional
  - can’t work from allocations to deriving price schedules
  - start from price schedules and derive allocations
Main theoretical challenge

- Consumers are intrinsically multidimensional
  - ⇒ can’t work from allocations to deriving price schedules
  - * start from price schedules and derive allocations

⇒ Key theoretical contribution: generalize the standard screening conditions to the multidimensional case
Main theoretical results

1. Optimality conditions that any optimal menu must satisfy
   - subsume well-known cases (e.g., unidimensional case)
   - have clear interpretations that shed light on insurer’s incentives

   ⟹ Allow us to show that:
   - the social planner would like the monopolist to exclude less
   - the monopolist may screen even when the social planner pools
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2. The optimum with an arbitrary number of contracts can be well-approximated by a finite number of contracts

But theory doesn’t resolve questions about:

(a) how fast optimal menu converges in number of allowable contracts
(b) extent of screening and exclusion under the optimal menu
(c) optimal regulation of a monopoly market
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(a) how fast optimal menu converges in number of allowable contracts

(b) extent of screening and exclusion under the optimal menu

(c) optimal regulation of a monopoly market

→ go to the numbers!
Main numerical findings

(a) Convergence is fast
   → increasing contract density x10 raises insurer objective <$10/hh/year

(b) Monopolist offers substantially less coverage than the social planner
   → opts for greater screening and exclusion

(c) Key quasiconcavity assumption is largely satisfied in our population
   → derive comparative statics to inform policy simulations
Model

- Set of potential contracts indexed by $x \in [0, 1]$
  - each with cost-sharing function $c(\cdot, x)$ and premium $\rho$
  - vertically differentiated
Set of potential contracts
Set of potential contracts (vertically differentiated = “stacked”)

\[ c(a, x) \]

\[ x = 0 \]

\[ x = 1 \]

\[ 0 \]

45°
Model

• Set of potential contracts indexed by $x \in [0, 1]$
  ▶ vertically differentiated
  ▶ each with cost-sharing function $c(\cdot, x)$ and premium $\rho$

• Population of consumers characterized by type $\theta = (F, \psi, \omega)$
  ▶ $F$ : distribution over potential health states
  ▶ $\psi$ : risk aversion parameter
  ▶ $\omega$ : moral hazard parameter
Model

- Set of potential contracts indexed by \( x \in [0, 1] \)
  - vertically differentiated
  - each with cost-sharing function \( c(\cdot, x) \) and premium \( \rho \)

- Population of consumers characterized by type \( \theta = (F, \psi, \omega) \)
  - \( F \) : distribution over potential health states
  - \( \psi \) : risk aversion parameter
  - \( \omega \) : moral hazard parameter

- Consumers face two-stage decision problem, knowing their type \( \theta \):
  - **stage 1** : discrete choice over contracts
    - health state is realized (observed by consumer but hidden to insurer)
  - **stage 2** : continuous choice of healthcare utilization over \( \mathbb{R}_+ \)
Stage 2

- Given contract \((x)\) and realized health state \((l)\), choose healthcare spending \((a)\), trading off
  - Benefit of healthcare spending: \(b(a, l, \omega)\)
  - Out-of-pocket cost: \(c(a, x)\)

\[
a^* (l, x, \omega) = \arg\max_a \left[ b(a, l, \omega) - c(a, x) \right]
\]
Consumer demand for healthcare and health insurance

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Stage 1
• Choose contract to maximize expected utility

\[
U(x, \rho, \theta) = \int \left[ u_{\psi} \left( -\rho + b^*(l, x, \omega) - c^*(l, x, \omega) \right) \right] dF(l)
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Consumer demand for healthcare and health insurance

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\]

or with CARA, certainty equivalent

\[
CE(x, \rho, \theta) = v(x, \theta) - \rho
\]

\[
x^*(\rho, \theta) = \arg\max_x CE(x, \rho, \theta)
\]
Insurer’s objective function

- Insurer payoff $S$ from providing contract $x$ to type $\theta$ at premium $\rho$ is

$$S(x, \rho, \theta) = w^C \left( v(x, \theta) - \rho \right) + w^I \left( \rho - \gamma(x, \theta) + \gamma(x^0, \theta) \right) - w^G \gamma(x^0, \theta)$$

- **Consumer surplus**
- **Profit**
- **Govt spending**
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  - $\gamma(x, \theta)$ is expected cost of providing contract $x$
    - use **incremental pricing**: $x^0$ provided by govt, $x$ provided by insurer
  - weights $w = (w^C, w^I, w^G)$ reflect insurer’s objective
    - $w = (0, 1, 0)$: monopolist
    - $w = (1, 1, 1)$: planner (with no excess cost of funds)
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  - $w = (0, 1, 0)$: monopolist
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- **Insurer chooses** prices $\rho(x)$ and an allocation $\chi(\theta)$ to maximize

\[
\int S(\chi(\theta), \rho(\chi(\theta)), \theta) \, dG(\theta)
\]

s.t. $\chi(\theta) = x^*(\rho, \theta)$ and $\rho(x^0) = 0$
\( \rho(x) \) restricted to left-continuous, increasing functions
Can easily accommodate regulatory constraints
→ e.g., restriction to pre-specified set of contracts
Theoretical results

1. Necessary conditions for an optimal menu (an optimal $\rho(x)$)
   - in the continuum
   - when restricted to a fixed set of contracts

2. Convergence in the number of allowable contracts
1. Necessary conditions for an optimal menu

- Three focal cases: Insurer can offer (i) a fixed set of contracts,
  (ii) a fixed number of contracts,
  or (iii) a continuum of contracts
1. Necessary conditions for an optimal menu

- **Three focal cases**: Insurer can offer (i) a **fixed set** of contracts, (ii) a **fixed number** of contracts, or (iii) a **continuum** of contracts.

  Conditions and proof for (ii) provide building blocks for (i) and (iii).

  - Building blocks are **two basic perturbations**:  
    - (1) Perturb the levels of coverage offered
    - (2) Perturb the price differences between contracts

- **Key ingredient**: a type dimension in which demand is strictly increasing
  - Risk aversion  \( v(x, \theta)_{\psi} > 0 \)
Perturbation 1: raise the generosity of contract $x$
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- Fix $(\omega, F')$ and consider effects across marginal distribution of $\psi$

![Graph showing distribution of $\psi$ and shaded regions for consumers currently choosing $x$]
Perturbation 1: raise the generosity of contract $x$

- Fix $(\omega, F')$ and consider effects across marginal distribution of $\psi$

\[
g(\psi|\omega, F')
\]

Perturbing $x$ has **three effects:**

(i) consumers currently choosing $x$ are happier and more costly to serve

- change in payoff = $\int_{\psi^l}^{\psi^h} S_x(x, \rho, \theta) \ dG(\psi|\omega, F')$
Perturbation 1: raise the generosity of contract $x$

- Fix $(\omega, F)$ and consider effects across marginal distribution of $\psi$

\[
g(\psi|\omega, F) = \begin{cases} 
\text{consumers currently choosing } x^l \text{ who switch to } x & \text{if } \psi^l < \psi < \psi^h \\
\text{consumers currently choosing } x & \text{if } \psi < \psi^l \text{ or } \psi > \psi^h 
\end{cases}
\]

Perturbing $x$ has **three effects:**

(i) consumers currently choosing $x$ are happier and more costly to serve

(ii) some consumers currently choosing below $x$ now switch to $x$

- change in payoff $= \left(S(x, \psi^l) - S(x^l, \psi^l)\right) \frac{v_x(x, \psi^l)}{v_{\psi}(x, \psi^l) - v_{\psi}(x^l, \psi^l)} g(\psi^l|\omega, F)$
Perturbation 1: raise the generosity of contract $x$

- Fix $(\omega, F)$ and consider effects across marginal distribution of $\psi$.

Perturbing $x$ has **three effects**:

(i) consumers currently choosing $x$ are happier and more costly to serve

(ii) some consumers currently choosing below $x$ now switch to $x$

(iii) some consumers currently choosing above $x$ now switch to $x$

- change in payoff = 
  \[ (S(x, \psi^h) - S(x^h, \psi^h)) \frac{v_x(x, \psi^h)}{v_{\psi}(x^h, \psi^h) - v_{\psi}(x, \psi^h)} g(\psi^h | \omega, F) \]
Perturbation 1: raise the generosity of contract $x$

- At the optimum, the three effects must perfectly offset.
Perturbation 1: raise the generosity of contract $x$

- At the optimum, the three effects must perfectly offset.
- Define the sum of these effects as $V^1(x, \omega, F)$.
- At the optimum, $\int V^1(x, \omega, F) dG(\omega, F) = 0$ for all $x$. 
Perturbation 2: raise prices above $x$
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- Fix $(\omega, F)$ and consider effects across marginal distribution of $\psi$

Raising prices on all contracts above $x$ has **two effects:**
Perturbation 2: raise prices above $x$

- Fix $(\omega, F)$ and consider effects across marginal distribution of $\psi$

Raising prices on all contracts above $x$ has **two effects:**

(i) some consumers currently choosing above $x$ now switch to $x$

- change in payoff $= \left( S(x, \psi^h) - S(x^h, \psi^h) \right) \frac{1}{v_\psi(x^h, \psi^h) - v_\psi(x, \psi^h)} g(\psi^h | \omega, F)$
Perturbation 2: raise prices above \( x \)

- Fix \((\omega, F)\) and consider effects across marginal distribution of \( \psi \)

Raising prices on all contracts above \( x \) has two effects:

(i) some consumers currently choosing above \( x \) now switch to \( x \)

(ii) increase in margins on consumers that don’t switch down

- change in payoff = \((w^I - w^C)(1 - G(\psi^h|\omega, F))\)
Perturbation 2: raise prices above $x$

- At the optimum, the insurer compares the marginal costs and marginal benefits of raising premiums.
Perturbation 2: raise prices above $x$

- At the optimum, the insurer compares the marginal costs and marginal benefits of raising premiums.
- Define the sum of these effects as $V^2(x, \omega, F)$.
- At the optimum, $\int V^2(x, \omega, F) dG(\omega, F) = 0$ for all $x$. 

Sketch of Proof
Incentives to Exclude, Screen, and Trade

- Exclusion: Consider a specific version of Perturbation 2 where insurer raises prices on all contracts above $x^0$
  
  - The monopolist trades off ↓ the loss in profits on consumers it now excludes and ↑ the gain in profits on inframarginal consumers
  
  - The social planner trades off ↓↑ the change in social surplus among consumers it now excludes and ↓ the deadweight loss of transfers (if any)

- Screening: Simplify the problem by fixing $F$ and $\psi$, so only $\omega$ varies across consumers

- Trade: Not obvious that a monopolist insurer always trades given ex post moral hazard, but for a continuum of contracts with $x^0 \leq 1$ a small increase in $x$ has a second-order [↓] moral hazard impact, but first-order [↑] gain in risk protection
Incentives to Exclude, Screen, and Trade

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- **Screening**: Simplify the problem by fixing $F$ and $\psi$, so only $\omega$ varies across consumers
  
  - The social planner trades off ↓ the DWL of moral hazard (increasing in $\omega$) and ↑ the value of risk protection
  
  - But consumers with a high preference for healthcare utilization demand more generous coverage (increasing in $\omega$)
Incentives to Exclude, Screen, and Trade

- **Exclusion:** Consider a specific version of Perturbation 2 where insurer raises prices on all contracts above $x^0$
  - The monopolist trades off $\downarrow$ the loss in profits on consumers it now excludes and $\uparrow$ the gain in profits on inframarginal consumers
  - The social planner trades off $\downarrow\uparrow$ the change in social surplus among consumers it now excludes and $\downarrow$ the deadweight loss of transfers (if any)

- **Screening:** Simplify the problem by fixing $F$ and $\psi$, so only $\omega$ varies across consumers
  - The social planner trades off $\downarrow$ the DWL of moral hazard (increasing in $\omega$) and $\uparrow$ the value of risk protection
  - But consumers with a high preference for healthcare utilization demand more generous coverage (increasing in $\omega$)

- **Trade:** Not obvious that a monopolist insurer always trades given ex post moral hazard, but for a continuum of contracts with $x^0 < 1$
  - a small increase in $x$ has a second-order $[\downarrow]$ moral hazard impact, but first-order $\uparrow$ gain in risk protection
2. Convergence

- The problem with an arbitrary number of contracts is well approximated by a finite number of contracts.

- Numerical simplicity:
  - The details of how the finite set of contracts are constructed “simply do not matter.”
  - Not unique, but “once one has numerically found an optimum, there is no other optimum with qualitatively different implications.”

- Theoretical simplicity:
  - Can work with the either a finite number of contracts or a continuum, whichever is easier.
Theory doesn’t resolve questions about:

- how fast optimal menu converges in number of allowable contracts
- extent of screening and exclusion under the optimal menu
- optimal regulation of a monopoly market
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- extent of screening and exclusion under the optimal menu
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→ go to the numbers!
Simulate population of consumers using parameter estimates from Marone and Sabety (2022)

- Construct households as some # individuals of \{age, gender, risk score\}
- Calculate implied household types $\theta$
  - $F$ parameterized as shifted log-normal: $\log(l + \kappa) \sim N(\mu, \sigma^2)$
  - $b(a, l, \omega)$ parameterized as $(a - l) - \frac{1}{2\omega}(a - l)^2$
Set of potential contracts

<table>
<thead>
<tr>
<th></th>
<th>Full insurance</th>
<th>Gold</th>
<th>Silver</th>
<th>Bronze</th>
<th>Catastrophic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Out-of-pocket cost ($000)</td>
<td>0</td>
<td>2.5</td>
<td>5.0</td>
<td>7.5</td>
<td>10.0</td>
</tr>
<tr>
<td>Total healthcare spending ($000)</td>
<td>0</td>
<td>5</td>
<td>10</td>
<td>15</td>
<td>12.5</td>
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Set of potential contracts
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Set of potential contracts
As # contracts increases, payoffs converge... quickly!

- Payoffs for monopolist (Insurer profits)
- Payoffs for social planner (Social surplus)

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<tr>
<td>2</td>
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</tr>
<tr>
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<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>5</td>
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<td>1.5</td>
</tr>
<tr>
<td>9</td>
<td>2.0</td>
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</tr>
<tr>
<td>17</td>
<td>3.0</td>
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</tr>
<tr>
<td>33</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>65</td>
<td>9.0</td>
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$000 per household per year
## Simulation results

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<tr>
<th>Welfare outcomes</th>
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<td>$000 per household</td>
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</tr>
<tr>
<td>SS†</td>
<td>CS†</td>
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<td>1.04</td>
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### Optimal menus

- Social planner
- Monopolist

### Notes:

- †Relative to the Catastrophic contract.

- Monopolist offers much less coverage than the social planner
  - due to both exclusion and screening
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**Optimal menus**

- Social planner: 1.74, 1.74, –
- Monopolist: 1.04, 0.32, 0.72

**Notes:**

| Notes: | †Relative to the Catastrophic contract. |

- Monopolist offers much less coverage than the social planner
  - due to both exclusion and screening
- Monopoly generates 62% of the optimal feasible surplus
An “almost” first order approach

• What does the numerical algorithm actually do?
  ▶ finds optimal premium differences pair of contracts by pair of contracts
  ▶ loop over all contracts until things converge

• Is that ... valid?
An “almost” first order approach

• What does the numerical algorithm actually do?
  ▶ finds optimal premium differences pair of contracts by pair of contracts
  ▶ loop over all contracts until things converge

• Is that ... valid? Possibly!
  ▶ need one more (heroic) assumption!
First Order Approach Under Quasiconcavity

- If you prefer gold to silver, do you also prefer silver to bronze?
  - if so, can (theoretically) solve a much simpler problem
  - → additional insights!

- Is quasiconcavity ... satisfied?
First Order Approach Under Quasiconcavity

• If you prefer gold to silver, do you also prefer silver to bronze?
  ▶ if so, can (theoretically) solve a much simpler problem
  ▶ → additional insights!

• Is quasiconcavity ... satisfied? Possibly!
  ▶ in the single dimensional (risk aversion only) case, trivially
  ▶ in the multidimensional case, we can check! → go to the numbers!
Why is quasiconcavity useful?

- the profits on any incremental contract only depend on $p^j = \rho(x^j) - \rho(x^{j-1})$
- the solution pair of contracts by pair of contracts is the “real” solution
- $\Pi(\tilde{\rho}) = \Pi(\rho^*)$
Quasiconcavity in Theory and Practice

• Why is quasiconcavity useful?
  ▶ the profits on any incremental contract only depend on \( p^j = \rho(x^j) - \rho(x^{j-1}) \)
  ▶ the solution pair of contracts by pair of contracts is the “real” solution
  ▶ \( \Pi(\tilde{\rho}) = \Pi(\rho^*) \)

• Is quasiconcavity satisfied in the multidimensional case?
  ▶ Holds for 99% of consumers
  ▶ Profits from \( \tilde{\rho} \) are 99.95% of profits from \( \rho^* \)!
Why is quasiconcavity useful?

- the profits on any incremental contract only depend on $p^j = \rho(x^j) - \rho(x^{j-1})$
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Is quasiconcavity satisfied in the multidimensional case?

- Holds for 99% of consumers
- Profits from $\tilde{\rho}$ are 99.95% of profits from $\rho^*$!

→ Comparative statics to inform policy simulations!
Monotone Comparative Statics Results

- As $w^C$ rises, $\tilde{\rho}$ falls and becomes flatter $\forall x$
  - the monopolist unambiguously offers less coverage
  - ... and excludes a strictly positive measure of types from each $x^i$

- As $x^0$ increase, $p^j$ falls $\forall x \geq 2$
  - increasing the generosity of the outside good is an implicit subsidy on more generous coverage
Why Deal with a Monopolist at all?

- There is always a vector of subsidies \( s^j \) such that:
  - the subsidy does not cost more than \( \gamma^G(x^0, \theta) \)
  - the market implements the social planner’s preferred allocation
  - the firms in the market earn (weakly) positive profits
Why Deal with a Monopolist at all?

- There is always a vector of subsidies $s^j$ such that:
  - the subsidy does not cost more than $\gamma^G(x^0, \theta)$
  - the market implements the social planner’s preferred allocation
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- In our setting:
  - the social planner calculates $\gamma^G$ for Gold
  - the social planner gives the monopolist $\mathbb{E}(\gamma^G)$ for everyone in Gold
  - the social planner *heavily penalizes* the monopolist for everyone *not* in Gold
# Simulation results

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**Optimal menus**

- Social planner
  - $SS^\dagger$: 1.74
  - $CS^\dagger$: 1.74
  - $PS$: –
- Monopolist
  - $SS^\dagger$: 1.04
  - $CS^\dagger$: 0.32
  - $PS$: 0.72

**Regulation in monopoly market**

1. **Subsidize Gold**
   - $SS^\dagger$: 1.49
   - $CS^\dagger$: -2.70
   - $PS$: 4.18
   - Regulatory Impact:
     - Cstr.: 0.21
     - Slvr.: –
     - Gold: 0.79

**Notes:** $^\dagger$Relative to the Catastrophic contract.

- Solving for the optimal subsidy schedule is hard!
Simulation results

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</tr>
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<tbody>
<tr>
<td>$000 per household</td>
<td>Pct. of households</td>
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</thead>
<tbody>
<tr>
<td>Social planner</td>
<td>1.74</td>
<td>1.74</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>1.00</td>
<td>–</td>
</tr>
<tr>
<td>Monopolist</td>
<td>1.04</td>
<td>0.32</td>
<td>0.72</td>
<td>0.42</td>
<td>0.03</td>
<td>0.27</td>
<td>0.28</td>
<td>–</td>
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**Optimal menus**

- Social planner
- Monopolist

**Regulation in monopoly market**

(i) Subsidize Gold
(ii) Ban Bronze + Silver

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<tbody>
<tr>
<td>(i) Subsidize Gold</td>
<td>1.49</td>
<td>-2.70</td>
<td>4.18</td>
<td>0.21</td>
<td>–</td>
</tr>
<tr>
<td>(ii) Ban Bronze + Silver</td>
<td>1.05</td>
<td>0.40</td>
<td>0.65</td>
<td>0.44</td>
<td>0.56</td>
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**Notes:** †Relative to the Catastrophic contract.

- Solving for the optimal subsidy schedule is hard!
- Regulation constraining contract space works better than a naive subsidy
Concluding thoughts

- Health insurance menu design is a hard problem...
  but it’s not completely theoretically intractable

- Combining empirical insights with rigorous theoretical analysis can yield more than the sum of their parts

- Stay tuned!
  - Is imperfect competition like monopoly?  
  - What happens if you “turn off” selection or moral hazard?
Related literature and contribution

Health insurance markets

- **Modelling demand for insurance + utilization**: Cardon and Hendel (2001); Einav Finkelstein Ryan Schrimpf Cullen (2013); Azevedo and Gottlieb (2017)

- **Optimal menu design**: Bundorf Levin and Mahoney (2012); Ho and Lee (2021); Marone and Sabety (2022)

Theory on multidimensional screening

- **One good**: Laffont Maskin and Rochet (1987); Veiga and Weyl (2016)

- **Multiple goods**: Wilson (1993); Armstrong (1996); Rochet and Chone (1998); Manelli and Vincent (2006)
Sketch of Proof (Finite Set of Contracts)

• Show that optimality \( \implies \int \mathcal{V}^1(x, \omega, F) \, dG(\omega, F) = 0 \) for all \( x \).
  
  ▶ Fix a contract to \( \hat{x} \) to make more generous by \( \epsilon \) and an associated vector of premiums \( \rho^\epsilon \).
  
  ▶ Fix \( \omega \) and \( F \).
  
  ▶ Define the new boundaries \( \psi^l(\epsilon) \) and \( \psi^h(\epsilon) \) and how the change with \( \epsilon \),
    \( \psi^l_\epsilon(\epsilon) \) and \( \psi^h_\epsilon(\epsilon) \).
  
  ▶ Define \( \Pi(\rho^\epsilon) - \Pi(\rho) \) carefully so that it is easy to take the derivative
    \( (\Pi(\rho^\epsilon))_\epsilon \). This is the sum of:
    
    • The change in surplus from some slightly less risk-averse consumers
      purchasing contract \( \hat{x} \),
    
    • The change in surplus from some slightly more risk averse consumers
      purchasing contract \( \hat{x} \), and
    
    • The increased surplus given to inframarginal consumers.
  
  ▶ Note that, at the optimum, the expectation of the derivative of \( \Pi(\rho^\epsilon) \)
    evaluated at \( \epsilon = 0 \) must be zero.
  
  ▶ Show that passing the derivative through the integral – so that we can
    show the derivative is zero type by type and sum up – is valid.
Sketch of Proof (Finite Set of Contracts)

- Show that optimality \( \implies \int V^1(x, \omega, F) dG(\omega, F) = 0 \) for all \( x \).
- Show that optimality \( \implies \int V^2(x, \omega, F) dG(\omega, F) = 0 \) for all \( x \).
  - Fix a contract to \( \hat{x} \) such that premiums \( \rho^\epsilon(x) = \rho(x) \) for \( x \leq \hat{x} \) and \( \rho^\epsilon(x) = \rho(x) + \epsilon \) for \( x > \hat{x} \).
  - Fix \( \omega \) and \( F \).
  - Define the new lower bound of types choosing contract \( \hat{x} \), \( \psi^*(\epsilon) > \psi^*(0) \) and how it changes with \( \epsilon, \rho^*_\epsilon(\epsilon) \).
  - Define \( \Pi(\rho^\epsilon) - \Pi(\rho) \) carefully so that it is easy to take the derivative \( (\Pi(\rho^\epsilon))_\epsilon \). This is the sum of:
    - The increase in margins on inframarginal consumers times the number of inframarginal consumers: \( (1 - G(\psi^*(\epsilon)))_\epsilon \), and
    - change in surplus on consumers who “trade down.”
  - Note that, at the optimum, the expectation of the derivative of \( \Pi(\rho^\epsilon) \) evaluated at \( \epsilon = 0 \) must be zero.
  - Show that passing the derivative through the integral – so that we can show the derivative is zero type by type and sum up – is valid.

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  - The increase in margins on inframarginal consumers times the number of inframarginal consumers: \( (1 - G(\psi^*(\epsilon)))_\epsilon \), and
  - change in surplus on consumers who “trade down.”
- Note that, at the optimum, the expectation of the derivative of \( \Pi(\rho^\epsilon) \) evaluated at \( \epsilon = 0 \) must be zero.
- Show that passing the derivative through the integral – so that we can show the derivative is zero type by type and sum up – is valid.
Sketch of Proof

- Construct a sequence of premium vectors $\rho^n$ that converges to some feasible $\rho \in \mathcal{P}^0$, which is in the set of things the insurer can choose.
- Show that as $\rho^n \to \rho$, consumer surplus converges, too.
- Show that as consumer surplus converges, the consumer’s optimal contract converges with probability 1.
- (The hard part): Show that as the consumer optimal choice converges, monopoly profits (or social surplus) converge as well.
  - Relies on the fact that once the monopolist knows exactly what level of health care you’ll pick under the incentive compatible contract, profits are well-defined and well-behaved.
Imperfect Competition (Very Preliminary!)

![Graph showing SS as a Fraction of PC over time t.

- SS initially increases sharply before peaking and then decreases.
- The blue line represents another variable, possibly related to PC, showing a more gradual decrease.

Chade, Marone, Starc, Swinkels
April 2022 38 / 33
“Turning Off” Selection and Moral Hazard

• Under the planner ...
  ▶ absent moral hazard, everyone gets full insurance

• Under the monopolists ...
  ▶ asymmetric information generates rents for consumers
  ▶ the impact of moral hazard on consumer surplus is ambiguous