Mechanism Design for Social Good

Provision and Targeting for Vulnerable Populations

EC 2020 Tutorial, June 25 and 26

Session #1b
Self-targeting: theoretical models

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Possible Errors in Targeting

Type II errors (award errors): ineligible individuals getting benefits

ineligible individuals getting benefits and being accepted

Type I error: eligible individuals not getting benefits

Type Ib errors (rejection errors): eligible individuals applying for benefits and being rejected.

AND

Type Ia errors (incomplete take-up): eligible individuals not applying for benefits.

Kleven and Kopczuk (AEJ Policy, 2011)
Theoretical groundwork: outline

- Ordeal targeting: sacrificing productive efficiency for targeting efficiency
- How is ordeal targeting supposed to work?

- Theoretically, does increasing ordeals improve targeting efficiency?
  - Depends on cost shocks
  - Depends on technology to overcome ordeal
  - Depends on curvature of utility function

- Some empirical evidence

- It looks like an ordeal, but it is productive! Productive complexity.
What is ordeal targeting?

- Types (wage rate, consumption): \( a_i \quad i \in \{ L, H \} \) (poor, not poor)
- Gov goal: want to give benefit \( B \) to \( a_L \) but can’t observe \( a_i \)
  
  (In this talk we will ignore paying for \( B \) by taxing \( a_H \) (Nichols & Zeckhauser, 1982))

- Program: Give \( B \) to applicants with probability \( P \). \( P(a_L) > P(a_H) \)
- Problem: \( a_H \) still apply. (Type II error)

- Solution: Set application cost \( C(a_i, s) \)
  
  where \( s \) is ordeal level e.g standing in line \( s \) hours cost \( s \)*wage rate

- Result: \( a_H \) will not apply, thus improving targeting efficiency
Examples

- Unemployment schemes require individuals to report to the unemployment office weekly during working hours, which is challenging for the employed.

- Oportunidades in Mexico: appear in person to apply and recertify periodically, attending monthly health lectures.

- Manual labor requirements to receive aid in welfare programs:
  - Works Progress Administration (WPA) in US Great Depression
  - National Rural Employment Guarantee Act (NREGA) right-to-work in India
What’s the problem with ordeal targeting?

\( a_L \) that applies pay ordeal cost \( C(s, a_L) \)

- Dead Weight Loss (DWL) – a waste if not balanced by better targeting
- Cost born by the poor
- May discourage application among the poorest (Type 1a error)
Baseline model

- Apply: \( U(a_i - C(s, a_i)) + P(a_i)\delta U(a_i + B)) + (1 - P(a_i))\delta U(a_i) \)
- Not apply: \( U(a_i) + \delta U(a_i) \)
- Simplification: \( U(x) = x \quad C(s, a_i) = sa_i \)
- \( G(ain): -sa_i + P(a_i)\delta B \)
- Apply if \( G > 0 \)

\[ \frac{\partial G}{\partial a_i} < 0, \quad \frac{\partial G}{\partial s} < 0, \]

Increasing \( s \) decreases threshold type

Fig 1a

\[ \frac{\partial P(.)}{\partial a_i} < 0, \frac{\partial C(L,a_i)}{\partial a_i} > 0 \]

Alatas et al (JPE, 2016)
Baseline model

- Apply: \( U(a_i - C(s, a_i)) + P(a_i) \delta U(a_i + B)) + (1 - P(a_i)) \delta U(a_i) \)
- Not apply: \( U(a_i) + \delta U(a_i) \)
- Simplification: \( U(x) = x \quad C(s, a_i) = sa_i \)
- \( G(ain): -sa_i + P(a_i) \delta B \)
- Apply if \( G > 0 \)

So \( s \) improves targeting efficiency when:

\[
\frac{Pr(apply|a_L, s)}{Pr(apply|a_H, s)} \text{ is increasing in } s
\]

\[
\frac{\partial P(.)}{\partial a_i} < 0, \quad \frac{\partial C(L, a_i)}{\partial a_i} > 0
\]

Alatas et al (JPE, 2016)

Fig 1b: No errors
Not poor hurt more w/ increasing L
Theoretical groundwork: outline

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- Some empirical evidence

- It looks like an ordeal, but it is productive! Productive complexity.
Extension: Cost shocks

- When applying, people experience $\epsilon$ shocks.
  - $\epsilon > 0 \Rightarrow$ more likely to apply (have child care), $\epsilon < 0$ less likely (sick child).
  - Distributed w/ cdf $F(\cdot)$, mean 0 variance $\sigma^2$.

- Apply: $U(a_i - C(s, a_i)) + P(a_i)\delta U(a_i + B)) + (1 - P(a_i))\delta U(a_i) + \epsilon$
- Not apply: $U(a_i) + \delta U(a_i)$
- Now apply if $sa_i + P(a_i)\delta B + \epsilon > 0$ or $G(a_i, s) + \epsilon > 0$
- $Pr(apply|a_i, s) = 1 - F(-G(a_i, s))$

- So $s$ improves targeting efficiency when:
  $$\frac{1 - F(-G(a_L, s))}{1 - F(-G(a_H, s))}$$
  is increasing in $s$. 

Alatas et al (JPE, 2016)
Extension: Cost shocks

- When applying, people experience $\epsilon$ shocks.
  - $\epsilon > 0 \Rightarrow$ more likely to apply (have child care), $\epsilon < 0$ less likely (sick child).
  - Distributed w/ cdf $F(.)$ mean $0$ variance $\sigma^2$

- \[
  \frac{1-F(-G(s,a_L))}{1-F(-G(s,a_H))}
\]
  is increasing in $s$ when
  distribution of shocks have the monotone hazard property

- Meaning hazard rate \[
  \frac{f(-G(s,a_i))}{1-F(-G(s,a_i))}
\]
  is increasing in $a_i$
  e.g. uniform, normal, logistic distribution
  but not log logistic and other “thick-tailed” distributions

Alatas et al (JPE, 2016)
Effect of increasing ordeal w/ and w/out cost shocks

Alatas et al (JPE, 2016)

Fig 1b: No errors
Not poor hurt more w/ increasing L

Fig 2a: Log logistic errors
Poor hurt more w/ increasing L
Extension: Technology to overcome ordeal

- Previously: $C(s, a_i) = sa_i$ (standing in line $s$ hours * wage rate)
- Now: suppose you have to travel $s$ km to apply for $B$
- You can walk or bus: $l > k$
  - Walking: $ls_i$
  - Bussing: $v + ks_i$
- Increasing ordeal:
  - From 0 to close improves targeting
  - From close to far harms targeting
  (marginal cost for the poor is increasing more than for the rich.)

Alatas et al (JPE, 2016)
Extension: Concave utility

\[ U(x) = \ln(x) \]

\[ G = \ln(a_i - C(s, a_i)) + P(a_i)\delta \ln(a_i + B)) + (1 - P(a_i))\delta \ln(a_i) - \ln(a_i) + \delta \ln(a_i) \]
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- Some empirical evidence

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PKH self-targeting experiment

<table>
<thead>
<tr>
<th>Interviewer</th>
<th>Total households</th>
<th>2010 Collect consumption data LNPCE</th>
<th>2011 PMT and self targeting</th>
<th>Give B (4-13% of income)</th>
<th>substantial under reporting of assets in the initial interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>No ordeal</td>
<td>1998</td>
<td>35.3%</td>
<td>12.18%</td>
<td>4.3%</td>
<td></td>
</tr>
<tr>
<td>Ordeal</td>
<td>2000</td>
<td>37.7%</td>
<td>9.7%</td>
<td>3.7%</td>
<td></td>
</tr>
</tbody>
</table>

Far, Self (500) Close, Self
Far, +Spouse Close, +Spouse

Alatas et al (JPE, 2016)
Ordeal: who shows up?

- Regress $LNPCE_i = \alpha_1 + PMT_i \beta + \varepsilon_i$

- Regress $ShowUp_i$ against $PMT_i \beta$ and $\varepsilon_i$

Selection from ordeal consistent with PMT

...and is likely to improve upon it

<table>
<thead>
<tr>
<th></th>
<th>ShowUp$_i$</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td></td>
</tr>
<tr>
<td>(1)</td>
<td></td>
</tr>
</tbody>
</table>

|                          |            |            |
|--------------------------|------------|
| Observable consumption ($X'_i \beta$) | -2.217*** |
| (0.201)                  |            |
| Unobservable consumption ($\varepsilon_i$) | -0.907*** |
| (0.136)                  |            |

Stratum fixed effects
Observations 2,000
Mean of dependent variable 0.377
Ordeal improves targeting

But the poorest are still not getting it!

Yes, we reduce leakage!
(Type 2 error)
**Increasing ordeal: +spouse**

<table>
<thead>
<tr>
<th>Table 8: Experimental Results: Probability of Showing up as a Function</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td><strong>No stratum fixed effects</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>(1)  (2)  (3)</td>
</tr>
<tr>
<td>----------------------------------------------------------------</td>
</tr>
<tr>
<td>Both spouse subetreatment</td>
</tr>
<tr>
<td>0.196  4.303  0.461*</td>
</tr>
<tr>
<td>(0.146) (2.840) (0.237)</td>
</tr>
<tr>
<td>Log consumption</td>
</tr>
<tr>
<td>-1.324***</td>
</tr>
<tr>
<td>(0.145)</td>
</tr>
<tr>
<td>Both spouse subetreatment * Log consumption</td>
</tr>
<tr>
<td>-0.318</td>
</tr>
<tr>
<td>(0.217)</td>
</tr>
</tbody>
</table>
Increasing ordeal: +distance

Why? Which of the three theoretical possibilities explains it?

**TABLE 7. Experimental Results: Probability of Showing up as a Function of Distance**

<table>
<thead>
<tr>
<th></th>
<th>No stratum fixed effects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td>Close subtreatment</td>
<td>0.205</td>
</tr>
<tr>
<td></td>
<td>(0.146)</td>
</tr>
<tr>
<td>Log consumption</td>
<td>-1.434***</td>
</tr>
<tr>
<td></td>
<td>(0.143)</td>
</tr>
<tr>
<td>Close subtreatment* Log consumption</td>
<td>-0.093</td>
</tr>
<tr>
<td></td>
<td>(0.217)</td>
</tr>
</tbody>
</table>

**Showup**

**Measured Rates**

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Consumption Quintile

1, 2, 3, 4, 5
Umm… none.

- **cost shocks:**
  - logistic error fits best, and it satisfy the monotone hazard property

- **technology to overcome ordeal:**
  - May be possible, but when simulate data constraining everyone to the same transport technology, no difference.

- **curvature of utility function:**
  - linear utility fits best

- **So?? Why doesn’t increasing ordeal improve targeting**
  - Spouse: 28% request exemptions
  - Distance: 1.67 km
  - What would have worked is 6 hours wait (but that would be bad)

- **This is where theory meets the limits of policy implementation.**
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AND

**Type Ia errors** (incomplete take-up): eligible individuals not applying for benefits.

Kleven and Kopczuk (AEJ Policy, 2011)
# TABLE 1. SOCIAL PROGRAMS IN THE UNITED STATES

<table>
<thead>
<tr>
<th>PROGRAM</th>
<th>TAKE UP⁴</th>
<th>TARGETING²</th>
<th>COMPLEXITY²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medicaid</td>
<td>73%</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Medicare Part B³</td>
<td>96%</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Supplemental Security Income Program (SSI)</td>
<td>60%</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Social Security Disability Insurance (DI)</td>
<td>No estimate</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>The Earned Income Tax Credit (EITC)</td>
<td>80%-86%</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Temporary Assistance for Needy Families (TANF)⁴</td>
<td>60%-90%</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Housing Programs</td>
<td>below 50%</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Food Stamps</td>
<td>69%</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>The Special Supplemental Nutrition Program for Women, Infants and Children (WIC)</td>
<td>67%, 73%, 38%</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Child Care Subsidies</td>
<td>40%</td>
<td>High</td>
<td>High</td>
</tr>
</tbody>
</table>


All transaction costs: Kleven and Kopczuk (AEJ Policy, 2011)
Incomplete takeup is an issue not just in the US

<table>
<thead>
<tr>
<th>Country</th>
<th>Name of programme</th>
<th>Targeting accuracy for poorest quintile</th>
<th>Under-coverage (percentage of poor not reached)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>Bolsa Escola</td>
<td>1.98</td>
<td>73</td>
</tr>
<tr>
<td>Chile</td>
<td>PASIS (Pensiones Asistenciales de Ancianidad y de Invalidez) (old-age benefits)</td>
<td>2.67</td>
<td>84</td>
</tr>
<tr>
<td>Chile</td>
<td>Subdido Única Familial (SUF) (cash transfers)</td>
<td>3.32</td>
<td>73</td>
</tr>
<tr>
<td>Colombia</td>
<td>Subsidized Health Insurance Regime (SHIR) (health social assistance)</td>
<td>1.68</td>
<td>26</td>
</tr>
<tr>
<td>Mexico</td>
<td>Oportunidades</td>
<td>2.9</td>
<td>40</td>
</tr>
</tbody>
</table>
Reducing random noise with program complexity

- As before, each individual has ability level $a$.

- $a$ can be only be observed by gov with noise level $\sigma$ (language barriers, health): $\epsilon/\sigma \sim 0,1$, cdf $P(.)$, $P(0) = 1/2$. Individual knows own $\sigma$ but not $\epsilon$.

- Difference with Alatas et al (2016): $\epsilon$ is noise in signal of ability, not cost shock that is observed by individual when applying for benefits.

- Individual apply for benefits with screening intensity $\alpha$ (# of interviews/forms) with increasing cost function $f(\alpha)$ (transaction cost).

- Gov can reduce noise by increasing $\alpha$: $a' = a + \frac{\epsilon}{\alpha}$
Gov policy instruments:

As before assume 2 types $a_i$ $i \in \{L, H\}$ (poor, not poor) 

Government have a budget of $R$ and seek to give out a benefit $B \leq \bar{B}$ to as many $a_L$ as possible using 3 policy levers:

- $\alpha$ : screening intensity/ transaction costs
  - $\alpha \uparrow$ $f(\alpha) \uparrow \frac{\epsilon}{\alpha} \downarrow$

- $\bar{a}$ : strictness of eligibility criteria/ threshold
  - $a' = a + \frac{\epsilon}{\alpha} < \bar{a}$ receives $B$

- $B$ : program benefit
  - $B \uparrow$ $u(a_i + B - f(\alpha)) \uparrow$

\[
\max_{\alpha, \bar{a}, B} \ N_L (\alpha, \bar{a}, B) \\
\text{s.t.} \\
[N_L (\alpha, \bar{a}, B) + N_H (\alpha, \bar{a}, B)] B \leq R
\]

Kleven and Kopczuk (AEJ Policy, 2011)
Effect of policy instruments on i’s decision to apply

- Get benefit when \( a_i + \frac{\epsilon}{\alpha} < \bar{a} \) so \( \Pr(B|\text{apply}) = \Pr(\epsilon < \frac{\alpha(\bar{a} - a_i)}{\sigma_i}) = P\left(\frac{\alpha(\bar{a} - a_i)}{\sigma_i}\right) \)

- Apply when

\[
P\left(\frac{\alpha(\bar{a} - a_i)}{\sigma_i}\right) u(a_i + B - f(\alpha)) + (1 - P\left(\frac{\alpha(\bar{a} - a)}{\sigma_i}\right)) u(a_i - f(\alpha)) > u(a_i)
\]

- Rearranging, we see that policy \( \alpha, B \) sets a threshold probability:

\[
\tilde{P}(\alpha, B) \equiv \frac{u(a_i) - u(a_i - f(\alpha))}{u(a_i + B - f(\alpha)) - u(a_i - f(\alpha))}
\]

- Individual \( a_i, \sigma_i \) will only apply if

\[
P\left(\frac{\alpha(\bar{a} - a_i)}{\sigma_i}\right) > \tilde{P}(\alpha, B)
\]

Kleven and Kopczuk (AEJ Policy, 2011)
$\bar{a}$ (strictness of eligibility criteria)

Individual $a_i, \sigma_i$ will only apply if

\[ P \left( \frac{\alpha(\bar{a} - a_i)}{\sigma_i} \right) > \bar{P}(\alpha, B) \]

- **STRICT**: $\bar{a} < a_L < a_H$ (w/ no noise no one should get it).
  Pr (apply) decrease in precision.

- $a_L < \bar{a} < a_H$ (w/ no noise $a_L$ should get it).
  Pr (apply) increase in precision for $a_L$ and decrease in precision for $a_H$.

- **LENIENT**: $a_L < a_H < \bar{a}$ (w/ no noise everyone should get it).
  Pr (apply) increase in precision.
In summary: tradeoffs between targeting errors

- $\alpha$: screening intensity/transaction costs
- $\alpha \uparrow$ Type 1b & 2 error $\downarrow$ Type 1a error $\uparrow$

Pure ordeal would be: $f(\alpha) + s$

Does not help decrease noise, not useful for targeting here.

- B: program benefit
- B $\uparrow$ Type 2 error $\uparrow$ Type 1a error $\downarrow$
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