# 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

Kleven and Kopczuk (AEJ Policy, 2011)

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.

# 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): $a_i$ $i \in \{L, H\}$ (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. $\mathrm{P}(a_L) > P(a_H)$
- 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)

Alatas et al (JPE, 2016)

# Baseline model

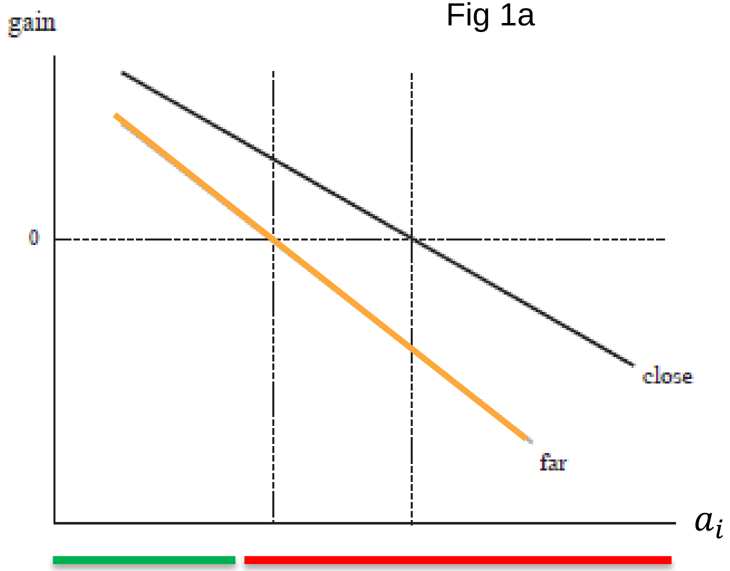
- $\frac{\partial P(.)}{\partial a_i} < 0, \frac{\partial C(L,a_i)}{\partial a_i} > 0$

- 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 $G > 0$

- $\frac{\partial G}{\partial a_i} < 0, \frac{\partial G}{\partial s} < 0,$
- Increasing s decreases threshold type

Fig 1a



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

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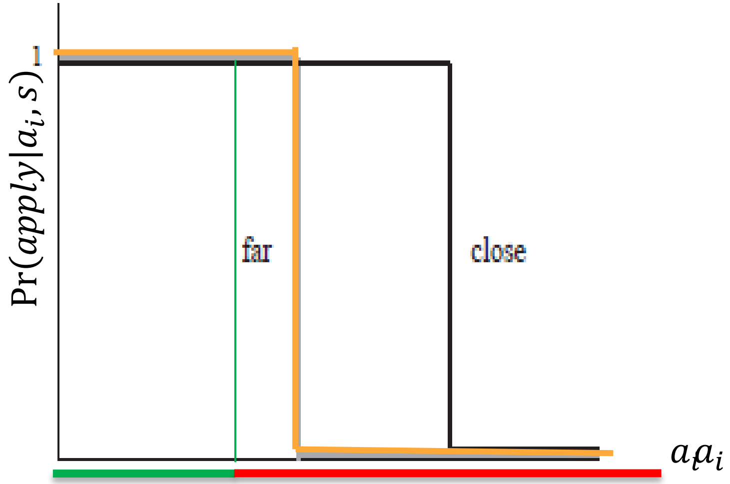
- Not apply: $U(a_i) + \delta U(a_i)$

- 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:

$$\frac{Pr(apply|a_{L:}\ s)}{Pr(apply|a_{H:}\ s)}$$ is increasing in $s$

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



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# 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.

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

- 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

Fig 2a: Log logistic errors
Poor hurt more w/ increasing L

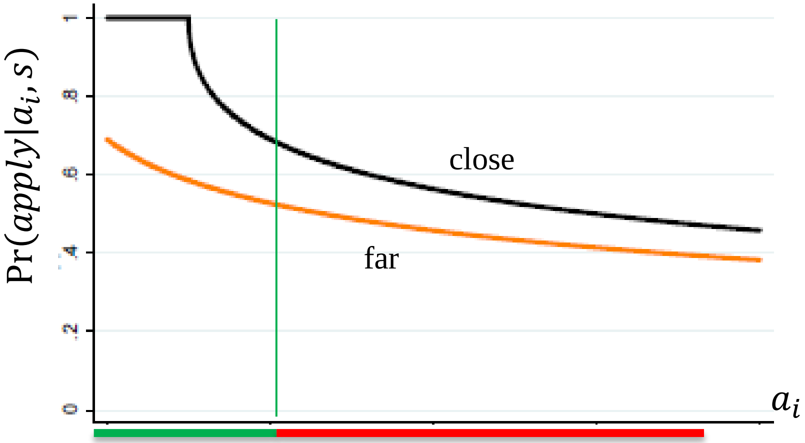
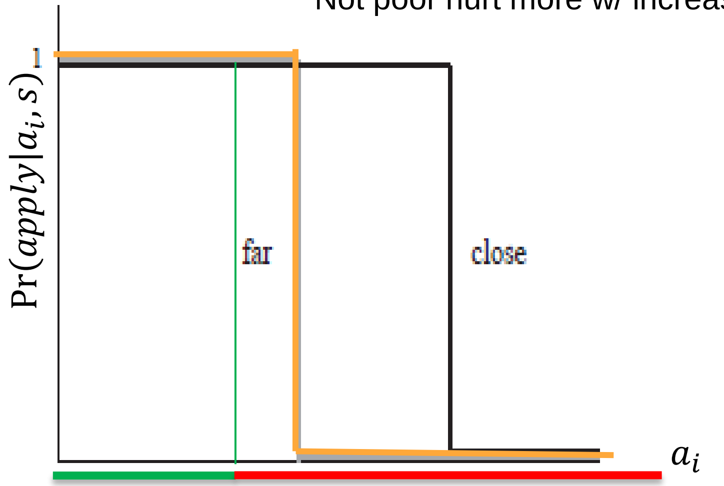



Fig 1b: No errors
Not poor hurt more w/ increasing L



Alatas et al (JPE, 2016)

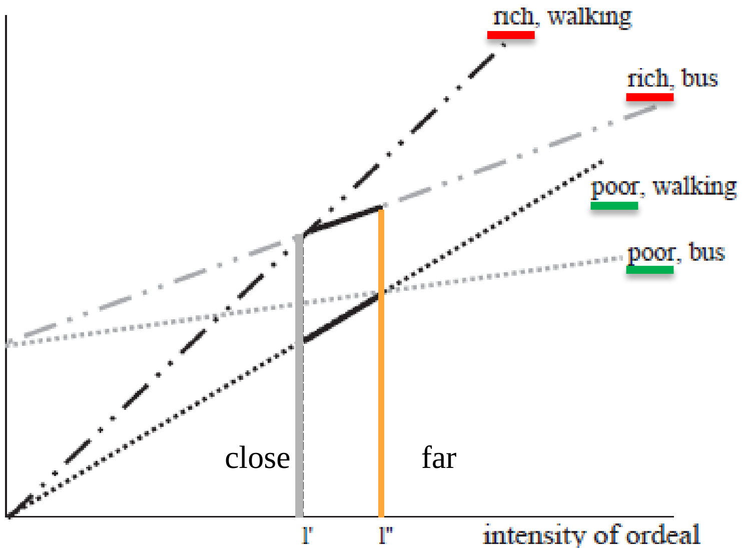
# Extension: Technology to overcome ordeal

- 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: $lsa_i$

  Bussing: $v + ksa_i$
- 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.)

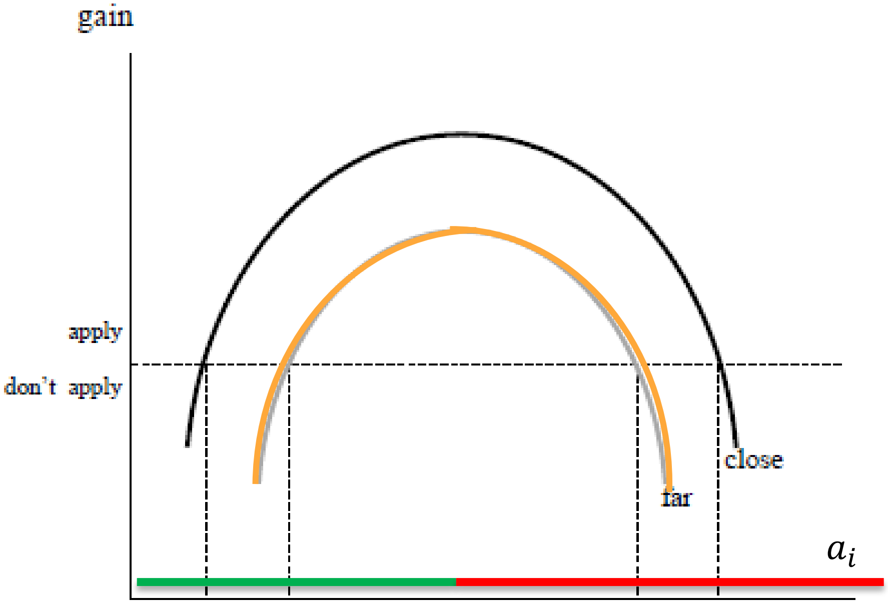


Alatas et al (JPE, 2016)

# Extension: Concave utility

$$U(x) = \ln(x)$$

$$G = ln(a_i - \mathrm{C}(s, a_i)) + \mathrm{P}(a_i)\delta ln(a_i + B)) + (1 - \mathrm{P}(a_i))\delta ln(a_i) - ln(a_i) + \delta ln(a_i)$$



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# PKH self-targeting experiment

| | | 2010 Collect consumption data LNPCE | 2011 PMT and self targeting | Give B (4-13% of income), | substantial under reporting of assets in the initial interview |
|---|---|---|---|---|---|
| | | Total households | % interviewed (applied) | % received benefits \| interview | % (from total) that receive benefits |
| Interviewer come to house | No ordeal | 1998 | 35.3% | 12.18% | 4.3% |
| Go to office to be interviewed | Ordeal | 2000 | 37.7% | 9.7% | 3.7% |

| | |
|---|---|
| **Far**, Self (500) | Close, Self |
| **Far**, **+Spouse** | Close, **+Spouse** |

# Ordeal: who shows up ?

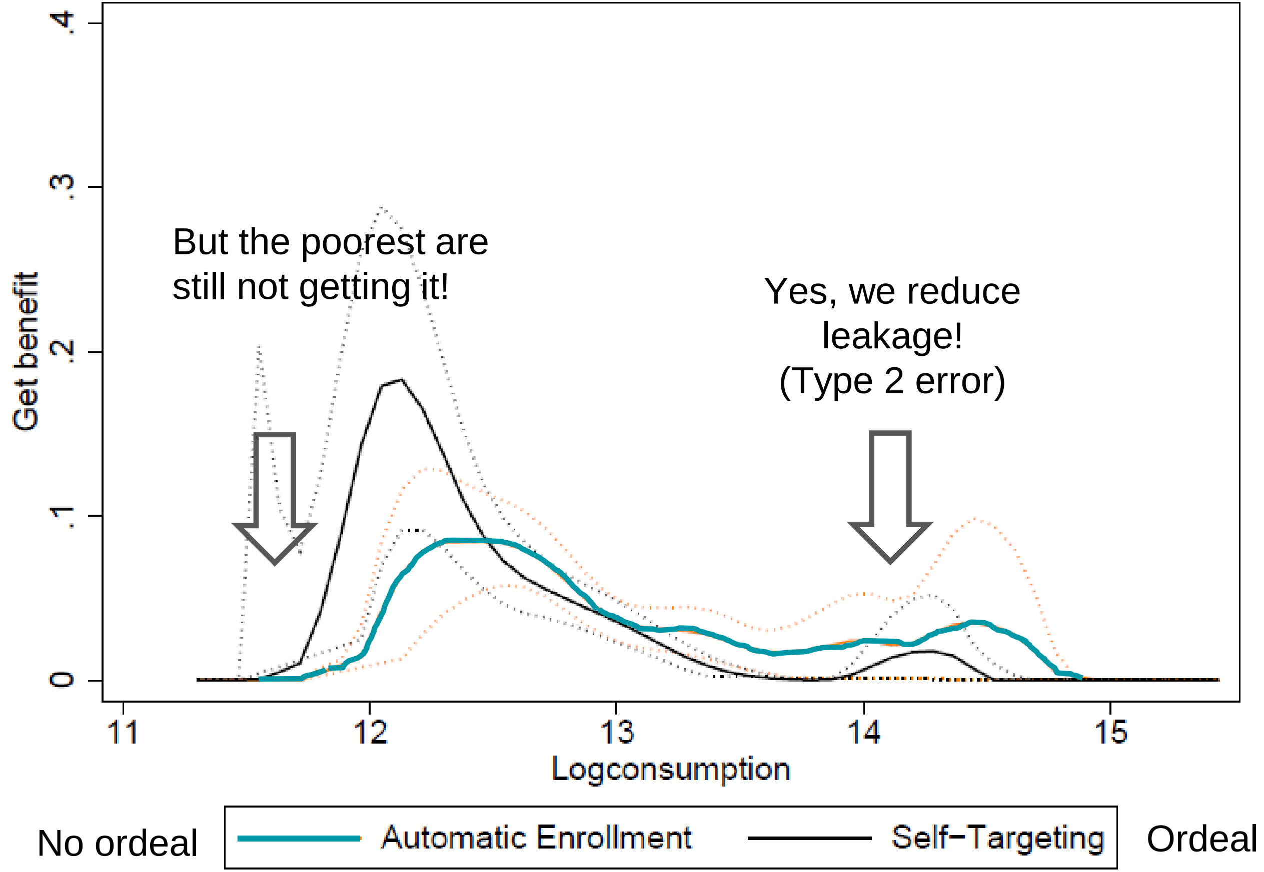
- Regress $LNPCE_i = \alpha_1 + PMT_i\ \beta + \varepsilon_i$
- Regress $ShowUp_i$ against
  $PMT_i\ \beta$ and $\varepsilon_i$

Selection from ordeal consistent with PMT →

…and is likely to improve upon it →

| | $ShowUp_i$ |
|---|---|
| | All |
| | (1) |
| Observable consumption ($X_i'\beta$) | -2.217*** |
| | (0.201) |
| Unobservable consumption ($\varepsilon_i$) | -0.907*** |
| | (0.136) |
| Stratum fixed effects | No |
| Observations | 2,000 |
| Mean of dependent variable | 0.377 |

# Ordeal improves targeting



# Increasing ordeal: +spouse

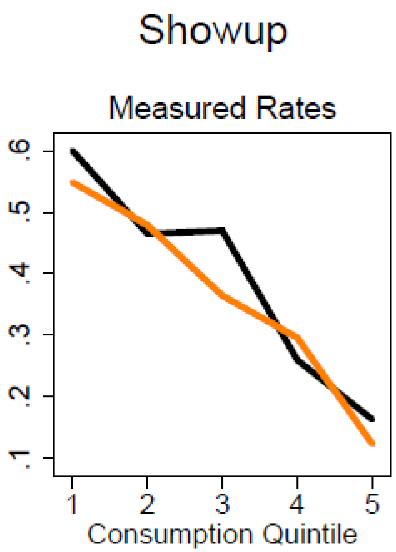
Table 8. Experimental Results: Probability of Showing up as a Function

| | No stratum fixed effects | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| Both spouse subtreatment | 0.196 | 4.303 | 0.461* |
| | (0.146) | (2.840) | (0.237) |
| Log consumption | | -1.324*** | |
| | | (0.145) | |
| Both spouse subtreatment * Log consumption | | -0.318 | |
| | | (0.217) | |

# Increasing ordeal: +distance

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

| | No stratum fixed effects | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| Close subtreatment | 0.205 | 1.345 | 0.195 |
| | (0.146) | (2.841) | (0.238) |
| Log consumption | | -1.434*** | |
| | | (0.143) | |
| Close subtreatment* Log consumption | | -0.093 | |
| | | (0.217) | |




Why? Which of the three theoretical possibilities explains it?

# 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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## TABLE 1. SOCIAL PROGRAMS IN THE UNITED STATES

| PROGRAM | TAKE UP[1] | TARGETING[2] | COMPLEXITY[2] |
|---|---|---|---|
| Medicaid | 73% | Medium | High |
| Medicare Part B[3] | 96% | Low | Low |
| Supplemental Security Income Program (SSI) | 60% | High | High |
| Social Security Disability Insurance (DI) | No estimate | High | High |
| The Earned Income Tax Credit (EITC) | 80%-86% | Medium | High |
| Temporary Assistance for Needy Families (TANF)[4] | 60%-90% | Medium | High |
| Housing Programs | below 50% | Medium | High |
| Food Stamps | 69% | Medium | Medium |
| The Special Supplemental Nutrition Program for Women,Infants and Children (WIC) | 67%, 73%, 38% | High | High |
| Child Care Subsidies | 40% | Medium | High |

Strictness of eligibility criteria

All transaction costs

Moffitt (2003), Currie (2004)

Mkandawire, UN Research Institute for Social Development, 2005

# Incomplete takeup is an issue not just in the US

| Country | Name of programme | Targeting accuracy for poorest quintile | Under-coverage *(percentage of poor not reached)* |
|---|---|---|---|
| Brazil | Bolsa Escola | 1.98 | 73 |
| Chile | PASIS (Pensiones Asistenciales de Ancianidad y de Invalidez) (old-age benefits) | 2.67 | 84 |
| Chile | Subdidio Única Familial (SUF) (cash transfers) | 3.32 | 73 |
| Colombia | Subsidized Health Insurance Regime (SHIR) (health social assistance) | 1.68 | 26 |
| Mexico | Oportunidades | 2.9 | 40 |

# 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 σ (language barriers, health): $\epsilon/\sigma \sim 0,1$ , cdf $P(.)$, $P(0) = 1/2$. Individual knows own σ 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 $B \uparrow$ $u(a_i + B - f(\alpha)) \uparrow$

$$\max_{\alpha, \bar{a}, B} \quad N_L(\alpha, \bar{a}, B)$$

$$s.t$$

$$[N_L(\alpha, \bar{a}, B) + N_H(\alpha, \bar{a}, B)]\, B \leq R$$

# Effect of policy instruments on i's decision to apply

- Get benefit when $a_i + \frac{\epsilon}{\alpha} < \bar{a}$ so $\Pr(B|apply) = \Pr(\epsilon < \frac{\alpha(\bar{a}-a_i)}{\sigma i}) = \mathrm{P}(\frac{\boldsymbol{\alpha}(\bar{\boldsymbol{a}}-a_i)}{\sigma_i})$
- Apply when

$$\mathrm{P}(\frac{\alpha(\bar{a}-a_i)}{\sigma_i})\, u(a_i + B - f(\alpha)) + (1 - P(\frac{\alpha(\bar{a}-a)}{\sigma_i})\, u\big(a_i - f(\alpha)\big) > u(a_i)$$

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

$$\tilde{P}(\boldsymbol{\alpha}, \boldsymbol{B}) \equiv \frac{u(a_i) - u\big(a_i - f(\alpha)\big)}{u\big(a_i + B - f(\alpha)\big) - u\big(a_i - f(\alpha)\big)})$$

- Individual $a_i$,$\sigma_i$ will only apply if

$$\mathrm{P}(\frac{\alpha(\bar{a}-a_i)}{\sigma_i}) > \tilde{\mathrm{P}}(\alpha, \mathrm{B})$$

# $\bar{a}$ (strictness of eligibility criteria)

Individual $a_i$,$\sigma_i$ will only apply if

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

- 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
- $\alpha$ ↑ Type 1b & 2 error ↓ Type 1a error ↑

Pure ordeal would be: $f(\alpha)$ + s
Does not help decrease noise, not useful for targeting here.

- B :program benefit
- B↑ Type 2 error ↑ Type 1a error ↓

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