Reconciling Seemingly Contradictory Results from the Oregon Health Insurance Experiment and the Massachusetts Health Reform

Amanda E. Kowalski

Gail Wilensky Professor of Applied Economics and Public Policy
Department of Economics, University of Michigan

January 2019

“How to Examine External Validity Within an Experiment.” *NBER WP 24834.*

“Behavior within a Clinical Trial and Implications for Mammography Guidelines” *NBER WP 25049.*

“Extrapolation using Selection and Moral Hazard Heterogeneity from within the Oregon Health Insurance Experiment.” *NBER WP 24647.*
Reconciling Seemingly Contradictory Results from Oregon and Massachusetts

1. I find selection and treatment effect heterogeneity within Oregon
2. I use it to reconcile Oregon and Massachusetts LATEs
3. I show that self-reported health & previous ER utilization explain heterogeneity and reconciliation
$U_D$: unobserved net cost of treatment

$p_C = 0.15$, $p_I = 0.41$
Number of ER Visits

Always Takers
$p_C = 0.15$

Compliers
$p_I = 0.41$

Never Takers

$U_D$: unobserved net cost of treatment

$Z = 0$

$D = 1$

$D = 0$

$Z = 1$

$D = 1$

$D = 0$
$U_D$: unobserved net cost of treatment
Number of ER Visits

Always Takers \[ p_C = 0.15 \] | Compliers \[ p_I = 0.41 \] | Never Takers

\[ U_D: \text{ unobserved net cost of treatment} \]
Number of ER Visits

Always Takers | Compliers | Never Takers

$p_C = 0.15$ | $p_I = 0.41$

$U_D$: unobserved net cost of treatment
\[ U_D: \text{unobserved net cost of treatment} \]
Number of ER Visits

- Treated outcome test statistic: $= 0.44$
- LATE: $= 0.26$
- Untreated outcome test statistic: $= 0.34$

- Always Takers: $p_C = 0.15$
- Compliers: $p_I = 0.41$
- Never Takers: $U_D$: unobserved net cost of treatment
$U_D$: unobserved net cost of treatment
Reconciling Seemingly Contradictory Results from Oregon and Massachusetts

1. I find selection and treatment effect heterogeneity within Oregon

2. I use it to reconcile Oregon and Massachusetts LATEs

3. I show that self-reported health & previous ER utilization explain heterogeneity and reconciliation
log premium

$AC(I)$

$p_{+, pre} = 8.7$

$p_{+, post} = 8.4$

$AC_{+, pre} = 8.6$

$AC_{+, post} = 8.5$

$D(I, 0)$

$D(I, \pi)$

$p_{C} = 0.70$

$p_{T} = 0.97$

$U_D$: unobserved net cost of treatment

$I$: fraction insured

14 of 21
$U_D$: unobserved net cost of treatment
Reconciling Seemingly Contradictory Results from Oregon and Massachusetts

1. I find selection and treatment effect heterogeneity within Oregon
2. I use it to reconcile Oregon and Massachusetts LATEs
3. I show that self-reported health & previous ER utilization explain heterogeneity and reconciliation
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<tr>
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<tr>
<td>Fair or Poor Health, Untreated(^a)</td>
<td>0.19</td>
<td>-</td>
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<td>Common Observables</td>
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The graph illustrates the relationship between the number of Emergency Room (ER) visits and the treatment effect, categorized by the number of ER visits in the pre-period:

- **Always Takers**
  - 0 pre-period ER visits
  - MTE(p)

- **Compliers**
  - 1 pre-period ER visit
  - 2-3 pre-period ER visits
  - MTE(x, p): pre-period ER visits

- **Never Takers**
  - ≥ 4 pre-period ER visits

The unobserved net cost of treatment, \( U_D \), is represented by the parameter values:

- \( p_C = 0.15 \)
- \( p_I = 0.41 \)
$U_D$: unobserved net cost of treatment
Reconciling Seemingly Contradictory Results from Oregon and Massachusetts

1. I find selection and treatment effect heterogeneity within Oregon
2. I use it to reconcile Oregon and Massachusetts LATEs
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Appendix
Reconciling Seemingly Contradictory Results from Oregon and Massachusetts

1. Findings

– Selection & treatment effect heterogeneity within Oregon
  ▪ Selection heterogeneity
  ▪ Treatment effect heterogeneity under an ancillary assumption

– Reconciling Oregon and Massachusetts LATEs
  ▪ Massachusetts MTE(p) also slopes downward
  ▪ MTE-reweighting from Oregon to Massachusetts can reconcile LATEs

– Self-reported health & previous ER utilization explain heterogeneity and reconciliation
  ▪ Reconciling LATEs using self-reported health
  ▪ Previous ER utilization explains heterogeneity within Oregon
  ▪ LATE-reweighting with common observables cannot reconcile LATEs
  ▪ MTE-reweighting with common observables can reconcile LATEs
## Number of ER Visits for Always Takers, Compliers and Never Takers

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Untreated Outcome Test</th>
<th>Treated Outcome Test</th>
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<tbody>
<tr>
<td></td>
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<td>(2)</td>
<td>(3)</td>
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<tr>
<td>Always Takers</td>
<td></td>
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<tr>
<td>Takers</td>
<td>1.89</td>
<td>1.45</td>
<td>0.55</td>
</tr>
<tr>
<td></td>
<td>(0.08)</td>
<td>(0.11)</td>
<td>(0.45)</td>
</tr>
<tr>
<td>Compliers</td>
<td>1.35</td>
<td>1.19</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>(0.17)</td>
<td>(0.11)</td>
<td>(0.03)</td>
</tr>
<tr>
<td>Never Takers</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>0.54</td>
<td>0.27</td>
<td>-0.29</td>
</tr>
<tr>
<td></td>
<td>(0.19)</td>
<td>(0.15)</td>
<td>(0.45)</td>
</tr>
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</table>

**Number of ER Visits**

- **Treated**: 1.89 (0.08), 1.45 (0.11), 0.55 (0.45), 0.44 (0.17)
- **Untreated**: 1.35 (0.17), 1.19 (0.11), 0.85 (0.03), 0.34 (0.13)
- **Treatment Effect (Treated - Untreated)**: 0.54 (0.19), 0.27 (0.15), -0.29 (0.45)
$U_D$: unobserved net cost of treatment
\[ Z = 0 \quad \text{D}=1 \quad 0 \leq U_D \leq p_c \]

\[ 0.00 \quad p_c = 0.15 \quad 1.00 \]

**Always Takers**

\[ U_D: \text{unobserved net cost of treatment} \]
$Z = 0$ | $D=1$ | $D=0$

$0 \leq U_D \leq p_c$

$p_c < U_D \leq 1$

$0.00 \quad p_c = 0.15 \quad 1.00$

Always Takers

$U_D$: unobserved net cost of treatment
$Z = 1$

- $D = 1$
  - $p_I < U_D \leq 1$

$Z = 0$

- $D = 1$
  - $0 \leq U_D \leq p_c$

- $D = 0$
  - $p_c < U_D \leq 1$

$p_c = 0.15$

$p_I = 0.41$

- **Always Takers**
- **Never Takers**

$U_D$: unobserved net cost of treatment
$Z = 1$  \hspace{1cm} D=1 \hspace{1cm} 0 \leq U_D \leq p_I \hspace{1cm} D=0 \hspace{1cm} p_I < U_D \leq 1$

$Z = 0$  \hspace{1cm} D=1 \hspace{1cm} 0 \leq U_D \leq p_c \hspace{1cm} D=0 \hspace{1cm} p_c < U_D \leq 1$

$U_D$: unobserved net cost of treatment
$Z = 1$  

$D = 1$:  

$0 \leq U_D \leq p_I$

$D = 0$:  

$p_I < U_D \leq 1$

$Z = 0$  

$D = 1$:  

$0 \leq U_D \leq p_C$

$D = 0$:  

$p_C < U_D \leq 1$

$p_c = 0.15$  

$p_I = 0.41$

Always Takers  

Compliers  

Never Takers

$U_D$: unobserved net cost of treatment
First Stage:

\[ V = V_U + (V_T - V_U) D \]
\[ V_T - V_U = \mu_D(Z) - \nu_D \]
First Stage:

\[ V = V_U + (V_T - V_U)D \]
\[ V_T - V_U = \mu_D(Z) - \nu_D \]

Assumptions:

**A.1.** (Continuity) \( F(\cdot) \): absolutely continuous with respect to the Lebesgue measure
First Stage:

\[ V = V_U + (V_T - V_U)D \]
\[ V_T - V_U = \mu_D(Z) - \nu_D \]

\[ U_D = F(\nu_D), \; U_D \sim U[0, 1] \]

Assumptions:

A.1. (Continuity) \( F(\cdot) \): absolutely continuous with respect to the Lebesgue measure

Proof: \( U_D \sim U[0, 1] \)

\[
F_{U_D}(u) = P(U_D \leq u) \\
= P(F(\nu_D) \leq u) \\
= P(\nu_D \leq F^{-1}(u)) \quad (F(\cdot) \text{ absolutely continuous by A.1}) \\
= F(F^{-1}(u)) = u
\]
First Stage:

\[ V = V_U + (V_T - V_U)D \]
\[ V_T - V_U = \mu_D(Z) - \nu_D \]

\[ U_D = F(\nu_D), \ U_D \sim U[0, 1] \]

Assumptions:

A.1. (Continuity) \( F(\cdot) \): absolutely continuous with respect to the Lebesgue measure

A.2. (Independence) \( (U_D, \gamma_T) \) and \( (U_D, \gamma_U) \perp Z \)
First Stage:

\[ V = V_U + (V_T - V_U)D \]
\[ V_T - V_U = \mu_D(Z) - \nu_D \]
\[ D = 1\{0 \leq V_T - V_U\} \]
\[ \Rightarrow D = 1\{U_D \leq P(D = 1 \mid Z = z)\} \]

\[ U_D = F(\nu_D), \ U_D \sim U[0, 1] \]

Assumptions:

A.1. (Continuity) \( F(\cdot) \): absolutely continuous with respect to the Lebesgue measure

A.2. (Independence) \( U_D, \gamma_T \) and \( U_D, \gamma_U \perp Z \)

Proof: \( D = 1\{U_D \leq P(D = 1 \mid Z = z)\} \)

\begin{align*}
D &= 1\{0 \leq V_T - V_U\} \\
&= 1\{0 \leq \mu_D(Z) - \nu_D\} \\
&= 1\{\nu_D \leq \mu_D(Z)\} \\
&= 1\{F(\nu_D) \leq F(\mu_D(Z))\} \quad \text{(definition of } F(\cdot) \text{ from A.1)} \\
&= 1\{U_D \leq F(\mu_D(Z))\} \quad \text{\((U_D = F(\nu_D) \text{ by definition})\)} \\
&= 1\{U_D \leq P(D = 1 \mid Z = z)\},
\end{align*}

where the last equality follows from

\begin{align*}
F(\mu_D(Z)) &= P(\nu_D \leq \mu_D(Z)) \\
&= P(\nu_D \leq \mu_D(z) \mid Z = z) \quad \text{\((U_D \perp Z \text{ by A.2})\)} \\
&= P(0 \leq \mu_D(Z) - \nu_D \mid Z = z) \\
&= P(0 \leq V_T - V_U \mid Z = z) \\
&= P(D = 1 \mid Z = z).
\end{align*}
First Stage:

\[ V = V_U + (V_T - V_U)D \]
\[ V_T - V_U = \mu_D(Z) - \nu_D \]
\[ D = 1 \{ 0 \leq V_T - V_U \} \]
\[ \Rightarrow D = 1 \{ U_D \leq P(D = 1 | Z = z) \} \]

\[ U_D = F(\nu_D), \; U_D \sim U[0, 1] \]

Assumptions:

A.1. (Continuity) \( F(\cdot) \): absolutely continuous with respect to the Lebesgue measure

A.2. (Independence) \( (U_D, \gamma_T) \) and \( (U_D, \gamma_U) \perp Z \)

A.3. (Instrument Relevance) \( \mu_D(Z) \): nondegenerate random variable
First Stage:

\[ V = V_U + (V_T - V_U)D \]

\[ V_T - V_U = \mu_D(Z) - \nu_D \]

\[ D = 1\{0 \leq V_T - V_U\} \]

\[ \Rightarrow D = 1\{U_D \leq P(D = 1 \mid Z = z)\} \]

\[ Z = 0: \quad D = 1\{U_D \leq p_C\}, \quad p_C = P(D = 1 \mid Z = 0) \]

\[ Z = 1: \quad D = 1\{U_D \leq p_I\}, \quad p_I = P(D = 1 \mid Z = 1) \]

Assumptions:

A.1. (Continuity) \( F(\cdot) \): absolutely continuous with respect to the Lebesgue measure

A.2. (Independence) \((U_D, \gamma_T)\) and \((U_D, \gamma_U) \perp Z\)

A.3. (Instrument Relevance) \(\mu_D(Z)\): nondegenerate random variable
First Stage:

\[ V = V_U + (V_T - V_U)D \]
\[ V_T - V_U = \mu_D(Z) - \nu_D \]
\[ D = I\{0 \leq V_T - V_U\} \]
\[ \Rightarrow D = I\{U_D \leq P(D = 1 | Z = z)\} \]
\[ Z = 0: \quad D = I\{U_D \leq p_C\}, \quad p_C = P(D = 1 | Z = 0) \]
\[ Z = 1: \quad D = I\{U_D \leq p_I\}, \quad p_I = P(D = 1 | Z = 1) \]

\[ U_D = F(\nu_D), \quad U_D \sim U[0, 1] \]

\( U_D: \) unobserved net cost of treatment
First Stage:

\[ V = V_U + (V_T - V_U)D \]
\[ V_T - V_U = \mu_D(Z) - \nu_D \]
\[ D = 1 \{ 0 \leq V_T - V_U \} \]
\[ \Rightarrow D = 1 \{ U_D \leq P(D = 1 \mid Z = z) \} \]
\[ Z = 0 : \quad D = 1 \{ U_D \leq p_C \}, \quad p_C = P(D = 1 \mid Z = 0) \]
\[ Z = 1 : \quad D = 1 \{ U_D \leq p_I \}, \quad p_I = P(D = 1 \mid Z = 1) \]

\[ U_D = F(\nu_D), \quad U_D \sim U[0, 1] \]

<table>
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<tr>
<th>$Z = 0$</th>
<th>$D = 1$</th>
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<tbody>
<tr>
<td>$0 \leq U_D \leq p_C$</td>
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$p_c = 0.15$

Always Takers

$U_D$: unobserved net cost of treatment
First Stage:

\[ V = V_U + (V_T - V_U)D \]
\[ V_T - V_U = \mu_D(Z) - \nu_D \]
\[ D = 1 \{ 0 \leq V_T - V_U \} \]
\[ \Rightarrow D = 1 \{ U_D \leq P(D = 1 \mid Z = z) \} \]

\[ Z = 0: \quad D = 1 \{ U_D \leq p_c \}, \quad p_c = P(D = 1 \mid Z = 0) \]
\[ Z = 1: \quad D = 1 \{ U_D \leq p_I \}, \quad p_I = P(D = 1 \mid Z = 1) \]

\[ U_D = F(\nu_D), \quad U_D \sim U[0, 1] \]

**Diagram:**

- **Z = 0**
  - D = 1
  - \( 0 \leq U_D \leq p_c \)
  - \( p_c < U_D \leq 1 \)

- **Z = 1**
  - D = 1
  - \( 0 \leq U_D \leq p_c \)
  - \( p_c < U_D \leq 1 \)

- **Always Takers**
  - \( p_c = 0.15 \)

\( U_D \): unobserved net cost of treatment
First Stage:

\[ V = V_U + (V_T - V_U)D \]
\[ V_T - V_U = \mu_D(Z) - \nu_D \]
\[ D = 1\{0 \leq V_T - V_U\} \]
\[ \Rightarrow D = 1\{U_D \leq P(D = 1 \mid Z = z)\} \]
\[ Z = 0: \quad D = 1\{U_D \leq p_C\}, \quad p_C = P(D = 1 \mid Z = 0) \]
\[ Z = 1: \quad D = 1\{U_D \leq p_I\}, \quad p_I = P(D = 1 \mid Z = 1) \]

\[ U_D = F(\nu_D), \quad U_D \sim U[0, 1] \]

\[ 0.00 \quad p_c = 0.15 \quad p_I = 0.41 \quad 1.00 \]

Always
Takers

Never
Takers

\[ U_D: \text{unobserved net cost of treatment} \]
First Stage:

\[ V = V_U + (V_T - V_U)D \]
\[ V_T - V_U = \mu_D(Z) - \nu_D \]
\[ D = 1 \{ 0 \leq V_T - V_U \} \]
\[ \Rightarrow D = 1 \{ U_D \leq P(D = 1 | Z = z) \} \]

\[ Z = 0 : \quad D = 1 \{ U_D \leq p_C \}, \quad p_C = P(D = 1 | Z = 0) \]
\[ Z = 1 : \quad D = 1 \{ U_D \leq p_I \}, \quad p_I = P(D = 1 | Z = 1) \]

\[ U_D = F(\nu_D), \quad U_D \sim U[0, 1] \]

\[ Z = 1 \quad D=1 \quad D=0 \quad \]
\[ 0 \leq U_D \leq p_I \quad p_I < U_D \leq 1 \]

\[ Z = 0 \quad D=1 \quad D=0 \]
\[ 0 \leq U_D \leq p_C \quad p_C < U_D \leq 1 \]

\[ 0.00 \quad p_C = 0.15 \quad p_I = 0.41 \quad 1.00 \]

Always Takers
Never Takers

\[ U_D : \text{unobserved net cost of treatment} \]
First Stage:

\[ V = V_U + (V_T - V_U)D \]
\[ V_T - V_U = \mu_D(Z) - \nu_D \]
\[ D = 1\{0 \leq V_T - V_U\} \]

\[ \Rightarrow D = 1\{U_D \leq P(D = 1 | Z = z)\} \]

\[ Z = 0: \quad D = 1\{U_D \leq p_C\}, \quad p_C = P(D = 1 | Z = 0) \]
\[ Z = 1: \quad D = 1\{U_D \leq p_I\}, \quad p_I = P(D = 1 | Z = 1) \]

\[ U_D = F(\nu_D), \quad U_D \sim U[0, 1] \]

\[
\begin{align*}
Z = 1 & \quad \text{D=1} & \quad \text{D=0} \\
\quad \text{0} \leq U_D \leq p_I & & \quad p_I < U_D \leq 1 \\
Z = 0 & \quad \text{D=1} & \quad \text{D=0} \\
\quad \text{0} \leq U_D \leq p_C & & \quad p_C < U_D \leq 1 \\
\end{align*}
\]

\begin{align*}
0.00 & \quad p_c = 0.15 & \quad p_I = 0.41 & \quad 1.00 \\
\text{Always} & \quad \text{Compliers} & \quad \text{Never} & \quad \text{Takers} \\
\text{Takers} & & & \\
\end{align*}

\[ U_D: \text{unobserved net cost of treatment} \]
First Stage:

\[ V = V_U + (V_T - V_U)D \]
\[ V_T - V_U = \mu_D(Z) - \nu_D \]
\[ D = 1\{0 \leq V_T - V_U\} \]
\[ \Rightarrow D = 1\{U_D \leq P(D = 1 | Z = z)\} \]
\[ Z = 0: \quad D = 1\{U_D \leq p_C\}, \quad p_C = P(D = 1 | Z = 0) \]
\[ Z = 1: \quad D = 1\{U_D \leq p_I\}, \quad p_I = P(D = 1 | Z = 1) \]

\[ U_D = F(\nu_D), \quad U_D \sim U[0, 1] \]

Second Stage:

\[ Y = Y_U + (Y_T - Y_U)D \]
\[ Y_T = g_T(U_D, \gamma_T) \]
\[ Y_U = g_U(U_D, \gamma_U) \]

Assumptions (Second Stage):

A.4. (Treated and Untreated) \(0 < P(D = 1) < 1\)

A.5. (Finite Average Outcomes) \(E[Y_T], E[Y_U]\) are finite
First Stage:

\[ V = V_U + (V_T - V_U)D \]
\[ V_T - V_U = \mu_D(Z) - \nu_D \]
\[ D = 1 \{ 0 \leq V_T - V_U \} \]
\[ \Rightarrow D = 1 \{ U_D \leq P(D = 1 \mid Z = z) \} \]
\[ Z = 0 : \quad D = 1 \{ U_D \leq p_C \}, \quad p_C = P(D = 1 \mid Z = 0) \]
\[ Z = 1 : \quad D = 1 \{ U_D \leq p_I \}, \quad p_I = P(D = 1 \mid Z = 1) \]

\[ U_D = F(\nu_D), \ U_D \sim U[0, 1] \]

Second Stage:

\[ Y = Y_U + (Y_T - Y_U)D \]
\[ Y_T = g_T(U_D, \gamma_T) \]
\[ Y_U = g_U(U_D, \gamma_U) \]

\[ Z \perp (\gamma_T, \gamma_U) \text{ by A.2.} \]

<table>
<thead>
<tr>
<th></th>
<th>Always Takers</th>
<th>Compliers</th>
<th>Never Takers</th>
</tr>
</thead>
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<tr>
<td></td>
<td>( p_C = 0.13 )</td>
<td>( p_I = 0.41 )</td>
<td>1</td>
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</tbody>
</table>

\( U_D \): unobserved net cost of treatment
Selection and Treatment Effect Heterogeneity

Selection + Treatment Effect Heterogeneity:

\[ \text{MTO}(x, p) = \mathbb{E}[Y_T \mid X = x, U_D = p] \]

Selection Heterogeneity:

\[ \text{MUO}(x, p) = \mathbb{E}[Y_U \mid X = x, U_D = p] \]

Treatment Effect Heterogeneity:

\[ \text{MTE}(x, p) = \mathbb{E}[Y_T - Y_U \mid X = x, U_D = p] \]

Selection Heterogeneity from Literature:

\[ \mathbb{E}[Y_U \mid D = 1] - \mathbb{E}[Y_U \mid D = 0] \]

Treatment Effect Heterogeneity from Literature:

\[ \mathbb{E}[Y_T - Y_U \mid D = 1] - \mathbb{E}[Y_T - Y_U \mid D = 0] \]
Identifying Selection and Moral Hazard Heterogeneity

Untreated Outcome Test

\[ E[Y_U \mid p_C < U_D \leq p_I] - E[Y_U \mid p_I < U_D \leq 1] = \int_0^1 (\omega(p, p_C, p_I) - \omega(p, p_I, 1)) \text{MUO}(p) \, dp \]

Treated Outcome Test

\[ E[Y_T \mid 0 \leq U_D \leq p_C] - E[Y_T \mid p_C < U_D \leq p_I] = \int_0^1 (\omega(p, 0, p_C) - \omega(p, p_C, p_I)) \text{MTO}(p) \, dp \]

with weights \( \omega(p, p_L, p_H) = \frac{1}{(p_H - p_L)} \{p_L \leq p < p_H\} \)
First Stage:

\[ V = V_U + (V_T - V_U)D \]
\[ V_T - V_U = \mu_D(Z) - \nu_D \]
\[ D = 1\{0 \leq V_T - V_U\} \]
\[ \Rightarrow D = 1\{U_D \leq P(D = 1 \mid Z = z)\} \]

\[ U_D = F(\nu_D), \quad U_D \sim U[0, 1] \]

Second Stage:

\[ Y = Y_U + (Y_T - Y_U)D \]
\[ Y_T = g_T(U_D, \gamma_T) \]
\[ Y_U = g_U(U_D, \gamma_U) \]

\[ Z \perp (\gamma_T, \gamma_U) \text{ by A.2.} \]

Ancillary Assumption:

**AA.1.** (Linear Selection Heterogeneity and Linear Treatment Effect Heterogeneity)

\[ \text{MTO}(p) = E[Y_T \mid U_D = p] = \alpha_T + \beta_T p \]
\[ \text{MUO}(p) = E[Y_U \mid U_D = p] = \alpha_U + \beta_U p \]
\[ \text{MTE}(p) = E[Y_T - Y_U \mid U_D = p] = (\alpha_T - \alpha_U) + (\beta_T - \beta_U) p. \]
MTE-Reweighting from Oregon to Massachusetts Can Reconcile LATEs

Integrate the weighted MTE, MTO and MUO functions over a general range of enrollment margin $p_L < U_D \leq p_H$

\[
E \left[ Y_T \mid p_L < U_D \leq p_H \right] = \int_0^1 \omega(p, p_L, p_H) \text{MTO}(p) \, dp
\]

\[
E \left[ Y_U \mid p_L < U_D \leq p_H \right] = \int_0^1 \omega(p, p_L, p_H) \text{MUO}(p) \, dp
\]

\[
E \left[ Y_T - Y_U \mid p_L < U_D \leq p_H \right] = \int_0^1 \omega(p, p_L, p_H) \text{MTE}(p) \, dp
\]

using weights $\omega(p, p_L, p_H) = 1\{p_L < p \leq p_H\}/(p_H - p_L)$
First Stage:

\[ V = V_U + (V_T - V_U)D \]

\[ V_T - V_U = \mu_D(Z,X) - \nu_D \]

\[ D = 1\{0 \leq V_T - V_U\} \]

\[ \Rightarrow D = 1\{U_D \leq P(D = 1 | Z = z, X)\} \]

\[ Z = 0: \quad D = 1\{U_D \leq p_{CX}\}, \quad p_{CX} = P(D = 1 | Z = 0, X) \]

\[ Z = 1: \quad D = 1\{U_D \leq p_{IX}\}, \quad p_{IX} = P(D = 1 | Z = 1, X) \]

Second Stage with Shape Restriction:

\[ Y = Y_U + (Y_T - Y_U)D \]

\[ Y_T = \delta_T'X + \lambda_T U_D + \xi_T \]

\[ Y_U = \delta_U'X + \lambda_U U_D + \xi_U \]

\[ Z \perp (\gamma_T, \gamma_U) \text{ by A.2.} \]

Ancillary Assumption - Linearity of MTO(x,p), MUO(x,p) in p:

\[ \text{AA.2. MTO}(x,p) = E[Y_T | X = x, U_D = p] = \delta_T'x + \lambda_T p \]

\[ \text{AA.3. MTO}(x,p) = E[Y_T | X = x, U_D = p] = \delta_T'x + \lambda_T p \]

\[ \text{MTO}(x,p) = E[Y_T - Y_U | X = x, U_D = p] = (\delta_T' - \delta_U')x + (\lambda_T - \lambda_U)p \]
# Subgroup Analysis of Common Observables with LATE and MTE(\(p\))

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<td>(P)</td>
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## Subgroup Analysis of Common Observables with LATE and MTE(\(p\))

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Reconciling Seemingly Contradictory Results from Oregon and Massachusetts

• Build on selection/moral hazard in insurance

• Build on MTE and LATE
  – Bjorklund and Moffitt (1987)
  – Imbens and Angrist (1994)
  – Vytlacil (2002)
  – Brinch, Mogstad, Wiswall (2015)