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

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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
Number of ER Visits

<table>
<thead>
<tr>
<th>Always Takers</th>
<th>Compliers</th>
<th>Never Takers</th>
</tr>
</thead>
<tbody>
<tr>
<td>(p_C = 0.15)</td>
<td>(p_I = 0.41)</td>
<td>(U_D: \text{unobserved net cost of treatment})</td>
</tr>
</tbody>
</table>

\(Z = 0\) \[\begin{array}{c|c|c|c}
\hline
&D=1&\text{D}=0&\\
\hline
Z = 1&\text{D}=1&\text{D}=0&\\
\hline
\end{array}\)
$U_D$: unobserved net cost of treatment
$U_D$: unobserved net cost of treatment

$p_C = 0.15 \quad p_I = 0.41$
Number of ER Visits

Always Takers | Compliers | Never Takers

$p_C = 0.15$ | $p_I = 0.41$ | $U_D$: unobserved net cost of treatment
Number of ER Visits

- treated
- untreated

LATE = 0.26
untreated outcome test statistic = 0.34

$p_C = 0.15$
$p_I = 0.41$

$U_D$: 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: 1

$U_D$: unobserved net cost of treatment
<table>
<thead>
<tr>
<th></th>
<th>Intercept</th>
<th>S.E.</th>
<th>Slope</th>
<th>S.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTO(p)</td>
<td>2.05</td>
<td>0.14</td>
<td>-2.12</td>
<td>0.82</td>
</tr>
<tr>
<td>MUC(p)</td>
<td>1.41</td>
<td>0.19</td>
<td>-0.80</td>
<td>0.31</td>
</tr>
<tr>
<td>MTE(p)</td>
<td>0.64</td>
<td>0.24</td>
<td>-1.32</td>
<td>0.88</td>
</tr>
</tbody>
</table>

Number of ER Visits

Always Takers  | Compliers  | Never Takers |
0              | $p_C = 0.15$ | $p_I = 0.41$ |

$p^* = 0.48$

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

$I$: fraction insured
$U_D$: 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
<table>
<thead>
<tr>
<th>Oregon Health Insurance Experiment of 2008</th>
<th>Means</th>
<th>Difference in Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td></td>
<td>All</td>
<td>Always Takers</td>
</tr>
<tr>
<td>Fair or Poor Health, Untreated*</td>
<td>0.42</td>
<td>-</td>
</tr>
<tr>
<td>Number of Pre-period ER Visits</td>
<td>0.87</td>
<td>1.36</td>
</tr>
<tr>
<td>Common Observables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>40.69</td>
<td>39.45</td>
</tr>
<tr>
<td>Female</td>
<td>0.56</td>
<td>0.72</td>
</tr>
<tr>
<td>English</td>
<td>0.91</td>
<td>0.90</td>
</tr>
<tr>
<td>N</td>
<td>19,643</td>
<td>2,986</td>
</tr>
</tbody>
</table>

| Massachusetts Health Reform of 2006      |       |         |         |             |           |            |
|                                          | (1)   | (2)     | (3)    | (1) - (2) | (2) - (3) |
|                                          | All   | Always Takers | Compliers | Never Takers |            |            |
| Fair or Poor Health, Untreated*          | 0.19  | -       | 0.21    | 0.18        | -         | 0.03       |
| Common Observables                       |       |         |         |             |           |            |
| Age                                      | 42.00 | 42.15   | 42.42   | 38.98       | -0.26     | 3.43       |
| Female                                   | 0.51  | 0.52    | 0.43    | 0.38        | 0.10      | 0.04       |
| English                                  | 0.96  | 0.98    | 0.86    | 0.81        | 0.12      | 0.05       |
| N                                        | 62,456 | 55,966  | 3,175  | 3,314       |           |            |
The graph illustrates the number of ER visits for different compliance groups under two MTE scenarios: $MTE(p)$ and $MTE(x, p)$.

- **$MTE(p)$** represents the marginal treatment effect for the compliers' compliances ($c$).
- **$MTE(x, p)$** represents the marginal treatment effect for the compliers' compliances ($x$) in the pre-period ER visits.

The graph is labeled with the number of pre-period ER visits:

- **$\geq 4$ pre-period ER visits**
- **2–3 pre-period ER visits**
- **1 pre-period ER visit**
- **0 pre-period ER visits**

The compliance groups are labeled as:

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

The probabilities are given as:

- $p_C = 0.15$
- $p_I = 0.41$

The label $U_D$: unobserved net cost of treatment is placed at the bottom of the graph.
$U_D$: unobserved net cost of treatment
Reconciling Seemingly Contradictory Results from Oregon and Massachusetts

1. I find selection and treatment effect heterogeneity within Oregon

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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>Number of ER Visits</th>
<th>Mean</th>
<th>Untreated Outcome Test</th>
<th>Treated Outcome Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>Always 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>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>Treatment Effect</td>
<td>0.54</td>
<td>0.27</td>
<td>-0.29</td>
</tr>
<tr>
<td>(Treated - Untreated)</td>
<td>(0.19)</td>
<td>(0.15)</td>
<td>(0.45)</td>
</tr>
</tbody>
</table>
$U_D$: unobserved net cost of treatment
$Z = 0 \quad | \quad \textbf{D=1} \quad |$

$0 \leq U_D \leq p_c$

$p_c = 0.15$

$U_D$: unobserved net cost of treatment
Always Takers

$U_D$: unobserved net cost of treatment
Always Takers

Never Takers

$U_D$: unobserved net cost of treatment
$Z = 1$ \\
$D = 1$ \\
$0 \leq U_D \leq p_I$ \\

$D = 0$ \\
$p_I < U_D \leq 1$ \\

$Z = 0$ \\
$D = 1$ \\
$0 \leq U_D \leq p_C$ \\

$D = 0$ \\
$p_C < U_D \leq 1$ \\

$p_C = 0.15$ \\
$p_I = 0.41$ \\

$U_D$: unobserved net cost of treatment

Always Takers \\
Never Takers
\( U_D: \) unobserved net cost of treatment

Always Takers

\( 0 \leq U_D \leq p_I \)

\( p_I < U_D \leq 1 \)

Compliers

\( 0 \leq U_D \leq p_C \)

\( p_C < U_D \leq 1 \)

Never Takers

\( p_C = 0.15 \)

\( p_I = 0.41 \)
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: \( U_D \sim U[0, 1] \)

\[
F_{U_D}(u) = P(U_D \leq u) \\
= P(F(\nu_D) \leq u) \\
= P(\nu_D \leq F^{-1}(u)) \\
= F(F^{-1}(u)) = u
\]

(F(\cdot) absolutely continuous by A.1)
First Stage:

\[ V = V_U + (V_T - V_U)D \]
\[ V_T - V_U = \mu_D(Z) - \nu_D \]
\[ U_D = F(\nu_D), \quad U_D \sim U[0, 1] \]

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) \((U_D, \gamma_I)\) and \((U_D, \gamma_U) \perp Z\)

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

\[ D = 1\{0 \leq V_T - V_U\} \]
\[ = 1\{0 \leq \mu_D(Z) - \nu_D\} \]
\[ = 1\{\nu_D \leq \mu_D(Z)\} \]
\[ = 1\{F(\nu_D) \leq F(\mu_D(Z))\} \] (definition of \( F(\cdot) \) from A.1)
\[ = 1\{U_D \leq F(\mu_D(Z))\} \] (\( U_D = F(\nu_D) \) by definition)
\[ = 1\{U_D \leq P(D = 1 \mid Z = z)\}, \]

where the last equality follows from

\[ F(\mu_D(Z)) = P(\nu_D \leq \mu_D(Z)) \]
\[ = P(\nu_D \leq \mu_D(z) \mid Z = z) \] (\( U_D \perp Z \) by A.2)
\[ = P(0 \leq \mu_D(Z) - \nu_D \mid Z = z) \]
\[ = P(0 \leq V_T - V_U \mid Z = z) \]
\[ = P(D = 1 \mid Z = z). \]
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:

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

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

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

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

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

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

\[ Z = 0 \quad \begin{array}{c}
\text{D=1} \\
0 \leq U_D \leq p_C
\end{array} \]

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

Always Takers

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

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

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

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

---

Diagram:

- \( Z = 0 \)  \( D = 1 \)  \( D = 0 \)
- \( 0 \leq U_D \leq p_c \)
- \( p_c < U_D \leq 1 \)
- \( 0.00 \)  \( p_c = 0.15 \)  \( 1.00 \)

Always Takers

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

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

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

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

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

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

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

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

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

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

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

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

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

\[ \text{Always Takers} \quad \text{Never Takers} \]

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

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

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

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

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

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

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

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

Always Takers

Compliers

Never Takers

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

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

Second Stage:

\[
Y = Y_U + (Y_T - Y_U)D \\
Y_T = g_T(U_D, \gamma_T) \\
Y_U = g_U(U_D, \gamma_U) \\
Z \perp (\gamma_T, \gamma_U) \text{ by A.2.}
\]

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:

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

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

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>Always Takers</th>
<th>Compliers</th>
<th>Never Takers</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>(p_C = 0.13)</td>
<td>(p_I = 0.41)</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

Selection + Treatment Effect Heterogeneity:  \[ MTO(x, p) = E[Y_T \mid X = x, U_D = p] \]
Selection Heterogeneity:  \[ MUO(x, p) = E[Y_U \mid X = x, U_D = p] \]
Treatment Effect Heterogeneity:  \[ MTE(x, p) = E[Y_T - Y_U \mid X = x, U_D = p] \]

Selection Heterogeneity from Literature:  \[ E[Y_U \mid D = 1] - E[Y_U \mid D = 0] \]
Treatment Effect Heterogeneity from Literature:  \[ E[Y_T - Y_U \mid D = 1] - E[Y_T - Y_U \mid D = 0] \]
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 \( \omega(p, p_L, p_H) = 1\{p_L \leq p < p_H\}/(p_H - p_L) \)
First Stage:

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

Second Stage:

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

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

Ancillary Assumption:

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

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

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

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

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

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

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

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

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 \(p\):

AA.2. MTO\((x, p)\) = \(E [Y_T \mid X = x, U_D = p] = \delta'_T x + \lambda_T p\)

AA.3. MTO\((x, p)\) = \(E [Y_T \mid X = x, U_D = p] = \delta'_T x + \lambda_T p\)

MTO\((x, p)\) = \(E [Y_T - Y_U \mid X = x, U_D = p] = (\delta'_T - \delta'_U) x + (\lambda_T - \lambda_U)p\)
Subgroup Analysis of Common Observables with LATE and MTE($p$)

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
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<td></td>
<td>All</td>
<td>≥ median\textsuperscript{a}</td>
<td>&lt; median\textsuperscript{a}</td>
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<tr>
<td></td>
<td>(0.39)</td>
<td>(0.18)</td>
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<td>(0.21)</td>
<td>(0.21)</td>
<td>(0.16)</td>
<td>(0.34)</td>
</tr>
<tr>
<td>$p_C$</td>
<td>0.15</td>
<td>0.13</td>
<td>0.17</td>
<td>0.20</td>
<td>0.10</td>
<td>0.15</td>
<td>0.16</td>
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<tr>
<td></td>
<td>(0.003)</td>
<td>(0.005)</td>
<td>(0.005)</td>
<td>(0.005)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.01)</td>
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<tr>
<td>$p_I$</td>
<td>0.41</td>
<td>0.43</td>
<td>0.39</td>
<td>0.43</td>
<td>0.38</td>
<td>0.41</td>
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<tr>
<td></td>
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<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.02)</td>
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<tr>
<td>MTE intercept</td>
<td>0.64</td>
<td>0.98</td>
<td>0.31</td>
<td>0.48</td>
<td>0.92</td>
<td>0.72</td>
<td>0.14</td>
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<tr>
<td></td>
<td>(0.24)</td>
<td>(0.28)</td>
<td>(0.39)</td>
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<td>(0.33)</td>
<td>(0.25)</td>
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</tr>
<tr>
<td>MTE slope</td>
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<td>-1.06</td>
<td>-2.20</td>
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<tr>
<td></td>
<td>(0.88)</td>
<td>(1.04)</td>
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<td>(1.08)</td>
<td>(1.40)</td>
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<tr>
<td>$p^*$</td>
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<td>0.33</td>
<td>-0.63</td>
<td>0.45</td>
<td>0.42</td>
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<td>9,806</td>
<td>10,932</td>
<td>8,690</td>
<td>17,871</td>
<td>1,751</td>
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</table>
# Subgroup Analysis of Common Observables with LATE and $\text{MTE}(\rho)$

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
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<tbody>
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<td>Age</td>
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<tr>
<td></td>
<td>All</td>
<td>$\geq$ median$^a$</td>
<td>$&lt; \text{median}^a$</td>
<td>Female</td>
<td>Male</td>
<td>English</td>
<td>Non-English</td>
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<tr>
<td><strong>Massachusetts Health Reform of 2006</strong></td>
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<td>0.87</td>
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<td>(0.003)</td>
<td>(0.005)</td>
<td>(0.003)</td>
<td>(0.02)</td>
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<tr>
<td>$p_I$</td>
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<td>0.93</td>
<td>0.96</td>
<td>0.74</td>
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<tr>
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<td><strong>N</strong></td>
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<td>38,808</td>
<td>23,648</td>
<td>59,233</td>
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</table>
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)