Educational Policy and Intergenerational Mobility

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Motivation

- Rank-Rank slope: Correlation between child income ranking and adult income ranking.

- There is a considerable variation in the rank-rank slope across states.

<table>
<thead>
<tr>
<th>State</th>
<th>Rank-Rank</th>
<th>State</th>
<th>Rank-Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>California</td>
<td>0.237</td>
<td>46th</td>
</tr>
<tr>
<td>2nd</td>
<td>Utah</td>
<td>0.244</td>
<td>45th</td>
</tr>
<tr>
<td>3rd</td>
<td>Idaho</td>
<td>0.248</td>
<td>44th</td>
</tr>
<tr>
<td>4th</td>
<td>Wyoming</td>
<td>0.255</td>
<td>43rd</td>
</tr>
<tr>
<td>5th</td>
<td>Nevada</td>
<td>0.263</td>
<td>42nd</td>
</tr>
</tbody>
</table>

Table 1: Top 5/Worst 5 States on Rank-Rank Slope

(Datasource: Chetty et al (2014))
Research Question

- Research Question: What factors generate the variation across states?
Our argument: Variation in public school educational policy and spending can partially account for it.

- Early child investments are critical in improving child’s human capital. (Cunha and Heckman (2007), Caucutt and Lochner (2012))
- Public school spending plays an important role.

We consider three aspects of public school spending across districts.

1. Level.
2. Finance systems.
3. Distribution.

We construct a dynamic model.

Key Ingredients:

1. Child’s human capital formulation. (early vs late)
2. Disutility from inequality.
3. Districts vote over tax rate.
Our model captures the data well.

- Three aspects of public school spending are important to understand the intergenerational mobility.

Counterfactual simulations suggest that

- The distribution of public school spending and educational policy has a large impact on the intergenerational mobility.
- The impact of the level is modest.
Papers on Intergenerational mobility.


Papers on public school spending.

Roadmap

1 Facts
2 Model
3 Calibration
4 Results
5 Conclusion
The List of the Datasources

## Education Expenditure Inequality

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gini Coefficient (×100)</td>
<td>16.3</td>
<td>15.0</td>
<td>13.8</td>
<td>15.8</td>
<td>15.5</td>
<td>13.0</td>
</tr>
<tr>
<td>Theil index (×100)</td>
<td>43.7</td>
<td>37.1</td>
<td>31.0</td>
<td>40.7</td>
<td>40.5</td>
<td>30.6</td>
</tr>
<tr>
<td>Within states</td>
<td>13.7</td>
<td>14.4</td>
<td>14.0</td>
<td>12.6</td>
<td>13.4</td>
<td>9.9</td>
</tr>
<tr>
<td>Between states</td>
<td>33.0</td>
<td>22.8</td>
<td>17.0</td>
<td>28.2</td>
<td>27.1</td>
<td>20.7</td>
</tr>
</tbody>
</table>

Table 2: Education Expenditure Inequality within and between States

(Data source: Murray et al. (1998), Corcoran et al. (2003))
## Level of Public School Spending

Average public school spending per pupil varies across states.

<table>
<thead>
<tr>
<th>State</th>
<th>Level</th>
<th>State</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Jersey</td>
<td>$9,961</td>
<td>Utah</td>
<td>$3,827</td>
</tr>
<tr>
<td>New York</td>
<td>$9,582</td>
<td>Mississippi</td>
<td>$4,205</td>
</tr>
<tr>
<td>Connecticut</td>
<td>$9,159</td>
<td>Idaho</td>
<td>$4,372</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>$7,767</td>
<td>Alabama</td>
<td>$4,673</td>
</tr>
<tr>
<td>Maryland</td>
<td>$7,425</td>
<td>Arkansas</td>
<td>$4,717</td>
</tr>
</tbody>
</table>

Table 3: Top 5/Worst 5 States on Average Public School Spending per Pupil

(Datasource: U.S. Census Bureau)
Public School Finance Systems

Three main systems:

1. Full state funding system. (3 states in 1993-1994)
   - Financed only by statewide taxes.

2. Foundation program. (39 states)
   - Minimum amount of public spending is guaranteed.

3. Equalization program. (6 states)
   - The targeted revenue based on the tax base is guaranteed.
Importance of Level and Educational Policy

- The overall correlation between the rank-rank slope and average public school spending is -0.0128.
- Creating two subgroups improves the correlation.
  - -0.0632 (foundation program)
  - -0.5939 (percent equalization/guaranteed tax base program).

Figure 1: Relation between Public School Spending per Pupil and Rank-Rank Slope

(Datasource: U.S. Census Bureau and Chetty et al (2014))
Distribution of Public School Spending

- Distribution of public school spending varies considerably among states.
  - Example: Colorado and Georgia (Figure 2).
  - # of school districts, level of school spending and educational policy are similar.
  - Rank-Rank slope is different. (0.269 (CO), 0.349 (GA) )

![Graph showing distribution of public school spending per pupil in Colorado and Georgia](image)

Figure 2: Distribution of Public School Spending per Pupil in Colorado and Georgia

(Data source: U.S. Census Bureau)
Model Environment

- Three-period model with voting over tax rate.
  - 1st period: 18 years.
    - School districts decide on their consumption and invest in their children.
  - 2nd & 3rd: 6 years.
    - Children decide on their consumption and human capital.

- Continuum of individuals.

- In a state $s$, there are $n$ districts each indexed by $j$ has income $y_{sj}$.
  - No heterogeneity within a school district.
Human Capital Formation

- 1st period: Depends on public, private resources, and child’s learning ability:

\[ h_{csj2} = a_{csj}x_{sj1}^{\gamma_1}x_{sj}^{\gamma_2}, \]  
(1)

- 2nd & 3rd period: Based on a Ben-Porath type production function:

\[ h_{csj3} = a_{csj}(n_{csj2}h_{csj2})^{\eta_1}x_{sj2}^{\eta_2} + h_{csj2}. \]  
(2)

- Public resources are obtained from an income tax.

- Level of public resources determined by the public school finance system.
Preferences

- School districts’ preferences contain
  - Own consumption. \((u(c_{sj}))\)
  - Child’s utility in the following periods. \((V(a_{csj}, h_{csj}, g_{csj}))\)
    - Depends on their consumption in the two periods.
  - Disutility from inequality. \((d(\frac{\sigma_{h_{csj}}}{\mu_{h_{csj}}}))\)
    - Based upon Alesina and Giuliano (2009).
    - Assume that school district \(j\) cares about the coefficient of variation of child’s human capital.

- Preferences are given by

\[
u(c_{sj}) + \theta V(a_{csj}, h_{csj2}, g_{csj}) - \xi_s d\left(\frac{\sigma_{h_{csj}}}{\mu_{h_{csj2}}}\right),\]

- \(\theta\): Degree of altruism.
Child’s Problem

- Child earns wage, \( w_c \).

\[
w_c = (1 - p_s)w_s + p_s w_{U.S.}
\]

- Solution to \( V(a_{csj}, h_{csj2}, g_{csj}) \) is

\[
V(a_{csj}, h_{csj2}, g_{csj}) = \max_{c_{csj2}, c_{csj3}, n_{csj2}, x_{sj2}} u(c_{csj2}) + \beta u(c_{csj3})
\]

subject to

\[
c_{csj2} + \frac{c_{csj3}}{1+r} + x_{sj2} = w_c h_{csj2} (1 - n_{csj2}) + \frac{w_c h_{csj3}}{1+r} + g_{csj},
\]

and (2).
Public school spending is financed by a statewide income tax. \( (\bar{x}_{sj} = \bar{x}_{sj} = \bar{x}) \) Thus,

\[
\bar{x}_s = \tau_s \mu_s = \tau_s \frac{1}{n} \sum_{j=1}^{n} y_{sj}.
\]

(3)

School district’s utility maximization problem is

\[
\max_{c_{sj1}, x_{sj1}, g_{csj}, \tau_s} u(c_{sj}) + \theta V(a_{csj}, h_{csj2}, g_{csj}) - \xi_s d\left(\frac{\sigma h_{csj2}}{\mu h_{csj2}}\right),
\]

subject to

\[
c_{sj} + x_{sj1} + g_{csj} = (1 - \tau_s) y_{sj},
\]

(1) and (3).
We assume that $\tau_s$ is determined by majority voting.

- Computation: Individual preference are single peaked in $\tau_s$.
- The equilibrium income tax rate $\tau_{sm}$ must satisfy

$$\int I_{\{\tau_{sj} \geq \tau_{sm}\}} dF(y_{sj}) \geq \frac{1}{2},$$

$$\int I_{\{\tau_{sj} \leq \tau_{sm}\}} dF(y_{sj}) \geq \frac{1}{2}.$$
Minimum level of public spending funded by statewide tax, \( \tau_s \), is guaranteed.

School districts can spend more by imposing local tax \( \tau_l \).

The equation for \( \bar{x}_{sj} \) is

\[
\bar{x}_{sj} = \tau_s \mu_s + \tau_l y_{sj},
\] (4)
First, given $\tau_s$, school district’s utility maximization problem is

$$
\max_{c_{sj1}, x_{sj1}, g_{csj}, \tau_{lj}} u(c_{sj}) + \theta V(a_{csj}, h_{csj2}, g_{csj}) - \xi_s d\left(\frac{\sigma h_{csj2}}{\mu h_{csj2}}\right),
$$

subject to

$$
c_{sj} + x_{sj1} + g_{csj} = (1 - \tau_s - \tau_{lj})y_{sj}.
$$

(1), (4), and $\tau_{lj} \geq 0$.

Next, based on $\{c_{sj1}, x_{sj1}, g_{csj}, \tau_{lj}\}$, school districts choose $\tau_{sj}$.

The equilibrium income tax rate $\tau_{sm}$ must satisfy

$$
\int I_{\{\tau_{sj} \geq \tau_{sm}\}} dF(y_{sj}) \geq \frac{1}{2},
$$

$$
\int I_{\{\tau_{sj} \leq \tau_{sm}\}} dF(y_{sj}) \geq \frac{1}{2}.
$$
Equalization Program

- State government sets $z_s$.
- If actual tax revenue is less than the revenue based on $z_s$, the difference is funded by $\tau_s$.
- Thus, $\bar{x}_{sj}$ and $\tau_s$ can be written as

$$
\bar{x}_{sj} = \begin{cases} 
\tau_{lj} z_s & \text{(if } y_j \leq z_s \text{)} \\
\tau_{lj} y_{sj} & \text{(otherwise)} 
\end{cases}, \quad (5)
$$

$$
\tau_s \mu = \int_j \tau_{lj} (z_s - y_{sj}). \quad (6)
$$
First, given $z_s$, school district’s utility maximization problem is

$$\max_{c_{sj}, x_{sj1}, g_{csj}, \tau_{lj}} u(c_{sj}) + \theta V(a_{csj}, h_{csj2}, g_{csj}) - \xi_s d(\frac{\sigma h_{csj2}}{\mu h_{csj2}}),$$

subject to

$$c_{sj} + x_{sj1} + g_{csj} = (1 - \tau_s - \tau_{lj}) y_{sj}.$$ 

subject to (1), (5), (6), and $\tau_{lj} \geq 0$.

Next, based on $\{c_{sj1}, x_{sj1}, g_{csj}, \tau_{lj}\}$, school districts choose $z_{sj}$.

The equilibrium income tax rate $z_{sm}$ must satisfy

$$\int I_{\{z_{sj} \geq z_{sm}\}} dF(y_{sj}) \geq \frac{1}{2},$$

$$\int I_{\{z_{sj} \leq z_{sm}\}} dF(y_{sj}) \geq \frac{1}{2}.$$
Recap of Model Elements

- Parents matter: Income, Schooling.
- States matter: Public school finance systems, Distribution of income, Inequality over redistribution.
- District matter: Local tax.
- Student matter: Ability.
Calibration

- Preferences: CRRA utility function,

\[
\frac{c_{sj}^{1-\alpha}}{1-\alpha} + \theta V(a_{csj}, h_{csj}, g_{csj}) - \xi_s \frac{\sigma_{h_{csj}}}{\mu_{h_{csj}}^{1-\kappa}}.
\]

\[
V(a_{csj}, h_{csj}, g_{csj}) = \frac{c_{csj}^{1-\zeta}}{1-\zeta} + \beta \frac{c_{csj}^{1-\zeta}}{1-\zeta}.
\]

- District income: Parametrized as

\[
y_{sj} = w_{sj} h_{sj} = w_{sj} \exp(\phi_{sj}) \iota_s
\]

- Child’s learning ability:

\[
a_{csj} = \exp(\rho_{sj}) \epsilon_{sj},
\]

where \(\epsilon_{sj} \sim \logN(\mu_s, \sigma^2_s)\).
## Fixed Parameters (Table 4)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>2.0</td>
<td>CRRA coefficient, $\frac{c_{sj}^{1-\alpha}}{1-\alpha}$.</td>
</tr>
<tr>
<td>$\zeta$</td>
<td>2.0</td>
<td>CRRA coefficient, $\frac{h_{csj}^{1-\zeta}}{1-\zeta}$.</td>
</tr>
<tr>
<td>$\theta$</td>
<td>0.5</td>
<td>Coefficient of Altruism</td>
</tr>
<tr>
<td>$\beta$</td>
<td>0.96$^6$</td>
<td>Discount factor</td>
</tr>
<tr>
<td>$r$</td>
<td>$(1 + 0.04)^6 - 1$</td>
<td>Interest Rate</td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.1</td>
<td>Return of schooling on human capital, Mincer (1974)</td>
</tr>
<tr>
<td>$\eta_1$</td>
<td>0.4</td>
<td>Return of time for human capital</td>
</tr>
<tr>
<td>$\eta_2$</td>
<td>0.2</td>
<td>Return of private inputs</td>
</tr>
<tr>
<td>$\rho$</td>
<td>0.05</td>
<td>Coefficient of schooling for child’s learning ability.</td>
</tr>
</tbody>
</table>
Estimated Parameters: $[\kappa, \gamma_1, \gamma_2]$ and $[\xi_s, \mu_s, \sigma_s^2]$.

Estimate $[\kappa, \gamma_1, \gamma_2, \xi, \mu_s, \sigma_s^2]$ in Washington State and $[\xi_s, \mu_s, \sigma_s^2]$ in others.

Use simulated method of moments.

Targeted moments:

1. Average public school spending per pupil
2. Average child family income.
3. Coefficient of variation on child family income.
4. 10 percentile of child family income.
5. 90 percentile of child family income.
6. Correlation between school district income and child family income.
7. Correlation between school district income and public school spending per pupil.

Washington (Full state funding): Use 1-6.

California (Full state funding): Use 1-3.

Others (Foundation program): Use 1, 2, and 7.
\( \kappa = 2.198, \gamma_1 = 0.106, \gamma_2 = 0.379. \)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>s =CA</th>
<th>s =CO</th>
<th>s =GA</th>
<th>s =MI</th>
<th>s =NH</th>
<th>s =NJ</th>
<th>s =OH</th>
<th>s =OR</th>
<th>s =VA</th>
<th>s =WA</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \xi_s )</td>
<td>0.333</td>
<td>0.826</td>
<td>0.668</td>
<td>0.699</td>
<td>0.610</td>
<td>0.471</td>
<td>0.479</td>
<td>0.429</td>
<td>0.814</td>
<td>0.051</td>
</tr>
<tr>
<td>( \mu_s )</td>
<td>1.099</td>
<td>1.217</td>
<td>0.924</td>
<td>0.983</td>
<td>0.949</td>
<td>1.039</td>
<td>0.990</td>
<td>1.074</td>
<td>0.994</td>
<td>1.198</td>
</tr>
<tr>
<td>( \sigma_s )</td>
<td>0.392</td>
<td>0.158</td>
<td>0.378</td>
<td>0.468</td>
<td>0.554</td>
<td>0.481</td>
<td>0.497</td>
<td>0.354</td>
<td>0.481</td>
<td>0.219</td>
</tr>
</tbody>
</table>

Table 5: Parameter Estimates \([\xi_s, \mu_s, \sigma_s]\)
Selected Targeted Moments

![Graphs showing correlations between Public School Spending per Pupil and Average Child Family Income for various states. States include NJ, GA, NH, CA, WA, MI, OH, OR, VA, CO, VA, NH, MI, OH, WA, CA, CO, OR, MI, OH, NJ.](image)

Figure 3
Selected Targeted Moments

Figure 4: Public School Spending by Parents’ Income
Figure 5: Mean of Child Income Ranking by Adult Income Ranking
Figure 6
Three counterfactual simulations.

1. No heterogeneity on coefficient of disutility from inequality.
   - $\xi_s = \xi_s' = \bar{\xi}_s$.
   - $\xi_s = \xi_s' = 0$.

2. No heterogeneity in public school finance system.
   - Switch to a full state funding.

3. No heterogeneity in public school spending.
   - $\bar{x}_{js} = x_{j's'} = \bar{x}$.
Overall, there are modest changes.

Figure 7
No Disutility from Inequality

- Intergenerational mobility becomes lower in Colorado and Oregon.

Figure 8
Switching to a Full State Funding

- Improves intergenerational mobility.
- Especially for states which have unequal distribution.

![Graph showing the impact of Full State Funding](image)

**Figure 9**
Impact of level of public school spending is modest.

Figure 10
Conclusion

- Public school spending can account for 30% of the variation in intergenerational mobility across school districts.
- Three aspects: Level, educational policy and distribution.
- Counterfactual simulations show that the impact of the distribution of the public school spending and educational policy is large.