Transatlantic Differences in Taxation, Redistribution and Provision of Public Goods: How Fair is Inequality?

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Introduction

• Economic differences between the U.S. and European countries well-documented
  • Average tax rate, public vs. private provision of education & health care, income inequality

• Pronounced Transatlantic differences in perceptions
  • Role of effort vs. luck, roots of poverty, upward mobility

• Growing interest in the link between the two
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Transatlantic Differences in Data

Table: Transatlantic Differences in Economic Variables and Beliefs

<table>
<thead>
<tr>
<th></th>
<th>Tax Revenue (% of GDP)</th>
<th>Share of Public Edu. &amp; Health Care Expenditure</th>
<th>Post-tax Income GINI</th>
<th>Share w. Belief that Luck is Pivotal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>U.S.</strong></td>
<td>26.9%</td>
<td>44.8%</td>
<td>0.378</td>
<td>29.9%</td>
</tr>
<tr>
<td><strong>Europe</strong></td>
<td>39.9%</td>
<td>78.6%</td>
<td>0.289</td>
<td>42.8%</td>
</tr>
</tbody>
</table>

European average is comprised of Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom.

Source: OECD Statistics Database & World Values Survey
## Research Questions

- **How well can given differences in taxes deliver Transatlantic differences?**
  - Public vs. private good provisions, perceptions on the fairness of income inequality, ...  

- **What are the macroeconomic implications of the alternative tax policies?**
  - Level and distributional properties of output, consumption, education, labor and human capital  

- **How do aggregate and individual welfare vary under different tax regimes?**
  - Single vs. double-peaked preferences over taxes  

- **What normative policy recommendations can be inferred from the model?**
  - Mixed vs. polar systems
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Model

Results

Conclusions

Literature

Redistributive Policy Literature:

- **Behavioral Explanations**

- **Economic Explanations**

- **Political Explanations**

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Education Literature:

• Bénabou (2000, AER; 2002, ECTA), Zhang (2005, JEDC)
Contributions and Main Results

First paper...

- to address Transatlantic differences through modeling public and private goods explicitly in agents’ choice set
- to deliver economic *and* perceptual differences by relating to welfare measures in a general equilibrium model based on given differences in tax rates
  - Lower U.S. tax rate to explain lower U.S. public education, higher total education expenditure, higher output and labor, more unequal output and educational attainment, and lower share of luck on income inequality
  - Majority of individuals roughly indifferent between the calibrated U.S. and European economies
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- Generates the U-shaped pattern of per-capita income over public-to-total-good ratio as in the data
  - Increase in the distortionary tax rate discourages private education and encourages public education attendance
  - Decrease in private education offsets increase in public education attainment unless public education is chosen by a large fraction of population

- Inverted U-shaped behavior of share of luck in income inequality over taxes
  - Low tax and more variant private education to induce a large impact of inborn competence on schooling and labor supply
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Model Description

- Heterogeneous-agent OLG model with two cohorts
- Middle-aged decide how much to work, consume and bequest private education if any (or choose public education) to Young
- Only idiosyncratic & no aggregate shocks
  - Inborn competence shock to change optimal labor, education & expected consumption decisions
  - Luck shock orthogonal to decision rules and inborn competence shock, affecting actual income and consumption
- Young generate human capital to be used when middle-aged via inborn competence, education, aggregate and parental human capital
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Timeline of the Model

1. Middle-aged with human capital $h$ observes young’s inborn competence (e.g. IQ) $\xi$.

2. Given tax rate $\tau$, aggregate human capital $\bar{H}$, public education $\bar{E}$, and transfers $\bar{Tr}$; middle-aged chooses private education $e$, labor $l$, and expected consumption $E(c)$.

3. Using $h$, $l$ and luck shock $\eta$, middle-aged generates income $y$ & consumption $c$ realizes.

4. Combining $\xi$, $\bar{H}$, $h$, $\bar{E}$ or $e$, young generates $h'$ to be used when middle-aged.

$t \quad \downarrow \quad t+1$

$t+1 \quad \uparrow$

Middle-aged dies, young grows to be middle-aged with $h'$ & observes new young’s inborn competence $\xi'$.
Recursive Competitive Equilibrium

The recursive competitive equilibrium under constant taxes is a set of value functions, decision rules, allocations and stationary distribution, such that

1. Given $\overline{H}$, $\overline{E}$, $\overline{Tr}$ and $\tau$, $\tilde{l}(h, \xi; \overline{H}, \overline{E}, \overline{Tr}, \tau)$ and $\tilde{e}(h, \xi; \overline{H}, \overline{E}, \overline{Tr}, \tau)$ are optimal decision rules to household agent $i$’s problem, $\tilde{h}(h, \xi; \overline{H}, \overline{E}, \overline{Tr}, \tau)$ is the implied human capital rule by the optimal education decision, $V(h, \xi; \overline{H}, \overline{E}, \overline{Tr}, \tau)$ is the resultant value function, and inborn competence and luck shocks follow their exogenous law of motions:

$$V(h, \xi; \overline{H}, \overline{E}, \overline{Tr}, \tau) = \max_{\{l, e\}} \left\{ \sum_{\eta} \pi(\eta) u(c(\eta)) + v(1 - l) + \rho \sum_{\xi'} \pi(\xi', \xi) V(h', \xi'; \overline{H}, \overline{E}, \overline{Tr}, \tau) \right\}$$

subject to

$$y = \Theta l^{(1-\lambda)} h^{\lambda} + \eta$$

$$c = (1 - \tau)y + \overline{Tr} - e$$

$$e \geq 0$$

$$h' = \begin{cases} 
\xi(\overline{E})^{e} h^{(1-\varepsilon)} \overline{H}^{(1-\varepsilon)(1-\gamma)} & e = 0 \\
\xi(\varepsilon + \nu \overline{E})^{e} h^{(1-\varepsilon)} \overline{H}^{(1-\varepsilon)(1-\gamma)} & e > 0
\end{cases}$$

$$\log(\xi) \sim N(0, \sigma_{\xi}^2)$$

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\]

subject to

\[
y = \Theta l^{(1-\lambda)} h^\lambda + \eta \quad (2)
\]

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\[e \geq 0 \quad (4)\]

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$$V(h, \xi; \overline{H}, \overline{E}, \overline{Tr}, \tau) = \max_{\{l, e\}} \left\{ \sum_{\eta} \pi(\eta)u(c(\eta)) + v(1 - l) + \rho \sum_{\xi'} \pi(\xi', \xi)V(h', \xi'; \overline{H}, \overline{E}, \overline{Tr}, \tau) \right\}$$

subject to

$$y = \Theta l(1 - \lambda) h^\lambda + \eta$$

$$c = (1 - \tau)y + \overline{Tr} - e$$

$$e \geq 0$$

$$h' = \begin{cases} \xi(\overline{E})^\varepsilon h^{(1 - \varepsilon)\gamma \overline{H}^{(1 - \varepsilon)(1 - \gamma)}} & e = 0 \\ \xi(e + \nu \overline{E})^\varepsilon h^{(1 - \varepsilon)\gamma \overline{H}^{(1 - \varepsilon)(1 - \gamma)}} & e > 0 \end{cases}$$

$$\log(\xi) \sim N(0, \sigma^2_{\xi})$$

$$\eta \sim N(0, \sigma^2_{\eta})$$
Recursive Competitive Equilibrium

The recursive competitive equilibrium under constant taxes is a set of value functions, decision rules, allocations and stationary distribution, such that

1. Given $H$, $E$, $Tr$ and $\tau$, $\tilde{l}(h, \xi; H, E, Tr, \tau)$ and $\tilde{e}(h, \xi; H, E, Tr, \tau)$ are optimal decision rules to household agent $i$’s problem, $\tilde{h}(h, \xi; H, E, Tr, \tau)$ is the implied human capital rule by the optimal education decision, $V(h, \xi; H, E, Tr, \tau)$ is the resultant value function, and inborn competence and luck shocks follow their exogenous law of motions:

\[
V(h, \xi; H, E, Tr, \tau) = \max_{\{l, e\}} \left\{ \sum_{\eta} \pi(\eta)u(c(\eta)) + v(1 - l) + \rho \sum_{\xi'} \pi(\xi', \xi) V(h', \xi'; H, E, Tr, \tau) \right\}
\]

subject to

\[
y = \Theta l^{(1 - \lambda)} h^\lambda + \eta \quad (2)
\]
\[
c = (1 - \tau) y + Tr - e \quad (3)
\]
\[
e \geq 0 \quad (4)
\]
\[
h' = \begin{cases} 
\xi(E)^{\epsilon} h^{(1 - \epsilon)(1 - \gamma)} & e = 0 \\
\xi(e + vE)^{\epsilon} h^{(1 - \epsilon)(1 - \gamma)} & e > 0
\end{cases} \quad (5)
\]

\[
\log(\xi) \sim N(0, \sigma_\xi^2) \quad (6)
\]
\[
\eta \sim N(0, \sigma_\eta^2) \quad (7)
\]
Recursive Competitive Equilibrium

2. Aggregate variables stay constant at all periods and the time-invariant stationary distribution satisfies:

\[
\mu(h', \xi'; \bar{H}, \bar{E}, \bar{Tr}, \tau) = \sum_{\xi'} \int_{\mathcal{H} \times \Xi} \chi_{\{\tilde{h}(h, \xi; \bar{H}, \bar{E}, \bar{Tr}, \tau) = h'\}} \pi(\xi', \xi) d\mu(h, \xi; \bar{H}, \bar{E}, \bar{Tr}, \tau)
\]

(8)

3. Government runs a balanced budget and follows its predetermined fiscal rule:

\[
\bar{E}(\tau) + \bar{Tr}(\tau) = \bar{T}(\tau) = \int_{\mathcal{H} \times \Xi} \tau y d\mu(h, \xi; \bar{H}, \bar{E}, \bar{Tr}, \tau)
\]

(9)

\[
\bar{Tr}(\tau) = \psi \bar{T}(\tau)
\]

(10)

\[
\bar{E}(\tau) = (1 - \psi) \bar{T}(\tau)
\]

(11)

4. Variable definitions and expectations hold:

\[
\bar{H}(\tau) = \int_{\mathcal{H} \times \Xi} h d\mu(h, \xi; \bar{H}, \bar{E}, \bar{Tr}, \tau)
\]

(12)

\[
\bar{Y}(\tau) = \int_{\mathcal{H} \times \Xi} y d\mu(h, \xi; \bar{H}, \bar{E}, \bar{Tr}, \tau)
\]

(13)
Recursive Competitive Equilibrium

2. Aggregate variables stay constant at all periods and the time-invariant stationary distribution satisfies:

\[ \mu(h', \xi'; \overline{H}, \overline{E}, \overline{Tr}, \tau) = \sum_{\xi'} \int_{\mathcal{H} \times \Xi} \chi\{\tilde{h}(h, \xi; \overline{H}, \overline{E}, \overline{Tr}, \tau) = h'\} \pi(\xi', \xi) d\mu(h, \xi; \overline{H}, \overline{E}, \overline{Tr}, \tau) \]

\[ \text{(8)} \]

3. Government runs a balanced budget and follows its predetermined fiscal rule:

\[ \overline{E}(\tau) + \overline{Tr}(\tau) = \overline{T}(\tau) = \int_{\mathcal{H} \times \Xi} \tau y d\mu(h, \xi; \overline{H}, \overline{E}, \overline{Tr}, \tau) \]

\[ \text{(9)} \]

\[ \overline{Tr}(\tau) = \psi \overline{T}(\tau) \]

\[ \text{(10)} \]

\[ \overline{E}(\tau) = (1 - \psi) \overline{T}(\tau) \]

\[ \text{(11)} \]

4. Variable definitions and expectations hold:

\[ \overline{H}(\tau) = \int_{\mathcal{H} \times \Xi} hd\mu(h, \xi; \overline{H}, \overline{E}, \overline{Tr}, \tau) \]

\[ \text{(12)} \]

\[ \overline{Y}(\tau) = \int_{\mathcal{H} \times \Xi} y d\mu(h, \xi; \overline{H}, \overline{E}, \overline{Tr}, \tau) \]

\[ \text{(13)} \]
Recursive Competitive Equilibrium

2. Aggregate variables stay constant at all periods and the time-invariant stationary distribution satisfies:

$$\mu(h', \xi'; \overline{H}, \overline{E}, \overline{Tr}, \tau) = \sum \int_{\mathcal{H} \times \Xi} \chi\{\tilde{h}(h, \xi; \overline{H}, \overline{E}, \overline{Tr}, \tau) = h'\} \pi(\xi', \xi) d\mu(h, \xi; \overline{H}, \overline{E}, \overline{Tr}, \tau)$$

(8)

3. Government runs a balanced budget and follows its predetermined fiscal rule:

$$\overline{E}(\tau) + \overline{Tr}(\tau) = \overline{T}(\tau) = \int_{\mathcal{H} \times \Xi} \tau y d\mu(h, \xi; \overline{H}, \overline{E}, \overline{Tr}, \tau)$$

(9)

$$\overline{Tr}(\tau) = \psi \overline{T}(\tau)$$

(10)

$$\overline{E}(\tau) = (1 - \psi) \overline{T}(\tau)$$

(11)

4. Variable definitions and expectations hold:

$$\overline{H}(\tau) = \int_{\mathcal{H} \times \Xi} h d\mu(h, \xi; \overline{H}, \overline{E}, \overline{Tr}, \tau)$$

(12)

$$\overline{Y}(\tau) = \int_{\mathcal{H} \times \Xi} y d\mu(h, \xi; \overline{H}, \overline{E}, \overline{Tr}, \tau)$$

(13)
Recursive Competitive Equilibrium

2. Aggregate variables stay constant at all periods and the time-invariant stationary distribution satisfies:

\[ \mu(h', \xi'; \bar{H}, \bar{E}, \bar{Tr}, \tau) = \sum_{\xi'} \int_{\mathcal{H} \times \Xi} \chi\{\bar{h}(h, \xi; H, E, Tr, \tau) = h'\} \pi(\xi', \xi) d\mu(h, \xi; H, E, Tr, \tau) \]

(8)

3. Government runs a balanced budget and follows its predetermined fiscal rule:

\[ \bar{E}(\tau) + \bar{Tr}(\tau) = \bar{T}(\tau) = \int_{\mathcal{H} \times \Xi} \tau y d\mu(h, \xi; H, E, Tr, \tau) \]

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(8)

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Recursive Competitive Equilibrium

2. Aggregate variables stay constant at all periods and the time-invariant stationary distribution satisfies:

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(8)

3. Government runs a balanced budget and follows its predetermined fiscal rule:

\[ \bar{E}(\tau) + \bar{Tr}(\tau) = \bar{\tau}(\tau) = \int_{H \times \Xi} \tau y \, d\mu(h, \xi; H, \bar{E}, \bar{Tr}, \tau) \]  

(9)

\[ \bar{Tr}(\tau) = \psi \bar{\tau}(\tau) \]  

(10)

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\[ \bar{H}(\tau) = \int_{H \times \Xi} h \, d\mu(h, \xi; H, \bar{E}, \bar{Tr}, \tau) \]  

(12)

\[ \bar{Y}(\tau) = \int_{H \times \Xi} y \, d\mu(h, \xi; H, \bar{E}, \bar{Tr}, \tau) \]  

(13)
Recursive Competitive Equilibrium

5. Aggregate resource constraint holds:

\[ Y(\tau) = \bar{C}(\tau) + \bar{E}(\tau) + \int_{\mathcal{H} \times \Xi} ed\mu(h, \xi; \bar{H}, \bar{E}, \bar{Tr}, \tau) \]  (14)

6. Total variation, fair variation and luck variations are defined rationally as follows:

\[ \sigma^2_Y(\tau) = \int_{\mathcal{H} \times \Xi} (y - \bar{Y}(\tau))^2 d\mu(h, \xi; \bar{H}, \bar{E}, \bar{Tr}, \tau) \]  (15)

\[ \sigma^2_L = \sigma^2_\eta \]  (16)

\[ \sigma^2_F(\tau) = \sigma^2_Y(\tau) - \sigma^2_L \]  (17)

7. Share of fair variation and variation due to luck satisfy:

\[ \iota_F(\tau) = \frac{\sigma^2_F(\tau)}{\sigma^2_Y(\tau)} \]  (18)

\[ \iota_L(\tau) = 1 - \iota_F(\tau) = \frac{\sigma^2_L}{\sigma^2_Y(\tau)} \]  (19)
Recursive Competitive Equilibrium

5. Aggregate resource constraint holds:

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\[ \sigma^2_L = \eta \]  (16)

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$$\sigma^2 = \sigma^2_\eta \quad (16)$$

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Recursive Competitive Equilibrium

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(19)
Recursive Competitive Equilibrium

5. Aggregate resource constraint holds:

\[ \bar{Y}(\tau) = \bar{C}(\tau) + \bar{E}(\tau) + \int_{H \times \Xi} ed\mu(h, \xi; \bar{H}, \bar{E}, \bar{Tr}, \tau) \]  

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(15)

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(18)

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(19)
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\]  
(15)

\[
\sigma^2_L = \sigma^2_\eta
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(16)

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(18)

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\iota_L(\tau) = 1 - \iota_F(\tau) = \frac{\sigma^2_L}{\sigma^2_Y(\tau)}
\]  
(19)
# Calibration

**Table: Benchmark Parameter Values**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Source/Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\lambda$</td>
<td>0.625</td>
<td>Bénabou (2002, ECTA)</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>0.200</td>
<td>Zhang (2005, JEDC)</td>
</tr>
<tr>
<td>$\rho$</td>
<td>0.800</td>
<td>Zhang (2005, JEDC)</td>
</tr>
<tr>
<td>$\varepsilon$</td>
<td>0.300</td>
<td>Bénabou (2002, ECTA) &amp; Zhang (2005, JEDC)</td>
</tr>
<tr>
<td>$\sigma_{\eta}^2$</td>
<td>0.259</td>
<td>Heathcote et al. (2010, RED)</td>
</tr>
<tr>
<td>$\nu$</td>
<td>0.500</td>
<td>Neutral Stance from Two Polar Cases</td>
</tr>
<tr>
<td>$\psi$</td>
<td>0.370</td>
<td>US Redistribution Share (OECD Database, 2008)</td>
</tr>
<tr>
<td>$\omega$</td>
<td>0.500</td>
<td>Frisch Elasticity=2 ( $u(c) + \psi(1 - l) = \log(c) - \phi l^{1+\omega} (1+\omega)$ )</td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.513</td>
<td>Calibrated to Match US Labor=0.287</td>
</tr>
<tr>
<td>$\sigma_{\xi}^2$</td>
<td>0.769</td>
<td>Calibrated to Match $\nu^L_{US} = 29.88%$</td>
</tr>
<tr>
<td>$\Theta$</td>
<td>3.345</td>
<td>Calibrated to Match $\nu^E_{EU} = 42.75%$</td>
</tr>
<tr>
<td>$\tau^L_{US}$</td>
<td>7.13%</td>
<td>Calibrated to Match $\frac{E_{US}}{E_{US}} = 44.83%$</td>
</tr>
<tr>
<td>$\tau^E_{EU}$</td>
<td>11.96%</td>
<td>Calibrated to Match $\frac{E_{EU}}{E_{EU}} = 78.54%$</td>
</tr>
</tbody>
</table>
Education Decision Rule

**Figure:** Education Decision Rule When $\tau = 7.13\%$
Education Decision Rule

Figure: Education Decision Rule When $\tau = 11.96\%$
Labor Decision Rule

**Figure:** Labor Decision Rule When $\tau = 7.13\%$
Labor Decision Rule

**Figure:** Labor Decision Rule When $\tau = 11.96\%$
Benchmark Results
Benchmark Results
Why the U-Shape?

Four competing factors:

- Lower disposable income → lower private education attainment in the intensive margin (−)
- Disincentivizing extensive margin effect of free public education → lower private and total education attainment (−)
- Lower return on education → lower private and total education attainment (−)
- Public education benefit to the less-endowed & its spillover benefits to the private school students → higher aggregate education attainment (+)
Why the U-Shape?

Four competing factors:

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- Lower return on education → lower private and total education attainment (−)
- Public education benefit to the less-endowed & its spillover benefits to the private school students → higher aggregate education attainment (+)
**Benchmark Results**

**Table:** Stationary Distribution Results over Taxes

<table>
<thead>
<tr>
<th>$\tau$</th>
<th>$Y$</th>
<th>$C$</th>
<th>$H$</th>
<th>$L$</th>
<th>$E$</th>
<th>$\bar{E}$</th>
<th>$Tr$</th>
<th>$Pop\cdot\bar{E}$</th>
<th>$\bar{E}/\bar{E}$</th>
<th>$\nu_L$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00%</td>
<td>2.046</td>
<td>1.756</td>
<td>0.793</td>
<td>0.338</td>
<td>0.290</td>
<td>0.000</td>
<td>0.000</td>
<td>0.00%</td>
<td>0.00%</td>
<td>16.87%</td>
</tr>
<tr>
<td>2.50%</td>
<td>1.933</td>
<td>1.640</td>
<td>0.725</td>
<td>0.328</td>
<td>0.262</td>
<td>0.032</td>
<td>0.019</td>
<td>0.00%</td>
<td>12.09%</td>
<td>18.50%</td>
</tr>
<tr>
<td>5.00%</td>
<td>1.737</td>
<td>1.475</td>
<td>0.612</td>
<td>0.310</td>
<td>0.217</td>
<td>0.057</td>
<td>0.034</td>
<td>19.56%</td>
<td>26.35%</td>
<td>21.49%</td>
</tr>
<tr>
<td>7.13%</td>
<td>1.401</td>
<td>1.220</td>
<td>0.424</td>
<td>0.283</td>
<td>0.150</td>
<td>0.067</td>
<td>0.040</td>
<td>53.03%</td>
<td>44.83%</td>
<td>29.88%</td>
</tr>
<tr>
<td>7.50%</td>
<td>1.387</td>
<td>1.210</td>
<td>0.417</td>
<td>0.281</td>
<td>0.147</td>
<td>0.068</td>
<td>0.040</td>
<td>55.04%</td>
<td>46.38%</td>
<td>31.37%</td>
</tr>
<tr>
<td>10.00%</td>
<td>1.263</td>
<td>1.117</td>
<td>0.351</td>
<td>0.271</td>
<td>0.125</td>
<td>0.083</td>
<td>0.049</td>
<td>75.32%</td>
<td>66.42%</td>
<td>40.76%</td>
</tr>
<tr>
<td>11.96%</td>
<td>1.268</td>
<td>1.128</td>
<td>0.355</td>
<td>0.270</td>
<td>0.126</td>
<td>0.099</td>
<td>0.058</td>
<td>85.25%</td>
<td>78.54%</td>
<td>42.75%</td>
</tr>
<tr>
<td>12.50%</td>
<td>1.275</td>
<td>1.134</td>
<td>0.357</td>
<td>0.270</td>
<td>0.128</td>
<td>0.105</td>
<td>0.062</td>
<td>87.47%</td>
<td>81.67%</td>
<td>43.22%</td>
</tr>
<tr>
<td>15.00%</td>
<td>1.355</td>
<td>1.202</td>
<td>0.400</td>
<td>0.264</td>
<td>0.146</td>
<td>0.134</td>
<td>0.079</td>
<td>94.20%</td>
<td>91.63%</td>
<td>40.08%</td>
</tr>
<tr>
<td>17.50%</td>
<td>1.442</td>
<td>1.268</td>
<td>0.448</td>
<td>0.257</td>
<td>0.169</td>
<td>0.166</td>
<td>0.097</td>
<td>98.04%</td>
<td>97.70%</td>
<td>36.89%</td>
</tr>
<tr>
<td>20.00%</td>
<td>1.624</td>
<td>1.409</td>
<td>0.557</td>
<td>0.251</td>
<td>0.213</td>
<td>0.213</td>
<td>0.126</td>
<td>100.00%</td>
<td>100.00%</td>
<td>29.99%</td>
</tr>
</tbody>
</table>
Fairness of Income Inequality

Inverted U-shape of the share of luck in total income inequality due to two factors:

- Equalizing role of taxes, public education provision and redistribution
  - In low tax regimes, diverse private education of majority & low levels of redistribution $\downarrow$ share of luck
  - In high tax regimes, majority attaining same public education & high levels of redistribution $\uparrow$ share of luck
- Level effect of output over constant variance of luck shock
  - On the left arm decreasing output over taxes $\uparrow$ share of luck
  - On the right arm increasing output over taxes $\downarrow$ share of luck
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- Level effect of output over constant variance of luck shock
  - On the left arm decreasing output over taxes ↑ share of luck
  - On the right arm increasing output over taxes ↓ share of luck
# Model Fit

## Table: Comparison of Model with Data

<table>
<thead>
<tr>
<th>Country</th>
<th>$\bar{\tau}$</th>
<th>$\bar{E}/\bar{E}$</th>
<th>$\bar{\nu}_L$</th>
<th>$\bar{Y}/Y^{US}$</th>
<th>$\bar{L}$</th>
<th>GINI($y$)</th>
<th>GINI($\hat{y}$)</th>
<th>GINI($e$)</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U.S.</td>
<td>12.02%</td>
<td>44.83%</td>
<td>29.88%</td>
<td>1.000</td>
<td>0.287</td>
<td>0.486</td>
<td>0.378</td>
<td>N/A (+)</td>
<td></td>
</tr>
<tr>
<td>Europe</td>
<td>21.19%</td>
<td>78.54%</td>
<td>42.75%</td>
<td>0.815</td>
<td>0.257</td>
<td>0.449</td>
<td>0.290</td>
<td>N/A (-)</td>
<td></td>
</tr>
<tr>
<td><strong>Model</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U.S.</td>
<td>7.13%</td>
<td>44.83%</td>
<td>29.88%</td>
<td>1.000</td>
<td>0.283</td>
<td>0.353</td>
<td>0.345</td>
<td>0.369</td>
<td></td>
</tr>
<tr>
<td>Europe</td>
<td>11.96%</td>
<td>78.54%</td>
<td>42.75%</td>
<td>0.910</td>
<td>0.270</td>
<td>0.338</td>
<td>0.324</td>
<td>0.190</td>
<td></td>
</tr>
</tbody>
</table>
Tax, Output and Public Education Share by Country

Source: OECD Database (2004-2008)
Tax, Output and Public Education Share by Country

\[
\overline{E_i} = \frac{0.398 + 0.957 \tau_i}{\xi_i} \quad p = 0.0001
\]

Source: OECD Database (2004-2008)
Different Spillover Rates

Figure: Per-Capita Output with Different Spillover Rates

- Zero-Spillover Specification
- Full-Spillover Specification
- Other Comparative Statics
Stationary Distribution for the U.S. Economy

Figure: Stationary Distribution for the U.S. Economy
Stationary Distribution for the European Economy

Figure: Stationary Distribution for the European Economy
Welfare over Taxes

**Figure:** Lifetime Welfare with Human Capital $h = 0.20$
Welfare over Taxes

Figure: Lifetime Welfare with Median Productivity
Conclusions

• Different tax policies alone deliver both Transatlantic economic and perceptual differences and differences in perceptions
  • ... without having to rely on differences in preferences, variations in deep structural parameters or other unorthodox elements

• The model generates a U-shaped pattern for macro variables over public-to-total good expenditure ratio as seen in the data
  • ... enables majority of agents to have comparable ex-ante welfare in the calibrated U.S. and European economies with double-peaked preferences

• Normatively, heavy reliance on either public or private education is preferable, but not taking the “middle road”
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  • ... without having to rely on differences in preferences, variations in deep structural parameters or other unorthodox elements

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  • ... enables majority of agents to have comparable ex-ante welfare in the calibrated U.S. and European economies with double-peaked preferences

• Normatively, heavy reliance on either public or private education is preferable, but not taking the “middle road”
Future Work

- Investigating transitional dynamics of the model
- Tailoring the model to study politico-economic equilibria
- Analyzing individual-level data on beliefs to detect patterns worthy of incorporating into heterogeneous-agent models
- Studying microeconometric estimations of model parameters
Future Work

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Relationship Between Public Good Share & Beliefs

![Graph showing relationship between social spending and belief that luck determines income.](image)

Figure: Alesina and Angeletos (2005, AER)

- $\hat{\nu}_{i}^{040} = 0.314 + 0.0054 \frac{E_i}{\bar{E}_i} \tau_i$
  $p = 0.049$

- $\hat{\nu}_{i}^{131} = -0.106 + 0.963 \frac{E_i}{\bar{E}_i}$
  $p = 0.032$

- $\hat{\nu}_{i}^{131} = 0.196 + 0.022 \tau_i$
  $p = 0.010$

- $\hat{\nu}_{i}^{131} = 0.337 + 0.018 \frac{E_i}{\bar{E}_i} \tau_i$
  $p = 0.015$

Introduction

Source: Authors' calculations based on data from the World Value Survey.

- Average for 1990-98.
- An index ranging from 1 to 10 (with 10 the highest) that captures the mean belief that luck determines income for each country.
- Data for 1981-97.
Public Expenditure by Country

Figure: Health Care & Total Edu. Exp. (% of GDP)

Source: OECD Database (2004-2008)
Government Expenditure Composition by Country

Figure: Government Expenditure (% of GDP)

Source: OECD Database (2004-2008)
Tax Revenue by Country

Figure: Tax Revenue (% of GDP)

Source: OECD Database (2004-2008)
Public Expenditure by Country

Figure: Health Care & Tertiary Edu. Exp. (% of GDP)

Source: OECD Database (2004-2008)

Transatlantic Differences
Public Expenditure by Country

Figure: Health Care Exp. (% of GDP)

Source: OECD Database (2004-2008)
Public Expenditure by Country

Figure: Total Edu. Exp. (% of GDP)

Source: OECD Database (2004-2008)
Public Expenditure by Country

Figure: Primary & Secondary Edu. Exp. (% of GDP)

Source: OECD Database (2004-2008)
Public Expenditure by Country

Figure: Tertiary Edu. Exp. (% of GDP)

Source: OECD Database (2004-2008)
Average Actual Hours Worked by Country

Figure: Labor Supply

Source: OECD Database (2004-2008)
Income Inequality by Country

Figure: Pre-Tax & Post-Tax Income GINI Coefficients

Source: OECD Database (2004-2008)

Transatlantic Differences

Educational Inequality
Dispersion on Educational Attainment

**Table:** Descriptive Statistics from International Adult Literacy Survey

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Differential</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>50-10 Percentile</td>
</tr>
<tr>
<td>European Average</td>
<td>290.60</td>
<td>44.48</td>
<td>61.42</td>
</tr>
<tr>
<td>United States</td>
<td>288.97</td>
<td>61.43</td>
<td>80.67</td>
</tr>
</tbody>
</table>

Source: Blau and Kahn (2005, RES)

- “…the very best schools in the U.S. are extraordinary … but the big concern in the U.S. is the diversity of quality of institutions.”

*Barry McGaw, (Director of Education for the OECD) on “Education at a Glance 2009: OECD Indicators”*
Luck Determines Income

Figure: Average Belief that Luck Determines Income by Country

People in Need Unfairly

**Figure:** Average Belief that People are in Need due to an Unfair Society

Distributional Property Graph

![Graph showing various GINI coefficients against tax rates.]

- **GINI Coefficient of Human Capital**
- **GINI Coefficient of Pre-Tax Income**
- **GINI Coefficient of Post-Tax Income**
- **GINI Coefficient of Consumption**
- **GINI Coefficient of Education**
- **GINI Coefficient of Labor**

**Tax Rate (in %)**

**Distributional Properties**
## Distributional Properties

**Table:** Distributional Properties of the Benchmark Model

<table>
<thead>
<tr>
<th>$\tau$</th>
<th>$\text{GINI}_h$</th>
<th>$\text{GINI}_y$</th>
<th>$\text{GINI}_\tilde{y}$</th>
<th>$\text{GINI}_c$</th>
<th>$\text{GINI}_e$</th>
<th>$\text{GINI}_l$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00%</td>
<td>0.333</td>
<td>0.333</td>
<td>0.343</td>
<td>0.505</td>
<td>0.070</td>
<td>0.296</td>
</tr>
<tr>
<td>2.50%</td>
<td>0.335</td>
<td>0.332</td>
<td>0.342</td>
<td>0.507</td>
<td>0.078</td>
<td>0.300</td>
</tr>
<tr>
<td>5.00%</td>
<td>0.346</td>
<td>0.340</td>
<td>0.341</td>
<td>0.518</td>
<td>0.100</td>
<td>0.346</td>
</tr>
<tr>
<td>7.13%</td>
<td>0.527</td>
<td>0.353</td>
<td>0.345</td>
<td>0.330</td>
<td>0.369</td>
<td>0.121</td>
</tr>
<tr>
<td>7.50%</td>
<td>0.353</td>
<td>0.344</td>
<td>0.330</td>
<td>0.526</td>
<td>0.121</td>
<td>0.366</td>
</tr>
<tr>
<td>10.00%</td>
<td>0.345</td>
<td>0.334</td>
<td>0.316</td>
<td>0.514</td>
<td>0.118</td>
<td>0.279</td>
</tr>
<tr>
<td>11.96%</td>
<td>0.503</td>
<td>0.338</td>
<td>0.324</td>
<td>0.309</td>
<td>0.190</td>
<td>0.111</td>
</tr>
<tr>
<td>12.50%</td>
<td>0.336</td>
<td>0.322</td>
<td>0.308</td>
<td>0.500</td>
<td>0.108</td>
<td>0.166</td>
</tr>
<tr>
<td>15.00%</td>
<td>0.327</td>
<td>0.309</td>
<td>0.301</td>
<td>0.488</td>
<td>0.095</td>
<td>0.074</td>
</tr>
<tr>
<td>17.50%</td>
<td>0.320</td>
<td>0.299</td>
<td>0.296</td>
<td>0.479</td>
<td>0.086</td>
<td>0.024</td>
</tr>
<tr>
<td>20.00%</td>
<td>0.314</td>
<td>0.290</td>
<td>0.290</td>
<td>0.474</td>
<td>0.075</td>
<td>0.000</td>
</tr>
</tbody>
</table>
Lorenz Curve for Human Capital
Lorenz Curve for Output

Distributional Properties 🔄 Lorenzh 🔄 Lorenzɛ 🔄 Lorenzɛ 🔄 Lorenzʌ 🔄 Lorenzʌ
Lorenz Curve for Consumption

\[ \tau = 0.00 \% \]
\[ \tau = 7.13 \% \]
\[ \tau = 11.96 \% \]
\[ \tau = 20.00 \% \]

Distributional Properties

\[ \text{Lorenz}_h \]
\[ \text{Lorenz}_y \]
\[ \text{Lorenz}_e \]
\[ \text{Lorenz}_l \]
Lorenz Curve for Education
Lorenz Curve for Labor

Distributional Properties  ▶  Lorenzh  ▶  Lorenzy  ▶  Lorenzc  ▶  Lorenze
Model Fit by Country

Figure: Model Fit of Per-Capita Output by Country
Model Fit by Country

Figure: Model Fit of Taxes by Country

- United States
- Australia
- Switzerland
- Portugal
- Spain
- Belgium
- Germany
- Italy
- Finland
- France
- Austria
- Netherlands
- Sweden
- Iceland
- Denmark
- Norway

- Tax Rate Implied by the COFOG
- Tax Rate Implied by the COFOG (Trend)
- Tax Rate by Model

Tax, Output & Public Good  ▶  Model Fit of Per-Capita Output  ▶  Model Fit of Perceptions
Model Fit by Country

Figure: Model Fit of Beliefs in Decisiveness of Luck by Country

% Believing Luck is Decisive
% Believing Luck is Decisive (Trend)
Luck Share Predicted by Model

Tax, Output & Public Good  Model Fit of Per-Capita Output  Model Fit of Taxes
### Zero-Spillover Results

**Table:** Stationary Distribution Results over Taxes with Zero-Spillover

<table>
<thead>
<tr>
<th>( \tau )</th>
<th>( Y )</th>
<th>( \bar{C} )</th>
<th>( \bar{H} )</th>
<th>( \bar{L} )</th>
<th>( \bar{E} )</th>
<th>( \bar{E} )</th>
<th>( \bar{Tr} )</th>
<th>( Pop_{\bar{E}} )</th>
<th>( \bar{E}/\bar{E} )</th>
<th>( \nu_1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00%</td>
<td>2.046</td>
<td>1.756</td>
<td>0.793</td>
<td>0.338</td>
<td>0.290</td>
<td>0.000</td>
<td>0.000</td>
<td>0.00%</td>
<td>0.00%</td>
<td>16.87%</td>
</tr>
<tr>
<td>2.50%</td>
<td>1.916</td>
<td>1.630</td>
<td>0.714</td>
<td>0.327</td>
<td>0.258</td>
<td>0.030</td>
<td>0.018</td>
<td>2.20%</td>
<td>11.89%</td>
<td>18.83%</td>
</tr>
<tr>
<td>5.00%</td>
<td>1.649</td>
<td>1.412</td>
<td>0.550</td>
<td>0.312</td>
<td>0.190</td>
<td>0.053</td>
<td>0.031</td>
<td>25.54%</td>
<td>29.52%</td>
<td>24.69%</td>
</tr>
<tr>
<td>7.50%</td>
<td>1.305</td>
<td>1.158</td>
<td>0.360</td>
<td>0.294</td>
<td>0.125</td>
<td>0.065</td>
<td>0.038</td>
<td>59.00%</td>
<td>52.63%</td>
<td>39.30%</td>
</tr>
<tr>
<td>10.00%</td>
<td>1.172</td>
<td>1.063</td>
<td>0.299</td>
<td>0.285</td>
<td>0.107</td>
<td>0.077</td>
<td>0.045</td>
<td>82.18%</td>
<td>72.24%</td>
<td>46.18%</td>
</tr>
<tr>
<td>12.50%</td>
<td>1.191</td>
<td>1.084</td>
<td>0.308</td>
<td>0.278</td>
<td>0.110</td>
<td>0.097</td>
<td>0.057</td>
<td>93.94%</td>
<td>87.81%</td>
<td>45.65%</td>
</tr>
<tr>
<td>15.00%</td>
<td>1.238</td>
<td>1.127</td>
<td>0.330</td>
<td>0.272</td>
<td>0.125</td>
<td>0.122</td>
<td>0.072</td>
<td>98.56%</td>
<td>97.91%</td>
<td>43.97%</td>
</tr>
<tr>
<td>17.50%</td>
<td>1.363</td>
<td>1.226</td>
<td>0.397</td>
<td>0.263</td>
<td>0.158</td>
<td>0.158</td>
<td>0.093</td>
<td>100.00%</td>
<td>100.00%</td>
<td>38.83%</td>
</tr>
<tr>
<td>20.00%</td>
<td>1.624</td>
<td>1.409</td>
<td>0.557</td>
<td>0.251</td>
<td>0.213</td>
<td>0.213</td>
<td>0.125</td>
<td>100.00%</td>
<td>100.00%</td>
<td>29.99%</td>
</tr>
</tbody>
</table>

**Spillover Comparison**

**Dist. Properties**

**Full-Spillover Specification**
## Full-Spillover Results

### Table: Stationary Distribution Results over Taxes with Full-Spillover

<table>
<thead>
<tr>
<th>$\tau$</th>
<th>$Y$</th>
<th>$\bar{C}$</th>
<th>$\bar{H}$</th>
<th>$\bar{L}$</th>
<th>$\bar{E}$</th>
<th>$\bar{E}$</th>
<th>$\bar{Tr}$</th>
<th>$\text{Pop} \cdot \bar{E}$</th>
<th>$\bar{E}/\bar{E}$</th>
<th>$\nu_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00%</td>
<td>2.046</td>
<td>1.756</td>
<td>0.793</td>
<td>0.338</td>
<td>0.290</td>
<td>0.000</td>
<td>0.000</td>
<td>0.00%</td>
<td>0.00%</td>
<td>16.87%</td>
</tr>
<tr>
<td>2.50%</td>
<td>1.935</td>
<td>1.672</td>
<td>0.729</td>
<td>0.325</td>
<td>0.263</td>
<td>0.030</td>
<td>0.018</td>
<td>1.64%</td>
<td>11.65%</td>
<td>18.49%</td>
</tr>
<tr>
<td>5.00%</td>
<td>1.862</td>
<td>1.617</td>
<td>0.696</td>
<td>0.297</td>
<td>0.240</td>
<td>0.061</td>
<td>0.036</td>
<td>16.13%</td>
<td>25.59%</td>
<td>19.53%</td>
</tr>
<tr>
<td>7.50%</td>
<td>1.832</td>
<td>1.596</td>
<td>0.672</td>
<td>0.269</td>
<td>0.234</td>
<td>0.091</td>
<td>0.054</td>
<td>31.58%</td>
<td>39.03%</td>
<td>19.96%</td>
</tr>
<tr>
<td>10.00%</td>
<td>1.807</td>
<td>1.574</td>
<td>0.655</td>
<td>0.249</td>
<td>0.233</td>
<td>0.119</td>
<td>0.070</td>
<td>43.12%</td>
<td>50.89%</td>
<td>20.74%</td>
</tr>
<tr>
<td>12.50%</td>
<td>1.816</td>
<td>1.580</td>
<td>0.658</td>
<td>0.251</td>
<td>0.236</td>
<td>0.148</td>
<td>0.087</td>
<td>53.97%</td>
<td>62.65%</td>
<td>20.52%</td>
</tr>
<tr>
<td>15.00%</td>
<td>1.867</td>
<td>1.605</td>
<td>0.696</td>
<td>0.249</td>
<td>0.263</td>
<td>0.184</td>
<td>0.108</td>
<td>62.21%</td>
<td>70.06%</td>
<td>19.18%</td>
</tr>
<tr>
<td>17.50%</td>
<td>1.980</td>
<td>1.675</td>
<td>0.768</td>
<td>0.244</td>
<td>0.305</td>
<td>0.229</td>
<td>0.135</td>
<td>67.63%</td>
<td>75.05%</td>
<td>17.43%</td>
</tr>
<tr>
<td>20.00%</td>
<td>2.089</td>
<td>1.761</td>
<td>0.849</td>
<td>0.244</td>
<td>0.328</td>
<td>0.274</td>
<td>0.161</td>
<td>72.47%</td>
<td>83.70%</td>
<td>15.41%</td>
</tr>
</tbody>
</table>
# Distributional Properties of Zero-Spillover Model

**Table**: Distributional Properties of the Zero-Spillover Model Specification

<table>
<thead>
<tr>
<th>( \tau )</th>
<th>( GINI_y )</th>
<th>( GINI_{\widetilde{y}} )</th>
<th>( GINI_c )</th>
<th>( GINI_h )</th>
<th>( GINI_l )</th>
<th>( GINI_e )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00%</td>
<td>0.333</td>
<td>0.333</td>
<td>0.343</td>
<td>0.505</td>
<td>0.070</td>
<td>0.296</td>
</tr>
<tr>
<td>2.50%</td>
<td>0.337</td>
<td>0.334</td>
<td>0.339</td>
<td>0.510</td>
<td>0.082</td>
<td>0.317</td>
</tr>
<tr>
<td>5.00%</td>
<td>0.349</td>
<td>0.344</td>
<td>0.324</td>
<td>0.526</td>
<td>0.114</td>
<td>0.407</td>
</tr>
<tr>
<td>7.50%</td>
<td>0.355</td>
<td>0.348</td>
<td>0.313</td>
<td>0.533</td>
<td>0.143</td>
<td>0.435</td>
</tr>
<tr>
<td>10.00%</td>
<td>0.348</td>
<td>0.339</td>
<td>0.304</td>
<td>0.521</td>
<td>0.145</td>
<td>0.337</td>
</tr>
<tr>
<td>12.50%</td>
<td>0.328</td>
<td>0.315</td>
<td>0.295</td>
<td>0.489</td>
<td>0.137</td>
<td>0.112</td>
</tr>
<tr>
<td>15.00%</td>
<td>0.324</td>
<td>0.309</td>
<td>0.293</td>
<td>0.484</td>
<td>0.132</td>
<td>0.047</td>
</tr>
<tr>
<td>17.50%</td>
<td>0.319</td>
<td>0.299</td>
<td>0.291</td>
<td>0.475</td>
<td>0.110</td>
<td>0.001</td>
</tr>
<tr>
<td>20.00%</td>
<td>0.314</td>
<td>0.290</td>
<td>0.290</td>
<td>0.474</td>
<td>0.075</td>
<td>0.000</td>
</tr>
</tbody>
</table>
### Distributional Properties of Full-Spillover Model

**Table:** Distributional Properties of the Full-Spillover Model Specification

<table>
<thead>
<tr>
<th>( \tau )</th>
<th>( GINI_y )</th>
<th>( GINI_{\hat{y}} )</th>
<th>( GINI_c )</th>
<th>( GINI_h )</th>
<th>( GINI_l )</th>
<th>( GINI_e )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00%</td>
<td>0.333</td>
<td>0.333</td>
<td>0.343</td>
<td>0.505</td>
<td>0.070</td>
<td>0.296</td>
</tr>
<tr>
<td>2.50%</td>
<td>0.336</td>
<td>0.333</td>
<td>0.342</td>
<td>0.508</td>
<td>0.079</td>
<td>0.298</td>
</tr>
<tr>
<td>5.00%</td>
<td>0.341</td>
<td>0.335</td>
<td>0.343</td>
<td>0.510</td>
<td>0.093</td>
<td>0.284</td>
</tr>
<tr>
<td>7.50%</td>
<td>0.344</td>
<td>0.336</td>
<td>0.343</td>
<td>0.510</td>
<td>0.107</td>
<td>0.268</td>
</tr>
<tr>
<td>10.00%</td>
<td>0.342</td>
<td>0.330</td>
<td>0.337</td>
<td>0.509</td>
<td>0.100</td>
<td>0.254</td>
</tr>
<tr>
<td>12.50%</td>
<td>0.335</td>
<td>0.318</td>
<td>0.321</td>
<td>0.500</td>
<td>0.068</td>
<td>0.200</td>
</tr>
<tr>
<td>15.00%</td>
<td>0.332</td>
<td>0.312</td>
<td>0.313</td>
<td>0.492</td>
<td>0.060</td>
<td>0.188</td>
</tr>
<tr>
<td>17.50%</td>
<td>0.327</td>
<td>0.303</td>
<td>0.300</td>
<td>0.479</td>
<td>0.048</td>
<td>0.173</td>
</tr>
<tr>
<td>20.00%</td>
<td>0.323</td>
<td>0.296</td>
<td>0.285</td>
<td>0.471</td>
<td>0.041</td>
<td>0.154</td>
</tr>
</tbody>
</table>

**Spillover Comparison**

**Zero-Spillover Specification**

**Full-Spillover Specification**
## Other Comparative Statics

**Table: Other Comparative Statics**

<table>
<thead>
<tr>
<th>Change</th>
<th>Level</th>
<th>U-Shape</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absence of Inborn Shocks</td>
<td>−</td>
<td>Steeper arms</td>
</tr>
<tr>
<td>Persistent Inborn Shocks</td>
<td>−</td>
<td>Slightly steeper arms</td>
</tr>
<tr>
<td>Higher Complementarity</td>
<td>+</td>
<td>Steeper right arm</td>
</tr>
<tr>
<td>Higher Return on Education</td>
<td>+</td>
<td>Slightly flatter arms</td>
</tr>
<tr>
<td>Higher Share of Human Capital</td>
<td>+</td>
<td>Steeper arms</td>
</tr>
<tr>
<td>Higher Altruism</td>
<td>+</td>
<td>Slightly steeper arms</td>
</tr>
<tr>
<td>Higher Redistribution</td>
<td>−</td>
<td>Steeper left arm</td>
</tr>
</tbody>
</table>

▶ **Different Spillover Rates**
Sensitivity Analysis

Table: Absence of Inborn Productivity Shocks ($\sigma_\xi^2 = 0$)

<table>
<thead>
<tr>
<th>$\tau$</th>
<th>$\bar{Y}$</th>
<th>$\bar{C}$</th>
<th>$\bar{H}$</th>
<th>$\bar{L}$</th>
<th>$\bar{E}$</th>
<th>$\bar{E}$</th>
<th>$\bar{E}/\bar{E}$</th>
<th>Pop.$\bar{E}$</th>
<th>$\nu_1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00%</td>
<td>0.818</td>
<td>0.622</td>
<td>0.200</td>
<td>0.342</td>
<td>0.197</td>
<td>0.000</td>
<td>0.00%</td>
<td>0.00%</td>
<td>100.00%</td>
</tr>
<tr>
<td>7.13%</td>
<td>0.586</td>
<td>0.472</td>
<td>0.124</td>
<td>0.311</td>
<td>0.113</td>
<td>0.026</td>
<td>0.015</td>
<td>23.24%</td>
<td>0.00%</td>
</tr>
<tr>
<td>11.96%</td>
<td>0.253</td>
<td>0.234</td>
<td>0.034</td>
<td>0.287</td>
<td>0.019</td>
<td>0.019</td>
<td>0.011</td>
<td>100.00%</td>
<td>100.00%</td>
</tr>
<tr>
<td>20.00%</td>
<td>0.421</td>
<td>0.368</td>
<td>0.080</td>
<td>0.268</td>
<td>0.053</td>
<td>0.053</td>
<td>0.031</td>
<td>100.00%</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

Table: Benchmark Model ($\sigma_\xi^2 = 0.769$)

<table>
<thead>
<tr>
<th>$\tau$</th>
<th>$\bar{Y}$</th>
<th>$\bar{C}$</th>
<th>$\bar{H}$</th>
<th>$\bar{L}$</th>
<th>$\bar{E}$</th>
<th>$\bar{E}$</th>
<th>$\bar{E}/\bar{E}$</th>
<th>Pop.$\bar{E}$</th>
<th>$\nu_1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00%</td>
<td>2.046</td>
<td>1.756</td>
<td>0.793</td>
<td>0.338</td>
<td>0.290</td>
<td>0.000</td>
<td>0.00%</td>
<td>0.00%</td>
<td>16.87%</td>
</tr>
<tr>
<td>7.13%</td>
<td>1.401</td>
<td>1.220</td>
<td>0.424</td>
<td>0.283</td>
<td>0.150</td>
<td>0.067</td>
<td>0.040</td>
<td>44.83%</td>
<td>53.03%</td>
</tr>
<tr>
<td>11.96%</td>
<td>1.268</td>
<td>1.128</td>
<td>0.355</td>
<td>0.270</td>
<td>0.126</td>
<td>0.099</td>
<td>0.058</td>
<td>78.54%</td>
<td>85.25%</td>
</tr>
<tr>
<td>20.00%</td>
<td>1.624</td>
<td>1.409</td>
<td>0.557</td>
<td>0.251</td>
<td>0.213</td>
<td>0.213</td>
<td>0.126</td>
<td>100.00%</td>
<td>29.99%</td>
</tr>
</tbody>
</table>

Comparative Statics
## Sensitivity Analysis

**Table:** Persistent Inborn Productivity Shocks ($\kappa = 0.40, \sigma_\xi^2 = 0.915$)

<table>
<thead>
<tr>
<th>$\tau$</th>
<th>$\bar{Y}$</th>
<th>$\bar{C}$</th>
<th>$\bar{H}$</th>
<th>$\bar{L}$</th>
<th>$\bar{E}$</th>
<th>$\bar{\mathcal{E}}$</th>
<th>$\bar{\mathcal{E}} / \bar{\mathcal{E}}$</th>
<th>Pop.$\bar{\mathcal{E}}$</th>
<th>$\nu_l$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00%</td>
<td>2.012</td>
<td>1.736</td>
<td>0.759</td>
<td>0.351</td>
<td>0.276</td>
<td>0.000</td>
<td>0.000</td>
<td>0.00%</td>
<td>16.99%</td>
</tr>
<tr>
<td>7.13%</td>
<td>1.318</td>
<td>1.177</td>
<td>0.378</td>
<td>0.290</td>
<td>0.141</td>
<td>0.059</td>
<td>0.035</td>
<td>41.98%</td>
<td>49.12%</td>
</tr>
<tr>
<td>11.96%</td>
<td>1.135</td>
<td>1.018</td>
<td>0.311</td>
<td>0.256</td>
<td>0.117</td>
<td>0.083</td>
<td>0.049</td>
<td>71.16%</td>
<td>77.84%</td>
</tr>
<tr>
<td>20.00%</td>
<td>1.537</td>
<td>1.339</td>
<td>0.508</td>
<td>0.224</td>
<td>0.197</td>
<td>0.196</td>
<td>0.135</td>
<td>100.00%</td>
<td>32.14%</td>
</tr>
</tbody>
</table>

**Table:** Benchmark Model ($\kappa = 0, \sigma_\xi^2 = 0.769$)

<table>
<thead>
<tr>
<th>$\tau$</th>
<th>$\bar{Y}$</th>
<th>$\bar{C}$</th>
<th>$\bar{H}$</th>
<th>$\bar{L}$</th>
<th>$\bar{E}$</th>
<th>$\bar{\mathcal{E}}$</th>
<th>$\bar{\mathcal{E}} / \bar{\mathcal{E}}$</th>
<th>Pop.$\bar{\mathcal{E}}$</th>
<th>$\nu_l$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00%</td>
<td>2.046</td>
<td>1.756</td>
<td>0.793</td>
<td>0.338</td>
<td>0.290</td>
<td>0.000</td>
<td>0.000</td>
<td>0.00%</td>
<td>16.87%</td>
</tr>
<tr>
<td>7.13%</td>
<td>1.401</td>
<td>1.220</td>
<td>0.424</td>
<td>0.283</td>
<td>0.150</td>
<td>0.067</td>
<td>0.040</td>
<td>44.83%</td>
<td>53.03%</td>
</tr>
<tr>
<td>11.96%</td>
<td>1.268</td>
<td>1.128</td>
<td>0.355</td>
<td>0.270</td>
<td>0.126</td>
<td>0.099</td>
<td>0.058</td>
<td>78.54%</td>
<td>85.25%</td>
</tr>
<tr>
<td>20.00%</td>
<td>1.624</td>
<td>1.409</td>
<td>0.557</td>
<td>0.251</td>
<td>0.213</td>
<td>0.213</td>
<td>0.126</td>
<td>100.00%</td>
<td>29.99%</td>
</tr>
</tbody>
</table>
### Sensitivity Analysis

#### Table: Higher Complementarity ($\gamma = 0.00$)

<table>
<thead>
<tr>
<th>$\tau$</th>
<th>$\bar{Y}$</th>
<th>$\bar{C}$</th>
<th>$\bar{H}$</th>
<th>$\bar{L}$</th>
<th>$\bar{E}$</th>
<th>$\bar{E}$</th>
<th>$\bar{Tr}$</th>
<th>$\bar{E}/\bar{E}$</th>
<th>$\text{Pop.} \bar{E}$</th>
<th>$\nu_l$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00%</td>
<td>2.361</td>
<td>2.039</td>
<td>0.996</td>
<td>0.345</td>
<td>0.321</td>
<td>0.000</td>
<td>0.000</td>
<td>0.00%</td>
<td>0.00%</td>
<td>11.71%</td>
</tr>
<tr>
<td>7.13%</td>
<td>1.442</td>
<td>1.281</td>
<td>0.444</td>
<td>0.285</td>
<td>0.133</td>
<td>0.068</td>
<td>0.040</td>
<td>50.74%</td>
<td>58.56%</td>
<td>31.30%</td>
</tr>
<tr>
<td>11.96%</td>
<td>1.388</td>
<td>1.251</td>
<td>0.416</td>
<td>0.277</td>
<td>0.127</td>
<td>0.110</td>
<td>0.064</td>
<td>86.31%</td>
<td>90.41%</td>
<td>37.47%</td>
</tr>
<tr>
<td>20.00%</td>
<td>1.936</td>
<td>1.682</td>
<td>0.759</td>
<td>0.293</td>
<td>0.254</td>
<td>0.254</td>
<td>0.149</td>
<td>100.00%</td>
<td>100.00%</td>
<td>21.44%</td>
</tr>
</tbody>
</table>

#### Table: Benchmark Model ($\gamma = 0.20$)

<table>
<thead>
<tr>
<th>$\tau$</th>
<th>$\bar{Y}$</th>
<th>$\bar{C}$</th>
<th>$\bar{H}$</th>
<th>$\bar{L}$</th>
<th>$\bar{E}$</th>
<th>$\bar{E}$</th>
<th>$\bar{Tr}$</th>
<th>$\bar{E}/\bar{E}$</th>
<th>$\text{Pop.} \bar{E}$</th>
<th>$\nu_l$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00%</td>
<td>2.046</td>
<td>1.756</td>
<td>0.793</td>
<td>0.338</td>
<td>0.290</td>
<td>0.000</td>
<td>0.000</td>
<td>0.00%</td>
<td>0.00%</td>
<td>16.87%</td>
</tr>
<tr>
<td>7.13%</td>
<td>1.401</td>
<td>1.220</td>
<td>0.424</td>
<td>0.283</td>
<td>0.150</td>
<td>0.067</td>
<td>0.040</td>
<td>44.83%</td>
<td>53.03%</td>
<td>29.88%</td>
</tr>
<tr>
<td>11.96%</td>
<td>1.268</td>
<td>1.128</td>
<td>0.355</td>
<td>0.270</td>
<td>0.126</td>
<td>0.099</td>
<td>0.058</td>
<td>78.54%</td>
<td>85.25%</td>
<td>42.75%</td>
</tr>
<tr>
<td>20.00%</td>
<td>1.624</td>
<td>1.409</td>
<td>0.557</td>
<td>0.251</td>
<td>0.213</td>
<td>0.213</td>
<td>0.126</td>
<td>100.00%</td>
<td>100.00%</td>
<td>29.99%</td>
</tr>
</tbody>
</table>

[Comparative Statics]
## Sensitivity Analysis

**Table:** Higher Return on Education \( (\varepsilon = 0.33) \)

<table>
<thead>
<tr>
<th>( \tau )</th>
<th>( \overline{Y} )</th>
<th>( \overline{C} )</th>
<th>( \overline{H} )</th>
<th>( \overline{L} )</th>
<th>( \overline{E} )</th>
<th>( \overline{E} )</th>
<th>( \overline{E}/\overline{E} )</th>
<th>( \text{Pop.}_\overline{E} )</th>
<th>( \nu_l )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00%</td>
<td>2.111</td>
<td>1.783</td>
<td>0.835</td>
<td>0.343</td>
<td>0.328</td>
<td>0.000</td>
<td>0.000</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>7.13%</td>
<td>1.555</td>
<td>1.322</td>
<td>0.511</td>
<td>0.295</td>
<td>0.192</td>
<td>0.073</td>
<td>0.043</td>
<td>38.06%</td>
<td>42.14%</td>
</tr>
<tr>
<td>11.96%</td>
<td>1.321</td>
<td>1.186</td>
<td>0.367</td>
<td>0.274</td>
<td>0.135</td>
<td>0.100</td>
<td>0.059</td>
<td>74.39%</td>
<td>82.01%</td>
</tr>
<tr>
<td>20.00%</td>
<td>1.697</td>
<td>1.492</td>
<td>0.591</td>
<td>0.288</td>
<td>0.206</td>
<td>0.206</td>
<td>0.121</td>
<td>99.50%</td>
<td>99.50%</td>
</tr>
</tbody>
</table>

---

**Table:** Benchmark Model \( (\varepsilon = 0.30) \)

<table>
<thead>
<tr>
<th>( \tau )</th>
<th>( \overline{Y} )</th>
<th>( \overline{C} )</th>
<th>( \overline{H} )</th>
<th>( \overline{L} )</th>
<th>( \overline{E} )</th>
<th>( \overline{E} )</th>
<th>( \overline{E}/\overline{E} )</th>
<th>( \text{Pop.}_\overline{E} )</th>
<th>( \nu_l )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00%</td>
<td>2.046</td>
<td>1.756</td>
<td>0.793</td>
<td>0.338</td>
<td>0.290</td>
<td>0.000</td>
<td>0.000</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>7.13%</td>
<td>1.401</td>
<td>1.220</td>
<td>0.424</td>
<td>0.283</td>
<td>0.150</td>
<td>0.067</td>
<td>0.040</td>
<td>44.83%</td>
<td>53.03%</td>
</tr>
<tr>
<td>11.96%</td>
<td>1.268</td>
<td>1.128</td>
<td>0.355</td>
<td>0.270</td>
<td>0.126</td>
<td>0.099</td>
<td>0.058</td>
<td>78.54%</td>
<td>85.25%</td>
</tr>
<tr>
<td>20.00%</td>
<td>1.624</td>
<td>1.409</td>
<td>0.557</td>
<td>0.251</td>
<td>0.213</td>
<td>0.213</td>
<td>0.126</td>
<td>100.00%</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

[Comparative Statics]
Sensitivity Analysis

Table: Higher Share of Human Capital ($\lambda = 0.6875$)

<table>
<thead>
<tr>
<th>$\tau$</th>
<th>$\bar{Y}$</th>
<th>$\bar{C}$</th>
<th>$\bar{H}$</th>
<th>$\bar{L}$</th>
<th>$\bar{E}$</th>
<th>$\bar{E}$</th>
<th>$\bar{T}_r$</th>
<th>$\bar{E}/\bar{E}$</th>
<th>$\text{Pop} \cdot \bar{E}$</th>
<th>$\iota_1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00%</td>
<td>2.111</td>
<td>1.783</td>
<td>0.835</td>
<td>0.343</td>
<td>0.328</td>
<td>0.000</td>
<td>0.000</td>
<td>0.00%</td>
<td>0.00%</td>
<td>15.64%</td>
</tr>
<tr>
<td>7.13%</td>
<td>1.555</td>
<td>1.322</td>
<td>0.511</td>
<td>0.295</td>
<td>0.192</td>
<td>0.073</td>
<td>0.043</td>
<td>38.06%</td>
<td>42.14%</td>
<td>24.94%</td>
</tr>
<tr>
<td>11.96%</td>
<td>1.321</td>
<td>1.186</td>
<td>0.367</td>
<td>0.274</td>
<td>0.135</td>
<td>0.100</td>
<td>0.059</td>
<td>74.39%</td>
<td>82.01%</td>
<td>36.68%</td>
</tr>
<tr>
<td>20.00%</td>
<td>1.697</td>
<td>1.492</td>
<td>0.591</td>
<td>0.288</td>
<td>0.206</td>
<td>0.206</td>
<td>0.121</td>
<td>99.50%</td>
<td>99.50%</td>
<td>25.15%</td>
</tr>
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</table>

Table: Benchmark Model ($\lambda = 0.625$)

<table>
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<tr>
<th>$\tau$</th>
<th>$\bar{Y}$</th>
<th>$\bar{C}$</th>
<th>$\bar{H}$</th>
<th>$\bar{L}$</th>
<th>$\bar{E}$</th>
<th>$\bar{E}$</th>
<th>$\bar{T}_r$</th>
<th>$\bar{E}/\bar{E}$</th>
<th>$\text{Pop} \cdot \bar{E}$</th>
<th>$\iota_1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00%</td>
<td>2.046</td>
<td>1.756</td>
<td>0.793</td>
<td>0.338</td>
<td>0.290</td>
<td>0.000</td>
<td>0.000</td>
<td>0.00%</td>
<td>0.00%</td>
<td>16.87%</td>
</tr>
<tr>
<td>7.13%</td>
<td>1.401</td>
<td>1.220</td>
<td>0.424</td>
<td>0.283</td>
<td>0.150</td>
<td>0.067</td>
<td>0.040</td>
<td>44.83%</td>
<td>53.03%</td>
<td>29.88%</td>
</tr>
<tr>
<td>11.96%</td>
<td>1.268</td>
<td>1.128</td>
<td>0.355</td>
<td>0.270</td>
<td>0.126</td>
<td>0.099</td>
<td>0.058</td>
<td>78.54%</td>
<td>85.25%</td>
<td>42.75%</td>
</tr>
<tr>
<td>20.00%</td>
<td>1.624</td>
<td>1.409</td>
<td>0.557</td>
<td>0.251</td>
<td>0.213</td>
<td>0.213</td>
<td>0.126</td>
<td>100.00%</td>
<td>100.00%</td>
<td>29.99%</td>
</tr>
</tbody>
</table>

Comparative Statics
Sensitivity Analysis

Table: Higher Altruism ($\rho = 0.88$)

<table>
<thead>
<tr>
<th>$\tau$</th>
<th>$\bar{Y}$</th>
<th>$\bar{C}$</th>
<th>$\bar{H}$</th>
<th>$\bar{L}$</th>
<th>$\bar{E}$</th>
<th>$\bar{E}$</th>
<th>$\bar{T}_{\bar{E}}$</th>
<th>$\bar{E}/\bar{E}$</th>
<th>$\text{Pop} \cdot \bar{E}$</th>
<th>$\nu_{l}$</th>
</tr>
</thead>
<tbody>
<tr>
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<td>2.355</td>
<td>1.978</td>
<td>1.000</td>
<td>0.353</td>
<td>0.377</td>
<td>0.000</td>
<td>0.000</td>
<td>0.00%</td>
<td>0.00%</td>
<td>12.99%</td>
</tr>
<tr>
<td>7.13%</td>
<td>1.743</td>
<td>1.465</td>
<td>0.620</td>
<td>0.307</td>
<td>0.225</td>
<td>0.080</td>
<td>0.047</td>
<td>35.53%</td>
<td>39.28%</td>
<td>20.54%</td>
</tr>
<tr>
<td>11.96%</td>
<td>1.415</td>
<td>1.233</td>
<td>0.433</td>
<td>0.280</td>
<td>0.157</td>
<td>0.111</td>
<td>0.065</td>
<td>70.62%</td>
<td>79.25%</td>
<td>32.03%</td>
</tr>
<tr>
<td>20.00%</td>
<td>1.663</td>
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<td>0.286</td>
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<td>0.215</td>
<td>0.126</td>
<td>97.93%</td>
<td>98.42%</td>
<td>27.62%</td>
</tr>
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</table>

Table: Benchmark Model ($\rho = 0.80$)

<table>
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<tr>
<th>$\tau$</th>
<th>$\bar{Y}$</th>
<th>$\bar{C}$</th>
<th>$\bar{H}$</th>
<th>$\bar{L}$</th>
<th>$\bar{E}$</th>
<th>$\bar{E}$</th>
<th>$\bar{T}_{\bar{E}}$</th>
<th>$\bar{E}/\bar{E}$</th>
<th>$\text{Pop} \cdot \bar{E}$</th>
<th>$\nu_{l}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00%</td>
<td>2.046</td>
<td>1.756</td>
<td>0.793</td>
<td>0.338</td>
<td>0.290</td>
<td>0.000</td>
<td>0.000</td>
<td>0.00%</td>
<td>0.00%</td>
<td>16.87%</td>
</tr>
<tr>
<td>7.13%</td>
<td>1.401</td>
<td>1.220</td>
<td>0.424</td>
<td>0.283</td>
<td>0.150</td>
<td>0.067</td>
<td>0.040</td>
<td>44.83%</td>
<td>53.03%</td>
<td>29.88%</td>
</tr>
<tr>
<td>11.96%</td>
<td>1.268</td>
<td>1.128</td>
<td>0.355</td>
<td>0.270</td>
<td>0.126</td>
<td>0.099</td>
<td>0.058</td>
<td>78.54%</td>
<td>85.25%</td>
<td>42.75%</td>
</tr>
<tr>
<td>20.00%</td>
<td>1.624</td>
<td>1.409</td>
<td>0.557</td>
<td>0.251</td>
<td>0.213</td>
<td>0.213</td>
<td>0.126</td>
<td>100.00%</td>
<td>100.00%</td>
<td>29.99%</td>
</tr>
</tbody>
</table>

Comparative Statics
Sensitivity Analysis

**Table:** Higher Share of Redistribution ($\psi = 0.407$)

<table>
<thead>
<tr>
<th>$\tau$</th>
<th>$\Upsilon$</th>
<th>$\bar{C}$</th>
<th>$\bar{H}$</th>
<th>$\bar{L}$</th>
<th>$\bar{E}$</th>
<th>$\bar{E}$</th>
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<th>Pop.$\cdot$$\bar{E}$</th>
<th>$\nu_l$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00%</td>
<td>2.046</td>
<td>1.756</td>
<td>0.793</td>
<td>0.338</td>
<td>0.290</td>
<td>0.000</td>
<td>0.00%</td>
<td>0.00%</td>
<td>16.87%</td>
</tr>
<tr>
<td>7.13%</td>
<td>1.159</td>
<td>1.043</td>
<td>0.403</td>
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<td>0.116</td>
<td>0.054</td>
<td>46.55%</td>
<td>53.45%</td>
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<td>0.337</td>
<td>0.256</td>
<td>0.106</td>
<td>0.090</td>
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<td>89.62%</td>
<td>44.02%</td>
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<td>0.196</td>
<td>100.00%</td>
<td>100.00%</td>
<td>31.50%</td>
</tr>
</tbody>
</table>

**Table:** Benchmark Model ($\psi = 0.370$)

<table>
<thead>
<tr>
<th>$\tau$</th>
<th>$\Upsilon$</th>
<th>$\bar{C}$</th>
<th>$\bar{H}$</th>
<th>$\bar{L}$</th>
<th>$\bar{E}$</th>
<th>$\bar{E}$</th>
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<td>0.00%</td>
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<td>1.756</td>
<td>0.793</td>
<td>0.338</td>
<td>0.290</td>
<td>0.000</td>
<td>0.00%</td>
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<td>1.128</td>
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<td>0.099</td>
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<td>0.557</td>
<td>0.251</td>
<td>0.213</td>
<td>0.126</td>
<td>100.00%</td>
<td>100.00%</td>
<td>29.99%</td>
</tr>
</tbody>
</table>

*Comparative Statics*