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

	Tax Revenue (% of GDP)	Share of Public Edu. & Health Care Expenditure	Post-tax Income GINI	Share w. Belief that Luck is Pivotal
U.S.	26.9%	44.8%	0.378	29.9%
Europe	39.9%	78.6%	0.289	42.8%

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

▸ % Tax ▸ % Public ▸ GINI ▸ % Luck

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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Literature

Redistributive Policy Literature:

- **Behavioral Explanations**
  - Alesina and Angeletos (2005,AER), Bénabou and Tirole (2006,QJE)
- Economic Explanations
  - Bénabou and Ok (2001,QJE), Alesina and Glaeser (2004,*Oxford Press*), Piketty (1995,QJE), Hassler *et al.* (2003,AER)
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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
  - High tax and high public school provision to minimize differences due to skill, education and hours worked & magnify the role of luck

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- 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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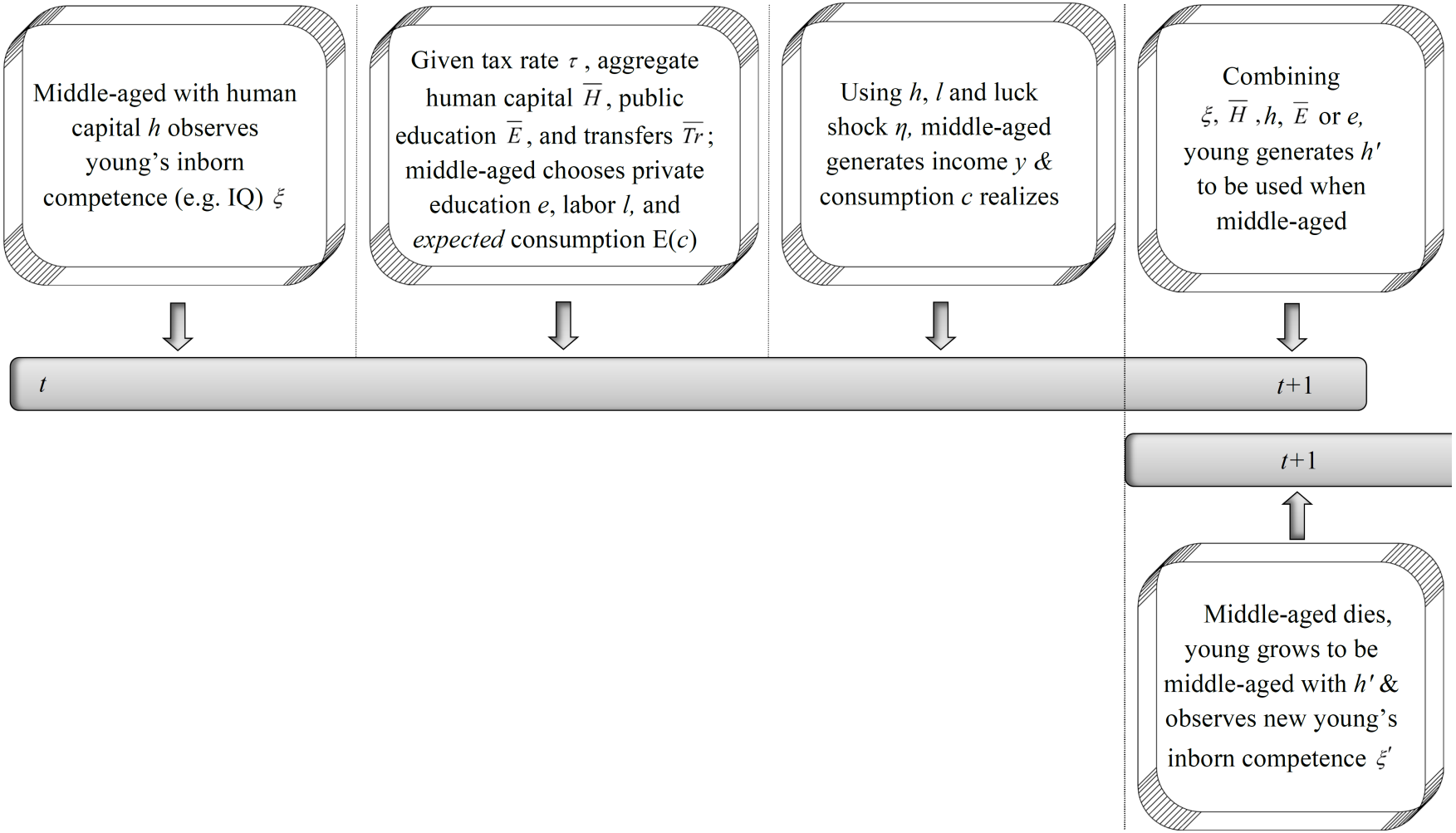
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Timeline of the Model



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 τ, $\tilde{I}(h,\xi;\overline{H},\overline{E},\overline{Tr},\tau)$ 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:

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subject to

$$y=\Theta I^{(1-\lambda)}h^{\lambda}+\eta \tag{2}$$

$$c=(1-\tau)y+\overline{Tr}-e \tag{3}$$

$$e\geq 0 \tag{4}$$

$$h'=\begin{cases}\xi(\overline{E})^{\varepsilon}h^{(1-\varepsilon)\gamma}\overline{H}^{(1-\varepsilon)(1-\gamma)} & e=0\\ \xi(e+\nu\overline{E})^{\varepsilon}h^{(1-\varepsilon)\gamma}\overline{H}^{(1-\varepsilon)(1-\gamma)} & e>0\end{cases} \tag{5}$$

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$$\log(\xi)\sim N(0,\sigma_{\xi}^{2}) \tag{6}$$

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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 τ, $\tilde{I}(h,\xi;\overline{H},\overline{E},\overline{Tr},\tau)$ 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:

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

subject to

$$y=\Theta I^{(1-\lambda)}h^{\lambda}+\eta \tag{2}$$

$$c=(1-\tau)y+\overline{Tr}-e \tag{3}$$

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$$\mu(h',\xi';\overline{H},\overline{E},\overline{Tr},\tau)=\sum_{\xi'}\int_{\mathcal{H}\times\Xi}\chi_{\{\tilde{h}(h,\xi;\overline{H},\overline{E},\overline{Tr},\tau)=h'\}}\pi(\xi',\xi)d\mu(h,\xi;\overline{H},\overline{E},\overline{Tr},\tau) \tag{8}$$

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

$$\overline{E}(\tau)+\overline{Tr}(\tau)=\overline{T}(\tau)=\int_{\mathcal{H}\times\Xi}\tau y d\mu(h,\xi;\overline{H},\overline{E},\overline{Tr},\tau) \tag{9}$$

$$\overline{Tr}(\tau)=\psi\overline{T}(\tau) \tag{10}$$

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4. Variable definitions and expectations hold:

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

$$\sigma^2_L = \sigma^2_\eta \tag{16}$$

$$\sigma^2_F(\tau) = \sigma^2_Y(\tau) - \sigma^2_L \tag{17}$$

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

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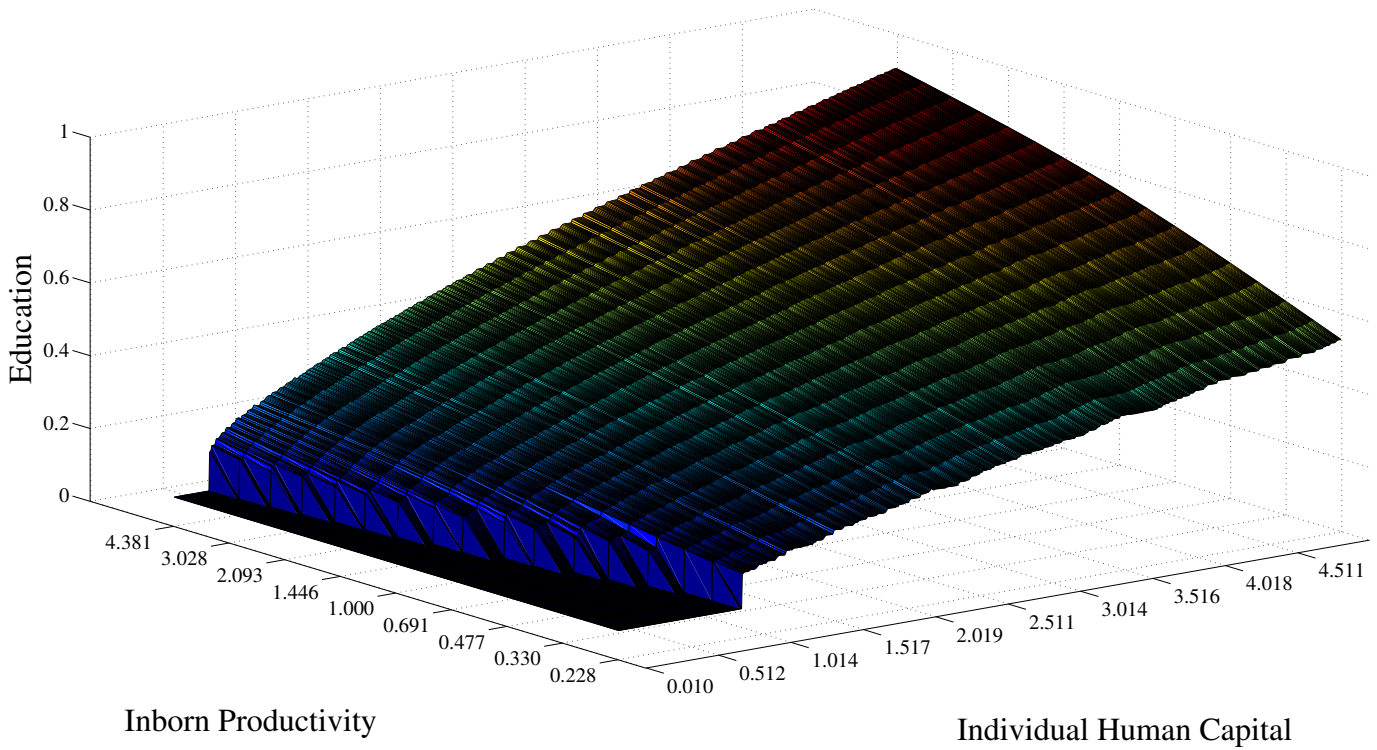
Calibration

Table: Benchmark Parameter Values

λ	0.625	Bénabou (2002, ECTA)
γ	0.200	Zhang (2005, JEDC)
ρ	0.800	Zhang (2005, JEDC)
ε	0.300	Bénabou (2002, ECTA) & Zhang (2005, JEDC)
σ_η^2	0.259	Heathcote *et al.* (2010, RED)
ν	0.500	Neutral Stance from Two Polar Cases
ψ	0.370	US Redistribution Share (OECD Database, 2008)
ω	0.500	Frisch Elasticity=2 ($u(c) + v(1-l) = \log(c) - \phi\frac{l^{1+\omega}}{1+\omega}$)
ϕ	0.513	Calibrated to Match US Labor=0.287
σ_ξ^2	0.769	Calibrated to Match $\iota_l^{US} = 29.88\%$
Θ	3.345	Calibrated to Match $\iota_L^{EU} = 42.75\%$
τ^{US}	7.13%	Calibrated to Match $\overline{E}^{US}/\overline{\mathcal{E}}^{US} = 44.83\%$
τ^{EU}	11.96%	Calibrated to Match $\overline{E}^{EU}/\overline{\mathcal{E}}^{EU} = 78.54\%$

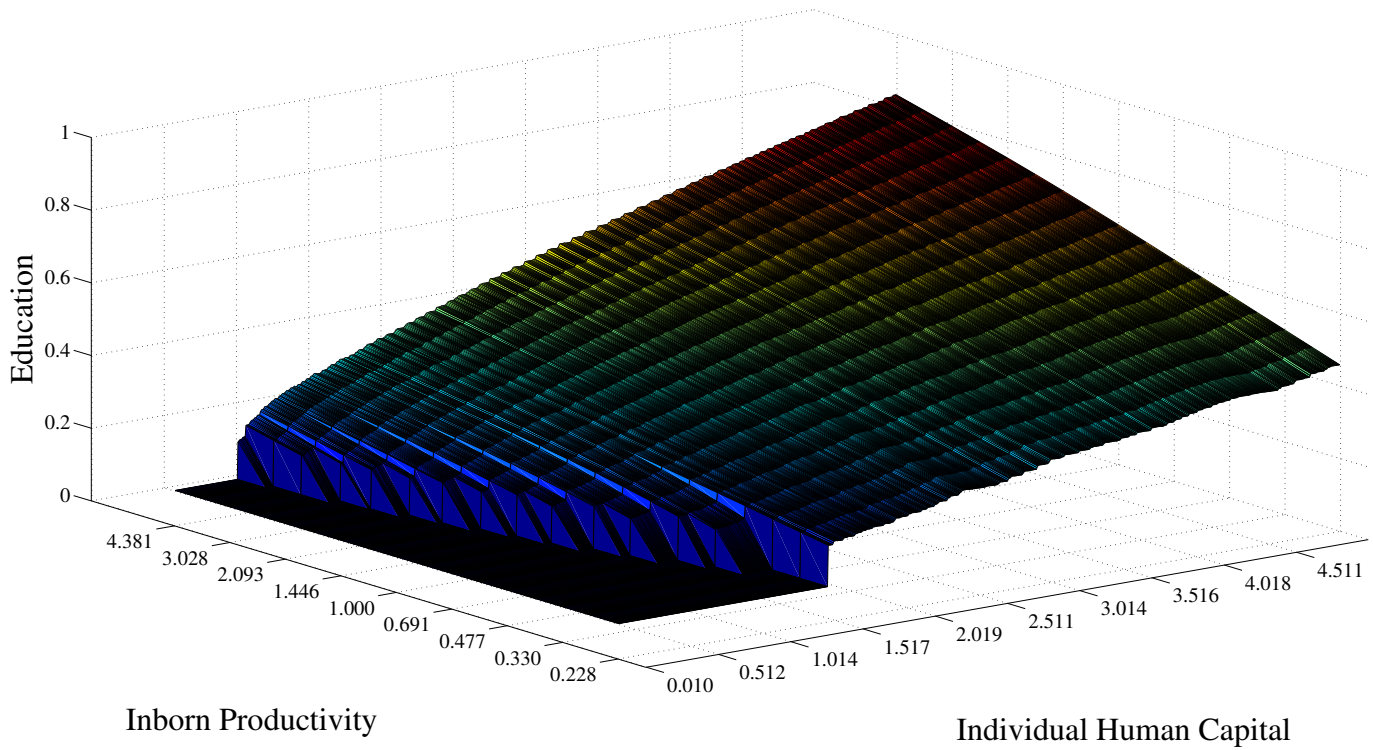
Education Decision Rule

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



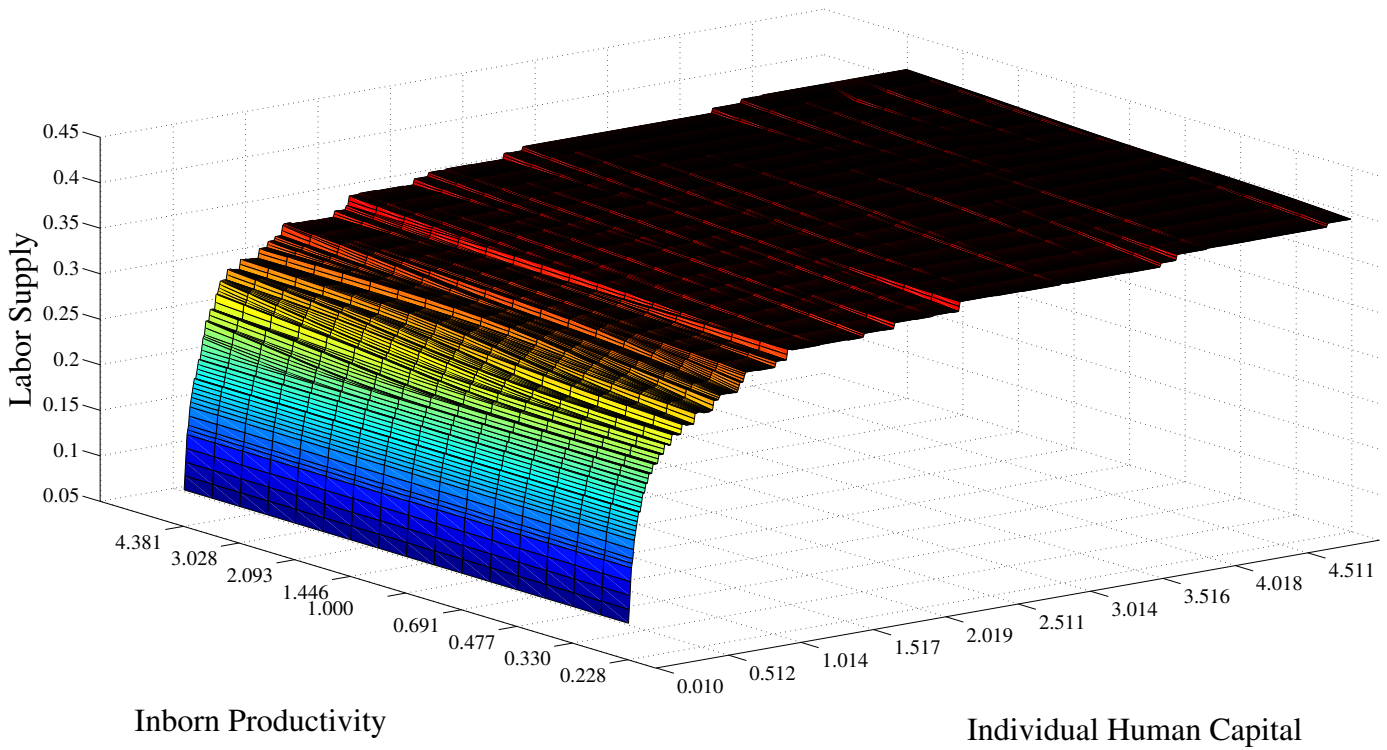
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Figure: Education Decision Rule When $\tau = 11.96\%$



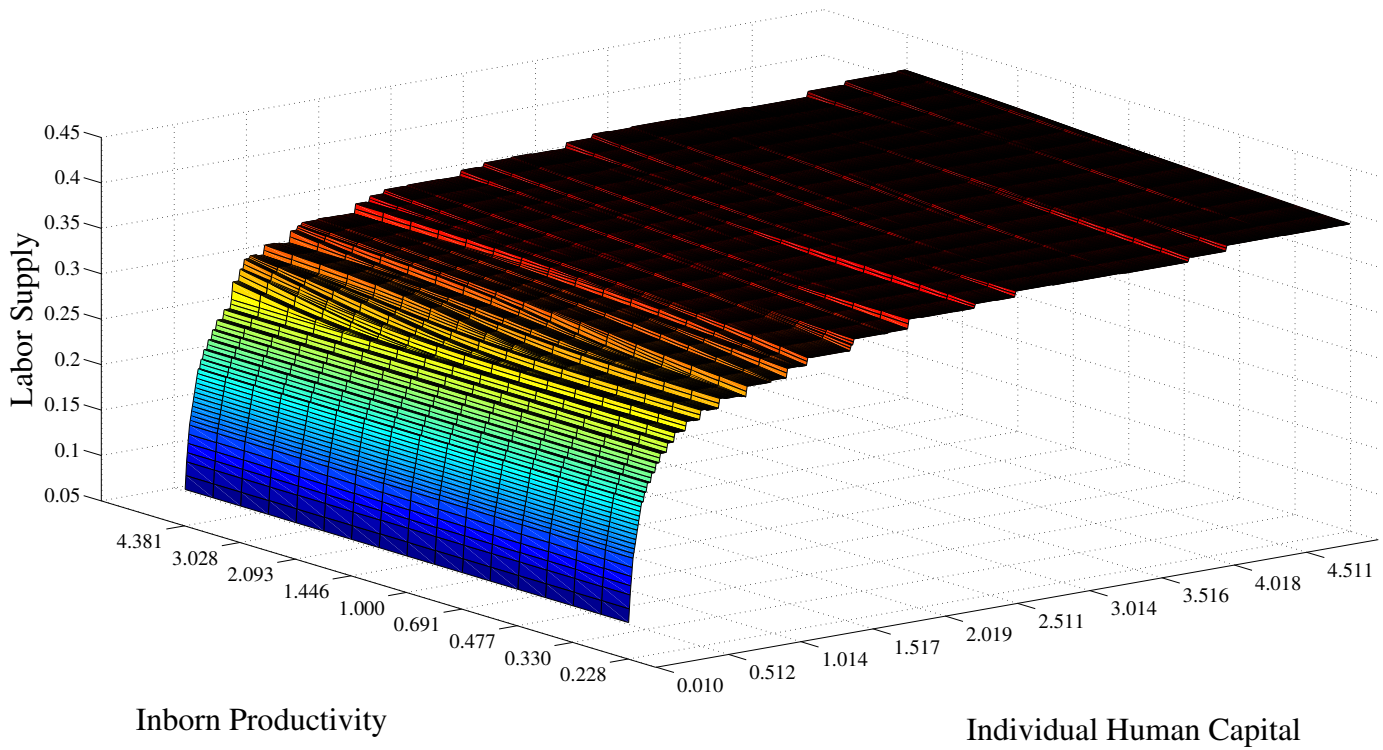
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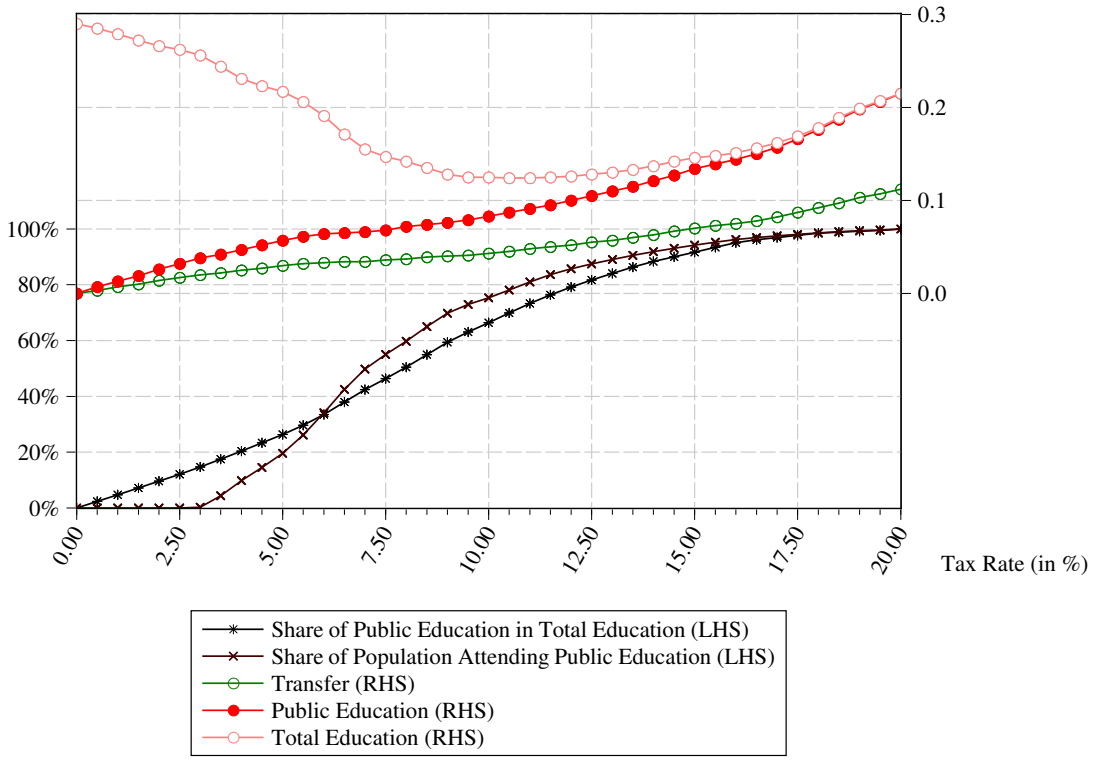


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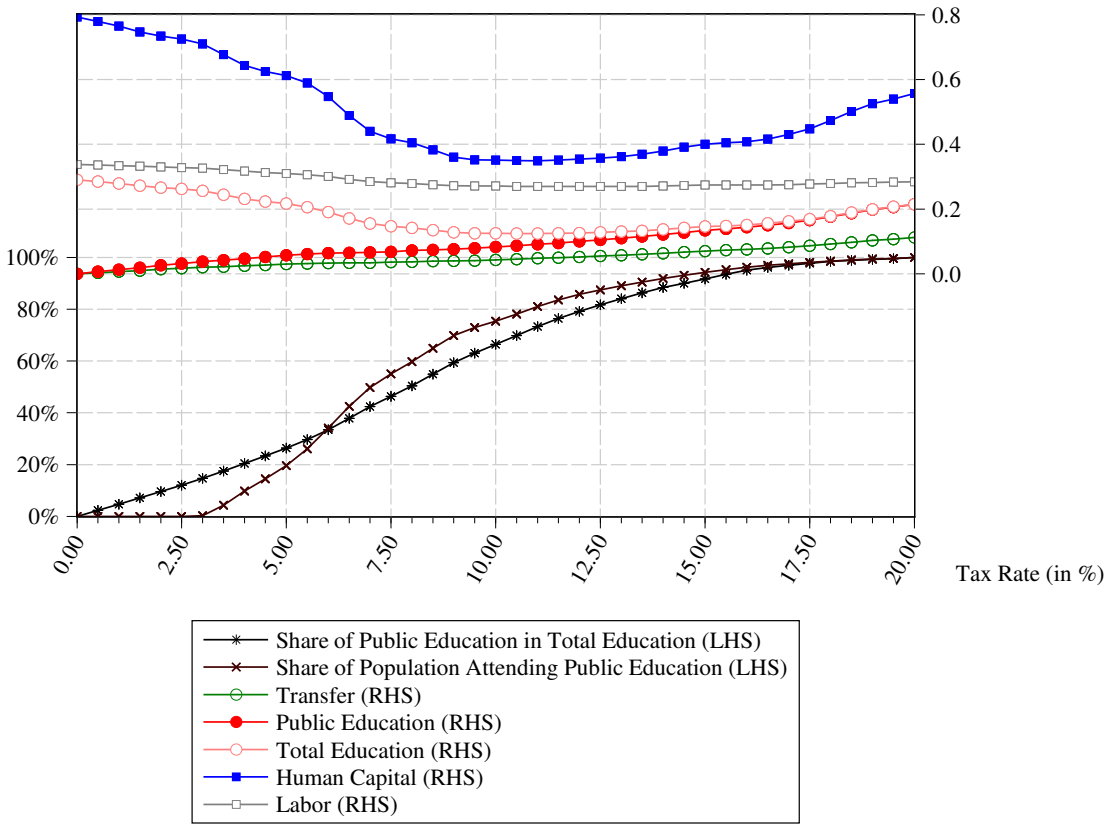
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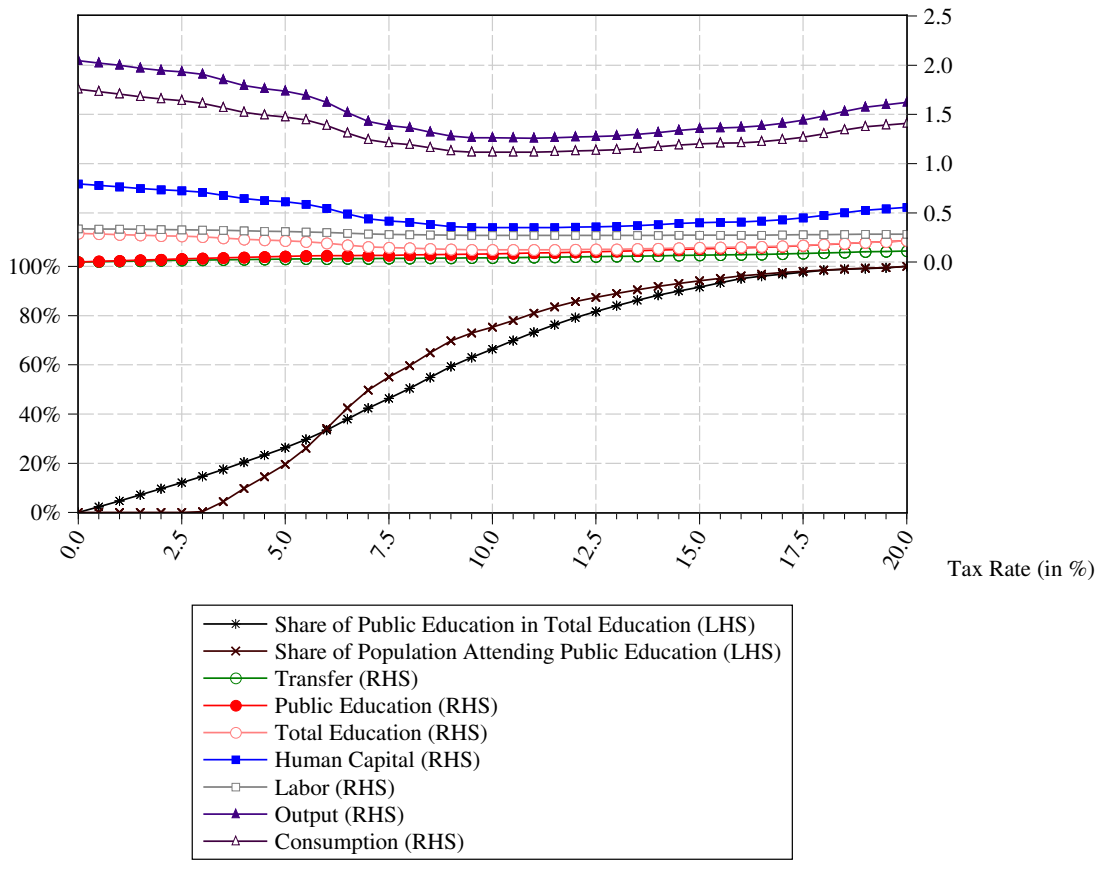
Benchmark Results



Benchmark Results



Benchmark Results



Why the U-Shape?

Four competing factors:

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

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Benchmark Results

Table: Stationary Distribution Results over Taxes

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

▸ Distributional Properties of the Model

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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  - On the left arm decreasing output over taxes $\uparrow$ share of luck
  - On the right arm increasing output over taxes $\downarrow$ share of luck

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
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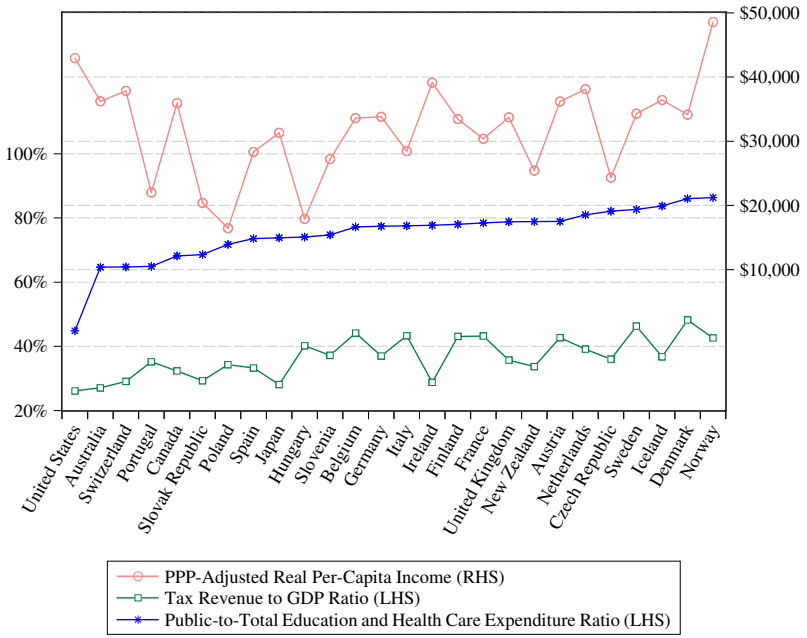
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Model Fit

Table: Comparison of Model with Data

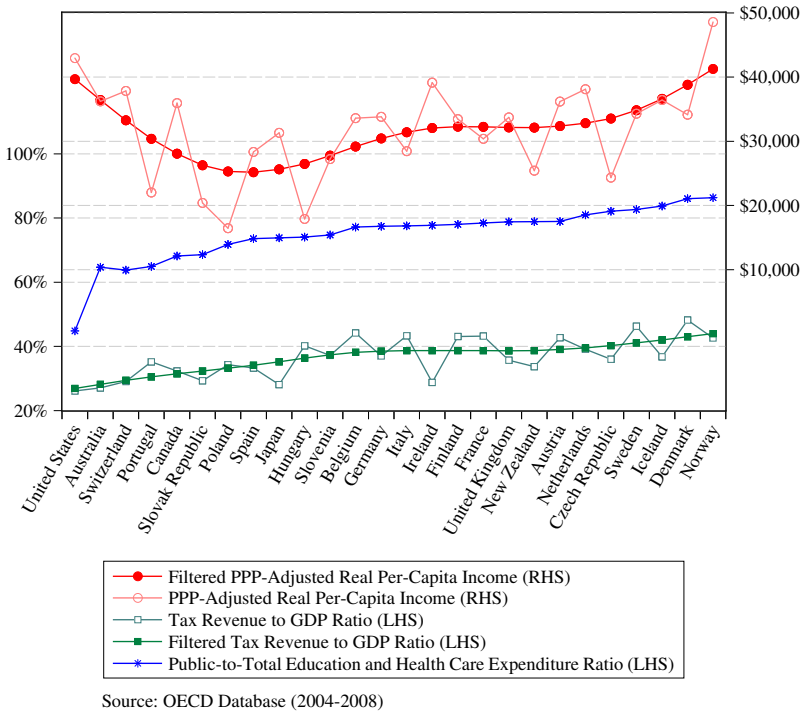
	Country	$\overline{\tau}$	$\overline{E}/\overline{\mathcal{E}}$	ι_L	$\overline{Y}/\overline{Y}^{US}$	$\overline{L}$	GINI(y)	GINI($\widehat{y}$)	GINI(e)
Data	U.S.	12.02%	44.83%	29.88%	1.000	0.287	0.486	0.378	N/A (+)
	Europe	21.19%	78.54%	42.75%	0.815	0.257	0.449	0.290	N/A (−)
Model	U.S.	7.13%	44.83%	29.88%	1.000	0.283	0.353	0.345	0.369
	Europe	11.96%	78.54%	42.75%	0.910	0.270	0.338	0.324	0.190

Tax, Output and Public Education Share by Country



Source: OECD Database (2004-2008)

Tax, Output and Public Education Share by Country



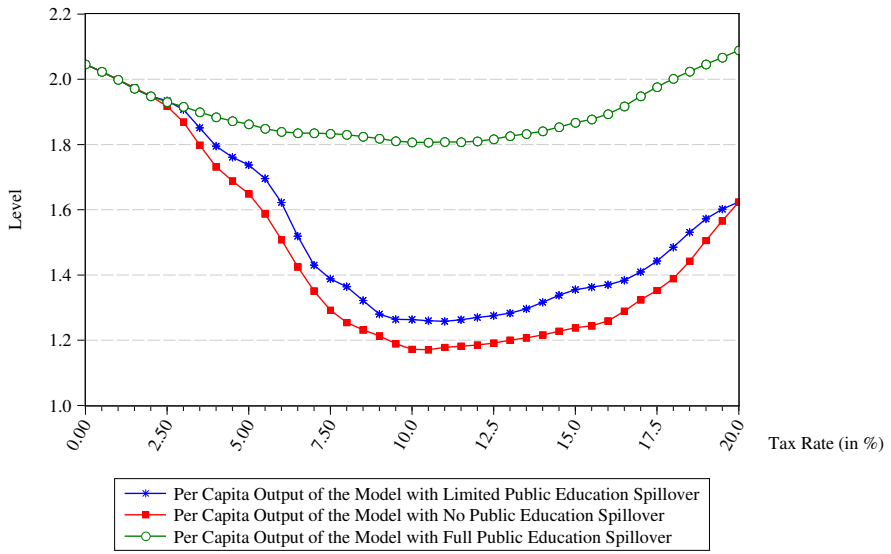
Source: OECD Database (2004-2008)

$$\frac{\overline{E_i}}{\mathcal{E}_i} = 0.398 + 0.957\tau_i \quad p = 0.0001$$

▸ Model Fit of Output ▸ Model Fit of Taxes ▸ Model Fit of Perceptions

Different Spillover Rates

Figure: Per-Capita Output with Different Spillover Rates

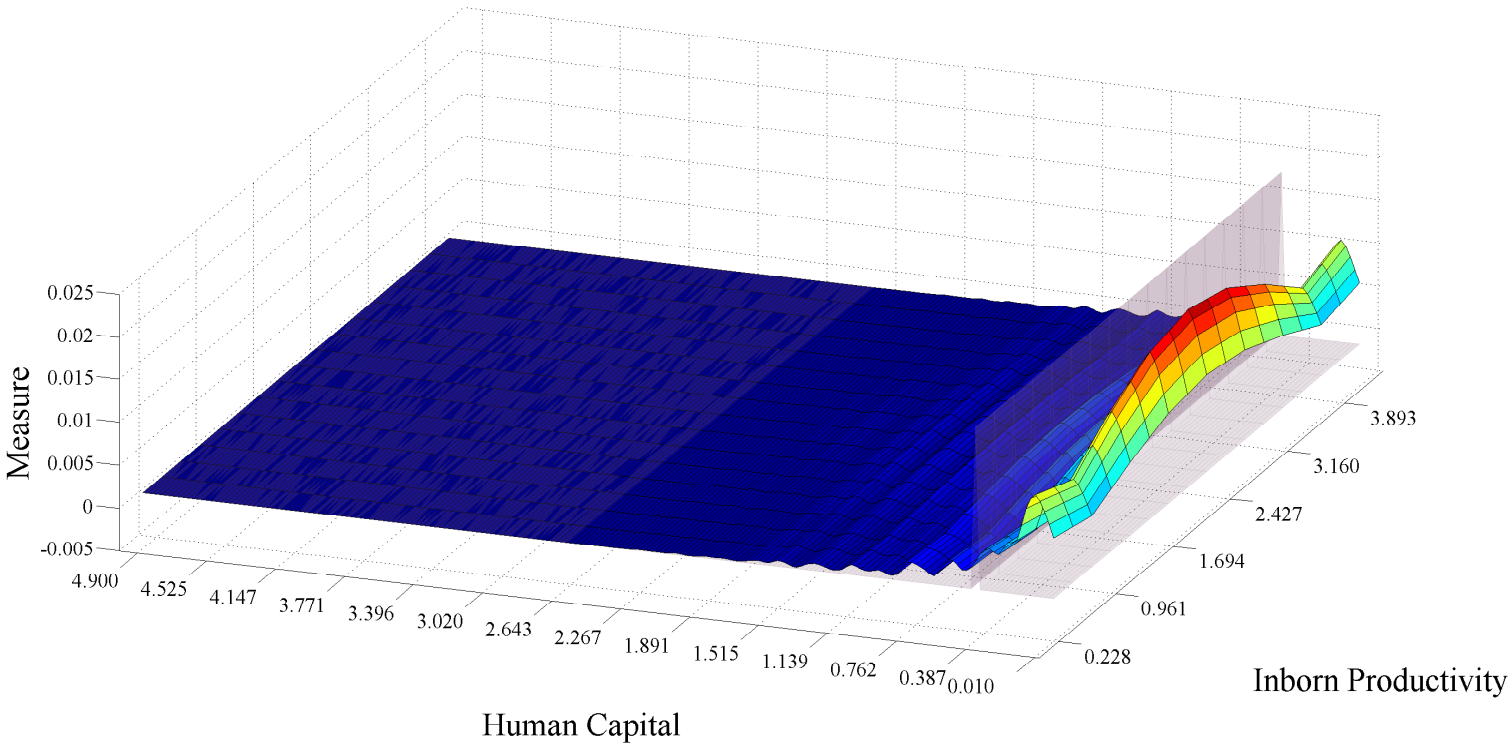


▸ Zero-Spillover Specification ▸ Full-Spillover Specification

▸ Other Comparative Statics

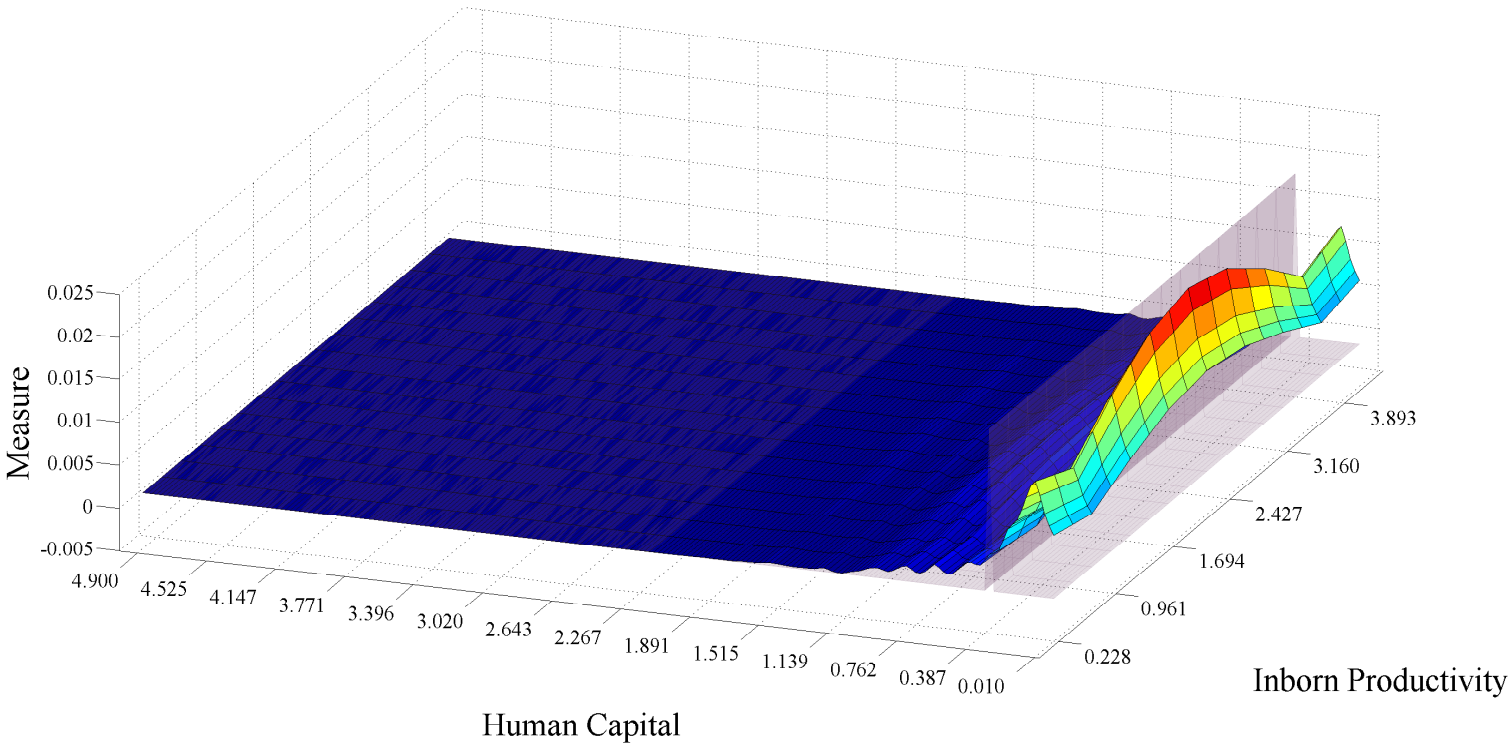
Stationary Distribution for the U.S. Economy

Figure: Stationary Distribution for the U.S. Economy



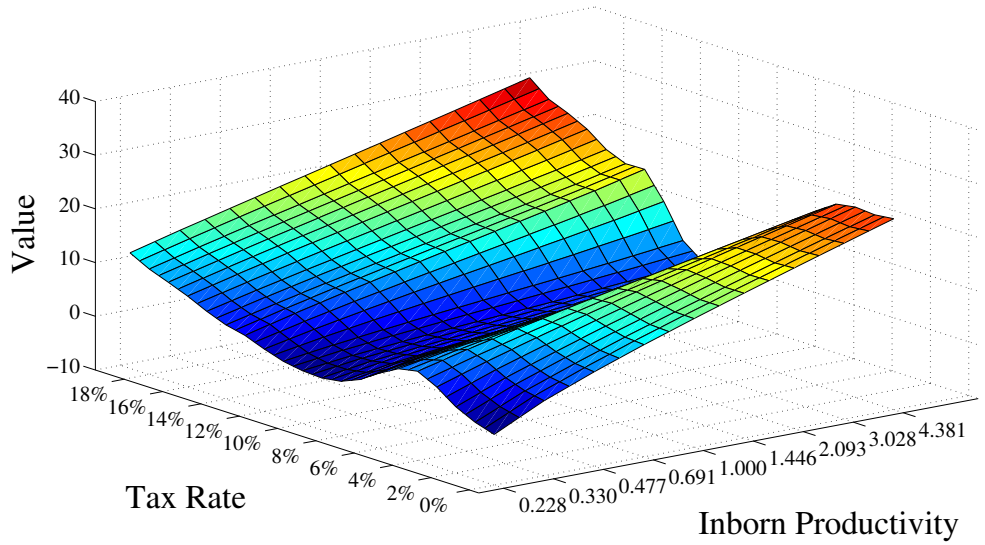
Stationary Distribution for the European Economy

Figure: Stationary Distribution for the European Economy



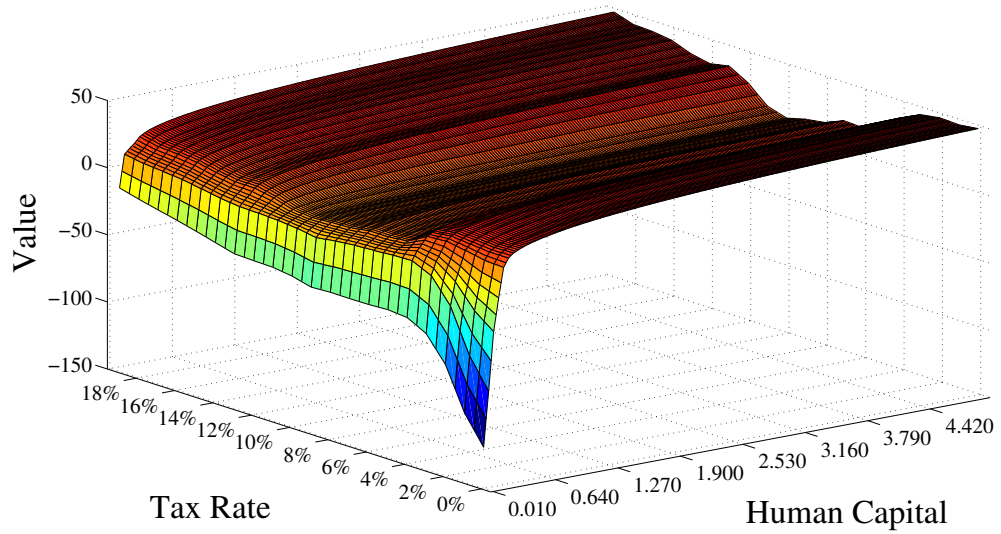
Welfare over Taxes

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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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

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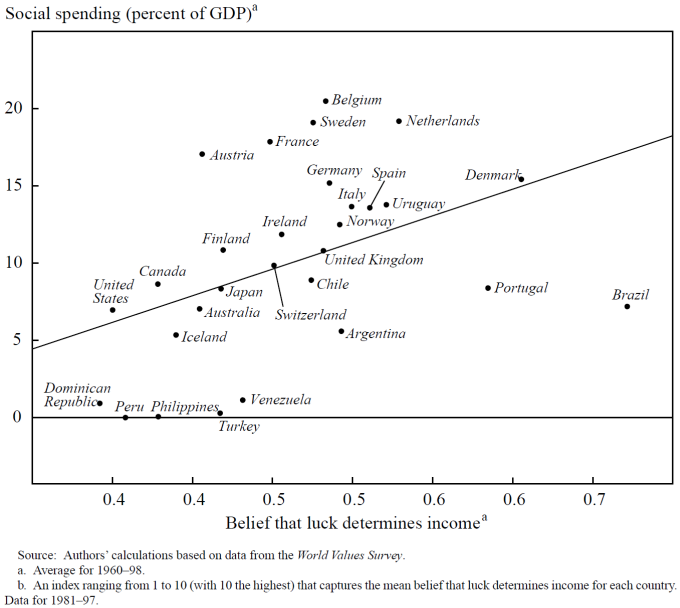
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Relationship Between Public Good Share & Beliefs



Source: Authors' calculations based on data from the *World Values Survey*.
a. Average for 1960–98.
b. 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.

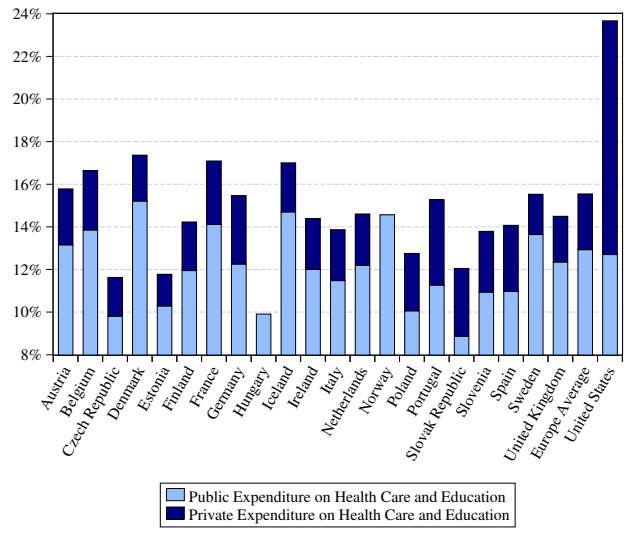
Figure: Alesina and Angeletos (2005,AER)

- $\widehat{\iota}_i^{e040} = 0.314 + 0.0054 \frac{\overline{E_i}}{\mathcal{E}_i} \tau_i$
  $p = 0.049$
- $\widehat{\iota}_i^{131} = -0.106 + 0.963 \frac{\overline{E_i}}{\mathcal{E}_i}$
  $p = 0.032$
- $\widehat{\iota}_i^{131} = 0.196 + 0.022 \tau_i$
  $p = 0.010$
- $\widehat{\iota}_i^{131} = 0.337 + 0.018 \frac{\overline{E_i}}{\mathcal{E}_i} \tau_i$
  $p = 0.015$

▸ Introduction

Public Expenditure by Country

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



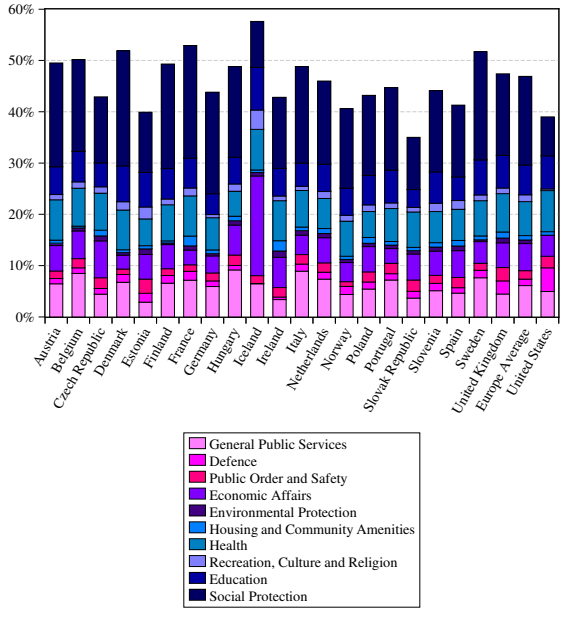
Source: OECD Database (2004-2008)

▸ Transatlantic Differences

▸ Health Care & Ter. Edu ▸ Health Care ▸ Total Edu. ▸ Prim. & Sec. Edu. ▸ Tertiary Edu.

Government Expenditure Composition by Country

Figure: Government Expenditure (% of GDP)

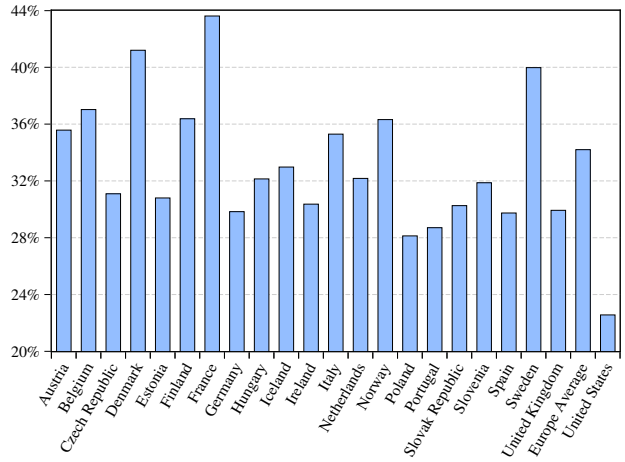


Source: OECD Database (2004-2008)

▸ Transatlantic Differences ▸ % Tax

Tax Revenue by Country

Figure: Tax Revenue (% of GDP)

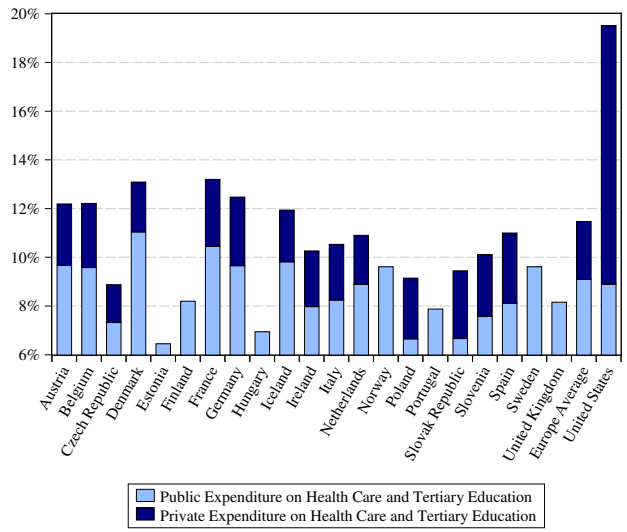


Source: OECD Database (2004-2008)

▸ Transatlantic Differences ▸ Gov't Exp.

Public Expenditure by Country

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



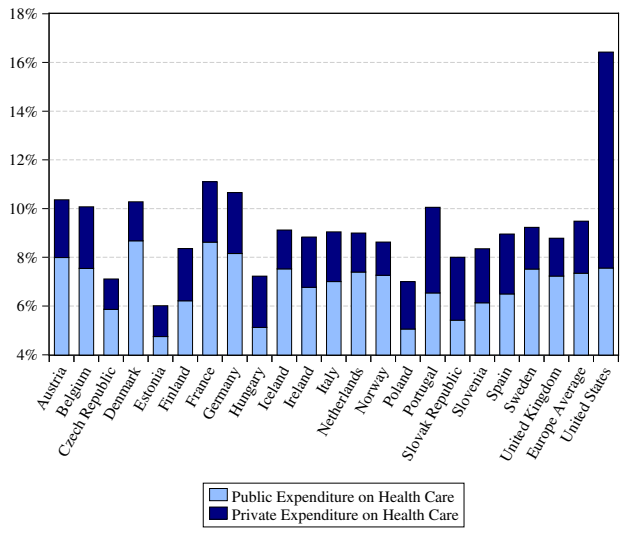
Source: OECD Database (2004-2008)

▸ Transatlantic Differences

▸ Public Share ▸ Health Care ▸ Total Edu. ▸ Prim. & Sec. Edu. ▸ Tertiary Edu.

Public Expenditure by Country

Figure: Health Care Exp. (% of GDP)



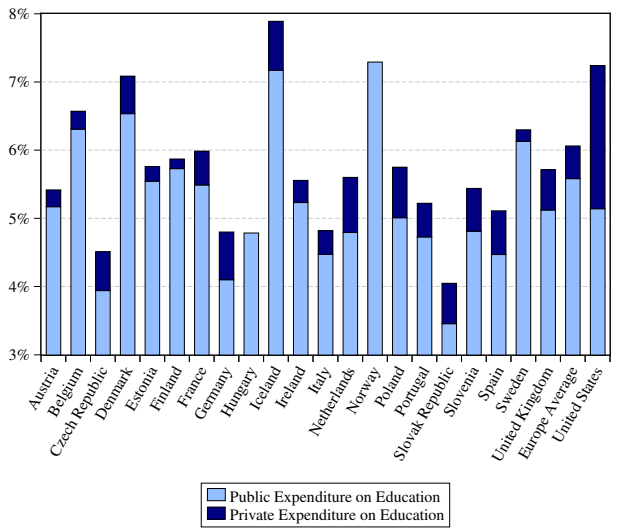
Source: OECD Database (2004-2008)

▸ Transatlantic Differences

▸ Public Share ▸ Health Care & Ter. Edu ▸ Total Edu. ▸ Prim. & Sec. Edu. ▸ Tertiary Edu.

Public Expenditure by Country

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



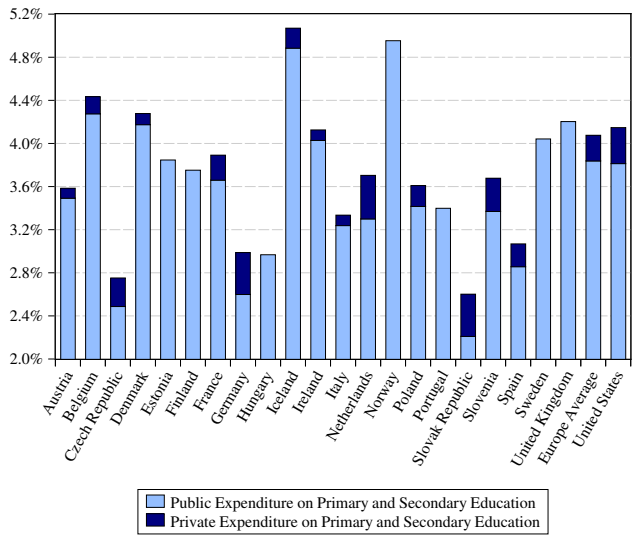
Source: OECD Database (2004-2008)

▸ Transatlantic Differences

▸ Public Share ▸ Health Care & Ter. Edu ▸ Health Care ▸ Prim. & Sec. Edu. ▸ Tertiary Edu.

Public Expenditure by Country

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



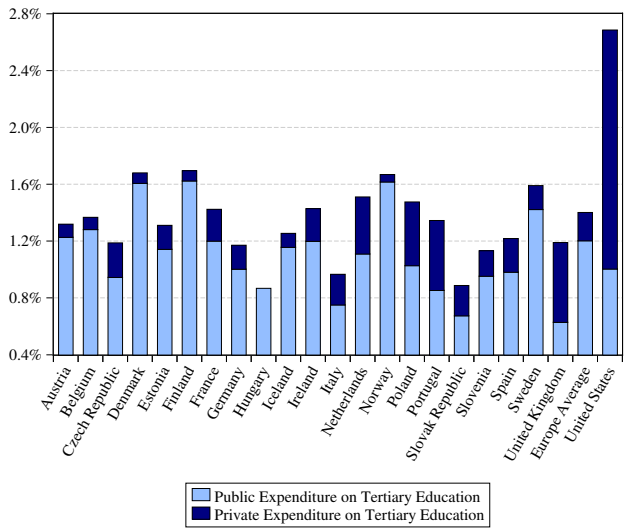
Source: OECD Database (2004-2008)

▸ Transatlantic Differences

▸ Public Share ▸ Health Care & Ter. Edu ▸ Health Care ▸ Total Edu. ▸ Tertiary Edu.

Public Expenditure by Country

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



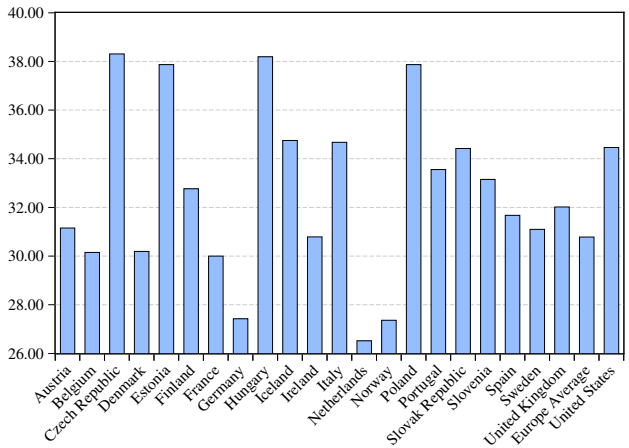
Source: OECD Database (2004-2008)

▸ Transatlantic Differences

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Average Actual Hours Worked by Country

Figure: Labor Supply

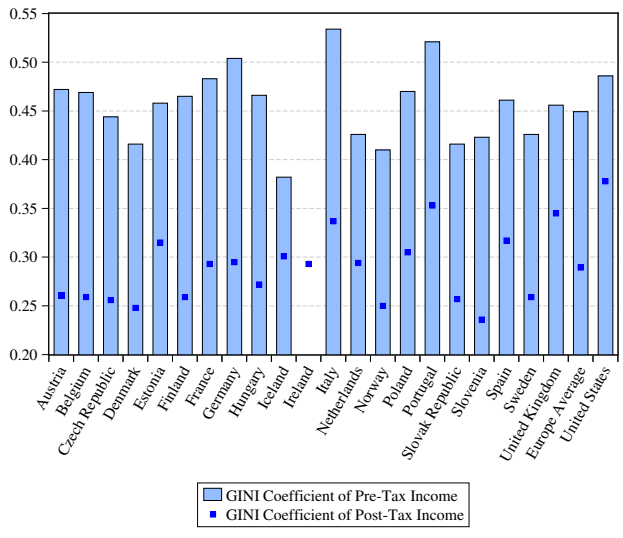


Source: OECD Database (2004-2008)

▸ Transatlantic Differences

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

	Mean	Std. Dev.	Differential	
			50-10 Percentile	90-50 Percentile
European Average	290.60	44.48	61.42	44.94
United States	288.97	61.43	80.67	59.98

Source: Blau and Kahn (2005, RES)

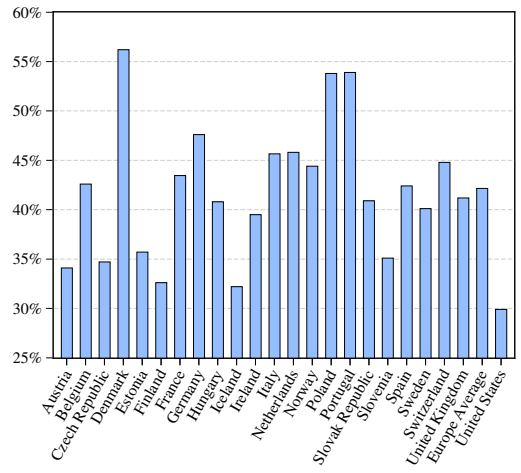
- "...the very best schools in the U.S. are extraordinary ... but the big concern in the U.S. is the *diversity* of quality of institutions."

Barry McGaw, (Director of Education for the OECD) on "Education at a Glance 2009: OECD Indicators"

▸ Transatlantic Differences ▸ Income Inequality

Luck Determines Income

Figure: Average Belief that Luck Determines Income by Country

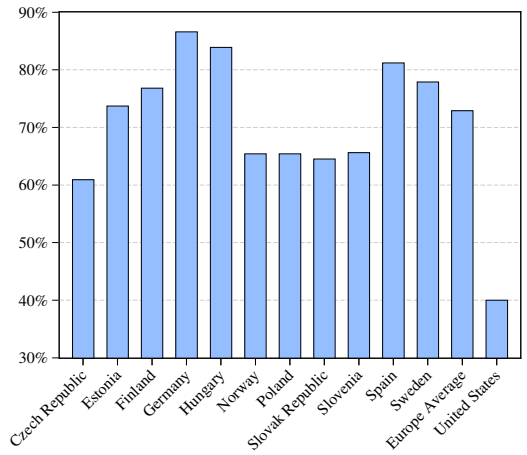


Source: World Values Survey (1981-2008)

▸ Transatlantic Differences ▸ % Lazy

People in Need Unfairly

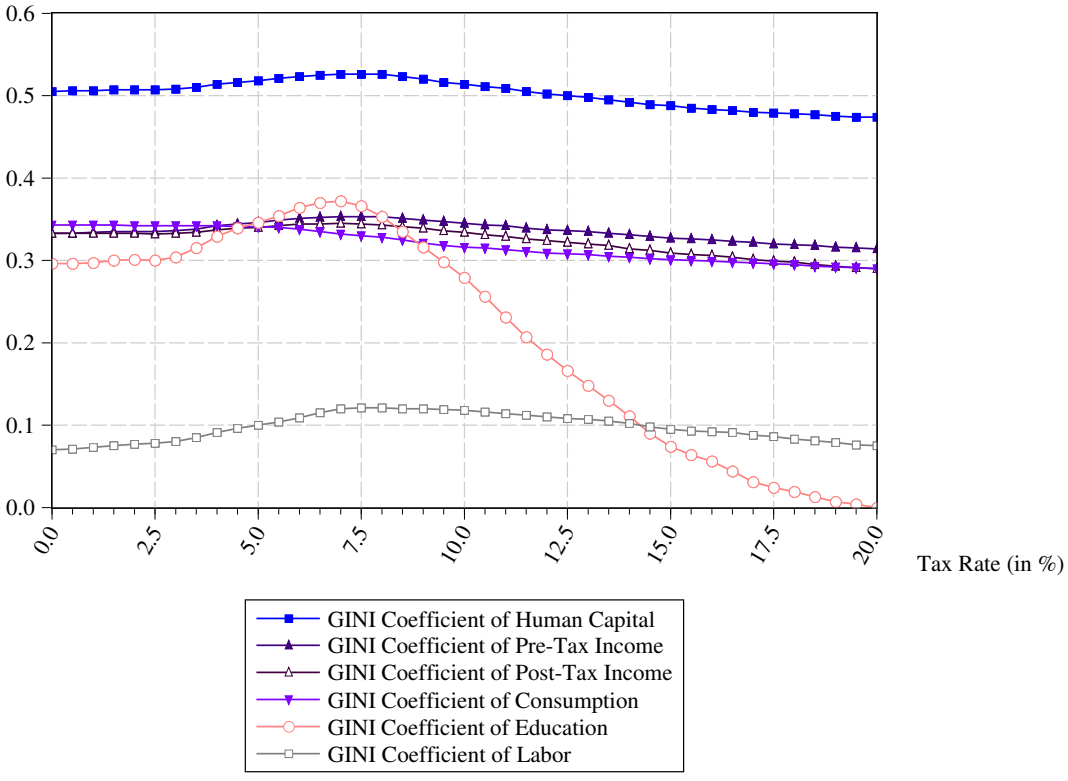
Figure: Average Belief that People are in Need due to an Unfair Society



Source: World Values Survey (1981-2008)

▸ Transatlantic Differences ▸ % Luck

Distributional Property Graph



▸ Distributional Properties

Distributional Properties

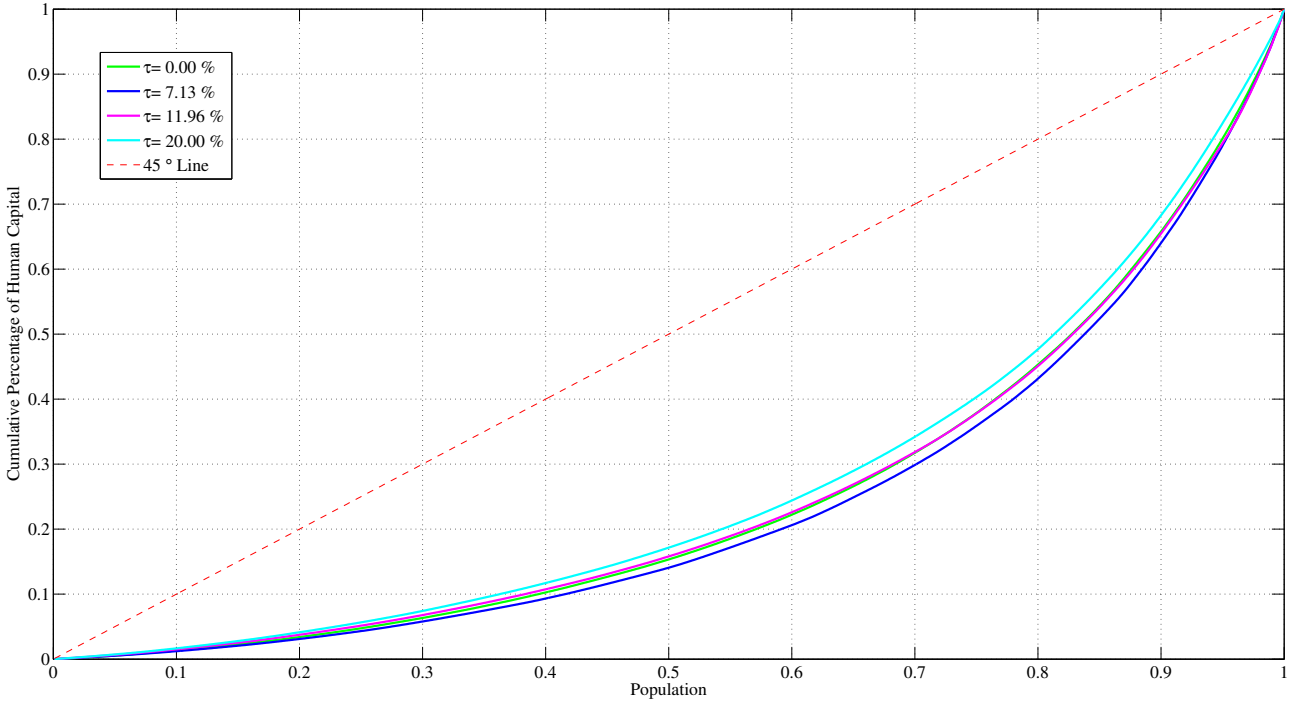
Table: Distributional Properties of the Benchmark Model

τ	$GINI_h$	$GINI_y$	$GINI_{\widehat{y}}$	$GINI_c$	$GINI_e$	$GINI_l$
0.00%	0.333	0.333	0.343	0.505	0.070	0.296
2.50%	0.335	0.332	0.342	0.507	0.078	0.300
5.00%	0.346	0.340	0.341	0.518	0.100	0.346
7.13%	0.527	0.353	0.345	0.330	0.369	0.121
7.50%	0.353	0.344	0.330	0.526	0.121	0.366
10.00%	0.345	0.334	0.316	0.514	0.118	0.279
11.96%	0.503	0.338	0.324	0.309	0.190	0.111
12.50%	0.336	0.322	0.308	0.500	0.108	0.166
15.00%	0.327	0.309	0.301	0.488	0.095	0.074
17.50%	0.320	0.299	0.296	0.479	0.086	0.024
20.00%	0.314	0.290	0.290	0.474	0.075	0.000

▸ Benchmark Results ▸ Dist. Property Graph

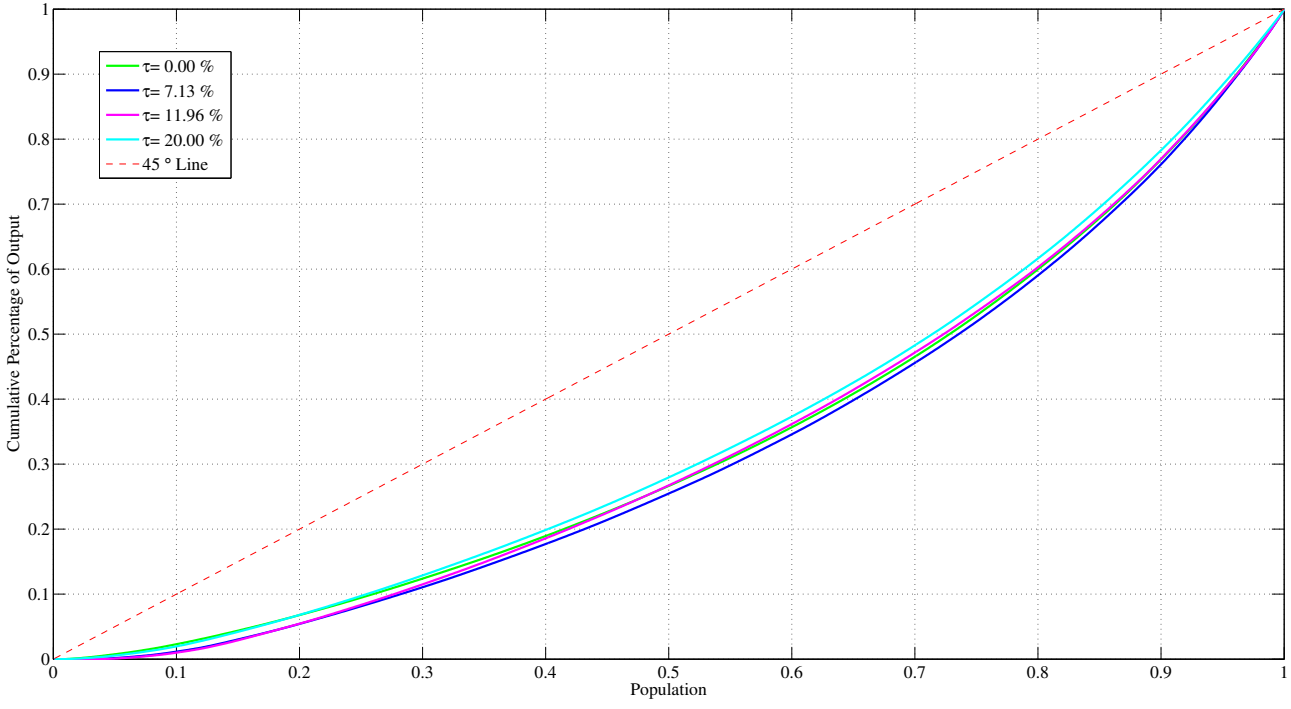
▸ $Lorenz_h$ ▸ $Lorenz_y$ ▸ $Lorenz_c$ ▸ $Lorenz_e$ ▸ $Lorenz_l$

Lorenz Curve for Human Capital



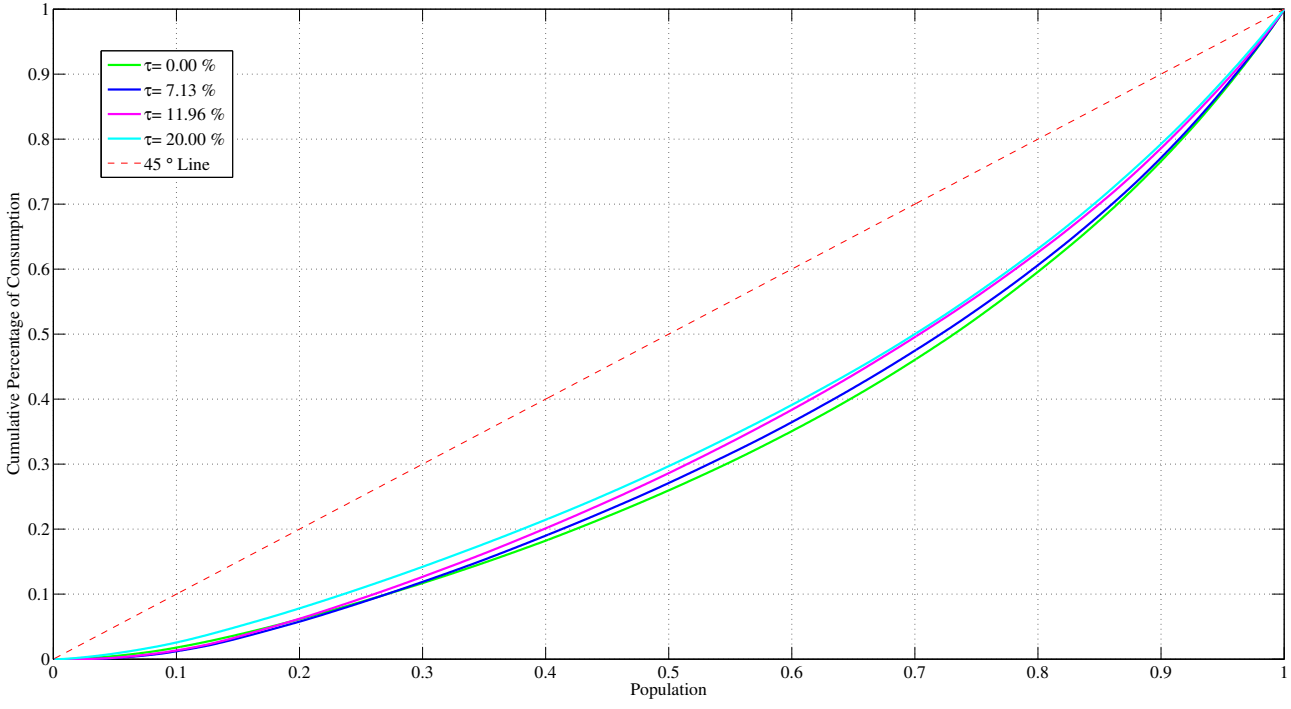
▸ Distributional Properties ▸ $Lorenz_y$ ▸ $Lorenz_c$ ▸ $Lorenz_e$ ▸ $Lorenz_l$

Lorenz Curve for Output



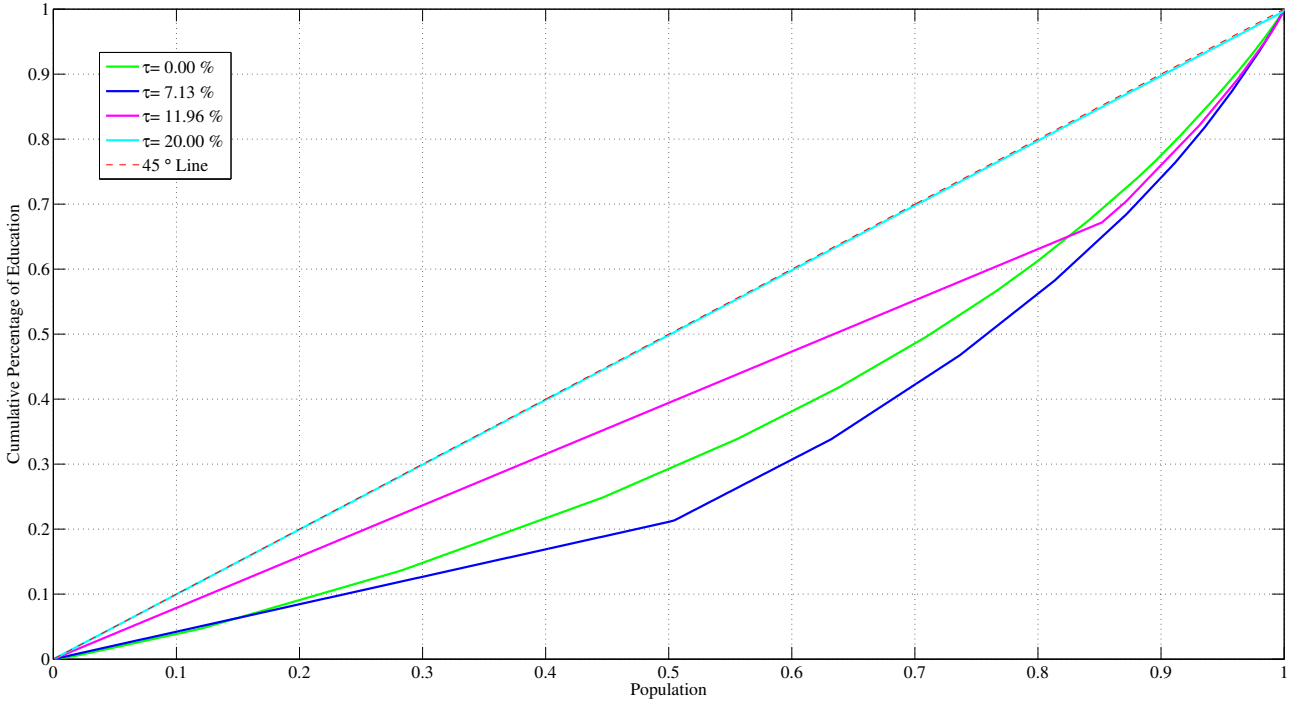
▸ Distributional Properties ▸ $Lorenz_h$ ▸ $Lorenz_c$ ▸ $Lorenz_e$ ▸ $Lorenz_l$

Lorenz Curve for Consumption



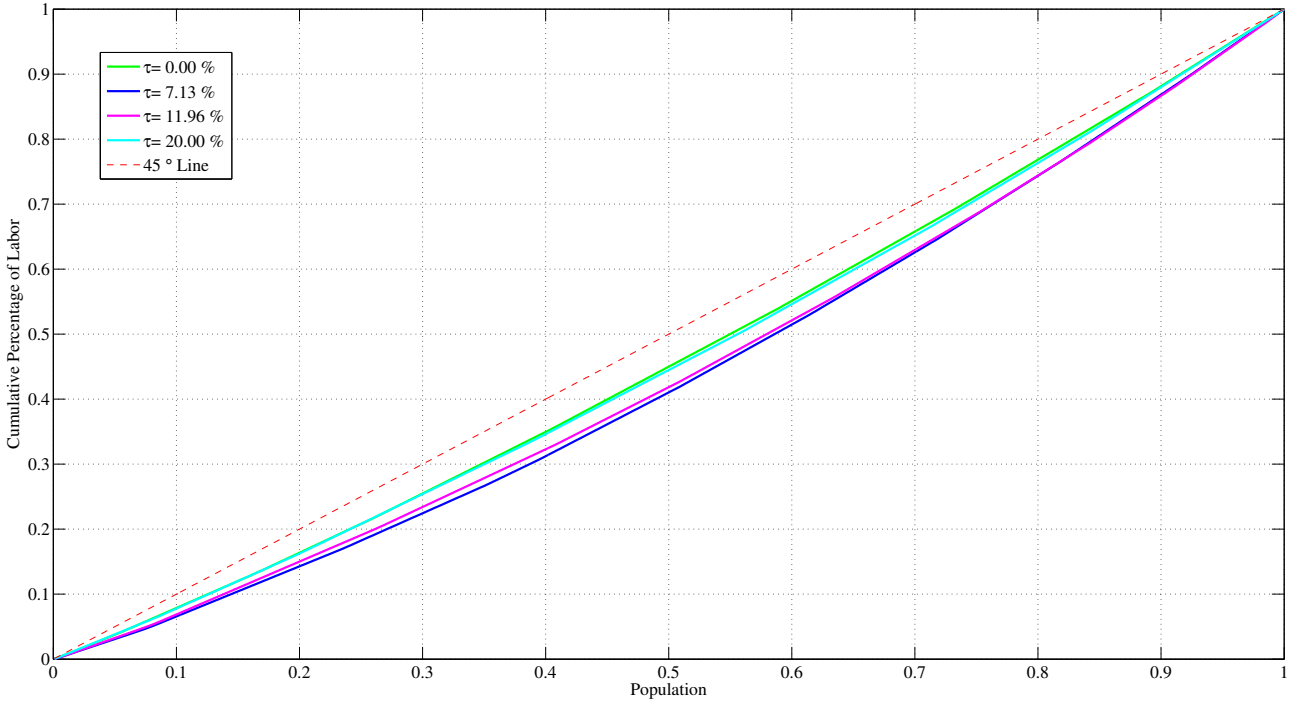
▸ Distributional Properties ▸ $Lorenz_h$ ▸ $Lorenz_y$ ▸ $Lorenz_e$ ▸ $Lorenz_l$

Lorenz Curve for Education



▸ Distributional Properties ▸ $Lorenz_h$ ▸ $Lorenz_y$ ▸ $Lorenz_c$ ▸ $Lorenz_l$

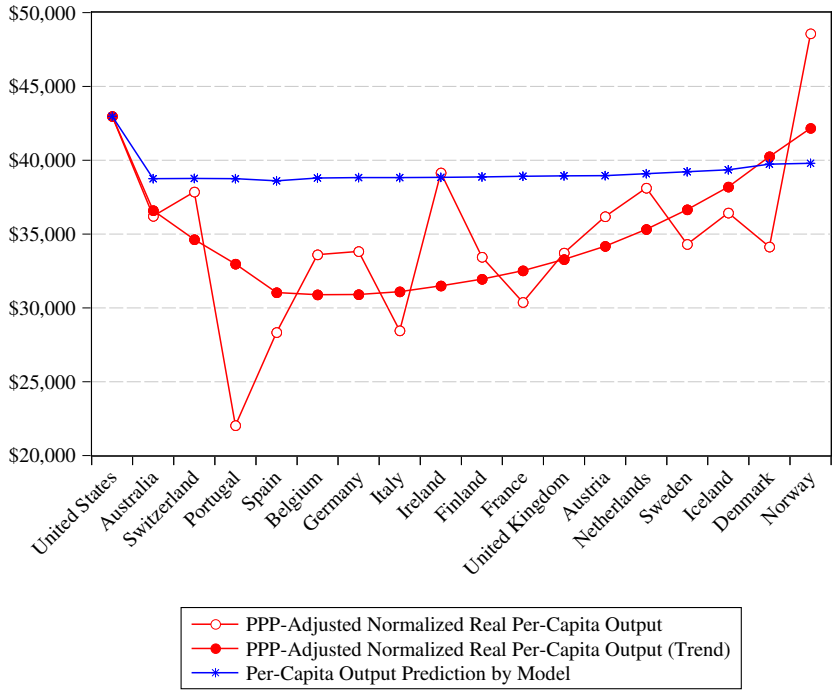
Lorenz Curve for Labor



▸ Distributional Properties ▸ $Lorenz_h$ ▸ $Lorenz_y$ ▸ $Lorenz_c$ ▸ $Lorenz_e$

Model Fit by Country

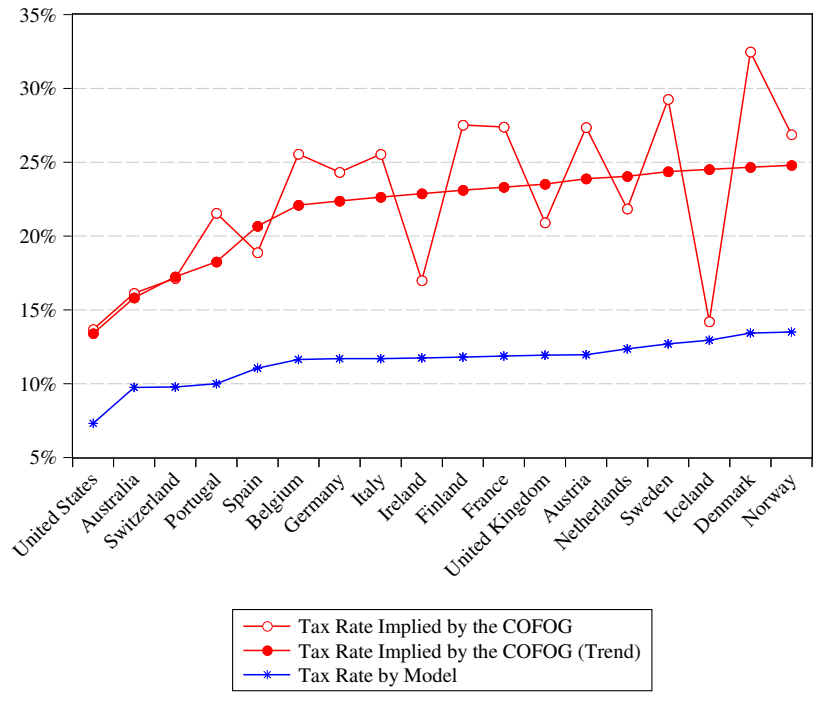
Figure: Model Fit of Per-Capita Output by Country



▸ Tax, Output & Public Good ▸ Model Fit of Taxes ▸ Model Fit of Perceptions

Model Fit by Country

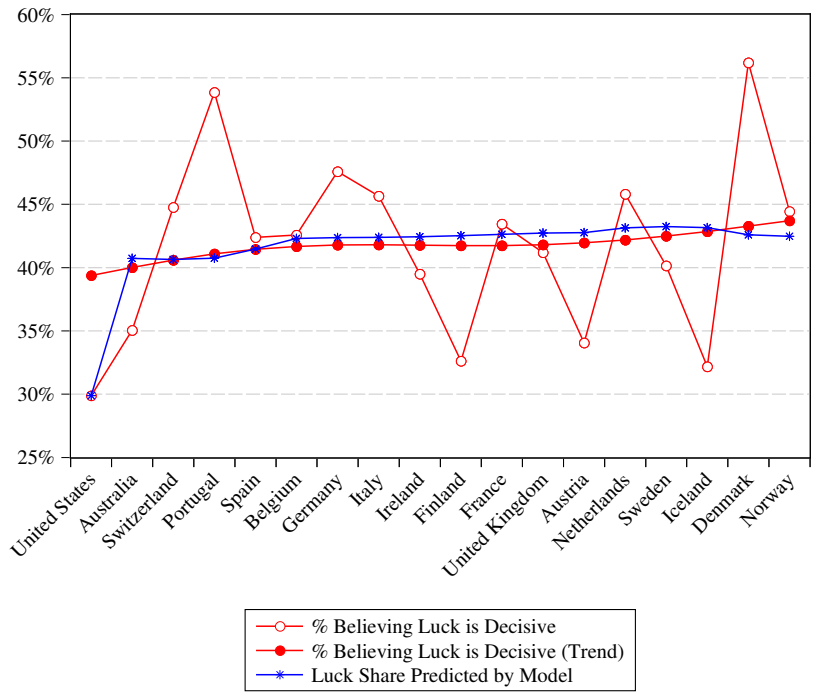
Figure: Model Fit of Taxes by Country



▸ 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



▸ 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

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

▸ Spillover Comparison ▸ Dist. Properties ▸ Full-Spillover Specification

Full-Spillover Results

Table: Stationary Distribution Results over Taxes with Full-Spillover

τ	$\overline{Y}$	$\overline{C}$	$\overline{H}$	$\overline{L}$	$\overline{\mathcal{E}}$	$\overline{E}$	$\overline{Tr}$	$Pop._{\overline{E}}$	$\overline{E}/\overline{\mathcal{E}}$	ι_l
0.00%	2.046	1.756	0.793	0.338	0.290	0.000	0.000	0.00%	0.00%	16.87%
2.50%	1.935	1.672	0.729	0.325	0.263	0.030	0.018	1.64%	11.65%	18.49%
5.00%	1.862	1.617	0.696	0.297	0.240	0.061	0.036	16.13%	25.59%	19.53%
7.50%	1.832	1.596	0.672	0.269	0.234	0.091	0.054	31.58%	39.03%	19.96%
10.00%	1.807	1.574	0.655	0.249	0.233	0.119	0.070	43.12%	50.89%	20.74%
12.50%	1.816	1.580	0.658	0.251	0.236	0.148	0.087	53.97%	62.65%	20.52%
15.00%	1.867	1.605	0.696	0.249	0.263	0.184	0.108	62.21%	70.06%	19.18%
17.50%	1.980	1.675	0.768	0.244	0.305	0.229	0.135	67.63%	75.05%	17.43%
20.00%	2.089	1.761	0.849	0.244	0.328	0.274	0.161	72.47%	83.70%	15.41%

▸ Spillover Comparison ▸ Dist. Properties ▸ Zero-Spillover Specification

Distributional Properties of Zero-Spillover Model

Table: Distributional Properties of the Zero-Spillover Model Specification

τ	$GINI_y$	$GINI_{\widehat{y}}$	$GINI_c$	$GINI_h$	$GINI_l$	$GINI_e$
0.00%	0.333	0.333	0.343	0.505	0.070	0.296
2.50%	0.337	0.334	0.339	0.510	0.082	0.317
5.00%	0.349	0.344	0.324	0.526	0.114	0.407
7.50%	0.355	0.348	0.313	0.533	0.143	0.435
10.00%	0.348	0.339	0.304	0.521	0.145	0.337
12.50%	0.328	0.315	0.295	0.489	0.137	0.112
15.00%	0.324	0.309	0.293	0.484	0.132	0.047
17.50%	0.319	0.299	0.291	0.475	0.110	0.001
20.00%	0.314	0.290	0.290	0.474	0.075	0.000

▸ Spillover Comparison ▸ Zero-Spillover Specification ▸ Full-Spillover Specification

Distributional Properties of Full-Spillover Model

Table: Distributional Properties of the Full-Spillover Model Specification

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

▸ Spillover Comparison ▸ Zero-Spillover Specification ▸ Full-Spillover Specification

Other Comparative Statics

Table: Other Comparative Statics

Change	Level	U-Shape
Absence of Inborn Shocks	$-$	Steeper arms
Persistent Inborn Shocks	$-$	Slightly steeper arms
Higher Complementarity	$+$	Steeper right arm
Higher Return on Education	$+$	Slightly flatter arms
Higher Share of Human Capital	$+$	Steeper arms
Higher Altruism	$+$	Slightly steeper arms
Higher Redistribution	$-$	Steeper left arm

Different Spillover Rates

Sensitivity Analysis

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

τ	$\overline{Y}$	$\overline{C}$	$\overline{H}$	$\overline{L}$	$\overline{\mathcal{E}}$	$\overline{E}$	$\overline{Tr}$	$\overline{E}/\overline{\mathcal{E}}$	$Pop._{\overline{E}}$	ι_I
0.00%	0.818	0.622	0.200	0.342	0.197	0.000	0.000	0.00%	0.00%	100.00%
7.13%	0.586	0.472	0.124	0.311	0.113	0.026	0.015	23.24%	0.00%	100.00%
11.96%	0.253	0.234	0.034	0.287	0.019	0.019	0.011	100.00%	100.00%	100.00%
20.00%	0.421	0.368	0.080	0.268	0.053	0.053	0.031	100.00%	100.00%	100.00%

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

τ	$\overline{Y}$	$\overline{C}$	$\overline{H}$	$\overline{L}$	$\overline{\mathcal{E}}$	$\overline{E}$	$\overline{Tr}$	$\overline{E}/\overline{\mathcal{E}}$	$Pop._{\overline{E}}$	ι_I
0.00%	2.046	1.756	0.793	0.338	0.290	0.000	0.000	0.00%	0.00%	16.87%
7.13%	1.401	1.220	0.424	0.283	0.150	0.067	0.040	44.83%	53.03%	29.88%
11.96%	1.268	1.128	0.355	0.270	0.126	0.099	0.058	78.54%	85.25%	42.75%
20.00%	1.624	1.409	0.557	0.251	0.213	0.213	0.126	100.00%	100.00%	29.99%

▸ Comparative Statics

Sensitivity Analysis

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

τ	$\overline{Y}$	$\overline{C}$	$\overline{H}$	$\overline{L}$	$\overline{\mathcal{E}}$	$\overline{E}$	$\overline{Tr}$	$\overline{E}/\overline{\mathcal{E}}$	$Pop._{\overline{E}}$	ι_I
0.00%	2.012	1.736	0.759	0.351	0.276	0.000	0.000	0.00%	0.00%	16.99%
7.13%	1.318	1.177	0.378	0.290	0.141	0.059	0.035	41.98%	49.12%	33.12%
11.96%	1.135	1.018	0.311	0.256	0.117	0.083	0.049	71.16%	77.84%	46.36%
20.00%	1.537	1.339	0.508	0.224	0.197	0.196	0.135	100.00%	100.00%	32.14%

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

τ	$\overline{Y}$	$\overline{C}$	$\overline{H}$	$\overline{L}$	$\overline{\mathcal{E}}$	$\overline{E}$	$\overline{Tr}$	$\overline{E}/\overline{\mathcal{E}}$	$Pop._{\overline{E}}$	ι_I
0.00%	2.046	1.756	0.793	0.338	0.290	0.000	0.000	0.00%	0.00%	16.87%
7.13%	1.401	1.220	0.424	0.283	0.150	0.067	0.040	44.83%	53.03%	29.88%
11.96%	1.268	1.128	0.355	0.270	0.126	0.099	0.058	78.54%	85.25%	42.75%
20.00%	1.624	1.409	0.557	0.251	0.213	0.213	0.126	100.00%	100.00%	29.99%

▸ Comparative Statics

Sensitivity Analysis

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

τ	$\overline{Y}$	$\overline{C}$	$\overline{H}$	$\overline{L}$	$\overline{\mathcal{E}}$	$\overline{E}$	$\overline{Tr}$	$\overline{E}/\overline{\mathcal{E}}$	$Pop._{\overline{E}}$	ι_I
0.00%	2.361	2.039	0.996	0.345	0.321	0.000	0.000	0.00%	0.00%	11.71%
7.13%	1.442	1.281	0.444	0.285	0.133	0.068	0.040	50.74%	58.56%	31.30%
11.96%	1.388	1.251	0.416	0.277	0.127	0.110	0.064	86.31%	90.41%	37.47%
20.00%	1.936	1.682	0.759	0.293	0.254	0.254	0.149	100.00%	100.00%	21.44%

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

τ	$\overline{Y}$	$\overline{C}$	$\overline{H}$	$\overline{L}$	$\overline{\mathcal{E}}$	$\overline{E}$	$\overline{Tr}$	$\overline{E}/\overline{\mathcal{E}}$	$Pop._{\overline{E}}$	ι_I
0.00%	2.046	1.756	0.793	0.338	0.290	0.000	0.000	0.00%	0.00%	16.87%
7.13%	1.401	1.220	0.424	0.283	0.150	0.067	0.040	44.83%	53.03%	29.88%
11.96%	1.268	1.128	0.355	0.270	0.126	0.099	0.058	78.54%	85.25%	42.75%
20.00%	1.624	1.409	0.557	0.251	0.213	0.213	0.126	100.00%	100.00%	29.99%

▸ Comparative Statics

Sensitivity Analysis

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

τ	$\overline{Y}$	$\overline{C}$	$\overline{H}$	$\overline{L}$	$\overline{\mathcal{E}}$	$\overline{E}$	$\overline{Tr}$	$\overline{E}/\overline{\mathcal{E}}$	$Pop._{\overline{E}}$	ι_l
0.00%	2.111	1.783	0.835	0.343	0.328	0.000	0.000	0.00%	0.00%	15.64%
7.13%	1.555	1.322	0.511	0.295	0.192	0.073	0.043	38.06%	42.14%	24.94%
11.96%	1.321	1.186	0.367	0.274	0.135	0.100	0.059	74.39%	82.01%	36.68%
20.00%	1.697	1.492	0.591	0.288	0.206	0.206	0.121	99.50%	99.50%	25.15%

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

τ	$\overline{Y}$	$\overline{C}$	$\overline{H}$	$\overline{L}$	$\overline{\mathcal{E}}$	$\overline{E}$	$\overline{Tr}$	$\overline{E}/\overline{\mathcal{E}}$	$Pop._{\overline{E}}$	ι_l
0.00%	2.046	1.756	0.793	0.338	0.290	0.000	0.000	0.00%	0.00%	16.87%
7.13%	1.401	1.220	0.424	0.283	0.150	0.067	0.040	44.83%	53.03%	29.88%
11.96%	1.268	1.128	0.355	0.270	0.126	0.099	0.058	78.54%	85.25%	42.75%
20.00%	1.624	1.409	0.557	0.251	0.213	0.213	0.126	100.00%	100.00%	29.99%

▸ Comparative Statics

Sensitivity Analysis

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

τ	$\overline{Y}$	$\overline{C}$	$\overline{H}$	$\overline{L}$	$\overline{\mathcal{E}}$	$\overline{E}$	$\overline{Tr}$	$\overline{E}/\overline{\mathcal{E}}$	$Pop._{\overline{E}}$	ι_I
0.00%	2.111	1.783	0.835	0.343	0.328	0.000	0.000	0.00%	0.00%	15.64%
7.13%	1.555	1.322	0.511	0.295	0.192	0.073	0.043	38.06%	42.14%	24.94%
11.96%	1.321	1.186	0.367	0.274	0.135	0.100	0.059	74.39%	82.01%	36.68%
20.00%	1.697	1.492	0.591	0.288	0.206	0.206	0.121	99.50%	99.50%	25.15%

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

τ	$\overline{Y}$	$\overline{C}$	$\overline{H}$	$\overline{L}$	$\overline{\mathcal{E}}$	$\overline{E}$	$\overline{Tr}$	$\overline{E}/\overline{\mathcal{E}}$	$Pop._{\overline{E}}$	ι_I
0.00%	2.046	1.756	0.793	0.338	0.290	0.000	0.000	0.00%	0.00%	16.87%
7.13%	1.401	1.220	0.424	0.283	0.150	0.067	0.040	44.83%	53.03%	29.88%
11.96%	1.268	1.128	0.355	0.270	0.126	0.099	0.058	78.54%	85.25%	42.75%
20.00%	1.624	1.409	0.557	0.251	0.213	0.213	0.126	100.00%	100.00%	29.99%

▸ Comparative Statics

Sensitivity Analysis

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

τ	$\overline{Y}$	$\overline{C}$	$\overline{H}$	$\overline{L}$	$\overline{\mathcal{E}}$	$\overline{E}$	$\overline{Tr}$	$\overline{E}/\overline{\mathcal{E}}$	$Pop._{\overline{E}}$	ι_I
0.00%	2.355	1.978	1.000	0.353	0.377	0.000	0.000	0.00%	0.00%	12.99%
7.13%	1.743	1.465	0.620	0.307	0.225	0.080	0.047	35.53%	39.28%	20.54%
11.96%	1.415	1.233	0.433	0.280	0.157	0.111	0.065	70.62%	79.25%	32.03%
20.00%	1.663	1.439	0.581	0.286	0.220	0.215	0.126	97.93%	98.42%	27.62%

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

τ	$\overline{Y}$	$\overline{C}$	$\overline{H}$	$\overline{L}$	$\overline{\mathcal{E}}$	$\overline{E}$	$\overline{Tr}$	$\overline{E}/\overline{\mathcal{E}}$	$Pop._{\overline{E}}$	ι_I
0.00%	2.046	1.756	0.793	0.338	0.290	0.000	0.000	0.00%	0.00%	16.87%
7.13%	1.401	1.220	0.424	0.283	0.150	0.067	0.040	44.83%	53.03%	29.88%
11.96%	1.268	1.128	0.355	0.270	0.126	0.099	0.058	78.54%	85.25%	42.75%
20.00%	1.624	1.409	0.557	0.251	0.213	0.213	0.126	100.00%	100.00%	29.99%

▸ Comparative Statics

Sensitivity Analysis

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

τ	$\overline{Y}$	$\overline{C}$	$\overline{H}$	$\overline{L}$	$\overline{\mathcal{E}}$	$\overline{E}$	$\overline{Tr}$	$\overline{E}/\overline{\mathcal{E}}$	$Pop._{\overline{E}}$	ι_I
0.00%	2.046	1.756	0.793	0.338	0.290	0.000	0.000	0.00%	0.00%	16.87%
7.13%	1.159	1.043	0.403	0.270	0.116	0.054	0.080	46.55%	53.45%	31.48%
11.96%	1.018	0.912	0.337	0.256	0.106	0.090	0.073	85.09%	89.62%	44.02%
20.00%	1.537	1.370	0.525	0.273	0.197	0.196	0.135	100.00%	100.00%	31.50%

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

τ	$\overline{Y}$	$\overline{C}$	$\overline{H}$	$\overline{L}$	$\overline{\mathcal{E}}$	$\overline{E}$	$\overline{Tr}$	$\overline{E}/\overline{\mathcal{E}}$	$Pop._{\overline{E}}$	ι_I
0.00%	2.046	1.756	0.793	0.338	0.290	0.000	0.000	0.00%	0.00%	16.87%
7.13%	1.401	1.220	0.424	0.283	0.150	0.067	0.040	44.83%	53.03%	29.88%
11.96%	1.268	1.128	0.355	0.270	0.126	0.099	0.058	78.54%	85.25%	42.75%
20.00%	1.624	1.409	0.557	0.251	0.213	0.213	0.126	100.00%	100.00%	29.99%

▸ Comparative Statics