Optimal Redistribution: Rising Inequality vs. Rising Living Standards

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Motivation

- Large increase in **income inequality** in the US from 1950 to 2010
  - Larger top income shares, thicker Pareto tail

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$\Rightarrow$ How does the standard of living affect the optimal tax-and-transfer ($t\&T$) system?

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- **This paper:** Optimal taxation with non-homothetic preferences
  - Heterogeneous income elasticities of demand across sectors (Engel's law)

    NH CES Comin, Lashkari, and Mestieri (2021), IA Preferences Alder, Boppart, and Müller (2022)

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  - Growth lowers income effects $\Rightarrow$ Ambiguous effects on efficiency costs of redistribution
- Quantitatively large effects of rising living standards
  - Growth calls for less redistribution
  - Dampens by at least 25% the optimal increase in redistribution due to rising inequality

Literature

- **Optimal taxation**
  - Stationary economies and business cycle fluctuations in homothetic one sector economies
    Mirrlees (1971), Diamond (1998), Saez (2001); Ramsey (1927), Werning (2007), Heathcote, Storesletten, and Violante (2017)
  - Optimal tax system over time in homothetic economies
    Mankiw, Weinzierl, and Yagan (2009), Diamond and Saez (2011), Scheuer and Werning (2017), Heathcote, Storesletten, and Violante (2020), Brinca, Duarte, Holter, and Oliveira (2022)
  - Optimal taxation with non-homothetic preferences
    Jaravel and Olivi (2022), Oni (2023)

- **Consumption patterns, Engel curves, and non-homothetic preferences**
  Geary (1950), Herrendorf, Rogerson, and Valentinyi (2013), Boppart (2014), Herrendorf, Rogerson, and Valentinyi (2014), Aguiar and Bils (2015), Comin, Lashkari, and Mestieri (2021), Alder, Boppart, and Müller (2022)

Mirrleesian Optimal Nonlinear Income Taxation with Non-Homothetic Preferences

Households

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  - $c = (c_1, \dots, c_J)$ denotes a basket of consumption goods
- Let u denote the indirect utility function

$$u(e; p, \Lambda) \equiv \max_{\{c_j\}_j} U(c) \quad \text{s.t.} \quad \sum_j \frac{p_j}{\Lambda} c_j = e$$

  - e: nominal expenditures
  - p: vector of relative prices, kept constant (drop it)
  - Λ: level of the economy $\Rightarrow$ **aggregate growth**

Optimal Taxation Problem

- Household's static maximization problem:

$$V(\theta;\mathcal{T}(\cdot),\Lambda) \equiv \max_{e,n} u(e;\Lambda) - B\frac{n^{1+\varphi}}{1+\varphi} \quad \text{s.t.} \quad e = n\theta - \mathcal{T}(n\theta)$$

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- Government's maximization problem given Pareto weights $\{w(\theta)\}$:

$$\max_{\mathcal{T}(\cdot;\Lambda)} \int_{\underline{\theta}}^{\overline{\theta}} V(\theta;\mathcal{T}(\cdot;\Lambda),\Lambda)w(\theta)f(\theta)d\theta \quad \text{s.t.} \quad \int_{\underline{\theta}}^{\overline{\theta}} \mathcal{T}(n(\theta;\mathcal{T}(\cdot;\Lambda),\Lambda)\theta;\Lambda)f(\theta)d\theta \geq G$$

  – Balanced budget where G is exogenous spending

Nonlinear Taxes: General Formula

- Optimal marginal rate equates efficiency costs of taxation to distribution gains $\forall \theta^*$

  Heathcote and Tsujiyama (2021)

$$\underbrace{1-\frac{1-\frac{\mathcal{T}'(y(\theta^*;\Lambda);\Lambda)}{1-\mathcal{T}'(y(\theta^*;\Lambda);\Lambda)}\frac{1}{1+\varphi}\frac{\theta^* f(\theta^*)}{1-F(\theta^*)}+\int_{\theta^*}^{\bar{\theta}}\mathcal{T}'(y(\theta;\Lambda);\Lambda)\eta(\theta;\Lambda)\frac{dF(\theta)}{1-F(\theta^*)}}{1+\int_{\underline{\theta}}^{\bar{\theta}}\mathcal{T}'(y(\theta;\Lambda);\Lambda)\eta(\theta;\Lambda)dF(\theta)}}_{E(\theta^*;\mathcal{T},\Lambda)}=\underbrace{1-\frac{\int_{\theta^*}^{\bar{\theta}}u_e(\theta;\Lambda)w(\theta)\frac{dF(\theta)}{1-F(\theta^*)}}{\int_{\underline{\theta}}^{\bar{\theta}}u_e(\theta;\Lambda)w(\theta)dF(\theta)}}_{D(\theta^*;\mathcal{T},\Lambda)}$$

  - Let $\eta(\theta;\Lambda) \equiv dy(\theta;\Lambda)/d\mathcal{T}(0;\Lambda)$ denote the income effect of type-θ worker
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- Changes in Λ can alter: $\eta(\theta;\Lambda)$, $u_e(\theta;\Lambda)$, $y(\theta;\Lambda)$

Nonlinear Taxes: Efficiency Cost $E(\theta^*; \mathcal{T}, \Lambda)$

- Efficiency costs of taxes and transfers depend on elasticities φ^{-1} and income effects η

$$E(\theta^*; \mathcal{T}, \Lambda) = 1 - \frac{1 - \frac{\mathcal{T}'(y(\theta^*;\Lambda);\Lambda)}{1-\mathcal{T}'(y(\theta^*;\Lambda);\Lambda)} \frac{1}{1+\varphi} \frac{\theta^* f(\theta^*)}{1-F(\theta^*)} + \int_{\theta^*}^{\bar{\theta}} \mathcal{T}'(y(\theta;\Lambda);\Lambda)\eta(\theta;\Lambda) \frac{dF(\theta)}{1-F(\theta^*)}}{1 + \int_{\underline{\theta}}^{\bar{\theta}} \mathcal{T}'(y(\theta;\Lambda);\Lambda)\eta(\theta;\Lambda) dF(\theta)}$$

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    - Decreases labor supply of all workers: income effect η
  - $E = 0$ with no behavioral responses $\varphi^{-1} = \eta = 0$

Nonlinear Taxes: Distribution Gains $D(\theta^*; \mathcal{T}, \Lambda)$

- Distribution gains of taxes and transfers depend on dispersion of marginal utilities u_e

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  - **Denominator:** Welfare gains from increasing lump-sum transfer
  - $D = 0$ when no heterogeneity $u_e(\theta; \Lambda) = u_e(\theta'; \Lambda)$

Homothetic Benchmark Neutrality Result

- Assume homothetic CRRA preferences

$$U(c) = \frac{\mathcal{C}(c)^{1-\gamma}}{1-\gamma}, \text{ where } \mathcal{C}(c) = \left(\sum_j \Omega_j^{\frac{1}{\sigma}} c_j^{\frac{\sigma-1}{\sigma}}\right)^{\frac{1-\sigma}{\sigma}}$$

  – Indirect utility function reads

$$\frac{(e/p^\star)^{1-\gamma}}{1-\gamma} - B\frac{n^{1+\varphi}}{1+\varphi}, \text{ with } p^\star = \frac{1}{\Lambda}\left(\sum_j \Omega_j p_j^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$$

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- **Proposition:** Optimal marginal rates $\forall\theta$ and T/Y ratios are independent of Λ.
  – Expenditures and incomes grow at constant rate α $\forall\theta$
  – Distribution gains are unaffected by growth as expenditure ratios remain constant
  – Income effects are unaffected at the optimal tax system

Non-Homothetic Preferences

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\+ Intuition: "Luxuries are easier to postpone"
Atkeson and Ogaki (1996), Browning and Crossley (2000)

Non-Homothetic Preferences

- **Proposition:** Consider the two state-of-the-art NH preferences:
  1. NH CES under continuum of gross-complement goods
     Bohr, Mestieri, and Yavuz (2023)
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- Evidence for DRRA/increasing IES
  Ogaki and Zhang (2001), Blundell, Browning, and Meghir (1994), Attanasio and Browning (1995), ...

Non-Homothetic Preferences & Growth

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1. **DRRA** $\Rightarrow$ Dispersion of **marginal utilities** decreases with growth

   $\rightarrow$ Redistribution should decrease with growth

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1. **DRRA** $\Rightarrow$ Dispersion of **marginal utilities** decreases with growth

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2. **DRRA** $\Rightarrow$ **Income effect** η decreases with growth

Non-Homothetic Preferences & Growth

$$\underbrace{1-\frac{1-\frac{\mathcal{T}'(y(\theta^*;\Lambda);\Lambda)}{1-\mathcal{T}'(y(\theta^*;\Lambda);\Lambda)}\frac{1}{1+\varphi}\frac{\theta^* f(\theta^*)}{1-F(\theta^*)}+\int_{\theta^*}^{\bar{\theta}}\mathcal{T}'(y(\theta;\Lambda);\Lambda)\eta(\theta;\Lambda)\frac{dF(\theta)}{1-F(\theta^*)}}{1+\int_{\underline{\theta}}^{\bar{\theta}}\mathcal{T}'(y(\theta;\Lambda);\Lambda)\eta(\theta;\Lambda)dF(\theta)}}_{E(\theta^*;\mathcal{T},\Lambda)}=\underbrace{1-\frac{\int_{\theta^*}^{\bar{\theta}}u_e(\theta;\Lambda)w(\theta)\frac{dF(\theta)}{1-F(\theta^*)}}{\int_{\underline{\theta}}^{\bar{\theta}}u_e(\theta;\Lambda)w(\theta)dF(\theta)}}_{D(\theta^*;\mathcal{T},\Lambda)}$$

1. **DRRA** $\Rightarrow$ Dispersion of **marginal utilities** decreases with growth

   $\rightarrow$ Redistribution should decrease with growth

2. **DRRA** $\Rightarrow$ **Income effect** η decreases with growth
   (a) Efficiency cost of taxes increases $\rightarrow$ Redistribution should decrease with growth
   (b) Efficiency cost of lump-sum transfer decreases $\rightarrow$ Redistribution should increase with growth

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Quantification in a Dynamic Model with Private Insurance

Quantification in a Dynamic Model

- Dynamic incomplete markets model with private saving
  - To disentangle inequality in expenditure, income, and wealth
  - To discipline DRRA with dynamic savings decisions
- Parametric tax-and-transfer system

  Ferriere, Grübener, Navarro, and Vardishvili (2023)

Households: Value Function

- Household's value function with productivity θ and assets a:

$$V(a,\theta) = \max_{e,a',n} \left\{ u(e;\Lambda) - B\frac{n^{1+\varphi}}{1+\varphi} + \beta \mathbb{E}_{\theta'}\left[V(a',\theta')\,|\theta\right] \right\}$$

  s.t.

$$e + a' \leq \theta n + (1+r)a - \mathcal{T}(\theta n), \quad a' \geq 0$$

  – Productivity θ follows a stochastic process
  – Discount factor β
  – Fixed interest rate r (partial equilibrium)

Calibration Overview

- Calibration to the US economy in 1950 and 2010 with three sectors

Calibration Growth

- Calibration to the US economy in 1950 and 2010 with three sectors

1. Aggregate changes
   - Growth in GDP per capita: 3.3,
   - Change in relative prices

Calibration Growth & Government

- Calibration to the US economy in 1950 and 2010 with three sectors

1. Aggregate changes
   - Growth in GDP per capita: 3.3,
   - Change in relative prices
2. Government
   - Parametric tax function plus lump-sum transfer
     Ferriere, Grübener, Navarro, and Vardishvili (2023)
     $$\mathcal{T}(y) = \exp\left[\log(\lambda)\left(y^{-2\tau}\right)\right] y - T$$
     + λ captures level of the tax rates, τ captures progressivity
     + T: spending on income security: $T/Y = 1.1\%$ in 1950 $\rightarrow$ 3.6% in 2010
     + Exogenous spending G, all remaining spending: $G/Y \approx 14\%$ constant

Calibration Inequality

- Wages follow AR(1) in logs, with appended Pareto tail
  - Persistence ρ fixed at 0.9
  - Shock innovation set to match variance of log income from SCF+
    Kuhn, Schularick, and Steins (2020)
  - Time-varying Pareto tail parameter
    Aoki and Nirei (2017)

1950	Income Share by Quintile				
Model	6%	11%	13%	21%	49%
Data (SCF+)	6%	11%	15%	21%	48%

2010	Income Share by Quintile				
Model	4%	9%	11%	19%	56%
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1950	**Wealth** Share by Quintile				
Model	0%	2%	6%	17%	76%
Data (SCF+)	0%	1%	4%	11%	84%

2010	**Wealth** Share by Quintile				
Model	0%	1%	5%	13%	81%
Data (SCF+)	-1%	1%	3%	10%	87%

SCF+ Expenditure Inequality

Calibration Preferences

- Non-homothetic CES parameters
  - Income elasticities of demand and elasticity of substitution between goods
    Estimates of Comin, Lashkari, and Mestieri (2021) based on CEX micro data
  - Change in aggregate sector shares between 1950 and 2010
    Computed based on Herrendorf, Rogerson, and Valentinyi (2013) [NIPA]

NH CES Estimates

Calibration Preferences

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  - Income elasticities of demand and elasticity of substitution between goods

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  - Change in aggregate sector shares between 1950 and 2010

    Computed based on Herrendorf, Rogerson, and Valentinyi (2013) [NIPA]
- Remaining preference parameters
  - Fix Frisch elasticity $1/\varphi$ to standard value of 0.5
  - Consumption curvature γ to match RRA ≈ 1 in 2010

NH CES Estimates

Implied RRA in the Model Decreasing RRA

- Calibrated non-homothetic preferences imply DRRA

Implied RRA in the Model Decreasing RRA

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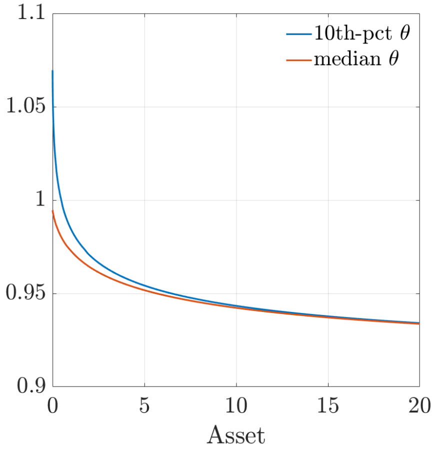
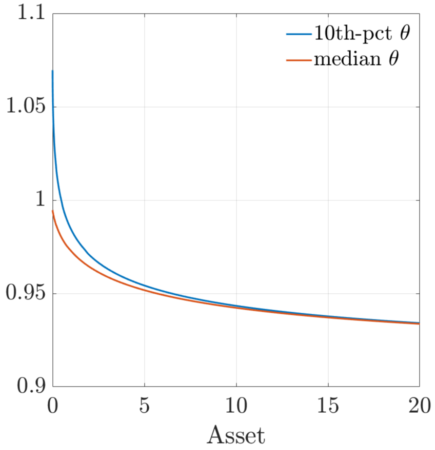


Literature IES & RA | Labor Supply | MPC and Wealth Effects

Implied RRA in the Model Decreasing RRA

- Calibrated non-homothetic preferences imply DRRA
  - RRA falls from 1.07 in 1950 to 1, small dispersion
- Implied labor supply dynamics
  - Falling labor supply over time; cross-sectional patterns
    Boppart and Krusell (2020), Mantovani (2022)



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  - Falling labor supply over time; cross-sectional patterns
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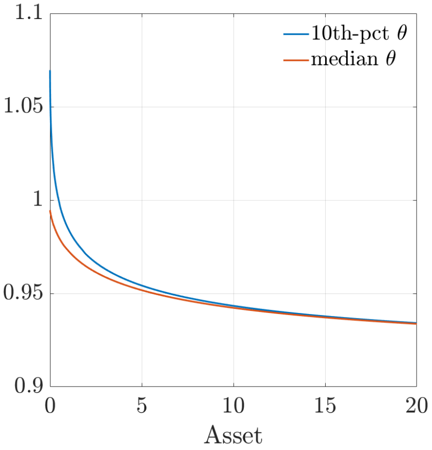
- Model relation between RRA, wealth effects, and MPCs

$$\eta\left(\varphi\frac{e}{\theta n}+\frac{e\mathcal{T}''(\theta n)}{\mathcal{T}'(\theta n)}\right)=\text{MPC}\times\text{RRA}$$



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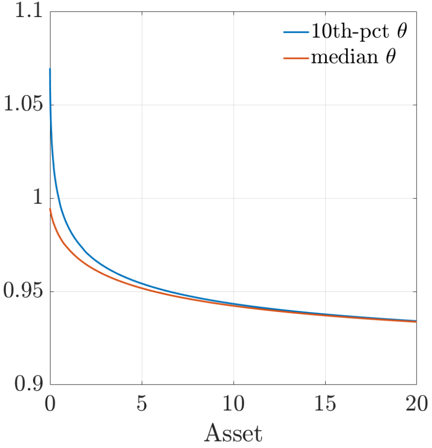
$$\eta\left(\varphi\frac{e}{\theta n}+\frac{e\mathcal{T}''(\theta n)}{\mathcal{T}'(\theta n)}\right)=\text{MPC}\times\text{RRA}$$

  - MPC ≈ 0.18, wealth effects ≈ 0.02 in 2010
    Golosov, Graber, Mogstad, and Novgorodsky (2023)



Literature IES & RA | Labor Supply | MPC and Wealth Effects

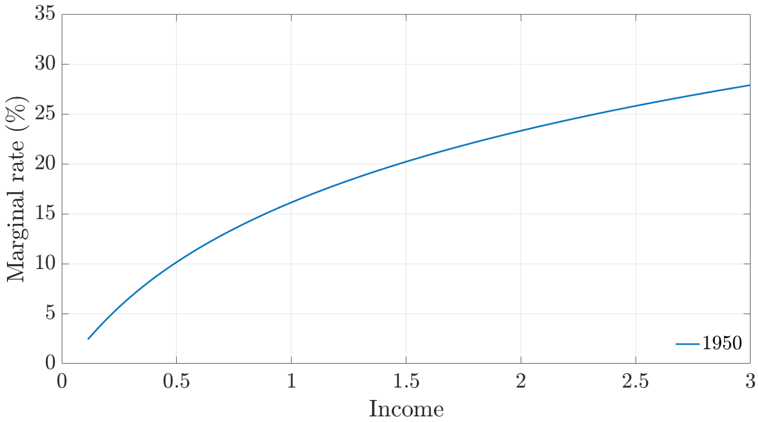
Rising Living Standards vs. Rising Inequality

- Use dynamic model to quantify effect of rising living standards relative to rising inequality
- Start from 1950
  - Inverse optimum in 1950

    Bourguignon and Spadaro (2012), Lockwood and Weinzierl (2016), Hendren (2020)
  - First add inequality only
  - Second compare optimal 2010 with inequality and growth

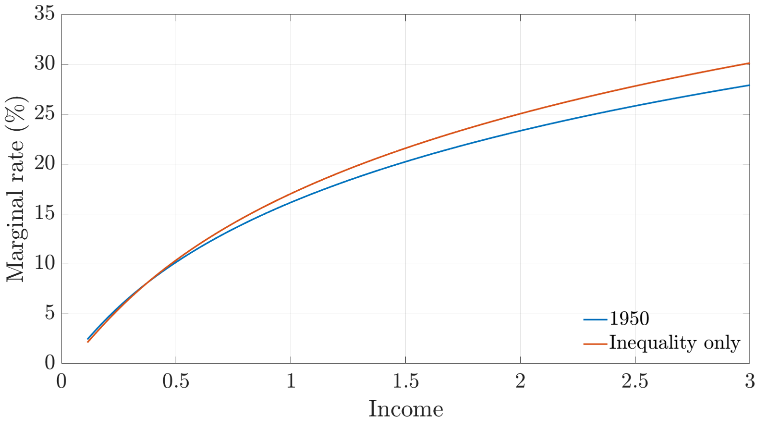
Weights

Optimal Marginal Rates



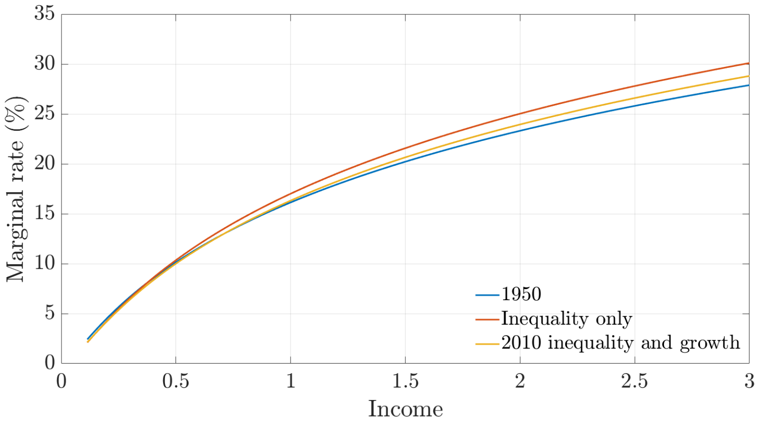
- Calibration in 1950: $T/Y \approx 1\%$

Optimal Marginal Rates



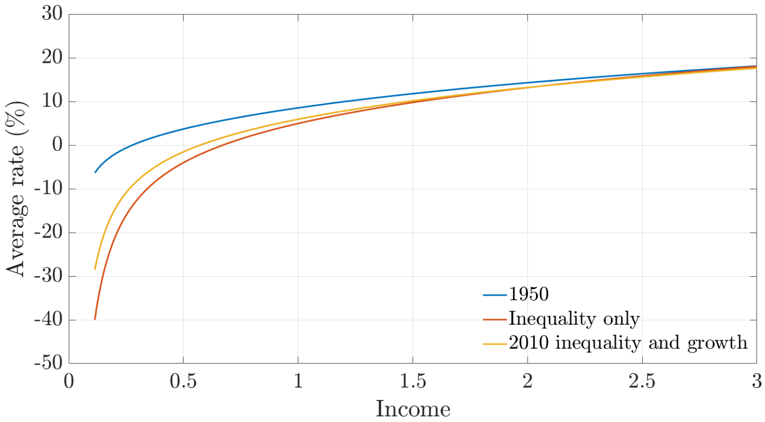
- Calibration in 1950: $T/Y \approx 1\%$ $\Rightarrow T/Y = 4.6\%$ with higher inequality

Optimal Marginal Rates



- Calibration in 1950: $T/Y \approx 1\% \;\Rightarrow T/Y = 3.3\%$ with higher inequality and growth
  - Growth reduces increase in T/Y by 35%

Optimal Average Rates



- Growth reduces increase in top-10 minus bottom-10 average rates by 30%

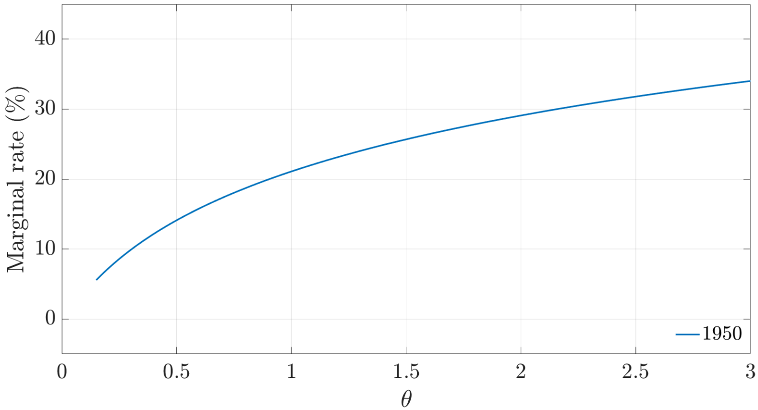
Quantitative Mirrlees Setup

- Calibration following a partial-insurance approach
  - Target consumption dispersion of the quantitative model in 1950 and 2010

Quantitative Mirrlees Setup

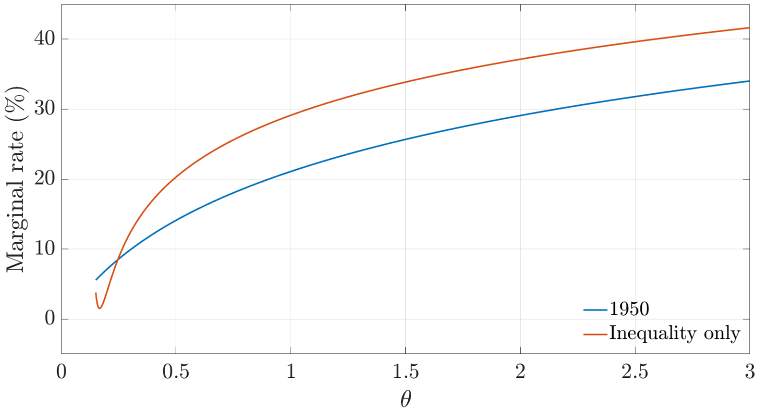
- Calibration following a partial-insurance approach
  - Target consumption dispersion of the quantitative model in 1950 and 2010
- Replicate the main quantitative exercise
  - Obtain similar effects of rising living standards relative to rising inequality

Optimal Marginal Rates Mirrlees



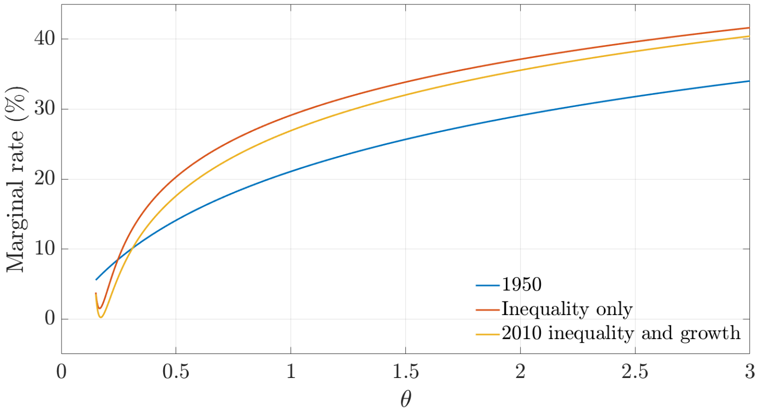
- Calibration in 1950: $T/Y \approx 1\%$

Optimal Marginal Rates Mirrlees



- Calibration in 1950: $T/Y \approx 1\%$ $\Rightarrow T/Y = 6.7\%$ with higher inequality

Optimal Marginal Rates Mirrlees



- Calibration in 1950: $T/Y \approx 1\%$ $\Rightarrow T/Y = 4.5\%$ with higher inequality and growth
  - Growth reduces increase in T/Y by 40%

Quantitative Mirrlees Setup

- Calibration following a partial-insurance approach
  - Target consumption dispersion of the quantitative model in 1950 and 2010
- Replicate the main quantitative exercise
- Decompose the different channels using the optimal tax formula
  - Decomposition into effects of marginal utilities, income effects, and the hours distribution

Optimal Marginal Rates Decomposition

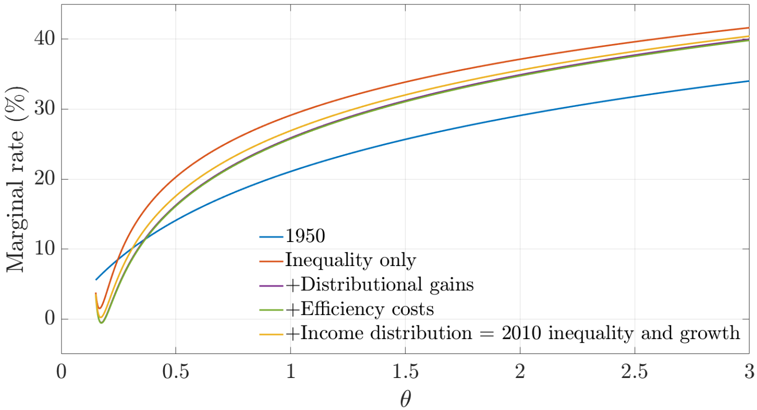
- In 1950, calibrated/optimal $T/Y \approx 1\%$

- Optimal T/Y in 2010
  – Accounting for inequality only: $T/Y = 6.7\%$
  – Accounting for growth as well: $T/Y = 4.5\% \Rightarrow$ -2.2 p.p.

Optimal Marginal Rates Decomposition

- In 1950, calibrated/optimal $T/Y \approx 1\%$
- Optimal T/Y in 2010
  - Accounting for inequality only: $T/Y = 6.7\%$
  - Accounting for growth as well: $T/Y = 4.5\% \Rightarrow$ -2.2 p.p.
    - $+$ Fall in **dispersion in marginal utilities**: -2.9 p.p.
    - $+$ Also accounting for lower income effects: -0.1 p.p.
    - $+$ Also accounting for the more compressed distribution of hours: $+$0.8 p.p.

Optimal Marginal Rates Decomposition



- 1950: $T/Y = 1.2\%$ $\Rightarrow$ $T/Y = 6.7\%$ with inequality, $T/Y = 4.5\%$ with growth
  $\Rightarrow$ $T/Y = 3.8\%$ with marginal utilities only, $T/Y = 3.7\%$ adding efficiency concerns

Quantitative Mirrlees Setup

- Calibration following a partial-insurance approach
- Replicate the main quantitative exercise
- Decompose the different channels using the optimal tax formula
- Robustness

Conclusion

Conclusion

- Optimal taxation with rising living standards
  - Affect efficiency and distribution concerns
- Dampen optimal increase in redistribution due to rising inequality

Appendix

Literature

Evidence: Risk Aversion and IES

- IES increasing in consumption/wealth, based on estimating consumption Euler equation
  Blundell, Browning, and Meghir (1994), Attanasio and Browning (1995), Atkeson and Ogaki (1996)

- DRRA supported by consumption data from Indian villages
  Ogaki and Zhang (2001), Zhang and Ogaki (2004)

- DRRA powerful in matching portfolio choices across the wealth distribution
  Wachter and Yogo (2010), Straub (2019), Cioffi (2021), Meeuwis (2022)

Data Appendix

SCF+

- Long-run data on income and wealth inequality in the US
  Compiled by Kuhn, Schularick, and Steins (2020)
  - Based on historical waves of the Survey of Consumer Finances (SCF)
  - Time period 1949-2016
- Income components
  - Wages and salaries
  - Income from professional practice and self-employment
  - Business and farm income
  - Excluded: rental income, interest, dividends, transfers

SCF+ (cont.)

- Net worth/wealth components (assets - debt)
  - Assets
    - Liquid assets: checking, savings, call/money market accounts, certificates of deposit
    - Housing and other real estate
    - Bonds, stocks and business equity, mutual funds
    - Cash value of life insurance
    - Defined-contribution retirement plans
    - Cars
  - Debt
    - Housing debt: debt on owner-occupied homes, home equity loans and lines of credit
    - Other debt: car loans, education loans, consumer loans

Back

SCF+ (cont.)

- Sample selection
  - Head of household aged 25 to 60
  - Minimum income restriction
    - $5,000 for 2010 (in 2016 dollars)
    - In 1950 such that ratio of minimum income to median is the same ($2,700)

Government Spending

- Programs included in transfers

  White House Office of Management & Budget

  – General retirement and disability insurance (excluding social security)
  – Federal employee retirement and disability; Unemployment compensation
  – Housing assistance; Food and nutrition assistance; Other income security

- Government spending

  – Supposed to capture all remaining federal spending
  – Purposefully chosen such that G/Y constant
    + Spending has risen in the data, but largely deficit-financed

- Difference in Average Marginal Tax Rate (AMTR) between top 10% and bottom 90%

  Mertens and Montiel Olea (2018)

  – 13%, 9%

Back

Model Appendix

Non-Homothetic Preferences Non-Homothetic CES

Comin, Lashkari, and Mestieri (2021)

- Utility from aggregated consumption: $\mathcal{C}(c)^{1-\gamma}/(1-\gamma)$
- Consumption aggregator $\mathcal{C}(c)$ implicitly defined by

$$\sum_{j}^{J} \left(\Omega_j (\mathcal{C}(c))^{\varepsilon_j}\right)^{\frac{1}{\sigma}} c_j^{\frac{\sigma-1}{\sigma}} = 1$$

  - ε_j governs income elasticity of demand for good j
  - σ is elasticity of substitution btw. goods

    $\Rightarrow$ $\partial c_j / \partial e = \sigma + (1-\sigma)\varepsilon_j/\bar{\varepsilon}$

- Focus on gross complements $\sigma < 1$

Back

Non-Homothetic Preferences Non-Homothetic CES

Comin, Lashkari, and Mestieri (2021)

- Conditions for DRRA with two goods: $\varepsilon_1 < \varepsilon_2 = 1$
  - Necessary condition: $\gamma > \varepsilon_1$
  - Sufficient condition: $\gamma + \varepsilon_1 \geq 2$
- Typical calibration with three goods $\Rightarrow$ quantitatively true

Back

Non-Homothetic Preferences Stone-Geary Preferences

Geary (1950)

- **One-sector** Stone-Geary preferences

$$u\left(c\right)=\frac{\left(c-\bar{c}\right)^{1-\gamma}}{1-\gamma}$$

- Subsistence consumption level $\bar{c}>0$

$\Rightarrow$ Implies increasing elasticity of intertemporal substitution (DRRA)

- Counterfactual: vanishing non-homotheticities

Non-Homothetic Preferences IA Preferences

Alder, Boppart, and Müller (2022)

- Preferences defined over expenditures $e = \sum_j p_j c_j$

$$u(e;p,\Lambda) = \frac{1}{1-\gamma}\left(\frac{1}{\mathbf{B}(p^*)}\left(e - \underbrace{\sum_j p_j^* \bar{c}_j}_{\mathbf{A}(p^*)}\right)\right)^{1-\gamma} - \mathbf{D}\left(p^*\right), \text{ with } p^* \equiv \frac{p}{\Lambda}$$

  – Price function $\mathbf{B}(p^*) = \left(\sum_j \Omega_j \left(p_j^*\right)^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$

D-Term Back

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  - Generalized Stone-Geary $\mathbf{A}(p^*)$
  - Price function $\mathbf{D}(p^*)$ is independent of expenditures e (PIGL)

D-Term Back

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  – Price function $\mathbf{B}(p^*) = \left(\sum_j \Omega_j \left(p_j^*\right)^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$

  – Generalized Stone-Geary $\mathbf{A}\left(p^*\right)$

  – Price function $\mathbf{D}\left(p^*\right)$ is independent of expenditures e (PIGL)

$\Rightarrow$ Typically implies DRRA

  – u exhibits DRRA $\Leftrightarrow \mathbf{A}\left(p^*\right) > 0$

Non-Homothetic Preferences IA Preferences

Alder, Boppart, and Müller (2022)

$$\mathbf{D}(p^*) = \frac{\nu}{\eta}\left(\left[\frac{\tilde{D}(p^*)}{B(p^*)}\right]^{\eta} - 1\right)$$

$$\tilde{D}(p^*) = \left(\sum_{j \in J} \theta_j {p_j^*}^{1-\iota}\right)^{\frac{1}{1-\iota}}$$

Back

Calibration Aggregates

- Prices for all goods p_A, p_G, p_S pinned down by growth and relative price changes
  - Aggregate growth in GDP per capita: 3.3
    NIPA
  - Prices relative to goods
    Computed based on Herrendorf, Rogerson, and Valentinyi (2013) [NIPA]
    - Agriculture (food) $\rightarrow$ 1.00, 1.87
    - Services $\rightarrow$ 1.00, 3.16
- Interest rate fixed at 2%; discount factor to match wealth-to-income ratio of 4 in 2010
  Piketty and Zucman (2014) [NIPA]
  - Untargeted wealth-to-income ratio in 1950 of 3 [data: 3.65]

Back

Calibration Preferences

- Non-homothetic CES parameters
  - $\{\varepsilon_j\}$ and σ: estimates of Comin, Lashkari, and Mestieri (2021) with CEX micro data
    - $\sigma = 0.3$; $\varepsilon_A = 0.1, \varepsilon_G = 1.0, \varepsilon_S = 1.8$

Back

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  - $\{\varepsilon_j\}$ and σ: estimates of Comin, Lashkari, and Mestieri (2021) with CEX micro data
    - $\sigma = 0.3$; $\varepsilon_A = 0.1, \varepsilon_G = 1.0, \varepsilon_S = 1.8$
  - Ω_j: match aggregate sector shares in 2010
    Computed based on Herrendorf, Rogerson, and Valentinyi (2013) [NIPA]
    - Agriculture (food) 8%, goods 26%, services 67%
    - Untargeted 1950: agriculture 17% [data 22%], goods 49% [39%], services 34% [39%]

Labor Supply in the Time Series and Cross-Section

- Fall in average hours across time: 7%

  Ruggles et al. (2022); Ramey and Francis (2009), Boppart and Krusell (2020)

- Correlation between hours and hourly wage in the cross-section
  - Roughly flat hours profile in 1950
  - Positive in 2010

  Ruggles et al. (2022); Mantovani (2022)

Back

Calibration Income inequality

- Wages follow AR(1) in logs, with appended Pareto tail
  - Time-varying Pareto tail parameter
    Aoki and Nirei (2017)
  - Time-varying innovation to AR(1) set to match variance of log income from SCF+
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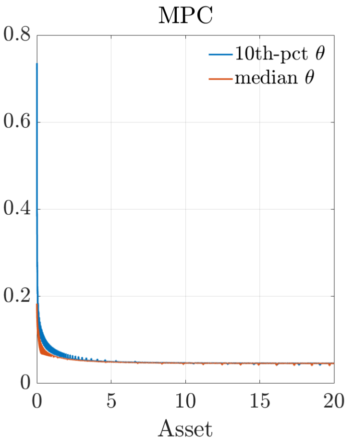
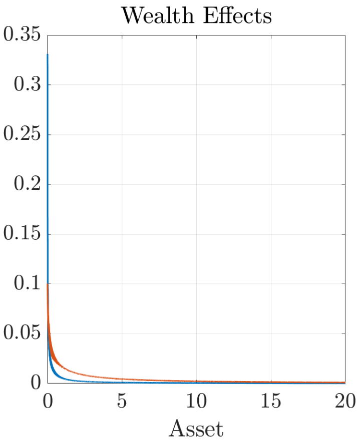
Calibration Expenditure Inequality

- Variance of log consumption in 2010: 0.46, top-quintile expenditure share of 45%
- Less expenditure inequality in 1950
- Variance of log consumption in 2010: 0.33, top-quintile expenditure share of 39%

Implied RRA in the Model MPCs and Wealth Effects





- Model MPC: 18% in 2010
  Johnson, Parker, and Souleles (2006), Fagereng, Holm, and Natvik (2021), Kaplan and Violante (2022)
- Wealth effects: 0.02 in 2010
  Golosov, Graber, Mogstad, and Novgorodsky (2023)

Wealth Effects: Evidence Golosov, Graber, Mogstad, and Novgorodsky (2023)

- How does income respond to unexpected wealth shocks?
  - Golosov et al. merge US tax data with data on lottery winnings
  - Compute earnings change over five years after lottery win
  - Earnings drop by on average $2.3\$$ per $100\$$ of win
- Replicate in model using mean post-tax win
  - Earnings drop by on average $2.1\$$ per $100\$$ of win

Back

Calibration: Inequality

- A partial-insurance approach
  - Calibrate $f(.)$ as exponentially modified Gaussian (EMG) to match dispersion in expenditures

Back

Calibration: Inequality

- A partial-insurance approach
  - Calibrate $f(.)$ as exponentially modified Gaussian (EMG) to match dispersion in expenditures
- In 2010, data on income and expenditure inequality
  - Dispersion: $\mathbb{V}[\log y] = 0.78$; $\mathbb{V}[\log e] \approx 0.35$

    SCF+ (Kuhn, Schularick, and Steins 2020); Attanasio and Pistaferri (2014), Heathcote, Perri, and Violante (2010)
  - Pareto tail: $\lambda_y = 1.65$; $\lambda_e \approx 3.3$

    Aoki and Nirei (2017); Toda and Walsh (2015)

Back

Calibration: Inequality

- A partial-insurance approach
  - Calibrate $f(.)$ as exponentially modified Gaussian (EMG) to match dispersion in expenditures
- In 2010, data on income and expenditure inequality
  - Dispersion: $\mathbb{V}[\log y] = 0.78$; $\mathbb{V}[\log e] \approx 0.35$

    SCF+ (Kuhn, Schularick, and Steins 2020); Attanasio and Pistaferri (2014), Heathcote, Perri, and Violante (2010)
  - Pareto tail: $\lambda_y = 1.65$; $\lambda_e \approx 3.3$

    Aoki and Nirei (2017); Toda and Walsh (2015)
- In 1950, data on income inequality only
  - Dispersion: $\mathbb{V}[\log y] = 0.57$; $\Rightarrow$ infer $\mathbb{V}[\log e] \approx 0.25$

    SCF+ (Kuhn, Schularick, and Steins 2020)
  - Pareto tail: $\lambda_y = 2.2 \Rightarrow$ infer $\lambda_e = 4.4$

    Aoki and Nirei (2017)

Back

Calibration: Expenditure Inequality

1950	Expenditure Share by Quintile				
Dynamic model	8%	13%	17%	23%	39%
Static model	9%	13%	17%	23%	38%

2010	Expenditure Share by Quintile				
Dynamic model	7%	11%	16%	21%	45%
Static model	7%	12%	16%	23%	43%

Efficiency vs. Distribution with Growth

- Use Mirrlees formula to quantify how growth changes efficiency vs. distribution concerns
  - Static "partial insurance" setup with expenditure distribution as in dynamic model

Back

Efficiency vs. Distribution with Growth

- Use Mirrlees formula to quantify how growth changes efficiency vs. distribution concerns
  - Static "partial insurance" setup with expenditure distribution as in dynamic model
- Start from 1950 and add only growth
  - Prices fall but skill inequality remains unchanged

Back

Efficiency vs. Distribution with Growth

- Use Mirrlees formula to quantify how growth changes efficiency vs. distribution concerns
  - Static "partial insurance" setup with expenditure distribution as in dynamic model
- Start from 1950 and add only growth
  - Prices fall but skill inequality remains unchanged
  - Inverse optimum in 1950

    Bourguignon and Spadaro (2012), Lockwood and Weinzierl (2016), Hendren (2020)

    + Pareto weights such that calibrated 1950 tax system is optimal

Back

Efficiency vs. Distribution with Growth

- Use Mirrlees formula to quantify how growth changes efficiency vs. distribution concerns
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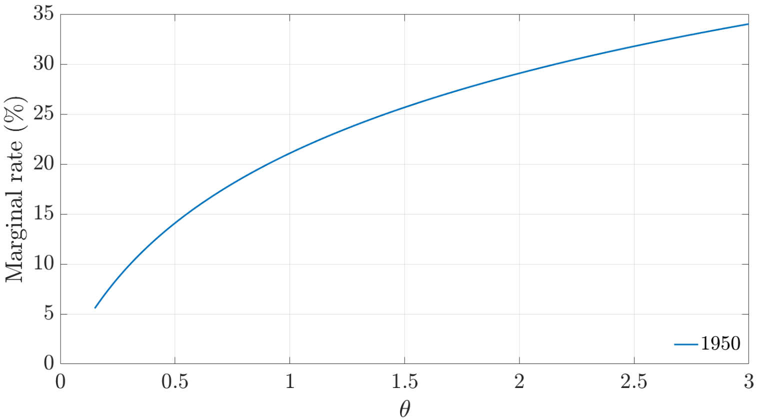
    Bourguignon and Spadaro (2012), Lockwood and Weinzierl (2016), Hendren (2020)
    - Pareto weights such that calibrated 1950 tax system is optimal
  - Optimal taxes with growth of 2010
    - Decomposition into effects of marginal utilities, income effects, and the hours distribution

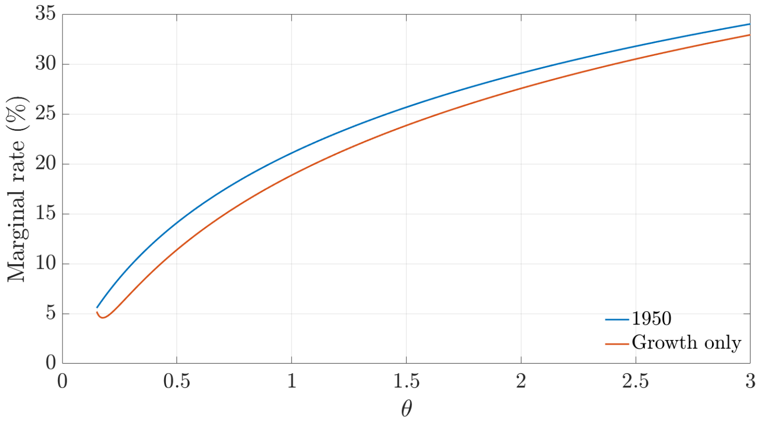
Optimal Marginal Rates with Growth



- Optimal 1950 transfers: $T/Y = 1.2\%$

Formula Back

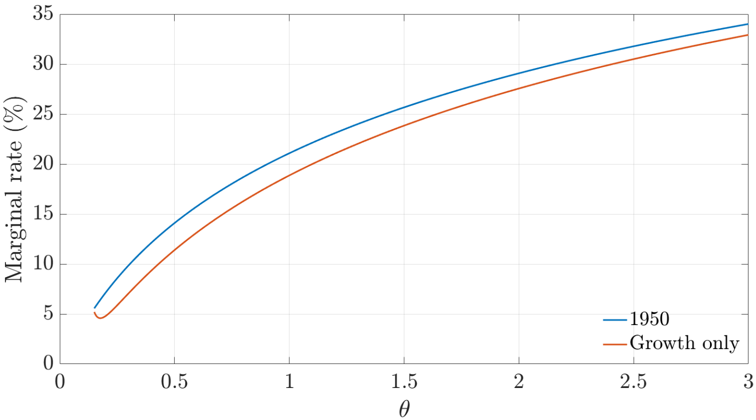
Optimal Marginal Rates with Growth



- Optimal 1950 transfers: $T/Y = 1.2\%$ $\Rightarrow$ With 2010 growth, $T/Y = -0.7\%$

Formula Back

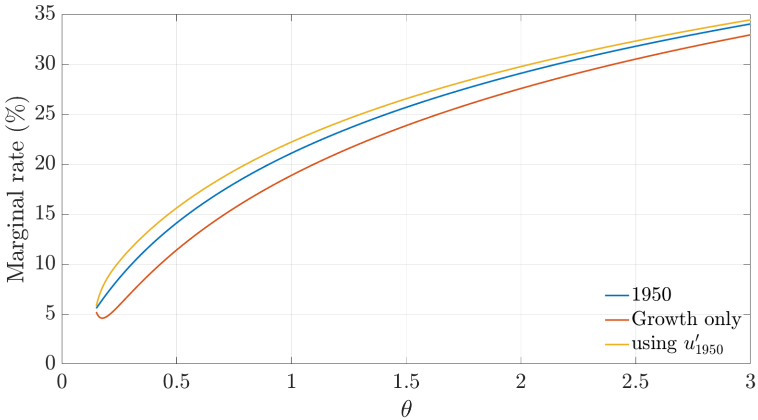
Optimal Marginal Rates with Growth



- With 2010 growth, $T/Y = -0.7\%$

Formula
Back

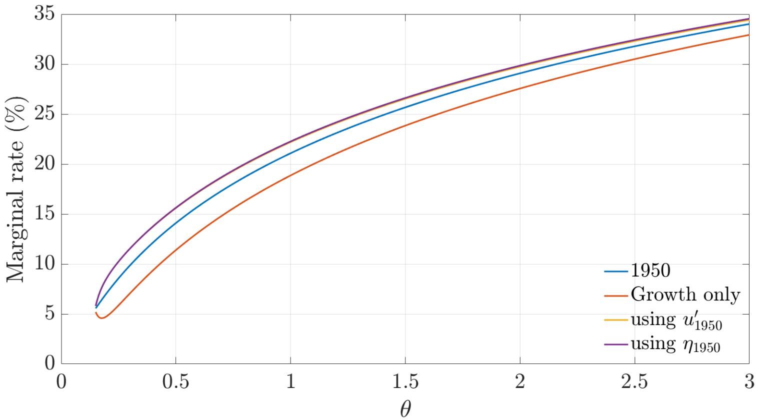
Optimal Marginal Rates with Growth



- With 2010 growth, $T/Y = -0.7\%$ $\Rightarrow$ With 1950 marg. u dispersion, $T/Y = 2.4\%$

Formula Back

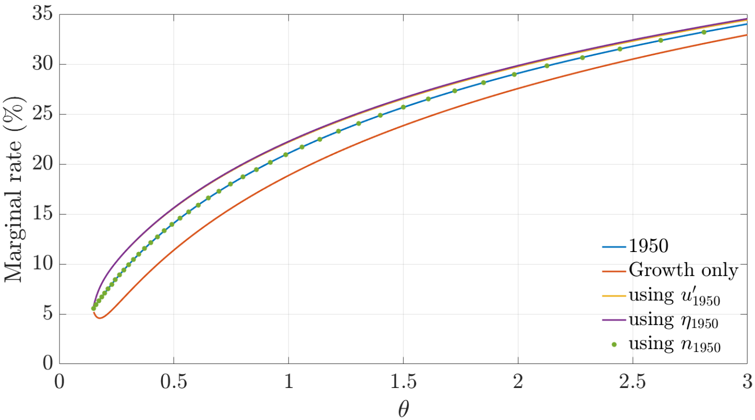
Optimal Marginal Rates with Growth



- With 2010 growth, $T/Y = -0.7\%$ $\Rightarrow$ With 1950 income effects, $T/Y = 2.4\%$

Formula Back

Optimal Marginal Rates with Growth



- With 2010 growth, $T/Y = -0.7\%$ $\Rightarrow$ With 1950 hours worked, $T/Y = 1.2\%$ (1950 level)

Formula Back

Efficiency vs. Distribution **Decomposition**

- Decomposition into effects of marginal utilities, income effects, and the hours distribution

$$\underbrace{1-\frac{1-\frac{\mathcal{T}'(y(\theta^*;\Lambda);\Lambda)}{1-\mathcal{T}'(y(\theta^*;\Lambda);\Lambda)}\frac{1}{1+\varphi}\frac{\theta^* f(\theta^*)}{1-F(\theta^*)}+\int_{\theta^*}^{\bar{\theta}}\mathcal{T}'(y(\theta;\Lambda);\Lambda)\eta(\theta;\Lambda)\frac{dF(\theta)}{1-F(\theta^*)}}{1+\int_{\underline{\theta}}^{\bar{\theta}}\mathcal{T}'(y(\theta;\Lambda);\Lambda)\eta(\theta;\Lambda)dF(\theta)}}_{E(\theta^*;\mathcal{T},\Lambda)}=\underbrace{1-\frac{\int_{\theta^*}^{\bar{\theta}}u_e(\theta;\Lambda)w(\theta)\frac{dF(\theta)}{1-F(\theta^*)}}{\int_{\underline{\theta}}^{\bar{\theta}}u_e(\theta;\Lambda)w(\theta)dF(\theta)}}_{D(\theta^*;\mathcal{T},\Lambda)}$$

- Starting from optimal taxes with growth

Back

Efficiency vs. Distribution Decomposition

- Decomposition into effects of marginal utilities, income effects, and the hours distribution

$$\underbrace{1 - \frac{1 - \frac{\mathcal{T}'(y(\theta^*;\Lambda);\Lambda)}{1-\mathcal{T}'(y(\theta^*;\Lambda);\Lambda)} \frac{1}{1+\varphi} \frac{\theta^* f(\theta^*)}{1-F(\theta^*)} + \int_{\theta^*}^{\bar{\theta}} \mathcal{T}'(y(\theta;\Lambda);\Lambda)\eta(\theta;\Lambda)\frac{dF(\theta)}{1-F(\theta^*)}}{1 + \int_{\underline{\theta}}^{\bar{\theta}} \mathcal{T}'(y(\theta;\Lambda);\Lambda)\eta(\theta;\Lambda)dF(\theta)}}_{E(\theta^*;\mathcal{T},\Lambda)} = \underbrace{1 - \frac{\int_{\theta^*}^{\bar{\theta}} u_e(\theta;\Lambda)w(\theta)\frac{dF(\theta)}{1-F(\theta^*)}}{\int_{\underline{\theta}}^{\bar{\theta}} u_e(\theta;\Lambda)w(\theta)dF(\theta)}}_{D(\theta^*;\mathcal{T},\Lambda)}$$

- Starting from optimal taxes with growth

  1. Optimal taxes with $u_e(\cdot)$ computed using p_{1950}

Back

Efficiency vs. Distribution Decomposition

- Decomposition into effects of marginal utilities, income effects, and the hours distribution

$$\underbrace{1 - \frac{1 - \frac{\mathcal{T}'(y(\theta^*;\Lambda);\Lambda)}{1-\mathcal{T}'(y(\theta^*;\Lambda);\Lambda)} \frac{1}{1+\varphi} \frac{\theta^* f(\theta^*)}{1-F(\theta^*)} + \int_{\theta^*}^{\bar{\theta}} \mathcal{T}'(y(\theta;\Lambda);\Lambda)\eta(\theta;\Lambda)\frac{dF(\theta)}{1-F(\theta^*)}}{1 + \int_{\underline{\theta}}^{\bar{\theta}} \mathcal{T}'(y(\theta;\Lambda);\Lambda)\eta(\theta;\Lambda)dF(\theta)}}_{E(\theta^*;\mathcal{T},\Lambda)} = \underbrace{1 - \frac{\int_{\theta^*}^{\bar{\theta}} u_e(\theta;\Lambda)w(\theta)\frac{dF(\theta)}{1-F(\theta^*)}}{\int_{\underline{\theta}}^{\bar{\theta}} u_e(\theta;\Lambda)w(\theta)dF(\theta)}}_{D(\theta^*;\mathcal{T},\Lambda)}$$

- Starting from optimal taxes with growth

  1. Optimal taxes with $u_e(\cdot)$ computed using p_{1950}
  2. Adding $\eta(\cdot)$ using p_{1950}

Back

Efficiency vs. Distribution Decomposition

- Decomposition into effects of marginal utilities, income effects, and the hours distribution

$$\underbrace{1-\frac{1-\frac{\mathcal{T}'(y(\theta^*;\Lambda);\Lambda)}{1-\mathcal{T}'(y(\theta^*;\Lambda);\Lambda)}\frac{1}{1+\varphi}\frac{\theta^* f(\theta^*)}{1-F(\theta^*)}+\int_{\theta^*}^{\bar{\theta}}\mathcal{T}'(y(\theta;\Lambda);\Lambda)\eta(\theta;\Lambda)\frac{dF(\theta)}{1-F(\theta^*)}}{1+\int_{\underline{\theta}}^{\bar{\theta}}\mathcal{T}'(y(\theta;\Lambda);\Lambda)\eta(\theta;\Lambda)dF(\theta)}}_{E(\theta^*;\mathcal{T},\Lambda)}=\underbrace{1-\frac{\int_{\theta^*}^{\bar{\theta}}u_e(\theta;\Lambda)w(\theta)\frac{dF(\theta)}{1-F(\theta^*)}}{\int_{\underline{\theta}}^{\bar{\theta}}u_e(\theta;\Lambda)w(\theta)dF(\theta)}}_{D(\theta^*;\mathcal{T},\Lambda)}$$

- Starting from optimal taxes with growth

1. Optimal taxes with $u_e(\cdot)$ computed using p_{1950}
2. Adding $\eta(\cdot)$ using p_{1950}
3. Adding $n(\cdot)$ using p_{1950}

Back

Efficiency vs. Distribution Decomposition

- Decomposition into effects of marginal utilities, income effects, and the hours distribution

$$\underbrace{1-\frac{1-\frac{\mathcal{T}'(y(\theta^*;\Lambda);\Lambda)}{1-\mathcal{T}'(y(\theta^*;\Lambda);\Lambda)}\frac{1}{1+\varphi}\frac{\theta^* f(\theta^*)}{1-F(\theta^*)}+\int_{\theta^*}^{\bar{\theta}}\mathcal{T}'(y(\theta;\Lambda);\Lambda)\eta(\theta;\Lambda)\frac{dF(\theta)}{1-F(\theta^*)}}{1+\int_{\underline{\theta}}^{\bar{\theta}}\mathcal{T}'(y(\theta;\Lambda);\Lambda)\eta(\theta;\Lambda)dF(\theta)}}_{E(\theta^*;\mathcal{T},\Lambda)}=\underbrace{1-\frac{\int_{\theta^*}^{\bar{\theta}}u_e(\theta;\Lambda)w(\theta)\frac{dF(\theta)}{1-F(\theta^*)}}{\int_{\underline{\theta}}^{\bar{\theta}}u_e(\theta;\Lambda)w(\theta)dF(\theta)}}_{D(\theta^*;\mathcal{T},\Lambda)}$$

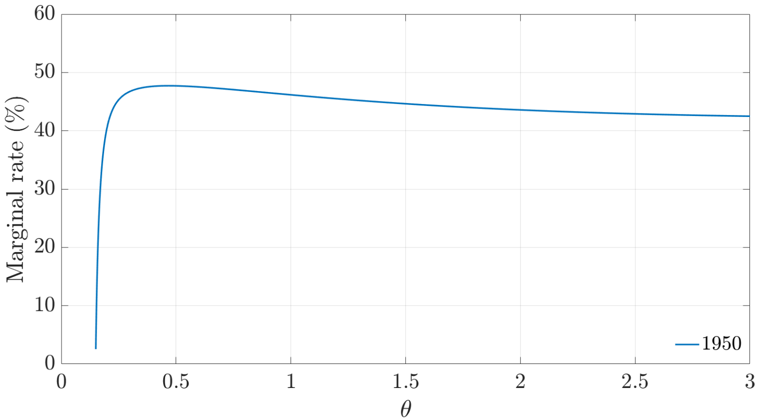
- Starting from optimal taxes with growth

  1. Optimal taxes with $u_e(\cdot)$ computed using p_{1950}
  2. Adding $\eta(\cdot)$ using p_{1950}
  3. Adding $n(\cdot)$ using p_{1950}

  $\Rightarrow$ Back to 1950

Back

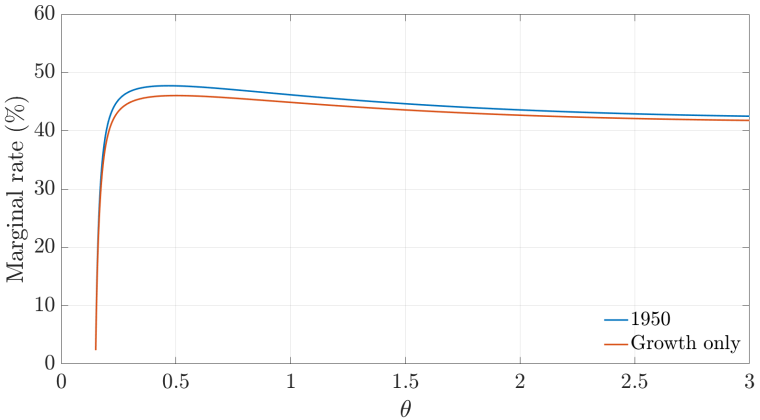
Optimal Marginal Rates with Growth **Utilitarian**



- Optimal 1950 transfers: $T/Y = 25.2\%$

Back

Optimal Marginal Rates with Growth **Utilitarian**



- Optimal 1950 transfers: T/Y $= 25.2\% \Rightarrow$ With 2010 growth, $T/Y = 24.0\%$

Back

Weights

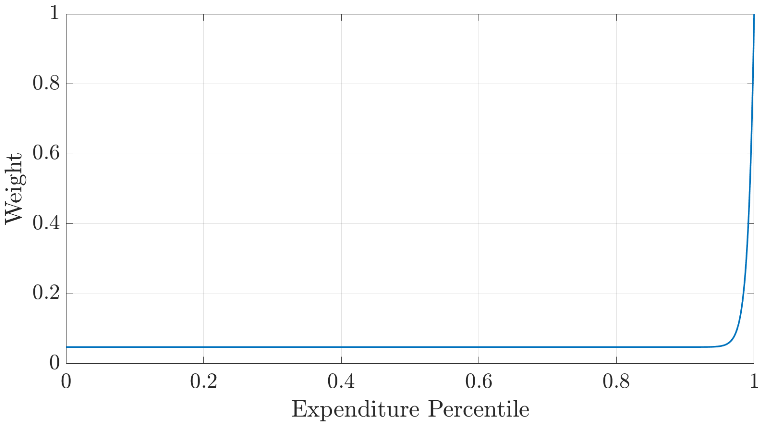
- More degrees of freedom in finding inverse optimum weights
- Restriction to functional form motivated by instruments: lump sum and progressivity
- Weights as function of percentiles of the expenditure distribution

$$\omega\left(p_i\right) = \mu + p_i(e_i)^{\nu}$$

- $\mu = 0.05$, $\nu = 116.4$

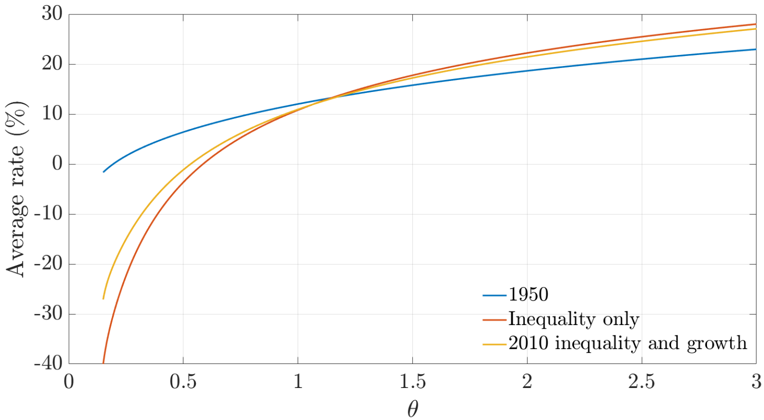
Back

Weights



Back

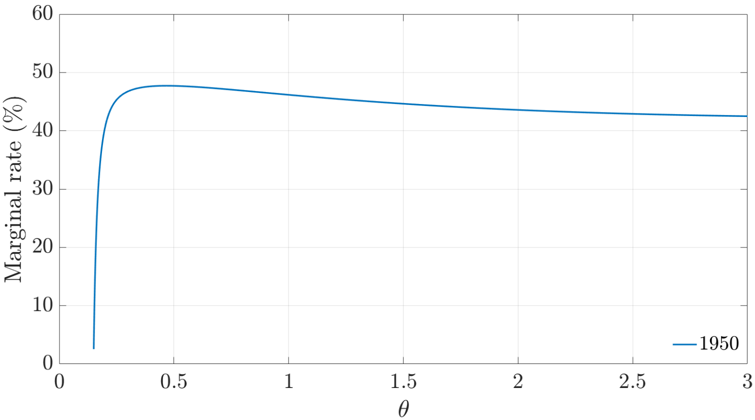
Optimal Average Rates Mirrlees



- Growth reduces increase in top-10 minus bottom-10 average rates by almost 30%

Back

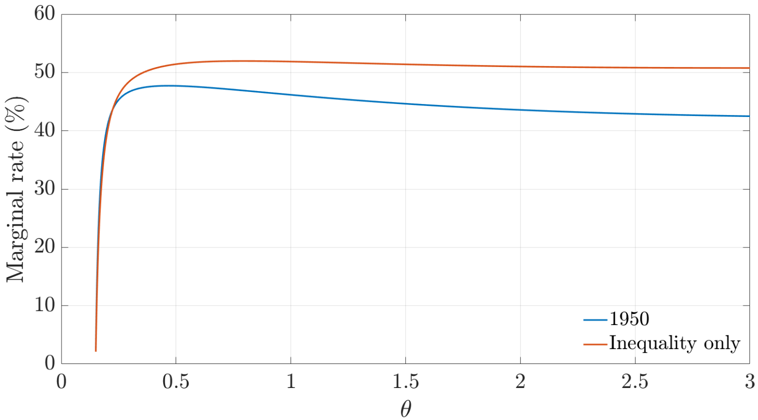
Optimal Marginal Rates Mirrlees Utilitarian



- Optimum in 1950: $T/Y = 25.2\%$

Back

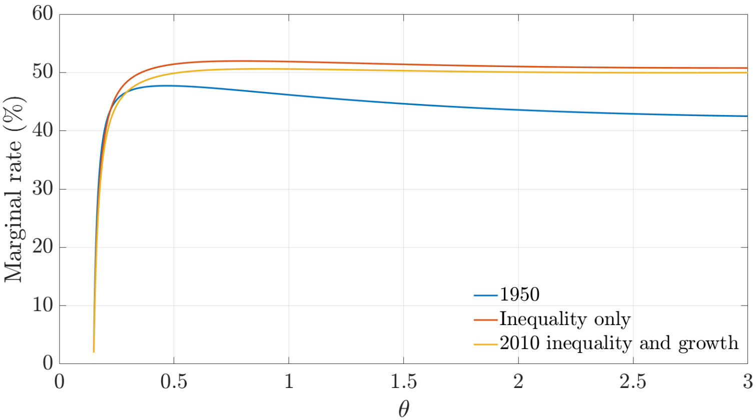
Optimal Marginal Rates Mirrlees Utilitarian



- Optimum in 1950: $T/Y = 25.2\%$ $\Rightarrow T/Y = 29.2\%$ with higher inequality

Back

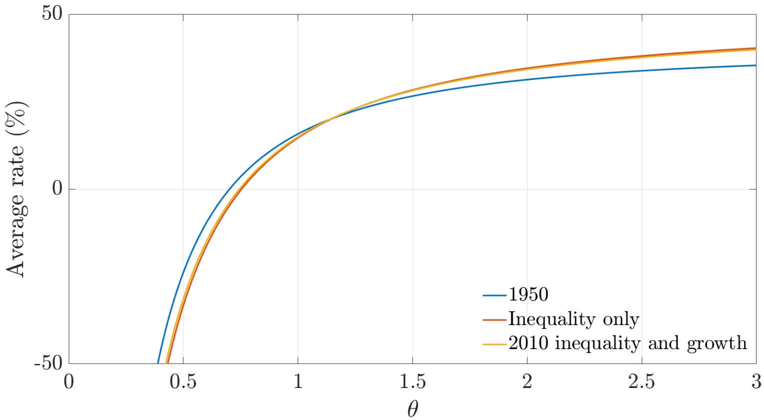
Optimal Marginal Rates Mirrlees Utilitarian



- Optimum in 1950: $T/Y = 25.2\%$ $\Rightarrow T/Y = 27.6\%$ with higher inequality and growth
  - Growth reduces increase in T/Y by 39%

Back

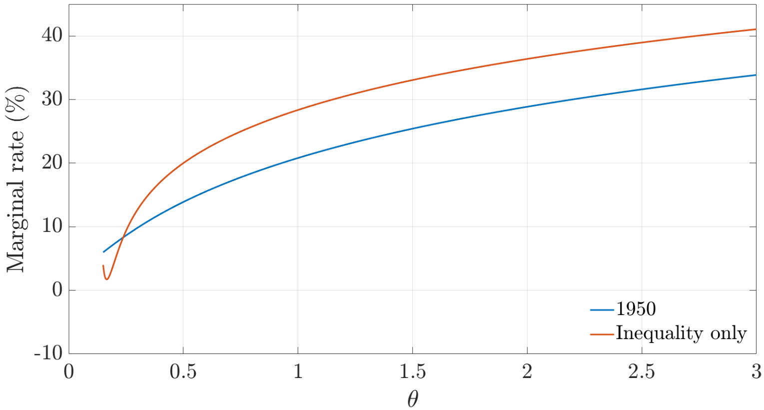
Optimal Average Rates Mirrlees Utilitarian



- Growth reduces increase in top-10 minus bottom-10 average rates by 9%

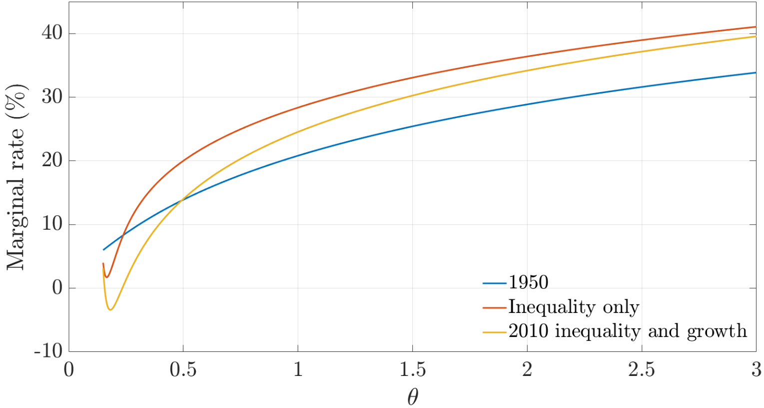
Back

Optimal Marginal Rates Mirrlees IA Preferences



- Calibration in 1950: $T/Y = 1.1\% \Rightarrow T/Y = 5.6\%$ with higher inequality

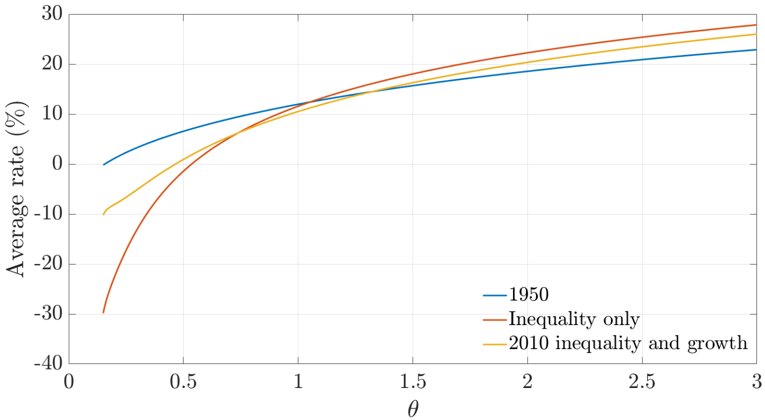
Optimal Marginal Rates Mirrlees IA Preferences



- Calibration in 1950: $T/Y = 1.1\% \;\Rightarrow T/Y = 2.0\%$ with higher inequality and growth
  - Growth reduces increase in T/Y by more than 80%

Parameters Back

Optimal Average Rates **Mirrlees IA Preferences**



- Growth reduces increase in top-10 minus bottom-10 average rates by almost 50%

Back

IA Parameters

- $1 - \eta = \gamma = 0.9$
- A-term
  - $\bar{c}_A = 0.03$, $\bar{c}_G = 0.00$, $\bar{c}_S = 0.005$
- B-term
  - $\sigma = 0.001$
  - $\omega_A = 0.06$, $\omega_G = 0.4$, $\omega_S = 1 - \omega_A - \omega_G$
- D-term
  - $\nu = 15$
  - $\iota = 2$
  - $\theta_A = 0.22$, $\theta_G = 0.62$, $\theta_S = 1 - \theta_A - \theta_G$

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