Optimal Public Debt with Redistribution

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Motivation

- Ongoing debates on how $\overbrace{\text{public debt}}^{\text{Blanchard (2019)}}$ and $\underbrace{\text{progressive taxes}}_{\text{Heathcote et al. (2020)}}$ should be used

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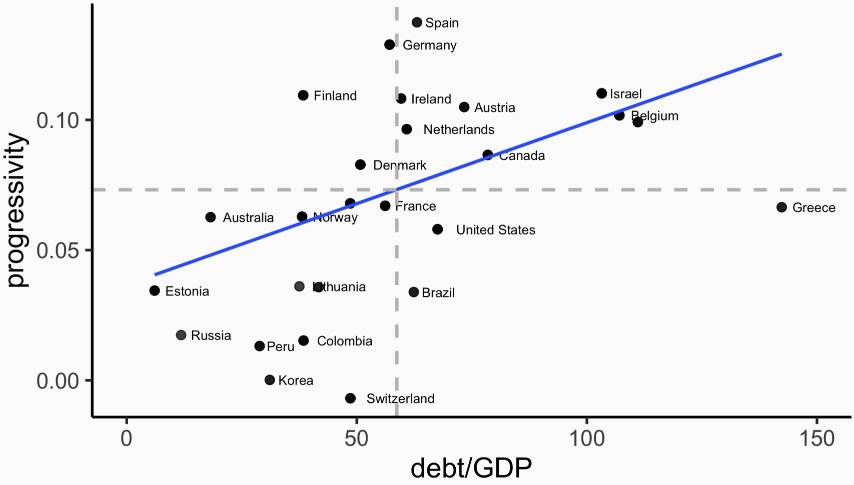
Figure 1: Public debt and progressivity across countries, 1970-2015 [IMF & Qiu and Russo, 2022]



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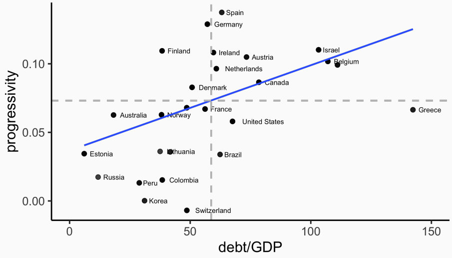

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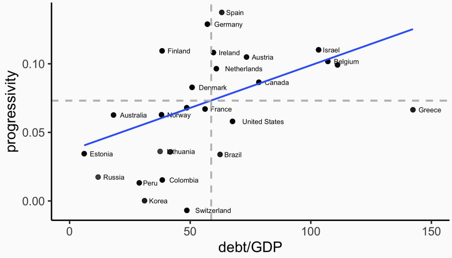

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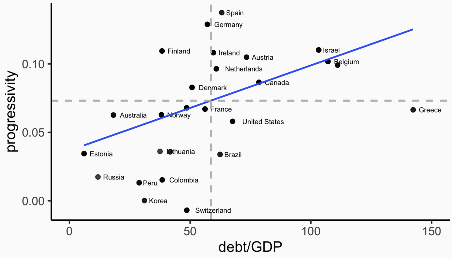

Questions:

1. What is the **optimal mix** of debt and redistributive taxation?
2. How does it depend on social **preferences for redistribution**?

This paper

- Optimal long-run mix of **debt** and **redistributive taxes** in standard het-agent models

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Main results

1. Planners with stronger preferences for **redistribution** favor
   (i) more progressive tax systems
   (ii) lower levels of public debt

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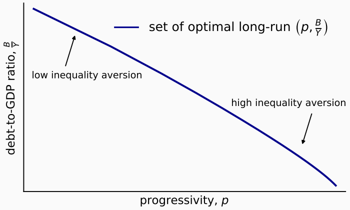

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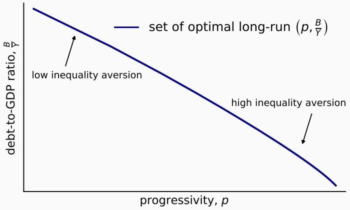

2. …mainly due to novel interest rate channel of progressivity
   – more progressive tax system $\rightarrow$ more insurance $\rightarrow$ less precautionary savings

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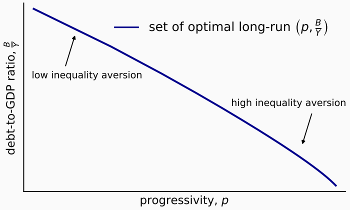

2. . . . mainly due to novel interest rate channel of progressivity
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3. US social preferences inconsistent with both Utilitarian and Rawlsian criteria
   – SWF that explains observed mix puts higher weight on well-being of rich

Related literature

1. **Optimal fiscal policy with incomplete markets**: Aiyagari, 1995; Aiyagari and McGrattan, 1998; **Flodén, 2001**; Bakış et al. (2015); Krueger and Ludwig (2016), Boar and Midrigan (2022), Angeletos et al. (2022), Dyrda and Pedroni (2022), Acikgoz et al. (2023), Auclert et al. (2023), LeGrand and Ragot (2023), ...
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2. **Optimal labor income taxation**: Mirrlees (1971), Varian (1980), Saez (2001), Golosov et al. (2006), Farhi and Werning (2013), Heathcote et al. (2017), Chang and Park (2021), Ferriere et al. (2022), ...
   - incorporate public debt into the analysis

Plan for today

1. Model
2. Interest rate channel of progressivity
3. Optimal policy
4. Inverting the optimum

Model

Standard heterogeneous-agent incomplete-markets model

- Continuum of households face **uninsurable** idiosyncratic income risk
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- Different productivity types are **perfect substitutes** in production
- Government controls supply of safe assets & nonlinear **labor income** tax schedule

Household block

- Given $\{r_t\}$ and $\{T_t(\cdot)\}$, agent entering period t in state $x = (a, \theta)$ solves

$$V_t(a,\theta) = \max_{\ell,c,a'} u(c) - v(\ell) + \beta \mathbb{E}_{\theta'|\theta}\left[V_{t+1}(a',\theta')\right] \quad \text{s.t} \quad \begin{cases} c + a' = (1 + r_t)a + \theta\ell - T_t(\theta\ell) \\ a' \geq -\phi. \end{cases}$$

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- Policy functions: $\boldsymbol{c}_t(x)$, $\boldsymbol{a}_t(x)$, $\boldsymbol{y}_t(x)$ and $\boldsymbol{z}_t(x) = \boldsymbol{y}_t(x) - T_t(\boldsymbol{y}_t(x))$

- Measure of households with productivity θ that have assets in set A at t

$$D_t(\theta, A) = Pr\{\theta_t = \theta, a_t \in A\}$$

Government budget constraint and market clearing

- Given **exogenous spending** G, government's budget constraint:

$$G + (1 + r_{t-1})B_{t-1} = B_t + \underbrace{\int T_t(\boldsymbol{y}_t(x))dD_t(x)}_{=\mathcal{T}_t(\{r_s\},\{T_s(\cdot)\})}$$

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- Asset market clearing:

$$\underbrace{\int \mathbf{a}_t(x)dD_t(x)}_{=\mathcal{A}_t(\{r_s\},\{T_s(\cdot)\})} = B_t$$

- Goods market clearing:

$$G + \underbrace{\int \mathbf{c}_t(x)dD_t(x)}_{=\mathcal{C}_t(\{r_s\},\{T_s(\cdot)\})} = \underbrace{\int \mathbf{y}_t(x)dD_t(x)}_{=\mathcal{Y}_t(\{r_s\},\{T_s(\cdot)\})}$$

Model discussion and calibration

- **CRP** tax schedules [Bénabou, 2002 and Heathcote et al., 2017]

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$$T_t(y) = y - \tau_t\, y^{1-p_t},$$

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- Calibrate model to **US** economy, following McKay et al., 2016 Calibration
  (i) β chosen to match a real interest rate of **2%**
  (ii) θ follows an AR(1) process in logs [Floden and Lindé, 2001 and Guvenen et al., 2014]

Interest rate channel of progressivity

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Q: How does a small **permanent** change in p affect equilibrium interest rate r?

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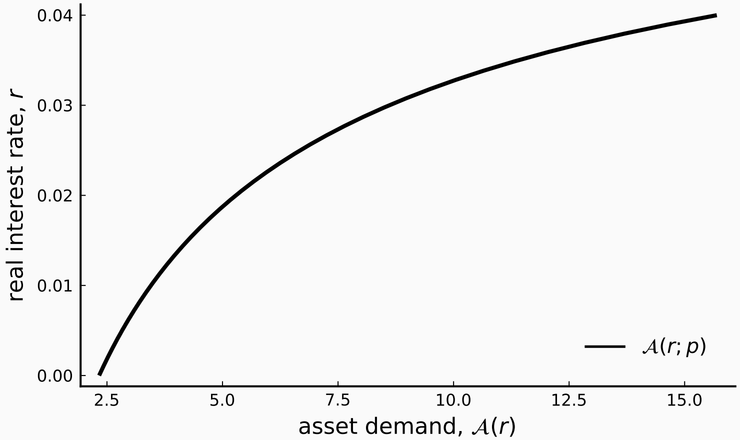

Figure 1: Equilibrium in the asset market before and after the reform

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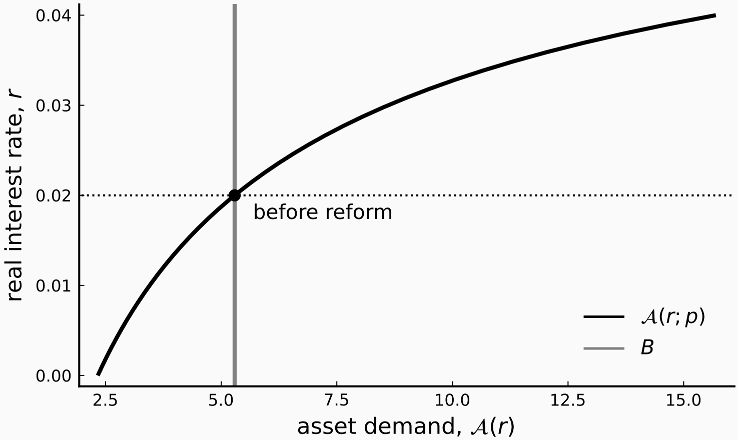

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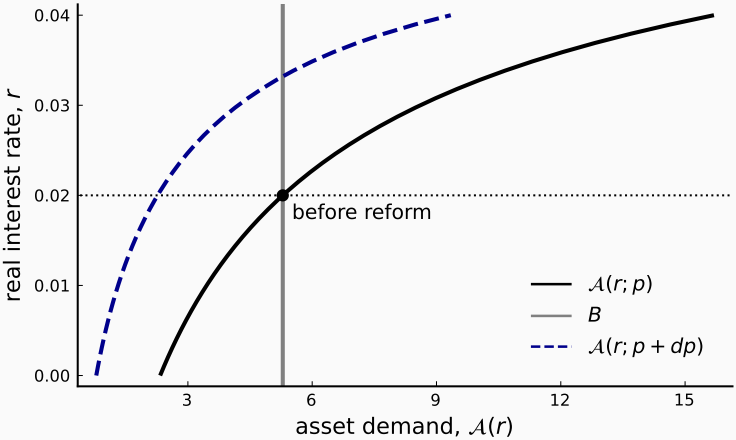

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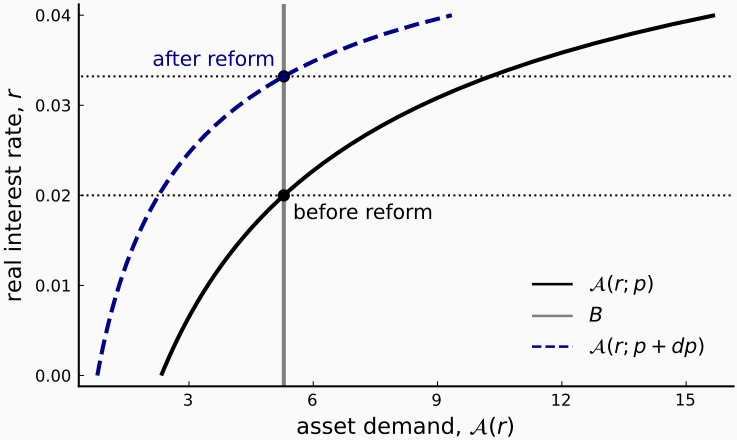

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Unintended effects of progressive tax reforms

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$$dV(x) = \sum_{s=0}^{\infty} \beta^s \mathbb{E}\left[u'(c_s) \left(\underbrace{y_s^{1-p} d\tau + a_s \, dr}_{\text{indirect effect in } s} - \underbrace{z_s \log y_s}_{\text{direct effect in } s} \right) \middle| \, x_0 = x \right].$$

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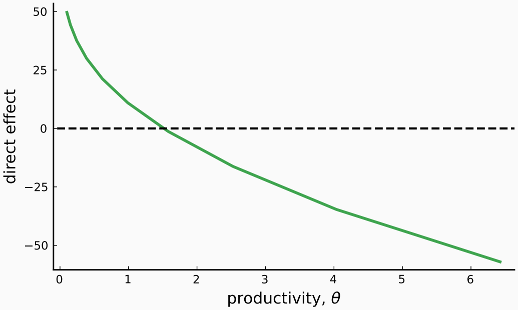

(a) Direct effect along the productivity dimenstion

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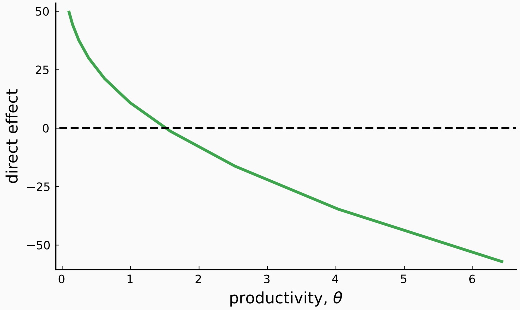

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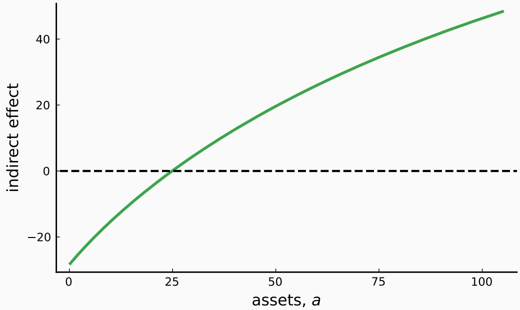

(b) Indirect effect along the asset dimension

Optimal policy

Optimal policy problem

- The dynamic **full-commitment** Ramsey problem for this economy is

$$\max_{\{r_t, B_t, p_t, \tau_t\}} \sum_{t=0}^{\infty} \beta^t \mathcal{U}_t\left(\{r_s\}, \{\tau_s\}, \{p_s\}\right) \quad \text{s.t} \quad \begin{cases} \mathcal{A}_t\left(\{r_s\}, \{\tau_s\}, \{p_s\}\right) = B_t, \\ G + (1 + r_{t-1})B_{t-1} = B_t + \mathcal{T}_t\left(\{r_s\}, \{\tau_s\}, \{p_s\}\right) \end{cases}$$

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with weights

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Note: SWF departs from welfarist approach Phelan, 2006; Farhi and Werning, 2007; Davila and Schaab, 2022

Simple condition for optimal long-run level of debt

For any $u = 0, 1, 2, \ldots$ the following must be true:

$$\sum_{t=0}^{\infty}\sum_{s=0}^{\infty}\beta^{t-u}\frac{\partial \mathcal{U}_t}{\partial r_s}\frac{\partial \boldsymbol{r}_s}{\partial B_u} + \sum_{t=0}^{\infty}\sum_{s=0}^{\infty}\beta^{t-u}\lambda_t\frac{\partial \mathcal{T}_t}{\partial r_s}\frac{\partial \boldsymbol{r}_s}{\partial B_u} + \lambda_u - \beta\lambda_{u+1}(1+\boldsymbol{r}_u) - \sum_{t=0}^{\infty}\beta^{t-u}\lambda_t\frac{\partial \boldsymbol{r}_t}{\partial B_u}B_{t-1} = 0$$

Simple condition for optimal long-run level of debt

Proposition

The optimal long-run level of debt B^{RSS}, if it exists, solves

$$\left[\frac{\mathcal{S}_{\mathcal{U},r}}{\lambda^{RSS}} + \mathcal{S}_{\mathcal{T},r}\right] \mathcal{S}_{\boldsymbol{r},B} + \{1 - \beta(1 + \boldsymbol{r})\} - \mathcal{S}_{\boldsymbol{r},B}\, B^{RSS} = 0,$$

where $\mathcal{S}_{F,X} \equiv \lim_{u\to\infty} \sum_{t=0}^{\infty} \beta^{t-u} \frac{\partial F_t}{\partial X_u}$ and $\lambda^{RSS} = \lim_{u\to\infty} \lambda_u$.

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Three key “sufficient statistics”:

1. marginal social value of public debt $\frac{\mathcal{S}_{\mathcal{U},r}}{\lambda^{RSS}} + \mathcal{S}_{\mathcal{T},r}$

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3. sensitivity of interest rates to changes in public debt $\mathcal{S}_{\mathbf{r},B}$

Existence of interior steady state with inequality-averse planners

Ramsey problem w/ utilitarian SWF does not converge to an interior steady state ...

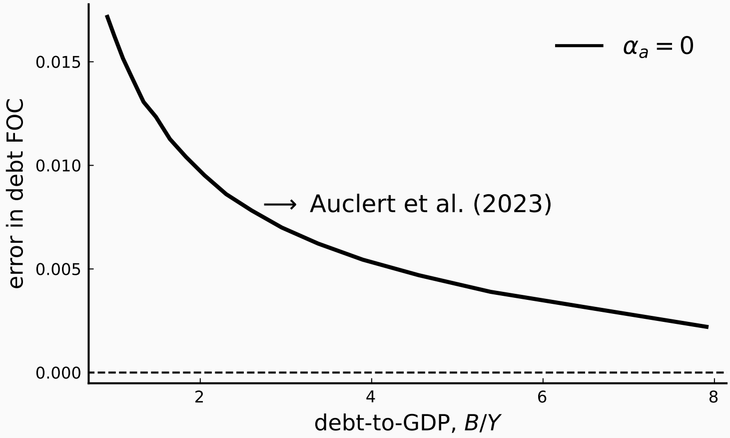
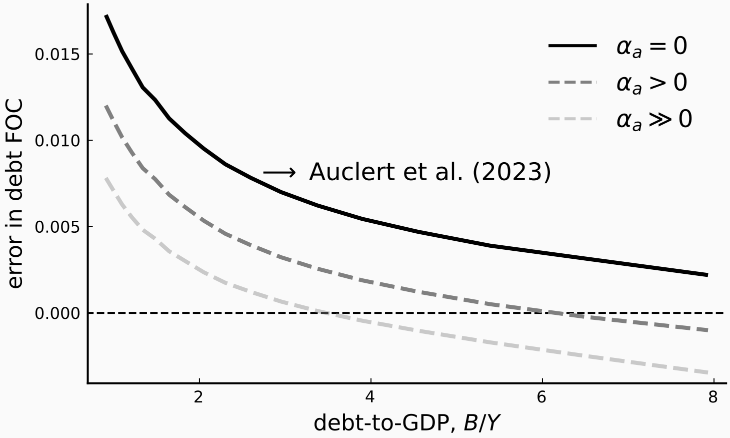


Figure 3: Verifying existence of interior steady state

back

Existence of interior steady state with inequality-averse planners

...but interior steady state exists with inequality-averse planners



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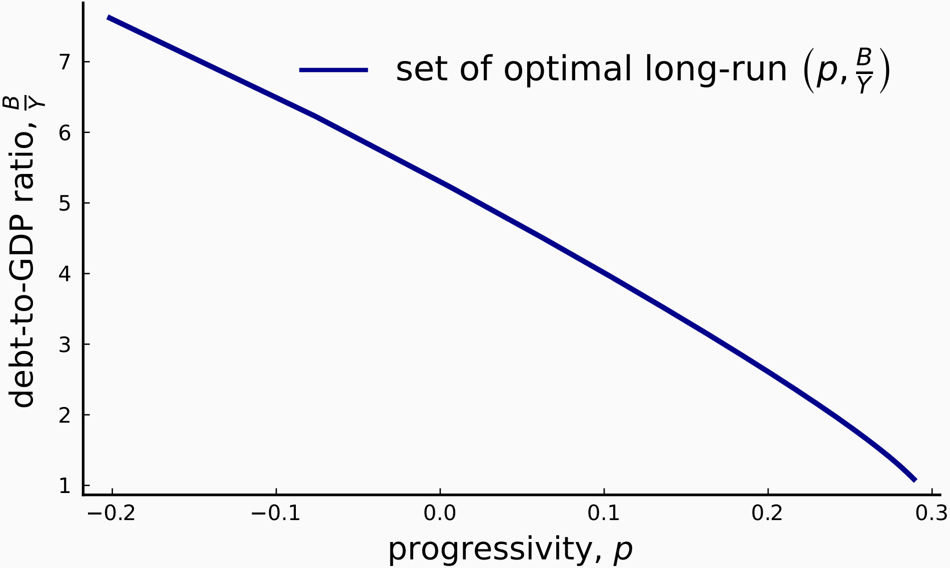
Optimal long-run mix of debt and progressivity



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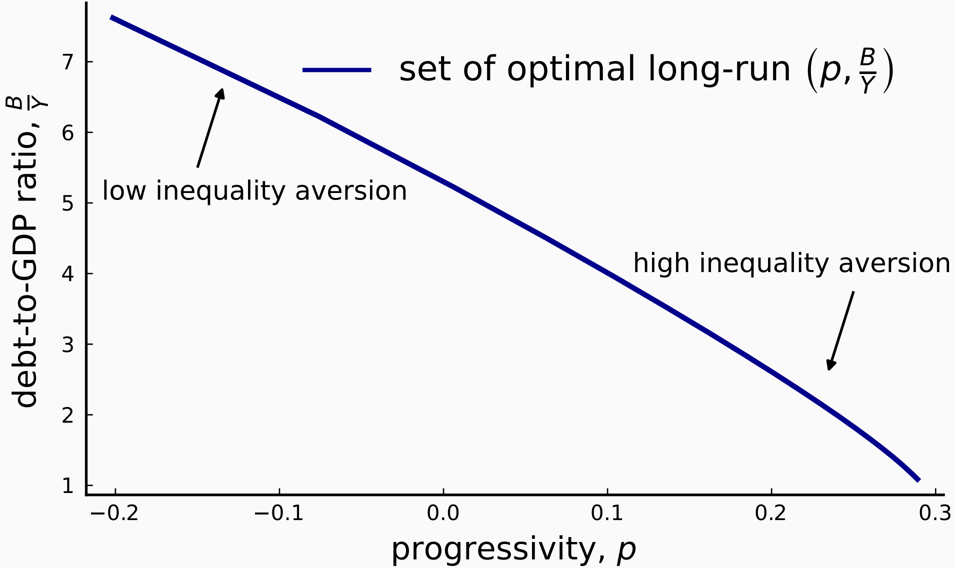

Extensions

1. Optimal policy without transitions OSS problem
   - maximize **steady-state welfare** à la Aiyagari and McGrattan (1998) figure
   - can use more standard SWFs figure
2. Multiple safe assets & taxes on savings figure
   - production technology $F(K, L)$ and allow firms to issue claims to capital
   - qualitative properties of optimal mix unchanged but quantitative differences
3. Alternative labor income tax schedules figure
   - introduce lumpsum transfers
   - jointly tax capital and labor income

Inverting the optimum

Basic idea behind the exercise

Q: What preferences for redistribution can rationalize **observed mix** of B and p?

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- Recall SWF

$$\sum_{t=0}^{\infty} \beta^t \int_i \omega_t(\theta_t^i, a_t^i) U(c_t^i, l_t^i)\, di$$

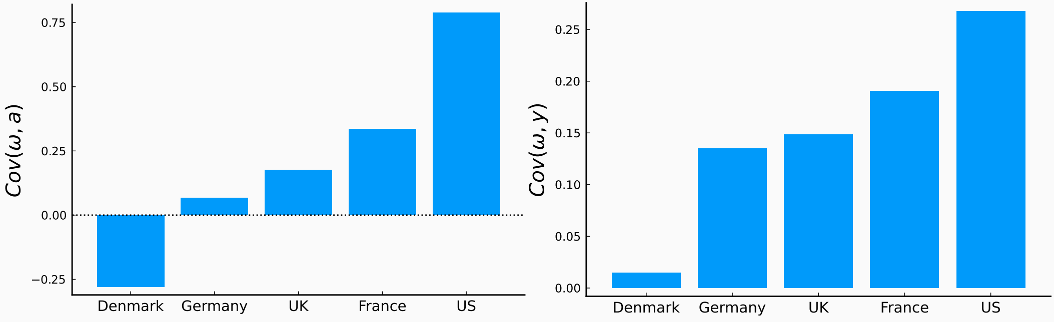
  with social welfare weights $\omega(\theta, a) \propto \exp\left(-\alpha_\theta \theta - \alpha_a a\right)$

- Find α_a and α_θ so that long-run solution gives $p^{RSS} = p^{US}$ and $\frac{B^{RSS}}{Y^{RSS}} = \frac{B^{US}}{Y^{US}}$

- Look at implied $Cov(\omega, a)$ and $Cov(\omega, y)$

Inverting the optimum in selected advanced economies

US vs Denmark



(a) Implied $Cov(\omega, a)$

(b) Implied $Cov(\omega, y)$

Figure 4: Inferred covariances of welfare weights and assets/income in advanced economies

Conclusion

Takeaways:

- inequality-averse planners prefer lower levels of B due to GE effects of p, even if
    1. transitional dynamics are not taken into account
    2. multiple safe assets
    3. relax restrictions on the tax system
- interest rate channel can lead to unintended effects of progressive tax reforms

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Future work:

1. What happens along transition to Ramsey steady state?
2. Political economy considerations?

Thank You!

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Calibration

Parameter	*Description*	*Value*
β	discounting	0.9879
ρ	persistence of AR (1)	0.966
σ	variance of AR(1)	0.703
EIS	curvature in u	1
$Frisch$	curvature in v	1/2
G/Y	spending-to-GDP	0.088
B/Y	debt-to-GDP	1.4
p	progressivity of taxes	0.181
τ	level of taxes	0.6740

Table 1: Parameters back

Optimal mix of debt and progressivity with lumpsum transfers

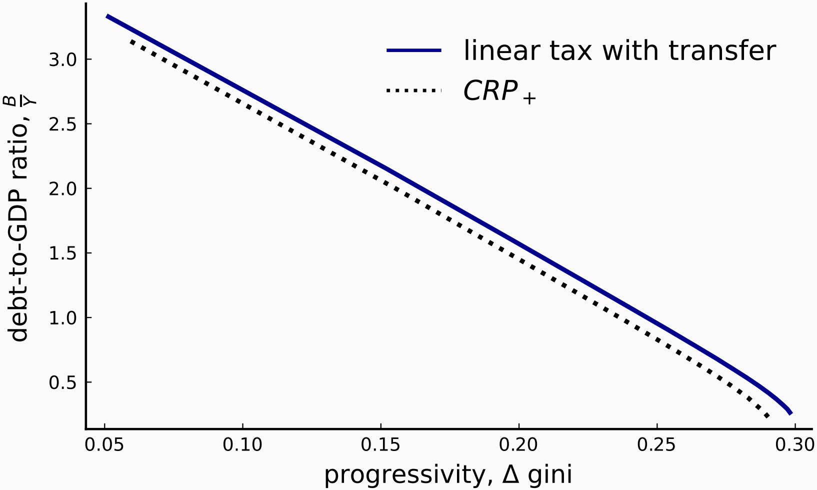


Figure 5: Optimal mix of debt and progressivity with lump-sum transfers

back

Optimal long-run mix of debt and progressivity ignoring transitions

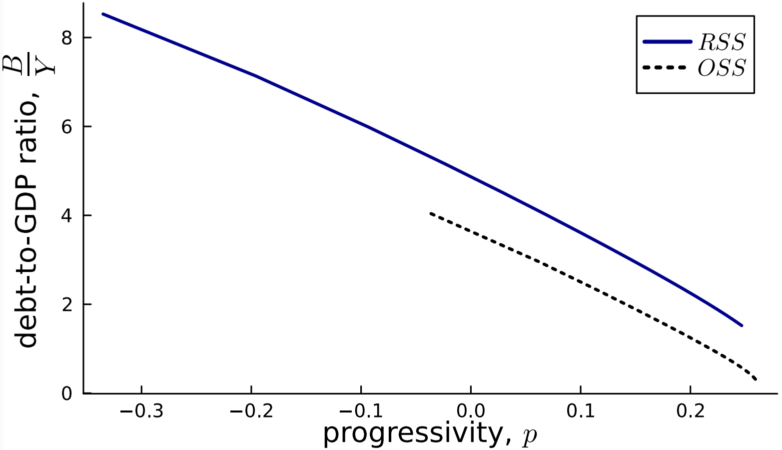


Figure 6: Optimal long-run mix of debt and progressivity across solution concepts

back

Optimal long-run mix of debt and progressivity across SWFs

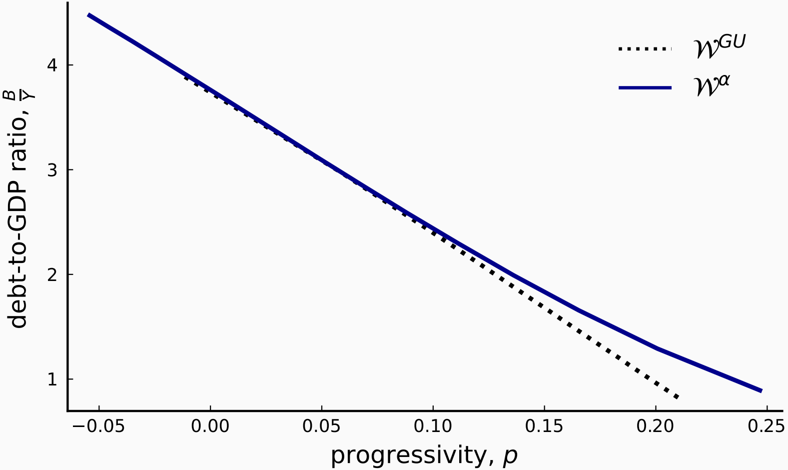


Figure 7: Optimal long-run mix of debt and progressivity across SWFs

back

Optimal mix of debt and progressivity in the RSS with capital and τ_k

Modified golden rule holds $\implies$ planner chooses τ_k to implement $F_K = \rho + \delta$

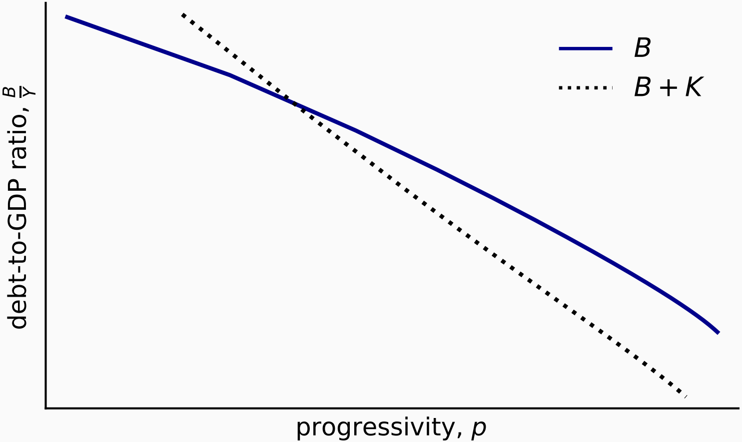
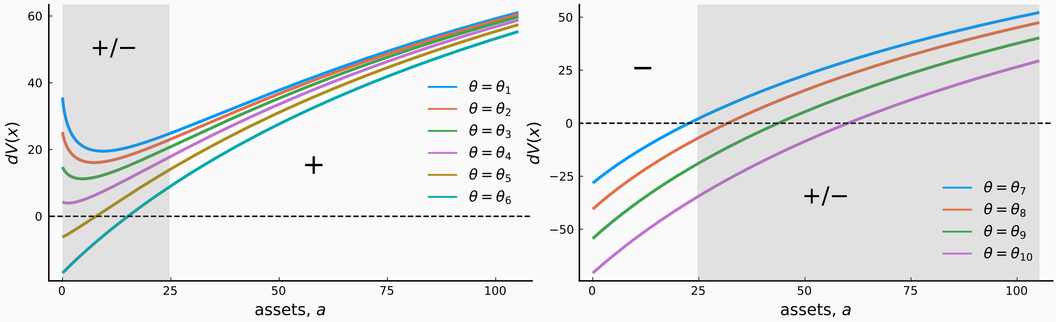


Figure 8: Optimal mix of debt and progressivity in the model with capital and τ_k

back

Unintended effects of progressive tax reforms: total effect

GE effect can dominate PE effect due to interest rate channel of progressivity



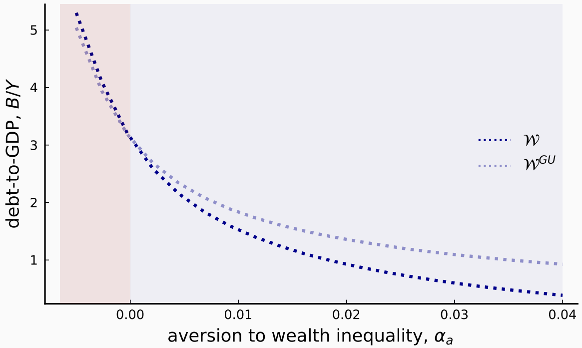
(a) Total effect at the bottom of the θ distribution

(b) Total effect at the top of the θ distribution

Figure 9: Individual responses across the state space

back

Optimal mix of debt and progressivity across SWFs



(a) Optimal debt-to-GDP, $\mathcal{W}$ vs $\mathcal{W}^{GU}$

(b) Optimal progressivity, $\mathcal{W}$ vs $\mathcal{W}^{GU}$

Figure 10: Optimal mix with generational and generalized utilitarian planners

back

Alternative welfare criteria

1. **Benchmark planners** [Davila and Schaab, 2022 or Phelan, 2006 & Farhi and Werning, 2007]

$$\mathcal{W}(r,\tau,p) = \sum_{t=0}^{\infty} \beta^t \int \omega(x) u(\boldsymbol{c}(x)) dD(x)$$

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3. **Bénabou planners** [Bénabou, 2002 & Boar and Midrigan, 2022]

$$\mathcal{W}^{\alpha}(r, \tau, p) = \left(\int \bar{c}(x)^{1-\frac{1}{\alpha}} dD(x) \right)^{\frac{1}{1-\frac{1}{\alpha}}},$$

with $\bar{c}(x)$ equal to consumption CE

back

Optimal steady state problem (OSS)

OSS Problem:

back

- Choose **time-invariant** tax code $\{\tau, p\}$ and steady state level of public debt B to

$$\max_{\{r,B,p,\tau\}} \mathcal{W}(r,\tau,p) \quad \text{s.t} \quad \begin{cases} \mathcal{A}(r,\tau,p) = B, \\ G + rB = \mathcal{T}(r,\tau,p) \end{cases}$$

- Alternative welfare criteria:

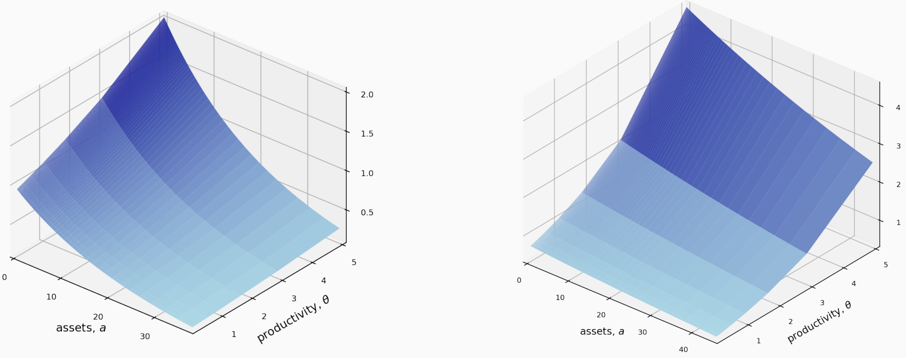
1. **Generalized utilitarian** planners

$$\mathcal{W}^{GU}(r,\tau,p) = \int_i \omega(\theta_0^i, a_0^i) V(\theta_0^i, a_0^i) di$$

2. **Bénabou** planners [Bénabou, 2002 & Boar and Midrigan, 2022]

$$\mathcal{W}^{\alpha}(r,\tau,p) = \left(\int \bar{c}(\theta_0^i, a_0^i)^{1-\frac{1}{\alpha}} di \right)^{\frac{1}{1-\frac{1}{\alpha}}}, \quad \text{with } \bar{c}(\theta, a) = \text{“consumption CE”}$$

Inverting the optimum: Denmark vs the United States



(a) Implied welfare weights for Denmark

(b) Implied welfare weights for the United States

Figure 11: Inferred welfare weights for Denmark and the United States

back