Differential Mortality and Welfare Gains from Social Security Benefit Formula

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Social Security

Old Age and Survivor Insurance (OASI)

- Largest government program in the US
  - collects 3.7% of GDP in tax revenue (2010)
  - pays out 4% of GDP in benefits (2010)
- Major source of income for elderly (40% of all income for 65+)
- It is primarily a retirment pension program, however
  - intragenerational income redistribution is a key part of it
  - and one of the motivations for its existance

Question

How Valuable Social Security is as an Income Redistribution Program?

- Social security has a progressive retirment benefit formula
  - it replaces higher fraction of past earnings for low earnings retirees

- Social security pays benefits as life annuity
  - it pays more to those who live longer
  - who happen to be high earnings individuals

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  - who happen to be high earnings individuals

  ⇒ this is a redistribution from poor to rich within each cohort

Question:

How much each individual is better off under current system relative to a system that has no redistribution?

What I do?

- Life cycle OLG model
  - Heterogeneous earnings profiles
  - Differential mortality across earnings profiles
- Calibrate to
  - Current US social security benefit formula
  - Differential mortality rates across lifetime earnings quintiles (estimated by Cristia (2007) using SSA data)
- Counterfactual experiment:

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  A pay-as-you-go system with separate balanced budgets for each earnings/mortality group

What I Find?

Preview of Results

- If each earnings/mortality group has a separate budget

  there is no redistribution across these groups, by construction

- Yet, I find that
  - this yields almost the same replacement ratios as the current system

  ⇒ retirment benefits for each inidividual is not very different

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Preview of Results

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- Yet, I find that
  - this yields almost the same replacement ratios as the current system

  ⇒ retirment benefits for each inidividual is not very different

⇒ Welfare is not very different relative to the US system
  - welfare of the very poor is lower by 0.3% of GDP
  - welfare of the very rich is higher by 0.9% of GDP
  - ex ante welfare is lower by 0.004% of GDP

Related Literature

- Brown et a. (2009), Coronado et. al (2000), Gustman and Steinmeier (2001) use micro silumulation to provide vairous financial measures of redistribution in social security across income groups.

- Brown (2003) uses life cycle model to provide utility based measure of redistribution in a mandatory annuity system across education, sex and race.

Model

Model
Individuals

- Large number of finitely lived individuals born each period
- Individuals are indexed by a parameter θ:
  - Drawn from distribution $\pi(\theta)$
  - Fixed through their lifetime
- Individual of type θ
  - Has – deterministic – earnings ability $z_j(\theta)$ at age j
  - Has survival rate $s_{j+1}(\theta)$ at age j

Model

Demographics

- Population grows at constant rate n – for all θ types
- There is a maximum age J: $s_{J+1}(\theta) = 0 \;\forall\; \theta$
- Type θ at age j makes up fraction $\pi(\theta) \cdot \mu_j(\theta)$ of the population

$$\mu_{j+1}(\theta) = \frac{s_{j+1}(\theta)}{1+n} \cdot \mu_j(\theta)$$

$$\sum_{\theta} \sum_{j=1}^{J} \pi(\theta) \cdot \mu_j(\theta) = 1$$

$$\sum_{j=1}^{J} \mu_j(\theta) = 1 \quad \text{for each } \theta$$

Model

Preferences

- Individual θ has preference over consumption and leisure

$$\sum_{j=1}^{J} \left(\Pi_{i=1}^{j} s_i(\theta) \right) \beta^{j-1} u(c_j, 1-h_j)$$

- I assume

$$u(c, 1-h) = \log(c) + \phi \frac{(1-h)^{1-\eta}}{1-\eta}$$

- Everyone retires at age J_R

Model
Technology

- Production technology (variables are per capita and detrended)

$$Y_t = AK_t^{\alpha} L_t^{1-\alpha}$$

- Output goes to consumption, investment and government purchases

$$C_t + (1+n)(1+g)K_{t+1} + G_t = Y_t + (1-\delta)K_t$$

- Factors are paid their marginal product

$$w_t = (1-\alpha) \cdot \frac{Y_t}{L_t} \text{ and } r_t = \alpha \cdot \frac{Y_t}{K_t} - \delta$$

- Decision problem for individual of type θ

$$V_j(\theta, a, \bar{e}) = \max_{c \geq 0, a' \geq 0, 1 \geq h \geq 0} u(c, 1-h) + \beta s_{j+1}(\theta) V_{j+1}(\theta, a', \bar{e}')$$

s.t.

$$\begin{aligned}(1+\tau_c)c + a'(1+g) \quad &\leq \quad a(1+(1-\tau_k)r) + (1-\tau_l) w z_j(\theta) h \\ &\quad\; - T_{ss}(w z_j(\theta) h) + B_{ss}(\bar{e}, j) + Tr(\theta)\end{aligned}$$

$$\bar{e}' = \begin{cases} \bar{e} + \min\left\{w z_j(\theta) h, y_{max}\right\}/35 & j < 36 \\ \bar{e} & j \geq 36. \end{cases}$$

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Model
Individual Problem

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- $T_{ss}(\cdot)$ and $B_{ss}(\cdot, j)$ are social security and tax and benefit
- $Tr(\theta)$ is lump-sum transfer

- Finances expenditure G

$$G = \tau_c C + \tau_k r \cdot K + \tau_l w \cdot L$$

- Collects and distribute accidental bequest

$$(1+n)Tr(\theta) = \sum_{j=1}^{J} \mu_j(\theta)(1 - s_{j+1}(\theta))(1 + (1-\tau_k)r)a_j'(\theta)$$

- Runs a pay-as-you-go social security

$$\sum_{\theta} \pi(\theta) \sum_{j=1}^{J} \mu_j(\theta) \left[T_{ss}(wz_j(\theta)h_j(\theta)) - B_{ss}(\bar{e}(\theta), j) \right] = 0$$

Model

Social Security Tax and Benefits

- Flat tax rate τ_{ss} up to a maximum y_{max}

$$T_{ss}(y) = \begin{cases} \tau_{ss} y & y \leq y_{max} \\ \tau_{ss} y_{max} & y > y_{max} \end{cases}$$

- Benefits are paid after retirement age, J_R

$$B_{ss}(\bar{e}, j) = \begin{cases} 0 & j < J_R \\ \varphi_{SS} b_{US}(\bar{e})/(1+g)^{j-J_R} & j \geq J_R. \end{cases}$$

  - $b_{US}(\cdot)$ is a nonlinear function of average indexed earning
  - φ_{SS} is an adjustment parameter to balance the budget

Calibration

Calibration
Earnings Ability Profiles

- Follow Altig et al. (2001), assume 12 income groups

$$\log(z_j(\theta)) = a_0(\theta) + a_1(\theta)j + a_2(\theta)j^2 + a_2(\theta)j^3$$

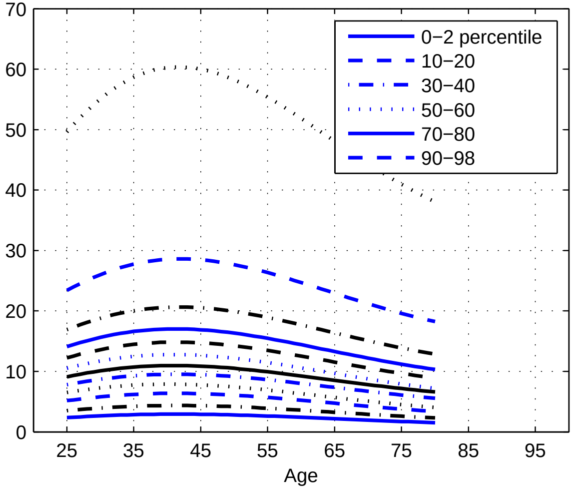
  - $\pi(\theta_1) = \pi(\theta_{12}) = 0.02$
  - $\pi(\theta_2) = \pi(\theta_{11}) = 0.08$
  - $\pi(\theta_3) = \cdots = \pi(\theta_{10}) = 0.1$

- Using PSID

  1. Run log hourly wages on cubics in age, demographics, fixed effects
  2. Use step 1 to generate lifetime-wage profiles
  3. Sort according to present value of implied lifetime income
  4. Divide into 12 groups – according to above
  5. Estimate coefficient $a_i(\theta)$'s within each group

Calibration

Earnings Ability Profiles



Calibration
Demographics

- Use Bell and Miller (2005), male mortality table for cohort of 1940

- Use Cristia (2007) mortality ratios

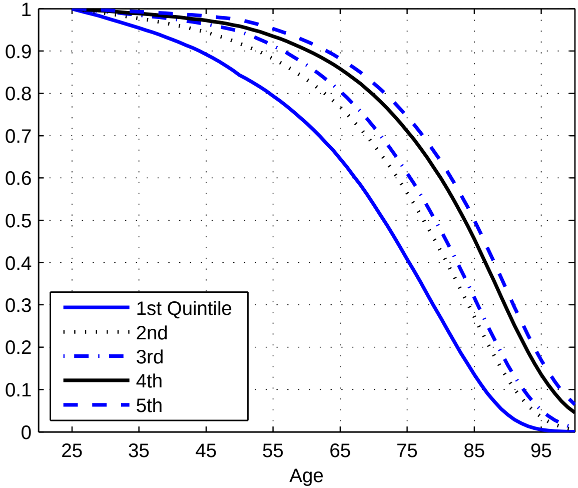
	Age Groups		
Lifetime Earnings Quintiles	35–49	50–64	65–75
Top	0.35	0.61	0.74
Fourth	0.56	0.68	0.94
Third	0.73	0.99	1.08
Second	1.13	1.10	1.14
Bottom	2.25	1.63	1.1

- Construct mortality tables for each earning quintile

  $\text{mortality for earning quitile}_q = \text{mortality ratio}_q \times \text{population mortality}$

Calibration

Unconditional Survival Probabilities for Each Earnings Quintile



Calibration

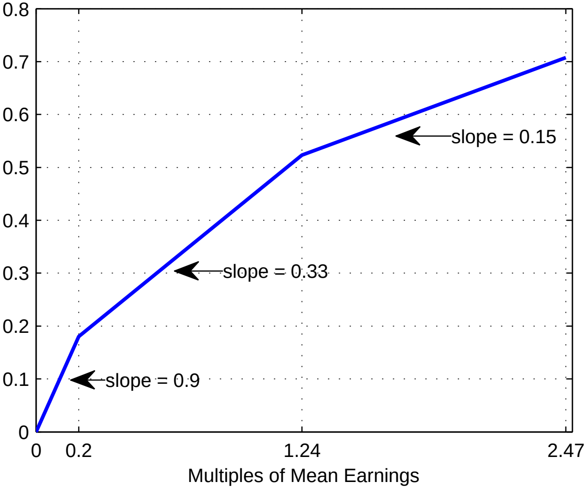
Social Security Benefit Formula

- Let $\bar{Y} = w \cdot L$ be the average labor earnings
- Set $y_{max} = 2.47\bar{Y}$
- Benefit formula

$$b_{US}(\bar{e}) = \begin{cases} 0.9 \times \bar{e} & \bar{e} \leq 0.2\bar{Y} \\ 0.18\bar{Y} + 0.33 \times (\bar{e} - 0.2\bar{Y}) & 0.2\bar{Y} < \bar{e} \leq 1.24\bar{Y} \\ 0.5243\bar{Y} + 0.15 \times (\bar{e} - 1.24\bar{Y}) & \bar{e} > 1.24\bar{Y} \end{cases}$$

Calibration

Social Security Benefit Formula



Calibration Summary

Parameter		Value
n		0.011
J	ages 25 to 100	76
β	capital-output ratio of 3	0.9834
η	labor supply elasticity of 0.4	4.0789
ϕ	average hours of 0.38	0.3991
g		0.0165
α		0.36
δ	investment-output ratio of 0.25	0.0557
A	wage is normalized to 1	0.8959
G	20% of GDP	0.2Y
τ_c	McDaniel (2007)	0.055
$\tau_l = \tau_k$	balance government budget	0.2038
J_R	age 65	41
τ_{ss}	social security admin.	0.106
φ_{SS}	balance social security budget	1.3279

Quantitative Exercise

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A Social Security System with no Redistribution

- Tax function is unchanged

$$T_{NoDist}(y) = T_{ss}(y)$$

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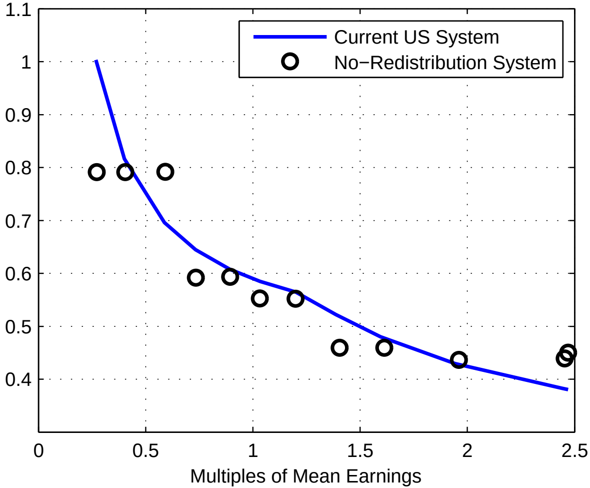
- There is a pay-as-you-go budget for each θ

$$\sum_{j=1}^{J} \mu_j(\theta) \left[T_{NoDist}(wz_j(\theta)h_j(\theta)) - B_{NoDist}(\bar{e}(\theta), j, \theta) \right] = 0$$

Replacement Ratios

US System vs. No-Redistribution System



what if there is no mortality differential?

Welfare Comparison

US System vs. No Redistribution System

- Let $V^{NoDist}(\theta)$ be welfare of type θ under alternative system

- Calculate compensating variations $x(\theta)$ such that

$$\sum_{j=1}^{J} \left(\Pi_{i=1}^{j} s_i(\theta)\right) \beta^{j-1} u((1+x(\theta))c_j^{SS}(\theta), 1-h_j^{SS}(\theta)) = V^{NoDist}(\theta)$$

- To express a welfare measure as percentage of GDP, plot

$$\frac{\sum_{j=1}^{J} \mu_j(\theta) x(\theta) c_j(\theta)}{Y}$$

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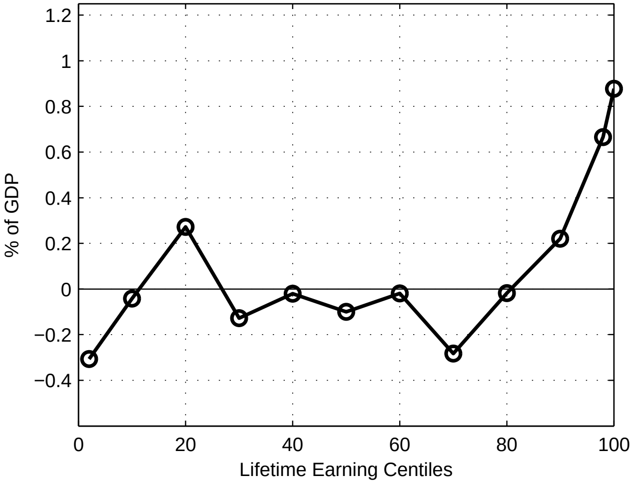

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Implications for Aggregates

US System vs. No Redistribution System

	Y	C	H	w	R	welfare (% of Y)
Current US	100	55	0.38	16.5	1.051	
No-Redistr.	100.9	55.52	0.384	16.5	1.051	-0.004

H is aggregate hours and R is return on saving

go to Conclusion

Alternative Policy 1
Lump-Sum benefits

- One way to increase progressivity is to pay benefits lump-sum
- This increases replacement ratios for poorer individuals
- At the same time increases labor supply distortions

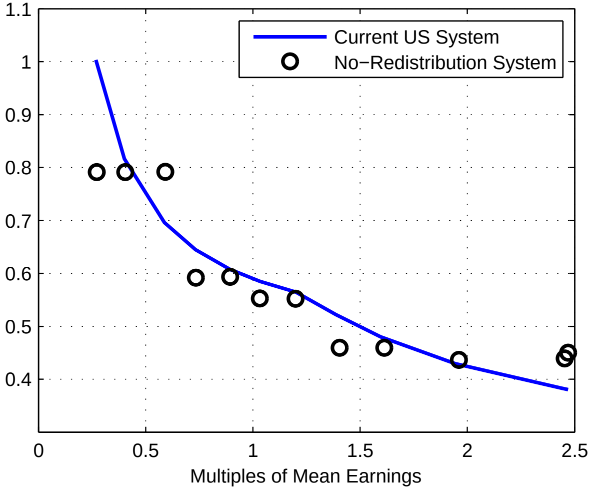
Alternative Policy 2

Start Paying Benefits at 60

- Suppose we pay benefits earlier – say starting at 60yrs old
- This will reduce the effect of differential mortality
- However, the replacement ratios need to be scaled down

Replacement Ratios

US System vs. No Redistribution System vs. Lump-Sum vs. Start at 60



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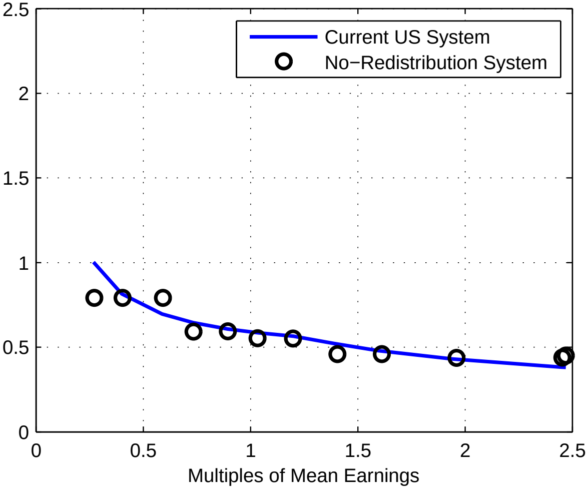

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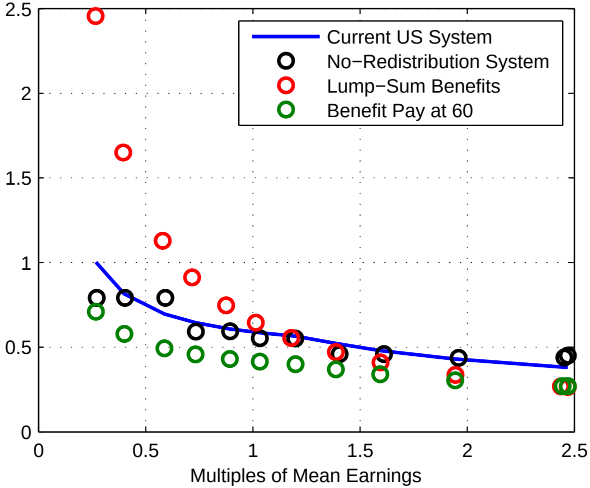

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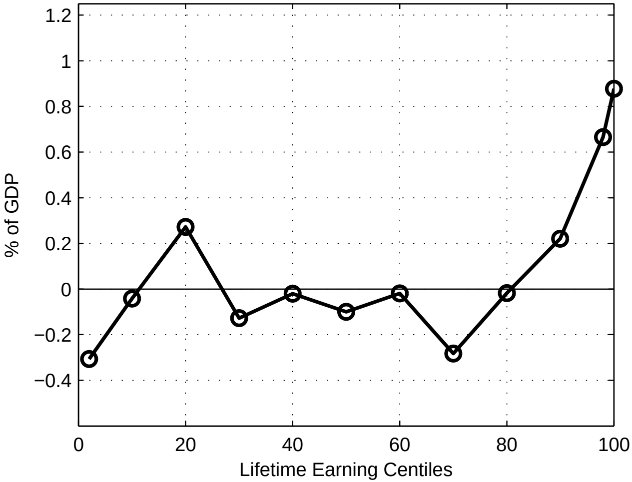

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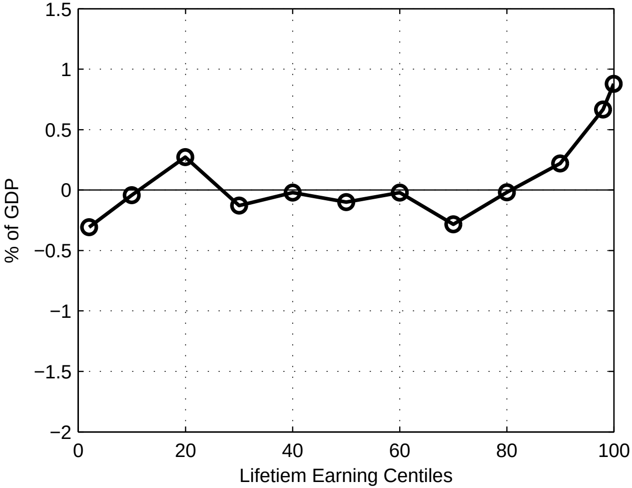

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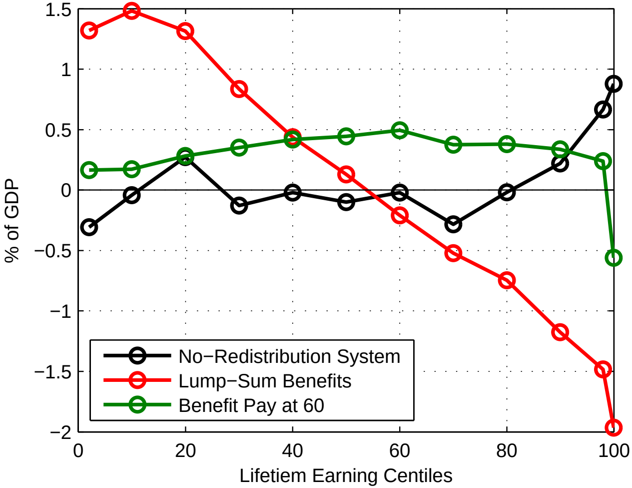

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	Y	C	H	w	R	welfare (% of Y)
Current US	100	55	0.38	16.5	1.051	
No-Redistr.	100.9	55.52	0.384	16.5	1.051	-0.004
Lump-sum	99	54.23	0.373	16.6	1.050	0.62
Start at 60	100.51	55	0.379	16.6	1.050	0.44

H is aggregate hours and R is return on saving

Conclusion

- Progressive benefit formula is one of the key features of US social security system
- One agument against privatization is that progressivity will be lost
- My calculations suggest that this feature of the system is not very valuable

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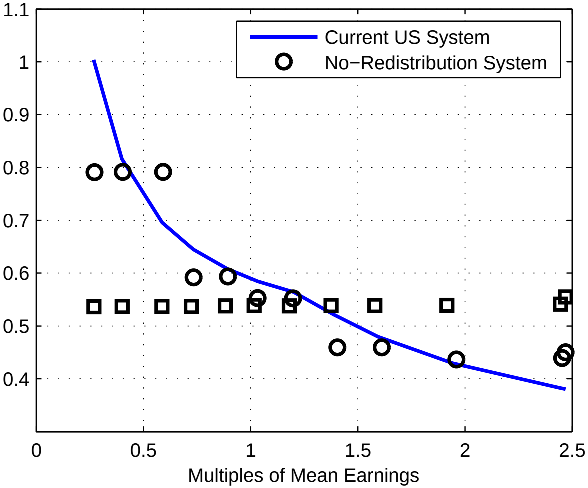
- My calculations suggest that this feature of the system is not very valuable
- **To do:** extend the model to include
  - Couples
  - Dependent and survivor benefits

Back up slides

Replacement Ratios without Mortality Heterogeneity

US System vs. No Redistribution System



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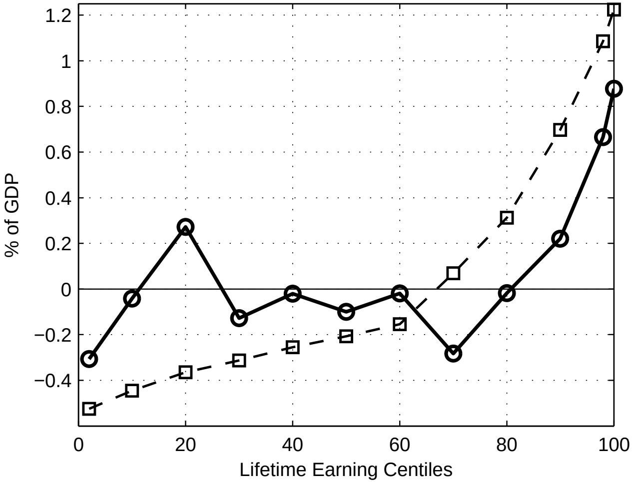
Welfare Comparison without Mortality Heterogeneity

US System vs. No Redistribution System



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References I