Retirement Financing: An Optimal Reform Approach

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Background and Motivation

- U.S. government has a big role in retirement financing
- Social security benefits are
  - 40 percent of all elderly income
  - main source of income for almost half of elderly
  - 30 percent of federal expenditures
- Social security taxes are 30 percent of federal tax receipts
- Demographic changes pose serious fiscal challenge

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- Social security taxes are 30 percent of federal tax receipts
- Demographic changes pose serious fiscal challenge

$\Rightarrow$ reform needed

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- We propose *optimal reform*: Polices that
  - minimize cost of tax and transfers to the government, while
  - respect individual behavioral responses
  - respect distribution of welfare in the economy
- To do this, we need:
  - a model that is a good description of the US economy
  - an approach that puts no ad hoc restriction on policy instruments

What We Do

- OLG model with many periods and heterogeneous agent
  - heterogeneous in labor productivity and mortality
  - labor productivity and mortality are correlated
  - no annuity market
  - US tax and transfer, and social security
- Model is calibrated to US aggregates
  - Consistent with distributional aspects
- We use the model to compute
  - lifetime welfare for each individual, i.e. status-quo welfare

What We Do

- A Mirrlees optimal nonlinear tax exercise
  - taxes cannot be conditioned on individual characteristics
  - no other restrictions on tax instruments

- We look for policies that
  1. minimize the NPDV of transfers to each generation
  2. do not lower anyones lifetime welfare relative to status-quo

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  cannot improve upon status-quo using only tax and transfer reform

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  linear asset subsidies achieve only a fraction of cost saving

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  rates are higher than status-quo (not by much)

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Related Literature

- **Retirement reform:** Huggett-Ventura(1999), Nishiyama-Smetters (2007), Kitao (2005), McGrattan and Prescott (2013), Blandin (2016),...

  study reforms in limited set of instruments, not necessarily optimal

- **Optimal taxation: (Ramsey approach)** Conesa-Krueger (2006), Heathcote et al. (2014), ... **(Mirrlees approach:)** Huggett-Parra (2010), Fukushima (2011), Heathcote-Tsujiyama(2015), Weinzierl (2011), Golosov et al. (forthcoming), Farhi-Werning (2013), Golosov-Tsyvinski (2006), Shourideh-Troshkin (2015), Bellofatto (2015)

  maximize social welfare ⇒ mix redistribution with improving efficiency

- **Pareto efficient taxation:** Werning (2007)

  theoretical framework, static model

- **Imperfect annuity market and the effect of social security:** Hubbard-Judd (1987), Hong and Rios-Rull (2007), Hosseini (2015), Caliendo et al. (2014), ...

  social security does not provide large efficiency gains

Outline

- Model
- Optimal Reform: Theory

    qualitative properties of efficient allocation

- Calibration
- Optimal Reform: Numbers

    distortions: efficient allocation vs status-quo

    optimal policies

    aggregate effects

- Conclusion

Individuals

- Large number of finitely lived individuals born each period
  - Population grows at constant rate n
  - There is a maximum age T
- Individuals are indexed by their type θ:
  - Drawn from distribution $F(\theta)$
  - Fixed through their lifetime
- Individual of type θ
  - Has – deterministic – earnings ability $\varphi_t(\theta)$ at age t
  - Has survival rate $p_{t+1}(\theta)$ at age t
- Assumption: $\varphi_t'(\theta) > 0$ and $p_{t+1}'(\theta) > 0$ for all t, θ

Preferences and Technology

- Individual θ has preference over consumption and leisure

$$\sum_{t=0}^{T} \beta^t P_t(\theta) \left[u(c_t) - v(l_t) \right]$$

where $P_t(\theta) = \Pi_{s=0}^{t} p_s(\theta)$

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- Aggregate production function

$$Y = (\tilde{r} + \delta)K + L$$

δ: depreciation rate

$\tilde{r}$: pre-tax rate of return net of depreciation

Markets and Government

- There is no annuity and/or life insurance, only risk free assets
  - upon death, the risk-free assets convert to bequest
  - bequest is transfered equality to all individuals alive

- Government
  - Collects taxes on labor earnings, consumption and corporate profit
  - Makes transfers to individuals in pre- and post- retirement ages
  - Makes exogenously given purchases

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$$G + (r - n)D + \textit{All Transfers} = \textit{All Taxes}$$

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government consumption purchases – exogenous

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steady state government debt – exogenous

Individual Optimization Problem

- Individual of type θ solves

$$U(\theta) = \max \sum_{t=0}^{T} \beta^t P_t(\theta)\left[u(c_t) - v(l_t)\right]$$

subject to

$$\begin{aligned}(1+\tau_c)c_t + a_{t+1} &= \varphi_t(\theta)l_t - T_y\left(\varphi_t(\theta)l_t\right) + Tr_t + S_t\left(E_t\right) \\ &\quad (1+r)a_t - T_a\left((1+r)a_t\right)\end{aligned}$$

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a_{t+1} : asset holding

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$\varphi_t(\theta)l_t$: labor earning

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Tr_t : transfer to workers pre-retirement

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E_t : the average labor earning history

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S_t : social security benefit – paid only after retirement

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r : after tax return on asset

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- There is a corporate tax profit τ_K

$$r = (1-\tau_K)\tilde{r}$$

Equilibrium

- Equilibrium is set of allocations, factor prices and policies such that
  - Individuals optimize – taking policies as given
  - factors are paid marginal product
  - government budget holds
  - markets clear and allocations are feasible

- Once we know equilibrium allocations we can find status-quo welfare

$$W_s(\theta) \equiv \sum_{t=0}^{T} \beta^t P_t(\theta) \left[u(c_t) - v(l_t)\right]$$

Optimal Policy Reform

- So far we have imposed no restriction on policies
- We can choose them to match he US system
- Or, we can choose them to be *optimal*
- Optimal means

  they deliver status-quo welfare at the lowest cost

- We characterize optimal policies next

A Cost Minimization Problem

$$\min_{\left\{T_y(\cdot),T_a(\cdot),...\right\}} \text{PDV of Net Transfers to a Generation}$$

s.t.

1- given policies $\left\{T_y(\cdot), T_a(\cdot), ...\right\}$, individual optimize

2- resulting allocation delivers no less welfare than status-quo

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- This is a very complicated problem

  choice variables are functions

  constraint set is function of those functions!

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  choice variables are functions

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- Instead, we use *primal approach*

  write the problem only in terms of allocations

▸ Show details

A Cost Minimization Problem

Planning Problem

$$\min \int \sum_{t=0}^{T} \frac{P_t(\theta)}{(1+r)^t} \left[c_t(\theta) - \varphi_t(\theta) l_t(\theta)\right] dF(\theta)$$

s.t.

A Cost Minimization Problem
Planning Problem

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$$U(\theta) \geq W_s(\theta)$$

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status-quo welfare for each θ

Properties of the Efficient Allocations

- Next, we investigate some properties of efficient allocations
- What margins should be distorted and why?
- Note that distortions $\neq$ taxes necessarily
- But are informative statistics about efficient allocations

Distortions

- Intra-temporal distortion: distorting labor supply margin

$$1-\tau_{\text{labor}}=\frac{v'\left(l_t\left(\theta\right)\right)}{\varphi_t\left(\theta\right)u'\left(c_t\left(\theta\right)\right)}$$

- Inter-temporal distortion: distorting "annuity margin"

$$1-\tau_{\text{annuity}}=\frac{u'\left(c_t\left(\theta\right)\right)}{\beta(1+r)u'\left(c_{t+1}\left(\theta\right)\right)}$$

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Intra-temporal Distortions

- Mirrlees-Diamond-Saez formula (Standard)

$$\frac{\tau_{\text{labor}}}{1-\tau_{\text{labor}}} = \left(\frac{1}{\epsilon(\theta)} + 1\right) \frac{1-F(\theta)}{\theta f(\theta)} g(\theta)$$

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Behavioral response: captured by elasticity of labor supply

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Tail trade-off: taxing type θ:

reduces output in proportion to $\theta f(\theta)$,

but relaxes incentive constraints for all types above

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Social value of resource extraction from type θ and above

$$g_t\left(\theta\right) = \int_{\theta}^{\bar{\theta}} \frac{u'\left(c(\theta)\right)}{u'\left(c_0(\theta')\right)} \left[1 - \frac{u'\left(c_0(\theta')\right)}{\lambda}\right] \frac{dF\left(\theta'\right)}{1-F\left(\theta\right)}$$

Inter-temporal Distortions

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$p'_{t+1}(\theta) > 0 \Rightarrow$ annuity is "taxed"

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- Intuition: for higher ability future consumption has higher weight

Implementation: Finding Optimal Taxes

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- We propose a set of taxes
  - A nonlinear tax (subsidy) on assets: $T_{a,t}((1+r)a_t)$
  - A nonlinear tax on labor earnings: $T_{y,t}(y_t)$
  - A type-independent retirement transfer: S_t

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  - A type-independent retirement transfer: S_t
- We can solve these tax functions numerically

▸ Show details

Calibration

1. Parametrize and estimate earning ability $\varphi_t(\theta)$
2. Parametrize and calibrate model of mortality $P_t(\theta)$
3. Parametrize and calibrate government policy – to US status-quo
4. Parametrize and calibrate preference and technology

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- Do 1, 2 and 3 independent of the model

- Use the model to do 4

Earning Ability Profiles

- Use labor income per hour as proxy for working ability (PSID)
- Assume

$$\log \varphi_t(\theta) = \log \theta + \log \tilde{\varphi}_t$$

with

$$\log \tilde{\varphi}_t = \beta_0 + \beta_1 t + \beta_2 t^2 + \beta_3 t^3$$

- θ has Pareto-Lognormal distribution w/ parameters $(\mu_\theta, \sigma_\theta, a_\theta)$

  $a_\theta = 3$ is tail parameter $\rightarrow$ standard

  $\sigma_\theta = 0.6$ is variance parameter $\rightarrow$ variance of log wage in CPS

  $\mu_\theta = -1/a_\theta$ is location parameter

▸ Show Profiles

Survival Profiles

- Assume Gompertz force of mortality hazard

$$\lambda_t(\theta) = \frac{m_0}{\theta^{m_1}} \left(\exp(m_2 t)/m_2 - 1\right)$$

and

$$P_t(\theta) = \exp(-\lambda_t(\theta))$$

m_1 which determines ability gradient

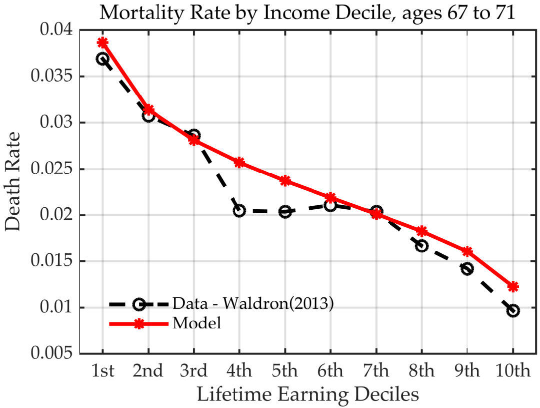
m_2 determines overall age pattern of mortality

m_0 is location parameter

- Use SSA's male mortality for 1940 birth cohort

- Use Waldron (2013) death rates (for ages 67-71)

Death Rates by Lifetime Earning Deciles



Status-quo Government Policies

- Government collects three types of taxes
  - non-linear progressive tax on taxable income – we use
  $$\mathcal{T}(y) = y - \phi y^{1-\tau},$$
  the HSV tax function ($\tau = 0.151$, $\phi = 4.74$)
  - FICA payroll tax – we use SSA's tax rates
  - linear consumption tax – McDaniel (2007)

- there is also a social security and Medicare benefit
  - we use SSA's benefit formula
  - 3% of GDP, paid equally to all retirees

Preferences

- Utility over consumption and hours

$$u(c) - v(l) = \log(c) - \psi \frac{l^{1+\frac{1}{\epsilon}}}{1+\frac{1}{\epsilon}}$$

- We choose $\epsilon = 0.5$

- ψ and β are chosen to match aggregate moments.

Parameters Chosen Outside the Model

Parameter	Description	Values/source
Demographics		
T	maximum age	75 (100 y/o)
R	retirement age	40 (65 y/o)
n	population growth rate	0.01
Preferences		
ϵ	elasticity of labor supply	0.5
Productivity		
$\sigma_\theta, a_\theta, \mu_\theta$	PLN parameters	0.5,3,-0.33
Technology		
r	return on capital/assets	0.04
Government policies		
$\tau_{ss}, \tau_{med}, \tau_c$	tax rates	0.124,0.029,0.055
G	government expenditure	$0.09 \times GDP$
D	government debt	$0.5 \times GDP$

Parameters Calibrated Using the Model

Moments		Data	Model
Wealth-income ratio		3	3
Average annual hours		2000	2000

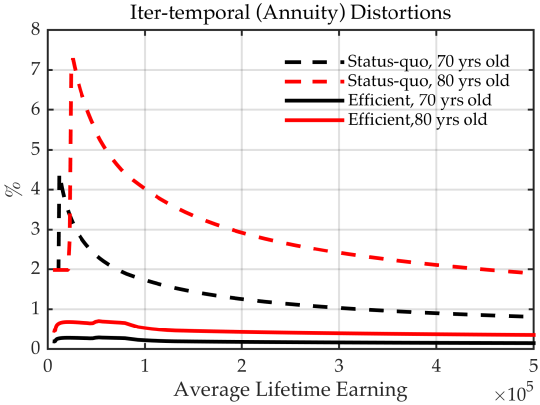
Parameter	Description	Values/source
β	discount factor	0.981
ψ	weight on leisure	0.74

▸ Show Distribution of Earnings, Assets

Optimal Policy Reform

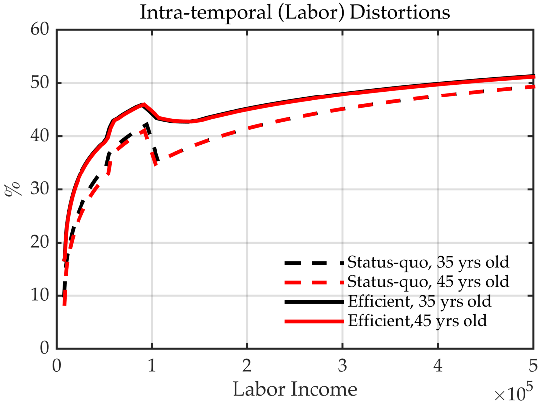
- We can now use our calibrated model to
  - Solve for status-quo allocations
  - Solve for efficient allocations
- Under both set of allocations we can calculate distortions
- The difference between two sets of distortions motivates policy reform
- We can also use the model to compute optimal tax functions

Inter-Temporal Distortions: Annuitization Margin



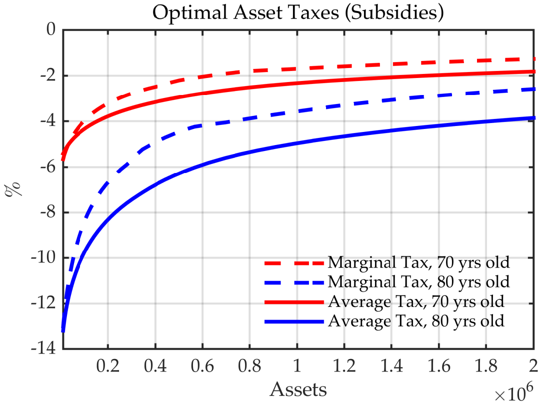
$$1 - \tau_{\text{annuity}} = \frac{u'\left(c_t\left(\theta\right)\right)}{\beta(1+r)u'\left(c_{t+1}\left(\theta\right)\right)}$$

Intra-Temporal Distortions: Labor Supply Margin

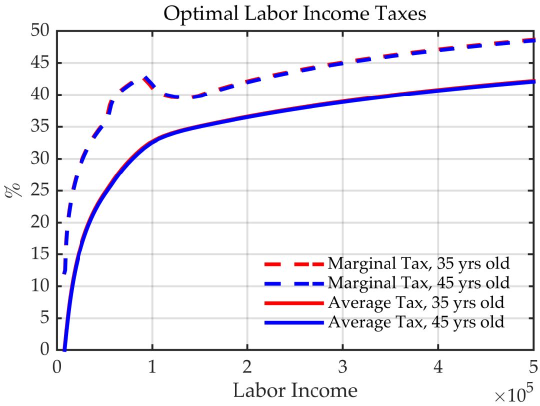


$$1 - \tau_{\text{labor}} = \frac{v'\left(l_t\left(\theta\right)\right)}{\varphi_t\left(\theta\right) u'\left(c_t\left(\theta\right)\right)}$$

Optimal Asset Taxes (Subsidies)



Optimal Labor Income Taxes



Aggregate Effects

Shares of GDP	Status-quo	Reform (efficient)
Consumption	0.70	0.65
Capital	3.00	3.67
Government Debt	0.50	0.07
Net worth	3.53	3.78
Tax Revenue (Total)	0.25	0.27
Labor income tax	0.15	0.16
Consumption tax	0.04	0.04
Capital tax	0.06	0.07
Government Transfers (Total)	0.14	0.10
To retirees	0.09	0.06
To workers	0.05	0.04
Asset subsidy	0	0.07

PDV of net transfers to each cohort falls by 9.3%

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- Implication:

  IF proper asset subsidies are not in place,

  phasing out old-age transfers is not a good idea!

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- Implication: differential mortality matters for optimal policy!

Conclusion

- This paper has two main contributions:

1. It develops a methodology to study optimal policy reform that

   does not rely on an arbitrary social welfare function

   allows separation of efficiency gains from redistribution

2. It points to a novel reason for subsidizing assets

   To correct for in-efficiencies due to imperfect annuity markets

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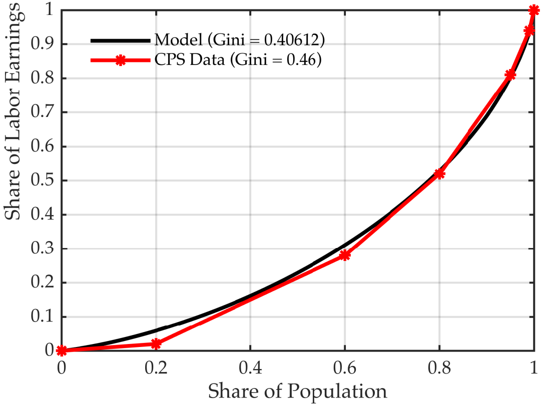
- Contrast to asset subsidies in the current US system

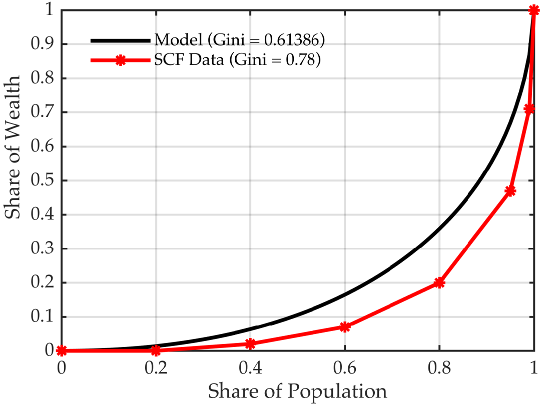
    asset subsidies should not stop at retirement

    asset subsidies must be progressive

Distribution of Earnings



Distribution of Wealth



Go to Back

A Cost Minimization Problem

- We start by writing objective in terms of allocations only
- From individual budget constraint PDV of Net Transfers is equal to

$$\min \int \sum_{t=0}^{T} \frac{P_t(\theta)}{(1+r)^t} \left[c_t(\theta) - \varphi_t(\theta) l_t(\theta)\right] dF(\theta)$$

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$$c = \varphi(\theta) l - T$$

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Go to Planning Problem

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$$U(\theta) = \max u(c) - v\left(\frac{y}{\varphi(\theta)}\right) \text{ s.t. } c = y - T(y)$$

A Cost Minimization Problem

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Go to Planning Problem

Intuition: Static Model

$$U'(\theta) = \frac{\varphi'(\theta) l(\theta)}{\varphi(\theta)} v'(l(\theta))$$

Implementation: Finding Optimal Taxes

- We have set of individual FOC's

$$\begin{aligned} P_t(\theta)u'(c_t) &= \beta(1+r)P_{t+1}(\theta)(1-T'_{a,t+1})u'(c_{t+1}) \\ (1-T'_{y,t})\varphi_t(\theta)u'(c_t) &= v'(l_t) \end{aligned}$$

- We also have their budget constraints

- Using these equations we can back-out tax and transfers such that efficient allocations are implemented

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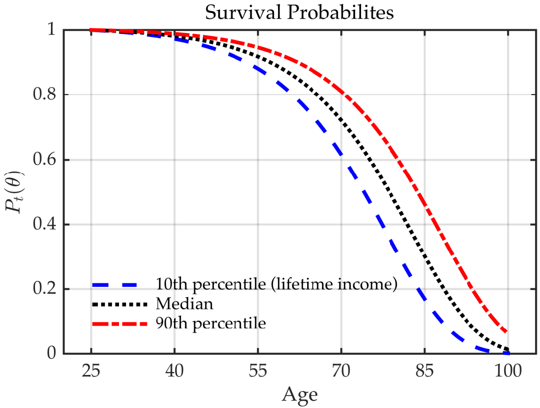
$$

- We also have their budget constraints
- Using these equations we can back-out tax and transfers such that efficient allocations are implemented
- Before, doing that we need to calibrate the model

▸ Go to Calibration

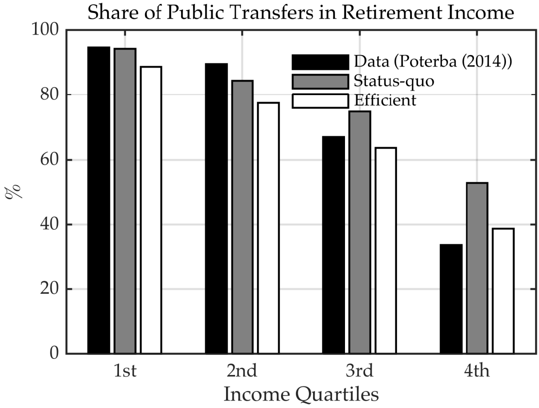
Unconditional Survival Probabilities



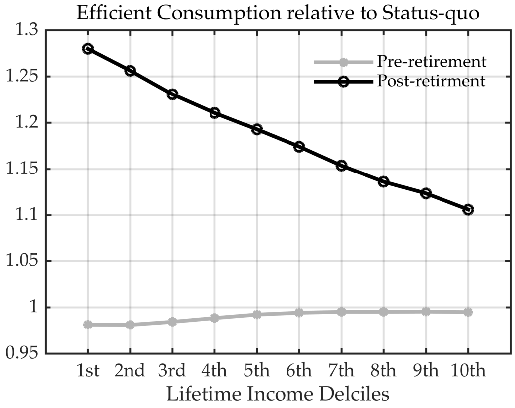
Earnings Ability Profiles

▸ Go Back

Source of Retirement Income



Consumption for pre- and post- Retirement



Optimal Replacement Ratio